ATTACHMENT 1 – COMMENTS AND CLARIFICATIONS

Table A1 **WaterNSW** (Dendrobium Mine Area 3C Longwall 20 & 21 Subsidence Management Plan (SMP) Application [letter dated 26 July 2019])

ID	Section	Comment	Response / Correction	Reference
1	Key Reasons for Objection p. 1	*<u>Existing impacts</u>: there is evidence that mining at Dendrobium has caused, and continues to cause, reductions in groundwater levels due to surface-to-seam fracturing, increased permeabilities and the presence of basal shear planes. WaterNSW remains concerned that performance measures for Wongawilli Creek may have already been exceeded.*	The Dendrobium Mine Development Consent (DA 60-03-2001) and subsequent SMP Approvals allow for impacts due to the longwall mining operation. South32 complies with the conditions of the Consent and SMP Approvals. The performance measures for Area 3B are provided in Table 1 of the SMP Approval. The conditions for the exceedance of performance measures for Wongawilli Creek are: • Structural integrity of the bedrock base of any significant pool or controlling rockbar cannot be restored. • Gas release results in vegetation dieback that does not revegetate. • Gas release results in mortality of threatened species or ongoing loss of aquatic habitat. • Iron staining and associated increases in dissolved iron resulting from the mining is observed in water at Wongawilli Creek downstream monitoring site Wongawilli Creek (FR6). • Fracturing resulting in diversion of flow such that >10% of the pools have water levels lower than baseline period. • Mining results in two consecutive exceedances of the ±3 standard deviation level (positive for Electrical Conductivity [EC], negative for pH and Dissolved Oxygen [DO]) from the baseline mean during the monitoring period: – pH 4.45 – EC 154.1 Micro Siemens per Centimetre [uS/cm] – DO 50.5%. • Measured surface water flow reduction in Wongawilli Creek at its confluence with Cordeaux River that is greater than predicted by the groundwater model (to the satisfaction of the Director General - Condition 13 of the SMP) that cannot be attributed to natural variation. As detailed in South32 (2019), the performance measures for Wongawilli Creek have not been exceeded. This position has been reported and discussed with the Department and WaterNSW.	Department of Planning and Environment (2015) *Mining Impacts at Dendrobium Coal Mine Area3B. Report to Government December 2015.* South32 (2019) *Response to Agency Submissions on the Dendrobium Area 3B Longwall 17 SMP Application – Attachment 1*.

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			Further to this, in December 2015, the DPE (now the Department of Planning, Industry and Environment [DPIE]) published a report on an interagency investigation into the environmental impacts of mining in Area 3B. It concluded that there had been no breach of the conditions or performance criteria in the consent or SMP approval.	
2	Key Reasons for Objection p. 1	*Future impacts: the ongoing groundwater level reductions from each additional longwall where surface-to-seam cracking occurs will continue to result in depressurisation of shallow aquifers and surface water loss. Further surface-to-seam connectivity adjacent to Wongawilli Creek is predicted over LW20-21, which is likely to increase cumulative impacts on the stream.*	See responses provided in Table A1, ID – 14 and 16.	
3	Key Reasons for Objection p. 1	*Geological structures: factors which contribute to the high risk of exceeding performance measures include the presence of dykes and faults through and to the south of LW20-21. There is also recent evidence suggesting that geological structures are acting as conduits for water loss, including anomalously low groundwater levels at a location immediately adjacent to Avon Reservoir which coincides with the intersection of two major lineaments. We are concerned that the implications of this evidence have not been addressed in the LW20-21 SMP documentation, presumably as the risk assessments undertaken by the company rated the likelihood of these issues as Rare to Very Rare.*	South32 carried out a risk assessment for the Dendrobium Longwalls 20 and 21 Subsidence Management Plan application in accordance with the recommendation from the Independent Expert Panel that Subsidence Management Plan applications consider the potential implications of mining within a risk assessment context, and in particular any implications for water quantity as a result of faulting, basal shear planes and lineaments (Axys 2019). Risk ranking was undertaken with consideration to the consequence of an event occurring and the likelihood of that hazard (event) that leads to the level of consequence identified. The consequence ranking may be completed on one or more of six identified types i.e. Health and Safety, Natural Environment, Community, Reputation, Legal and Financial. The scales for these consequences are shown in Section 13 “Risk Rank Method” of the Risk Assessment. It is noted that different types of consequences can have a different likelihood of occurrence, this equates to a different risk ranking being realised. For example, the ‘Natural Environment’ consequence of an event occurring may be low but with a high likelihood. However, a ‘Legal’ consequence of an event occurring may be high, but with a low likelihood. For any event, the combination of consequence and likelihood which results in the highest risk is documented in the Risk Assessment.	Axys (2019) *South32 - Illawarra Coal Review of Dendrobium Longwalls 20 and 21 Subsidence Management Plan*, AR2625, Revision 4 29 May 2019. Hgeo (2019) *Dendrobium Mine: Estimates of Seepage from Lake Avon following re-drilling of holes at AD3, AD4 and AD8*. August 2019. MSEC (2019) *Review of the effects of lineaments and geological*

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			During this assessment the group considered, as far as practicable, all consequences (shown in Section 13 of Axys 2019), however, to reduce the complexity and volume of reporting, only the highest 'risk ranking' for each hazard is documented in the Risk Assessment (Axys 2019). Using this process some consequences that are rated high may have an overall low 'risk rank' because the probability of the event (leading to the consequence level identified) is very low, whereby a consequence may have a high 'risk rank' because the probability of the event (leading to the consequence level identified) is higher. It is noted that the risk assessment does not identify any consequences with a rating higher than 30 "Major impacts" yet the environmental consequences for Longwalls 20 and 21 are predicted to continue for greater than five years duration. If the risk assessment documented the "Environmental" Area of Effect based on the length of impact being >20 years, then the consequence would fit into the 300 rank i.e. Severe impacts >20 years to land, biodiversity, ecosystem services, water resources or air. The likelihood of Longwalls 20 and 21 having a level 300 consequence on the environment is "Very rare" or a likelihood of 0.03, giving a risk ranking of 3. As this risk ranking is lower than the risk rankings based on other "Area of Effect" (the highest being 90) it is not documented in the Risk Assessment. Risk rankings for consequences other than those provided in Axys (2019) can be provided upon request. These are appropriate likelihood ratings as there has not been a non-compliance with Consent Conditions as a result of faults and dykes acting as conduits for water loss in the Southern Coalfield to South32's knowledge. The effects of lineaments and geological structures on measured surface subsidence in Area 3B has also been reviewed (MSEC letter report dated 13 March 2019). The review found that there was no measurable increase in the subsidence in the mapped locations of the lineaments, minor faults and dykes in Area 3B. The faults mapped though Longwalls 20 and 21 are of similar nature to the faults mapped	*structures on the measured surface subsidence in Area 3B at Dendrobium Mine*. Letter dated 13 March 2019.

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			in Area 3B. Increased subsidence is not predicted for these longwalls due to the presence of these geological structures. South32 has drilled numerous monitoring holes in the solid coal barrier between Lake Avon and Area 3B workings. The latest of these is monitoring holes at AD8. The shallowest piezometer in hole AD8 (S2436_25m; Hawkesbury Sandstone), located within metres of the lake shoreline and near the stream LA3, recorded a groundwater level of 307.6 m AHD, or ~6 m below the lake level. The piezometer at 65 m depth in AD8 has a water level that is ~1 m above the current lake level. During drilling of S2436 total water loss occurred at 6.2 m depth and was subsequently cased to allow further drilling. Drill core shows at least three angled joints and some lost core sections are between 8 and 11 m depth and an oxidised zone that extends to 39 m below the surface. It is unclear whether these structures are associated with mapped lineaments or contribute to the anomalous piezometric levels at S2436; however, packer testing showed that the permeability in all intervals is within or below the expected range for Hawkesbury Sandstone. Given the proximity of the bore to Lake Avon, further investigation was recommended. In July 2019, a new hole was drilled 8.3 m from AD8. Hole S2436B was drilled to a total depth of 39.33 m, just below the top of the Newport Formation in order to investigate the groundwater level within the Hawkesbury Sandstone. The hole was logged by geologists and using various geophysical tools. The permeability of the intersected strata was investigated using Borehole Magnetic Resonance (BMR) and 6m double packer tests (Lugeon tests). Comparison of logs confirms that the holes intersected very similar strata, and packer test permeability is similar over most intervals, except the shallowest interval in S2436B which is notably higher than in the original hole. The oxidised zone in S2436B extends only to ~3 m below the surface (compared with 39 m at S2436 only 8.3 m closer to tributary LA3). This may indicate that a nearby structure, possibly	

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			aligned with the tributary facilitated deeper infiltration of oxidising groundwater at S2436 than at S2436B. The standing water level in the re-drilled hole S2436B was measured at 6.0 m below the surface, several days after drilling and prior to testing. The standing water level equates to an elevation of 314.45 m AHD which is above the water level in Lake Avon (currently 312.17 m; 27/8/2019) and is in line with the expected water level at this location. Groundwater samples were collected from the pumps installed at depths of 35 m and 90 m in S2436A. The sample from S2436A_35 m is fresh (EC = 222 µS/cm) and of mixed cation bicarbonate type (Ca-Na-Mg-HCO3-Cl). The sample resembles other samples from Hawkesbury Sandstone and is distinct from water samples from Lake Avon which has an EC of ~70 µS/cm. The large difference (8 to 10 m) in observed water levels between the two monitoring bores is difficult to reconcile given their proximity (8.3 m) and the relatively high permeability of weathered Hawkesbury Sandstone. Any depressurisation of the lineament parallel to LA3 as a result of LW15 extraction is likely to impact on groundwater levels at S2436B as well as S2436. Equally, any depressurisation of a lineament to the south off the site associated with the Elouera fault system would have affected S2436B at least as much as S2436 given their relative positions. Further investigations will be discussed with the Dams Safety Committee in relation to further approvals for longwalls in Area 3B. Longwalls 20 and 21 are both distant from Lake Avon and the solid coal barrier where the AD8 investigation is underway.	
4	Key Reasons for Objection p. 1 - 2	*Adaptive management: the risks posed to WaterNSW values differ substantially between the two proposed longwalls, which affects the potential for adaptive management:* • *LW20 is designed to be mined at a shallow depth alongside Wongawilli Creek. The fracturing zone over this longwall may lead to substantial reductions*	The impact assessment for Wongawilli Creek has been based on the potential for Type 3 impacts, defined as *fracturing in rockbar or upstream pool resulting in reduction in standing water level based on current rainfall and surface water flow*. MSEC (2019) states: *It has been assessed that the likelihood of fracturing resulting in surface water flow diversions along Wongawilli Creek, due to the extraction of the proposed LW20 and LW21, is low, i.e. affecting less than 10 % of rockbars located within*	Hgeo (2019) *South32 Dendrobium Mine Assessment of surface water flow and quality effects of proposed Dendrobium*

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		in Hawkesbury Sandstone aquifer levels and/or may be inadvertently connected to the creek via basal shear planes or other structures. If that occurs, Wongawilli Creek is likely to experience severe impacts, which may continue following completion of the longwall. Due to the orientation of the longwall, any adaptive management options are unlikely to be effective. • *LW21 would also be mined very close to the stream, however it would at least be possible with its configuration to monitor and, if necessary, adaptively limit the length of this longwall to prevent further impacts to Wongawilli Creek.*	*the Study Area. However, minor fracturing could still occur along the creek, at distances up to approximately 400 m from the proposed longwalls.* The Longwall 20 -21 Groundwater Assessment (HydroSimulations 2019) assessed potential impacts to Wongawilli Creek. The Independent Expert Panel for Mining in the Catchment (IEPMC) recommended "erring on the side of caution and deferring to the Tammetta equation" until the height of fracturing can be confirmed through field investigations and/or geotechnical modelling (IEPMC, 2018). Hgeo (2019) relevantly states: *Taken as a guide, these estimates (Longwalls 20 and 21) indicate that fracturing above longwalls will not develop to the same extent as above longwalls in Area 3B, largely due to the proposed narrower longwall panels. Estimates based on Mills (2011) and Ditton and Merrick (2014) indicate that connective fracturing will extend to within the Bald Hill Claystone (and below the elevation of the Wongawilli Creek bed). The more conservative estimate based on Tammetta's (2013) approach extends into the Hawkesbury Sandstone at an elevation near, or above, the elevation of the Wongawilli Creek bed adjacent to LW20.* The potential reduction in groundwater levels and baseflow in Donalds Castle Creek and Wongawilli Creek has been assessed in various reports using a regional numerical groundwater model. Estimates of baseflow capture along Wongawilli Creek detailed in HydroSimulations (2017 – currently being revised) made estimates of baseflow capture being about 0.25-0.3 ML/d on average, while HydroSimulations (2016) estimated 0.3 ML/d. Baseflow loss has been estimated most recently in Hydrosimulations (2019): *Watershed Hydrogeo (2018) indicated the magnitude of loss along this reach is approximately 0.2 ML/d (allowing for gauging error at the upstream gauging station Wongawilli Creek Upper [WWU]) in this specific reach. Further there is likely to be a mining-related effect on flows at DCU – an effect that is clearly discerned from the comparison of modelled (via AWBM [Boughton, 2004]) and recent observed data, yet too small to result in the triggering of the defined Trigger Action Response Plan.* It is acknowledged that changes in surface water flow are not as easily discernible (e.g. Donalds Castle Upper [DCU], Wongawilli Creek Lower	*Longwalls 20 and 21.* Hgeo Pty Ltd, Date: May 2019, Report: D18301. HydroSimulations (2019) *Dendrobium Mine Longwalls 20 and 21 Groundwater Assessment* For Illawarra Coal Pty Ltd prepared by NPM Technical Pty Ltd, trading as HydroSimulations. Report: HS2019-19. IEPMC (2018) *Initial Report on Specific Mining Activities at the Metropolitan and Dendrobium Coal Mines.* MSEC (2019) *Subsidence Predictions and Impact Assessments for Dendrobium LW20 and LW21*. Report Number MSEC978 | Revision E.

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			[WWL]) likely due to gauging inaccuracy and the relatively small magnitude of loss compared to total flow at the downstream gauging stations. South32 has installed and upgraded flow gauges to improve the accuracy of flow monitoring gauges. An additional Wongawilli Creek downstream flow monitoring site at WWL has been installed at a flume and rockbar site, just upstream of the fire road crossing, Site WWL_A. This will improve the flow monitoring accuracy for Wongawilli Creek. Further to this, surface water flow TARPs are currently being reviewed in light of recent improvements to stream gauging and past experience of implementing TARPs. See Response in Table A1, ID – 2 for additional information regarding the TARP review. Additionally, South32 has commissioned an investigation to assess data from redrilled Boreholes S2442A and S2443 (near Sandy Creek Waterfall) following on from previous investigations into bedding plane and jointing shear. The aim of this work is to identify any potential horizontal movements caused by subsidence and verify any previous assumptions.	
5	Recommendations p. 2	*Reconsider the mine design and layout to minimise the potential impacts on Wongawilli Creek, including the following options:* • *Setting back Longwall 20 further west or reconfiguring it (e.g. substantial narrowing) to adequately mitigate the risk of exceeding the relevant performance measures.* • *Setting back LW21 an adequate distance to protect Wongawilli Creek, and the final distance should be subject to adaptive management using Time Domain Reflectometry or other suitable tools to monitor the progress of cracking and potential development of basal shear planes or mobilisation of other geological structures (faults, dykes or jointsets).*	The mining layout of the proposed longwalls is designed to avoid Wongawilli and Donalds Castle Creeks. Wongawilli Creek is located between the proposed Longwalls 20 and 21. The thalweg (i.e. base or centreline) of the creek is 125 m east of the tailgate of Longwall 20 and 240 m west of the finishing end of Longwall 21, at the closest points to the proposed longwalls. Donalds Castle Creek is located to the west of the proposed longwalls. The thalweg of the creek is 470 m from the maingate and finishing end of Longwall 20, at its closest point and outside the 35^{o} angle of draw of Longwalls 20 and 21. Predicted impacts to Wongawilli Creek are detailed in Hgeo (2019) and MSEC (2019) and provided in response Table A1, ID – 4.	Hgeo (2019) *South32 Dendrobium Mine Assessment of surface water flow and quality effects of proposed Dendrobium Longwalls 20 and 21*. Hgeo Pty Ltd, Date: May 2019, Report: D18301. MSEC (2019) *Subsidence Predictions and Impact Assessments for*

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				Dendrobium LW20 and LW21. Report Number MSEC978 | Revision E.
6	Recommendations p. 2	*Re-run the risk assessment for the SMP with detailed consideration of the recent evidence from the S2436 piezometers.*	See response Table A1, ID – 3 regarding the risk assessment process. The monitoring site S2436 (AD8) is approximately 3,630 m from Longwalls 20 and 21 at its closest point. Longwalls 20 and 21 are approximately 1,566 m from Cordeaux Reservoir and 2,878 m Avon Reservoir at their closest points. The shallowest piezometer in hole AD8 (S2436_25m; Hawkesbury Sandstone), located within metres of the lake shoreline and near the stream LA3, recorded a groundwater level of 307.6 m AHD, or ~6 m below the lake level. The piezometer at 65 m depth in AD8 has a water level that is ~1 m above the current lake level. Drill core shows at least three angled joints and some lost core sections are between 8 and 11 m depth and an oxidised zone that extends to 39 m below the surface. It is unclear whether these structures are associated with mapped lineaments or contribute to the anomalous piezometric levels at S2436; however, packer testing showed that the permeability in all intervals is within or below the expected range for Hawkesbury Sandstone. In July 2019, a new hole was drilled 8.3 m from AD8. Hole S2436B was drilled to a total depth of 39.33 m. The standing water level in the re-drilled hole S2436B was measured at 6.0 m below the surface, several days after drilling and prior to testing. The standing water level equates to an elevation of 314.45 m AHD which is above the water level in Lake Avon (currently 312.17 m; 27/8/2019) and is in line with the expected water level at this location (Hgeo 2019). Groundwater samples were collected from the pumps installed at depths of 35 m and 90 m in S2436A. The sample from S2436A_35 m is fresh (EC = 222 µS/cm) and of mixed cation bicarbonate type (Ca-Na-Mg-HCO3-Cl). The sample resembles other samples from Hawkesbury	Hgeo (2018) *Review of Potential Seepage Rates Adjacent to Lake Avon, Dendrobium Area 3B*. D18314, Memo by Hgeo Pty Ltd for South32 Illawarra Coal Hgeo (2019) *Groundwater Levels and Potential Seepage Rates Adjacent to Lake Avon, Dendrobium Area 3B.* D18329, Memo by Hgeo Pty Ltd for South32 Illawarra Coal. Hgeo (2019) *Dendrobium Mine: Estimates of Seepage from Lake Avon following re-drilling of holes at AD3, AD4 and AD8*. August 2019.

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			Sandstone and is distinct from water samples from Lake Avon which has an EC of ~70 µS/cm. There is no evidence that there is flow of water from Lake Avon to Area 3B mining via any geological structure associated with or in the vicinity of S2436. The modern water component in mine inflow is monitored by analysing water chemistry, including the isotope tritium. Samples are collected from goaf inflow, the surface and deep groundwater, via monitoring bores and water samples from seepage into the development workings. As of September 2018, there is no statistically significant detection of modern water (which might be from Lake Avon) in Area 3B inflow. The laboratory processing time for high precision tritium analysis can be more than 6 months and therefore results for some samples collected in the latter part of Longwall 14 are pending. As part of a pilot study of groundwater isotopes in groundwater and mine water at Dendrobium, a sample from Area 3B goaf inflow was analysed for Carbon 14 (14C). The sample returned the lowest modern carbon content (1.47 %MC) of any sample collected from the mine and groundwater bores, consistent with the findings from ongoing tritium analysis.	
7	Recommendations p. 2	*Provide greater clarity and more comprehensive surface water and groundwater monitoring and incorporate these into the Watercourse Impact Monitoring, Management and Contingency Plan.*	See response provided in Table A1, ID – 21.	
8	Recommendations p. 2	*Provide greater clarity on the extent of and rationale for proposed subsidence monitoring to confirm that key subsidence measurements are consistent with predictions.*	See response provided in Table A1, ID – 22.	
9	Recommendations p. 2	*WaterNSW also recommends that the Department seek advice on the SMP from the Independent Expert Panel on Mining in the Catchment, and/or delay determination until after the Panel's final report is published in August 2019, as it should provide more clarity on impacts on watercourses and opportunities to mitigate impacts.*	Whilst South32 supports robust regulatory oversight of approvals and post-approval applications, it should be recognised that the approach of incremental secondary approval of longwalls and increasing document review periods results in significant risk of time delays (e.g. due to consultation and assessment timeframes) with associated operational discontinuity, putting at risk the significant capital expenditure and time required to develop mining areas.	

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			Furthermore, incremental secondary approvals erode the effectiveness of long-term planning for a business and as such places unnecessary risk on the future viability of the mining operations, including the continuation of employment and local investment.	
10	Attachment A Existing Impacts p. 3	*… previous submissions about mining in Area 3B, WaterNSW considers that there have already been extensive environmental impacts on Wongawilli Creek, which we suggest may have already exceeded the relevant performance measures.*	See response provided in Table A1, ID – 1.	
11	Attachment A Existing Impacts p. 3	*The LW20-21 SMP documentation, including the specialist assessment of surface water flow effects (Hgeo, 2019), place considerable reliance on two pieces of evidence that current mining is not exceeding relevant performance measures – flow recordings at WWL and baseflow reduction predictions by the groundwater flow model (HydroSimulations, 2019). WaterNSW does not agree that these are accurate or convincing evidence, for the following reasons:* • *Inadequacy of surface water monitoring and modelling approach: as stated in Hgeo (2019), "the absence of a clear down-stream reduction in flow suggests that the losses are below the detection threshold of the AWBM modelling approach." WaterNSW considers that there are key deficiencies in the current monitoring and assessment regime, which means it is not able to accurately discern reductions in flows at WWL. These deficiencies include:* *a) the large (3.5 km) distance from the lower edge of Area 3A and 3B longwalls and the WWL gauge,*	South32 acknowledges multiple request have been made to revise the surface water flow TARPs. These are currently being reviewed in light of recent improvements to stream gauging and past experience of implementing TARPs. As part of the revised surface flow TARP discussions with WaterNSW and DPIE, the performance measures are being reassessed and quantified. A discussion paper (Watershed Hydrogeo 2019) was submitted to WaterNSW and DPIE and a workshop held 25 July 2019. It was agreed at the workshop that DPIE and WaterNSW would provide any feedback on the discussion paper and that S32 would revise the WIMMCP accordingly. The current TARP indicator for surface water flow relies on comparison of modelled stream flow against observed flows for the period of the most recent longwall. Variance between the two is then compared to 5-year running average rainfall. The calculation was developed at the time of Area 3B approval and based in part on the earlier method of assessment. This calculation is perhaps not as sensitive to changes in hydrology as other methods may be. As outlined in Watershed Hydrogeo (2019) a new methodology which is more sensitive to a number of flow parameters has been proposed.	Watershed Hydrogeo (2019) *South32 Illawarra Coal Dendrobium Area 3B Discussion of Surface Water Flow TARPs July 2019.*

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12	Attachment A Existing Impacts p. 3	*b) the imprecise nature of this gauge which uses a natural rockbar frequently impeded by sediment and vegetation, and*	An additional Wongawilli Creek downstream flow monitoring site to WWL has been installed at a flume and rockbar site, just upstream of the fire road crossing, Site WWL_A. This will improve the flow monitoring accuracy for Wongawilli Creek.	
13	Attachment A Existing Impacts p. 3	*c) the ability of the AWBM rainfall-runoff modelling, albeit modified to improve its calibration, to accurately predict flows.*	See response Table A1, ID – 11. It should be acknowledged that at the outset, no single measure of flow (Indicator) can summarise the presence of an impact and the scale of effects on a watercourse. As detailed in Watershed Hydrogeo (2019), South32 have proposed to move away from using the AWBM rainfall-runoff modelling. Under the proposed TARPs, three indicators will be used to measure surface water flows at assessment sites and reference sites including; Q50 (median flow), cease-to-flow frequency and the variation from Reference Site behaviour (Q%ile). Assessment of these indicators in the End of Panel Report would comprise three checks of pre-versus post-mining behaviour for each Assessment Site: a) Change in flow exceedance ("Q%ile") behaviour compared to Reference Sites. In essence, this aims at quantifying an otherwise visual or qualitative assessment of flow behaviour (compared to normalised Reference Site flow). This test is considered a broad indicator of hydrological behaviour; b) Relative change in Q50 compared to Reference Site flows; and c) Relative change in the frequency of cease-to-flow days compared to Reference Sites.	Watershed Hydrogeo (2019) *South32 Illawarra Coal Dendrobium Area 3B Discussion of Surface Water Flow TARPs July 2019.*
14	Attachment A Existing Impacts	• *Over-reliance on groundwater model: the incremental baseflow reduction predictions provided in Hgeo (2019) are noted to be based on estimates of baseflow reductions using a regional groundwater model (HydroSimulations, 2019). The groundwater*	As discussed and shown at a recent meeting with DPIE and WaterNSW, the analysis by Watershed HydroGeo of surface water flows for the purpose of revising the TARPs was compared against recent groundwater model predictions of surface water loss. Actual surface water losses inferred were typically 0 to 30% of those predicted	Hgeo (2019) *South32 Dendrobium Mine Assessment of surface water flow*

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	p. 3	*model is not calibrated to stream or base-flows, and the Independent Expert Panel on Mining in the Catchment (IEPMC) has questioned its ability to accurately predict surface water losses.*	by the recent groundwater model (HydroSimulations, 2019). The groundwater model has evolved over time to become more and more conservative as a result of recommendations by PSM (2017) and others. While the uncertainty in predictions is acknowledged, the predictions discussed in HydroSimulations (2019) and Hgeo (2019) should similarly be treated as conservative estimates.	*and quality effects of proposed Dendrobium Longwalls 20 and 21*. Hgeo Pty Ltd, Date: May 2019, Report: D18301. HydroSimulations (2019) *Dendrobium Mine Longwalls 20 and 21 Groundwater Assessment* For Illawarra Coal Pty Ltd prepared by NPM Technical Pty Ltd, trading as HydroSimulations. Report: HS2019-19. PSM (2017) *Height Of Cracking – Dendrobium Area 3B Dendrobium Mine*. Report prepared for DPE.
15	Attachment A Existing Impacts p. 3	• *Lack of confidence in groundwater model: the predictions of maximum and cumulative total surface water loss have effectively doubled between the Longwall 16 (HydroSimulations, 2018) and the Longwall 17 (HydroSimulations, 2019) groundwater models. In addition, the losses predicted from Avon Reservoir using the regional groundwater model for the period to 2020 has increased from less than 100 ML/year to almost 300 ML/year. No specific explanation of these increases is provided.*	These updated predictions from the Regional Groundwater Model are due to a correction in the zonation used in the processing model results. An error in the processing of Longwall 16 results meant that results were not added correctly and was corrected for Longwall 17. Both reported sets of results are conservative compared to recently analysed flow losses (see response to Table A1, ID - 14).	

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16	Attachment A Existing Impacts p. 3	• *Groundwater depressurisation: surface to seam fracturing across Area 3B and possibly 3A has resulted in groundwater depressurisation across undermined catchments, which in turn has resulted in reductions in flows in tributaries and creeks. Hgeo (2019) now predicts that no-flow days in Donalds Castle Creek at gauge DCU may increase from 3% of the time to 50%, and at Wongawilli Creek at gauge WWL from about 10% of the time to 40%. These predictions would appear to exceed the "minor reduction" allowed in the performance measures.*	As noted in the response to Table A1 ID - 14, increasing conservatism has been built into the model to align with independent reviews by PSM (2017), Mackie (2017) and others. The conservatism is now significant with respect to surface water take. Based on the analysis of Watershed HydroGeo presented to DPIE and WaterNSW at a meeting on 25 July 2019, mining of Area 3B to the end of Longwall 14 has so far resulted in no change in cease-to-flow days at WWL, and a small change (3% increase) at DCU, even though groundwater model predictions in HydroSimulations (2018, 2019) would indicate greater changes to hydrology at these gauging stations.	PSM (2017*) Height Of Cracking – Dendrobium Area 3B Dendrobium Mine*. Report prepared for DPE. Mackie (2017) *Height of fracturing at Dendrobium Mine – Peer review of PSM report*.
17	Attachment A Future Impacts p. 4	*... has the potential to cause significant impacts on pool water levels and water flows in Wongawilli Creek. This view is based on a combination of the following risk contributors:* • *Wongawilli Creek is located between the two proposed longwalls within the study area and immediately downstream of Areas 3A and 3B (see Figure 1 below from MSEC, 2019).* • *The length of Wongawilli Creek located within the Study Area is approximately 3.0 km, of which 0.8 km lies within the "35° angle of draw" where subsidence is expected to occur.* • *Beneath the incised valley of Wongawilli Creek, the depth of the seam is approximately 240 m.* • *Longwall 20 is oriented in a north-south direction (i.e. sub-parallel to Wongawilli Creek) and is closer to Wongawilli Creek (125 m at its closest point) than most of the longwalls in Areas 3A and 3B. The last time where longwalls were designed to be excavated close to and parallel to a deeply incised stream (see Figure 2) in the Special Areas were the 10-series Metropolitan Mine longwalls approaching and undermining Waratah Rivulet, and it is not clear*	The predictions for Wongawilli Creek include the cumulative effects from the existing longwalls in Areas 3A and 3B plus the proposed Longwalls 20 and 21. The maximum predicted total closure of 210 mm occurs adjacent to Longwalls 9 and 10. The majority of this movement is due to the existing longwalls in Area 3B, with only low level additional closure occurring at this location due to Longwalls 20 and 21. Away from this location, the maximum predicted additional closure due to Longwalls 20 and 21 is 150 mm. The assessed rate of Type 3 impacts on the rockbars along the section of Wongawilli Creek within the Study Area is less than 10 %. The 35° angle of draw represents the minimum extent that impact assessments should be carried out for vertical subsidence and its associated effects (tilt, curvature and conventional strain). The predicted limit of vertical subsidence (i.e. 20 mm subsidence contour) is located well within the 35° angle of draw. The predicted vertical subsidence at Wongawilli Creek is less than 20 mm due to the mining of Longwalls 20 and 21. The depth of cover directly beneath Wongawilli Creek does not affect the subsidence predictions as coal is not mined beneath the creek. The minimum depth of cover within the limit of secondary extraction for Longwalls 20 and 21 is 290 m. This value is similar to the minimum	

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		that the lessons from the severe impacts have been learnt.	depths of cover above Longwalls 6 to 8 in Area 3A and above Longwall 3 in Area 3B adjacent to Wongawilli Creek. Longwall 6 in Area 3A previously mined up to 110 m from Wongawilli Creek. In this location, mining occurred on both sides of this creek. There is mining on one side of Wongawilli Creek only where Longwall 20 is located closest to it. The Metropolitan 10-series longwalls mined directly beneath the Waratah Rivulet. At the sites where impacts were observed above solid coal outside of the mined longwalls, the rivulet was directly mined beneath further upstream, which increases the likelihood of pool impacts. Similar impacts are not predicted for Longwalls 20 and 21 as they are setback from Wongawilli Creek and do not mine directly beneath it. West Cliff Longwall 35 mined parallel to the Georges River at a minimum distance of 150 m. The observed rate of Type 3 impacts along this river was similar to the assessed rate of 10 %. The predicted closure for Longwalls 20 and 21 is less than that for the Georges River and, hence, the assessed rate of Type 3 impacts for Wongawilli Creek is less than 10 %.	
18	Attachment A Future Impacts p. 4	• *Both LW20 and LW21 are intersected by a dense zone of mapped dykes, faults and lineaments trending approximately ESE to WNW. These structural features lie parallel to subparallel with the roadways at the northern ends of Areas 3A and 3B (Figure 1) and appear to have been used to limit the northern extent of these domains.*	The mapped and inferred geology in proximity to Longwalls 20 and 21 are provided in Drawing No. MSEC978-07 of MSEC (2019). Dendrobium is a modern retreat longwall mine; the longwall technique requires large areas of geologically undisturbed ground as the technique is inherently an inflexible mining system. In order to provide certainty for mine planning South32 has undertaken extensive surface based exploration, including boreholes, 2D seismic surveys and aerial magnetic surveys. The surface based exploration identifies faults, dykes and sills as a basis for mine planning. The exploration techniques define areas of relatively undisturbed ground suitable for longwall mining. The surface based exploration	MSEC (2019) *Subsidence Predictions and Impact Assessments for Dendrobium LW20 and LW21*. Report Number MSEC978	Revision E. MSEC (2019) *Review of the effects of lineaments and geological*

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			techniques define the location of major structures which define the mining domains. In addition to surface based exploration Dendrobium undertakes in-seam exploration to define the location (margin & extent) of geological features that could not be detected by the surface exploration techniques e.g. sills or dykes with no magnetic signature or faults smaller than the resolution of the surface techniques. The effects of lineaments and geological structures on measured surface subsidence in Area 3B has also been reviewed (MSEC letter report dated 13 March 2019). The review found that there was no measurable increase in subsidence at the mapped locations of the lineaments, minor faults and dykes in Area 3B. The faults mapped though Longwalls 20 and 21 are of similar nature to the faults mapped in Area 3B. Increased subsidence is not predicted for these longwalls due to the presence of these geological structures.	*structures on the measured surface subsidence in Area 3B at Dendrobium Mine*. Letter dated 13 March 2019.
19	Attachment A Future Impacts p. 4	• *As noted by the IEPMC (2018), faults have been found to provide rapid conduits along which some swamps in the Springvale Mine (Western Coalfields) have become dewatered at considerable distances from longwalls. Illawarra Coal's SMP Application and various consultant reports (e.g. Hgeo, 2019) claim that such structural relationships (faults as conduits) are not expected to occur in the Southern Coalfields. However, these conclusions make no reference to the unexplained groundwater anomaly at Piezometer S2436.*	See response provided in Table A1, ID – 6 and Table A2, ID – 4.	
20	Attachment A Future Impacts p. 5	• *… there is a significant likelihood that LW20-21 would also have potential implications for stored waters if a Lower Cordeaux dam is constructed. The location and height of the dam wall has not been confirmed and the proposal is not well advanced, but it is important nevertheless to consider the potential implications of the LW20-21 SMP on this proposal.*	The indicative location of a potential Lower Cordeaux Dam was provided in a letter sent by WaterNSW to South32 in February 2018. The potential impacts of mining on any future reservoir and dam wall are dependent on what is constructed, how it is constructed and whether they are constructed before or after longwall mining. The potential reservoir FSL extends along the Cordeaux River, Donalds Castle Creek, Wongawilli Creek and their tributaries. A very small area of the FSL level is located above Longwall 20. The potential reservoir	

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			FSL level is also located adjacent to but does not overlap with Longwall 21. The extraction of the proposed longwalls will result in surface cracking and fracturing. These surface deformations will predominately occur directly above the proposed longwalls and, to lesser extents, outside the longwalls and within the 35° angle of draw. Minor and isolated fracturing could occur up to approximately 400 m from the proposed longwalls. The fracturing can result in iron staining and increased permeability in the near-surface strata. The proposed longwalls will also affect the permeability of the overburden. It is recommended that WaterNSW develop management strategies, in consultation with South32, to manage the potential impacts on any future infrastructure, should it be built.	
21	Attachment A Further Issues to be Addressed p. 6	• *… WaterNSW requests that the WIMMCP be amended to confirm which pool levels will be recorded on a continuous (datalogger) basis with regular manual readings and which ones will be manually recorded on a weekly basis. WaterNSW considers that all pools greater than 5 m long in the study area must be included in the monitoring program, and all pools longer than 10 m should be both automatically and manually measured. The plan also needs to make clear what baseline monitoring data will be available by the proposed commencement date and justification for its adequacy.* *WaterNSW understands that IC acknowledges current shortcomings with the WWL gauge discussed above, and intends to remedy these by establishing a new, partially-constructed gauge at the rockbar immediately upstream of Fire-Road 6. The conceptual design of this gauge was approved by WaterNSW some months ago, and rapid installation is to be encouraged. Details of the*	South32 acknowledges the recommendations from WaterNSW and has updated the WIMMCP accordingly (South32 2019). However, due to site limitations it may not be practical to fully implement the WaterNSW recommendations, i.e. the installation of a logger at all pools longer than 10 m. The ICEFT has recently inspected the reaches of Wongawilli Creek within the Dendrobium Area 3C Study Area in order to inform the Dendrobium Area 3C monitoring plan. Each pool of Wongawilli Creek within the Study Area will be monitored for field water quality parameters; pools with suitable conditions will have a water level logger installed; sites that are unsuitable for logger installation will have a benchmark installed for manual readings. The updated plan is included in the WIMMCP. An additional Wongawilli Creek downstream flow monitoring site at WWL has been installed at a flume and rockbar site, just upstream of the fire road crossing, Site WWL_A. This will improve the flow monitoring accuracy for Wongawilli Creek. As requested by WaterNSW, this information regarding the WWL gauge has been included in the WIMMCP.	South32 (2019) *Dendrobium Area 3C Watercourse Impact, Monitoring, Management And Contingency Plan*, September 2019.

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		methodology for developing a rating curve and associated relationship with the existing gauge should also be provided in the WIMMCP.		
22	Attachment A Further Issues to be Addressed p. 6	• *Subsidence Monitoring: The SMP application documents do not make clear what subsidence monitoring is proposed, nor discuss its adequacy in demonstrating whether key subsidence parameter predictions are consistent with actual movements. This needs to be clearly set out and justified.*	South32 has updated the SMP (South32 2019) and monitoring plans with consideration to the recommendations from WaterNSW. These will be included in Attachment 2.	South32 (2019) *Dendrobium Area 3C Subsidence Management Plan.* September 2019.
23	Attachment A Further Issues to be Addressed p. 6	• *Risk assessment: As well as the issues discussed above relating to the likelihood ratings for fault-conduit phenomena, WaterNSW questions the Likelihood ratings in the Risk Matrix in the risk assessment report (AXYS Consulting, 2019) with regards to 'surface cracking induced flow diversions' as well as 'groundwater depressurisation'. WaterNSW considers that both of which will almost certainly occur and for which the adopted control of providing a setback based on keeping total predicted valley closure below 200 mm is considered inadequate. The risk ratings for 'basal shear planes' are also not supported by any investigations. WaterNSW further questions the use of "investigations" and preparation of a "discussion paper" as treatment options.*	See response Table A1, ID – 3. South32 is currently investigating the hydrogeological characteristics of the Elouera Fault. As of August 2019, eight diamond core holes had been drilled at two sites. Seven holes intersect the fault allowing detailed analysis of the geotechnical and hydrogeological characteristics of the fault plane. Borehole Lugeon testing has been undertaken to determine permeability. Groundwater pumping tests and tracer tests are scheduled for the next quarter which will allow assessment of the permeability of the structure of the fault at the two sites. Additional drilling is being undertaken to determine modifications to the stress field associated with Elouera Workings. The stress field analysis will inform the mining assessment for Longwalls 17 and 18. The findings from the Elouera Fault investigations will provide further knowledge of fault structures and practical techniques for fault zone characterisation. The potential for 'unclamping' was assessed in the Risk Assessment (Axys 2019). The view of the specialist geotechnical engineers is that previous mining at Elouera Mine, including panels within tens of metres of the fault zone, would have caused relaxation of the fault zone already, with the effects of mining on the fault apparent in the current investigations.	Axys (2019) *South32 - Illawarra Coal Review of Dendrobium Longwalls 20 and 21 Subsidence Management Plan*, AR2625, Revision 4 29 May 2019.
24	Attachment A	• *Inappropriate Performance Indicators continuing to be used: WaterNSW raised several concerns with current performance indicators being used to assess whether Performance Measures are being*	Surface water flow TARPs are currently being reviewed in light of recent improvements to stream gauging and past experience of implementing TARPs.	Watershed Hydrogeo (2019) *South32 Illawarra Coal Dendrobium*

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	Further Issues to be Addressed p. 6	*approached or exceeded in its submission of LW17. We repeat these concerns in relation to the TARPs provided in the WIMMCP and recommend that the IEPMC's Initial Report and the Watershed Hydrogeo report (2018) recommendations in this regard be implemented in consultation with WaterNSW and DPIE.* *We further recommend that the Watercourse Impact Monitoring, Management and Contingency Plan be updated to incorporate a greater focus on surface water consequences, including re-drafting the Trigger Action Response Plans to make them unambiguous, quantitative and clearly tied to performance measures/indicators e.g. the performance indicator relating to Wongawilli Creek should refer to all potential impacts that may cause more than minor consequences on flow and pool levels, rather than just fracturing.*	As part of the revised surface flow TARP discussions with WaterNSW and DPIE, the performance measures are being reassessed and quantified. A discussion paper (Watershed Hydrogeo 2019) was submitted to WaterNSW and DPIE and a workshop held 25 July 2019. It was agreed at the workshop that DPIE and WaterNSW would provide any feedback on the discussion paper and that S32 would revise the WIMMCP accordingly.	*Area 3B Discussion of Surface Water Flow TARPs July 2019.*
25	Attachment A Further Issues to be Addressed p. 6 - 7	• *WaterNSW considers that expanded and clearer monitoring commitments are required. In particular, we recommend that:* - *A commitment is needed to drill a before-and after mining VWP arrays with geological and hydrogeological characterisation in the centerline of both proposed longwalls. The "before" piezometers and investigations should be drilled as soon as possible, with the locations and instrumentation design developed in consultation with WaterNSW.* - *At least two shallow (Hawkesbury Sandstone) and medium (Bulgo Sandstone) depth piezometer arrays should be drilled between Wongawilli Creek and LW20, another to the west of LW20 and one at each end of LW21. The holes between the longwalls and the creek must*	South32 agrees with the recommendations put forward in HydroSimulations (2019): *If access is possible, then two 'shallow sandstone' monitoring bores are recommended for installation between the longwalls and Wongawilli Creek, preferably within the Wongawilli Creek valley. These should be installed in the Hawkesbury Sandstone and upper Bulgo Sandstone. These could be compared with data-logged surface water sites that record surface water levels. These paired sites would allow the analysis of groundwater-surface water dynamics pre- and post-mining, an important concept given the recent (2017-18) low flow conditions along one reach of Wongawilli Creek. If access along the valley is not possible, then consideration of a deeper bore installed with instruments located at and just above and below the elevation of the creek near the longwalls could provide useful data.*	HydroSimulations (2019) *Dendrobium Mine Longwalls 20 and 21 Groundwater Assessment* For Illawarra Coal Pty Ltd prepared by NPM Technical Pty Ltd, trading as HydroSimulations. Report: HS2019-19.

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		be equipped with Time Domain Reflectometry (TDR) or an equivalent method to detect the development of basal shear planes.		

Table A2 **Office of Environment and Heritage** (Dendrobium Longwall 20 and 21 Subsidence Management Plan [letter dated 27 June 2019])

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1	Summary p. 1	*The SMP does not present any convincing evidence that the proposal will not have serious and irreversible impacts to many significant natural features (Niche 2019, Table 1), similar to those observed to date in Dendrobium Areas 2, 3A and 3B. Given the real chance of this impact, consideration of should be given to alternative mine designs or mining methods, such as that adopted by Wollongong Coal, who are moving to first workings mining that results in negligible surface subsidence across their Wonga East mining domain.*	Subsidence is an unavoidable consequence of longwall mining and includes vertical and horizontal movement of the land surface. The predicted impacts reported in Table 1 of Niche 2019 meet the performance requirements in the Dendrobium Mine Development Consent (DA 60-03-2001). In addition, a reduced maximum extraction height of 3.9 m will continue to be in place for Longwalls 20 and 21. The mining layout of the proposed longwalls is designed to avoid Wongawilli and Donalds Castle Creeks. Wongawilli Creek is located between the proposed Longwalls 20 and 21. The thalweg (i.e. base or centreline) of the creek is 125 m east of the tailgate of Longwall 20 and 240 m west of the finishing end of Longwall 21, at the closest points to the proposed longwalls. Donalds Castle Creek is located to the west of the proposed longwalls. The thalweg of the creek is 470 m from the maingate and finishing end of Longwall 20, at its closest point and outside the 35º angle of draw of Longwalls 20 and 21 (South32 2019). Mine layouts for Longwalls 20 and 21 have been developed using an Integrated Mine Planning Process (IMPP) (South32 2019). This process considers mining and environmental impacts when designing mine layouts. South32 has assessed mining layout options for Longwalls 20 and 21 against the following criteria: • Extent, duration and nature of any community, social and environmental impacts; • Coal customer requirements; • Roadway development and longwall continuity; • Mine services such as ventilation; • Recovery of the resource for the business and the State; and • Gas drainage, geological and geotechnical issues. Several layout alternatives for Longwalls 20 and 21 were assessed by South32 using a multi-disciplinary team including environment,	South32 (2019) *Dendrobium Area 3C Subsidence Management Plan.* September 2019.

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			community, mining and exploration expertise. These included variations in the number of longwalls and orientations, lengths, and setbacks of the longwalls from key surface features. These options were reviewed, analysed and modified until an optimised longwall layout was achieved. Area 3C is part of the overall mining schedule for Dendrobium Mine and has been designed to flow on from Areas 1, 2, 3A and 3B to provide a continuous mining operation. There are a number of surface and subsurface constraints within the vicinity of Area 3C including major surface water features such as Lake Cordeaux, Wongawilli Creek, Donalds Castle Creek; and a number of geological constraints such as dykes, faults, and particularly the Dendrobium Nepheline Syenite Intrusion, which has intruded into the Wongawilli Seam north-west of the proposed Longwall 20. The process of developing the layout for Longwalls 20 and 21 has considered predicted impacts on major natural features and aimed to minimise these impacts within geological and other mining constraints. No contingent mining areas containing Wongawilli Seam Coal resources with the possibility for extraction are currently available to South32. The layouts at Dendrobium Mine have been modified to reduce the potential for impacts to surface features. Changes to a mine layout have significant flow-on impacts to mine planning and scheduling as well as economic viability. These issues need to be taken into account when optimising mine layouts. The process adopted in designing the Longwalls 20 and 21 layout incorporated the hierarchy of avoid/minimise/mitigate as requested by the DPIE and OEH. Mine plan changes result in significant business and economic impact, including: • Reduction in coal extracted; • Reduction in royalties to the State; • Additional costs to the business; • Risks to longwall production due to additional roadway development requirements; and	

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			• Constraints on blending which can disrupt the supply of coal to meet customer requirements. Restricting mine layout flexibility can also have the following consequences: • Additional energy used to ventilate the mine; • Increased safety risks such as risk of frictional ignition on the longwall due to less than optimal ventilation; • Increased power usage, reduced fan lifespan and a requirement to install booster fans; • Requirement for heavy secondary support density; • Potential for horizontal stress and vertical abutment concentrations; • The risk of strata control associated with increased roadway development and longwall install and take-off faces; • Exposes the workforce to higher risk environments more frequently; • Results in a large number of equipment movements and interaction with workers and infrastructure; and • Requires specialised equipment and skilled personnel with limited availability.	
2	Summary p. 1	*Fracturing of up to 5.6km of streamlines is predicted in the study area (Niche 2019, p. 38), resulting in loss of pools and diversion of surface flow (MSEC 2019, p.46; HGEO 2019, p.20). Illawarra Coal suggest that surface fracturing and dilation will develop only in the top 10-20m of the bedrock and that surface water flows will re-emerge at the limits of the fracturing (MSEC 2019, South32 2019a, South32 2019b, South32 2019c). However, the simulated extent of connected fracturing provided by HydroSimulations (2019, Appendix D) shows that fracturing above the mine will intersect with the surface at points above LW20 and is expected to intersect with the downward extent of surface fracturing the across the full length of LW20 and several points along LW21. The SMP should be amended to clearly*	Subsidence is an unavoidable consequence of longwall mining and includes vertical and horizontal movement of the land surface. Subsidence effects include surface and sub-surface cracking, buckling, dilation and tilting. It should be acknowledged that potential subsidence directly over the goaf and not over the goaf have significantly different impacts regarding height of connective fracturing. MSEC 2019 states: *It is expected that fracturing of the bedrock would occur along the sections of the drainage lines that are located directly above the proposed LW20 and LW21. Fracturing can also occur outside the extents of the proposed longwalls, with minor and isolated fracturing occurring at distances up to approximately 400 m.* *The mining-induced compression due to valley closure effects can also result in dilation and the development of bed separation in the topmost bedrock, as it is less confined. This valley closure related dilation is expected to develop predominately within the top 10 m to 20 m of the bedrock. Compression can also result in buckling of the topmost bedrock resulting in heaving in the overlying surface soils.*	HydroSimulations (2019) *Dendrobium Mine Longwalls 20 and 21 Groundwater Assessment* For Illawarra Coal Pty Ltd prepared by NPM Technical Pty Ltd, trading as HydroSimulations. Report: HS2019-19. MSEC (2019) *Subsidence Predictions and*

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		reflect all predicted impacts, including connective fracturing.	HydroSimulations (2019) discusses the implementation of an assumed highly conservative height of connective fracturing (directly over the goaf) for the Dendrobium numerical groundwater model. Using the Tammetta equation and a surface-to-seam fracturing assumption for up to 300 m wide longwalls allows for the current understanding of geotechnical assessments. The groundwater model and impact assessment adopt a conservative approach, in line with the interpretation of Parsons Brinckerhoff (2013) and Pells Sullivan Meynink (2017) and the model Peer Reviewer and is as conservative, if not more so, than the IEP recommendation that the Tammetta model be used in favour over the methods of Ditton. That is, the assumption of connected fracturing from seam to surface above Longwall 9 and all longwalls of the same width. See Sections 2.8, 2.9 2.13 and 4, Figure 5, Appendices B, C and D of HydroSimulations (2019) describing the conceptual model of height of connective fracturing. For additional discussion on the potential for connectivity to the mine workings and the continuous refinement under which the groundwater model has been developed, see section 4.2 of the WIMMCP.	*Impact Assessments for Dendrobium LW20 and LW21*. Report Number MSEC978 | Revision E. PSM (2017) *Height Of Cracking – Dendrobium Area 3B Dendrobium Mine*. Report prepared for DPE. South32 (2019) *Dendrobium Area 3C Watercourse Impact, Monitoring, Management And Contingency Plan*, September 2019.
3	Summary p. 1	*The performance measures suggested for use in Area 3C by Illawarra Coal in the SMP are poorly defined and are not specific or measurable. Given the predictions for significant, permanent impacts to natural features, measurable performance measures are required to enable clear identification of impacts that are allowable under the SMP and development consent. Performance measures and associated TARPs for use in Area 3C should be comprehensively reviewed with involvement of appropriate agencies and independent peer review.*	The performance measures and monitoring of surface water and shallow groundwater in relation to mining at Area 3C are detailed in the WIMMCP and SIMMCP. The Trigger Action Response Plan (Appendix A of the WIMMCP and SIMMCP) specifies trigger levels and a three-tiered management response for assessing and responding to impacts from mining. The triggers are based on environmental data collected before mining commenced at Area 3B (baseline) and are updated from time to time as the monitoring phase of the SMP progresses. A SMP for Longwalls 20 and 21 has also been developed to support mining in Area 3C (South32 2019). The Longwall 20 and 21 SMP is an extension of the monitoring and management of subsidence impacts from the adjacent Area 3B to Area 3C. Stream monitoring sites reviewed as part of this assessment are included in the Longwalls 20 and 21 SMP, including sites upstream and downstream of the proposed Longwalls 20 and 21. Therefore, the	Hgeo (2019) *Dendrobium Mine Assessment of surface water flow and quality effects of proposed Dendrobium Longwalls 20 and 21*. Report: D18301. South32 (2019b) *Dendrobium Area 3C Subsidence Management Plan,* September 2019.

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			exiting TARPs are considered generally applicable to future monitoring and management of mining effects related to Longwalls 20 and 21 immediately adjacent and down-stream of Area 3B (Hgeo 2019). Surface water flow TARPs are currently being reviewed in light of recent improvements to stream gauging and past experience of implementing TARPs. As part of the revised surface flow TARP discussions with WaterNSW and DPIE, the performance measures are being reassessed and quantified. A discussion paper (Watershed Hydrogeo 2019) was submitted to WaterNSW and DPIE and a workshop held 25 July 2019. It was agreed at the workshop that DPIE and WaterNSW would provide any feedback on the discussion paper and that S32 would revise the WIMMCP accordingly.	South32 (2019) *Dendrobium Area 3C Swamp Impact, Monitoring, Management And Contingency Plan*, September 2019. South32 (2019) *Dendrobium Area 3C Watercourse Impact, Monitoring, Management And Contingency Plan*, September 2019. Watershed Hydrogeo (2019) *South32 Illawarra Coal Dendrobium Area 3B Discussion of Surface Water Flow TARPs July 2019.*
4	Summary p. 1	*The potential for faults/dykes/lineaments to interact with subsidence have not been adequately assessed in the SMP. These geological structures are mapped directly underneath Wongawilli Creek in the vicinity of LW20 and LW21 and these structures could also present avenues for direct connection of surface waters in Wongawilli Ck to the mine.*	South32 has undertaken extensive geological investigations, including remote sensing, surface exploration, underground drilling and mapping of geological structures and conditions underground. These studies identify faults, dykes and sills as a basis for mine planning. Numerous in-seam boreholes in Areas 1, 2, 3A and 3B have not detected any hydraulically charged geological features despite several of these being directly under a reservoir (Johnson 2018). South32 carried out a risk assessment for the Dendrobium Longwalls 20 and 21 Subsidence Management Plan application in accordance with the recommendation from the Independent Expert Panel that Subsidence Management Plan applications consider the potential	Johnson, M. (2018) *Memorandum Geology Between Avon Reservoir and Area 3B Mine Workings*. Axys (2019) *South32 - Illawarra Coal Review of Dendrobium Longwalls 20 and*

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			implications of mining within a risk assessment context, and in particular any implications for water quantity as a result of faulting, basal shear planes and lineaments (Axys 2019). This risk assessment documents the extensive work at Dendrobium Mine to understand geological constraints to mining and the potential for geological features to interact with subsidence induced stressors. The effects of lineaments and geological structures on measured surface subsidence in Area 3B has also been reviewed (MSEC letter report dated 13 March 2019). The review found that there was no measurable increase in the subsidence in the mapped locations of the lineaments, minor faults and dykes in Area 3B. The faults mapped though Longwalls 20 and 21 are of similar nature to the faults mapped in Area 3B. Increased subsidence is not predicted for these longwalls due to the presence of these geological structures.	*21 Subsidence Management Plan AR2625,* Revision 4 29 May 2019.
5	Summary p. 1	*Adequate baseline monitoring of upland swamps has not been undertaken. At a minimum, swamp shallow groundwater piezometers should be installed in those swamps predicted to experience greater than negligible environmental consequences. Swamps Den09, Den141, Den142, and Den144 should be monitored in this way and be collecting data at least 2 years before mining impacts are expected.*	Swamp monitoring sites will be installed ahead of mining to achieve 2 years baseline data (subject to timing and approval timeframes of any request to install additional monitoring). Monitoring is generally conducted through the mining period and for 2 years following active subsidence. Where impacts are observed, the monitoring period will be reviewed and this review will be reported in Impact Assessment Reports and End of Panel Reports (SIMMCP [South32 2019]). Shallow groundwater piezometers will be installed in Swamps 2, 5, 7, 9, 124, 140, 141, 142, 144 and 145 (as stated in Appendix 1, Table 1.1 Dendrobium Area 3C SIMMCP) to allow for appropriate baseline data collection.	South32 (2019) *Dendrobium Area 3C Swamp Impact, Monitoring, Management And Contingency Plan*, September 2019.
6	Summary p. 1	*SIMMCP (South32 2019b) states that the approved Dendrobium and Bulli Seam Strategic Biodiversity Offset (2016) fulfils the swamp offset requirements for Area 3C. However, that document only included four swamps (2, 6, 7 and 9) in Area 3C that were identified as being offset by the land at Maddens Plains. Swamps Den142 and Den144 are predicted to have greater than negligible and minor environmental consequences in the SMP and should also be offset if mining results in a greater than negligible impact.*	South32 will engage in discussions with DPIE and OEH to address OEH's comments on this matter and (if as a result it is determined) will provide offsets for Swamps Den142 and Den144 in accordance with the *Addendum to NSW Biodiversity Offsets Policy for Major Projects: Upland swamps impacted by longwall mining subsidence* (OEH 2016).	Office of the Environment and Heritage (2016) *Addendum to NSW Biodiversity Offsets Policy for Major Projects - Upland swamps impacted by longwall mining subsidence*.

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7	Appendix A Predicted Impacts to Natural Features p. 3	*Wongawilli Creek* • *Valley closure over 200mm is predicted for sections of Wongawilli Creek within the study area (MSEC 2019). Fracturing of bedrock and rockbars is likely and may lead to exceedance of conditions of project approval.*	Performance measures and indicators have been derived from the Dendrobium Development Consent. These performance measures will be applied to the Dendrobium Area 3C mining: • Operations shall not cause subsidence impacts at Wongawilli Creek other than "minor impacts" (such as minor fracturing, gas release, iron staining and minor impacts on water flows, water levels and water quality); and • Operations will not result in reduction (other than negligible reduction) in the quality or quantity of surface water or groundwater inflows to Lake Cordeaux or Lake Avon or surface water inflow to the Cordeaux River at its confluence with Wongawilli Creek. Details of predicted impacts, mitigation and contingency measures for watercourses are presented in Table 6-1 of the WIMMCP. MSEC (2019) prediction states: *It has been assessed that the likelihood of fracturing resulting in surface water flow diversions along Wongawilli Creek, due to the extraction of the proposed LW20 and LW21, is low, i.e. affecting less than 10 % of rockbars located within the Study Area. However, minor fracturing could still occur along the creek, at distances up to approximately 400 m from the proposed longwalls.*	MSEC (2019) *Subsidence Predictions and Impact Assessments for Dendrobium LW20 and LW21*. Report Number MSEC978 | Revision E. South32 (2019) *Dendrobium Area 3C Watercourse Impact, Monitoring, Management And Contingency Plan*, September 2019.
8	Appendix A Predicted Impacts to Natural Features p. 3	• *Water quantity is predicted to decline as a result of mining in Wongawilli Creek and Donalds Castle Creek (HGEO 2019).* • *Loss of surface water from these impacts to deeper storage via the likelihood of connective surface to seam fracturing (HydroSimulations 2019), means permanent loss of habitat for threatened species.*	The spatial distribution of modelled surface water losses has been mapped for a particular point in time at the end of Longwalls 20 and 21 and is included in Figure 1 (available at the end of Table A4). This illustrates which surface water features would likely experience a reduction in flow and where (a simulated 'wet' period has been used as this is conservative i.e. shows higher rates of loss).	
9	Appendix A Predicted Impacts to Natural Features	*Drainage Lines* • *Fracturing of bedrock base of streams and pools is predicted across drainage lines within the 35 degree angle of draw within the study area (Niche 2019, p.38). Loss of surface water is predicted, as has*	See response provided in Table A1, ID – 17 regarding potential fracturing of bedrock within the 35º angle of draw. See response provided in Table A2, ID – 1 regarding potential subsidence impacts to watercourses.	

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	p. 3	*been seen in other drainage lines at Dendrobium, e.g. WC21 in Area 3B.* • *5.6 km of watercourses are assessed as being prone to subsidence impacts (Niche 2019).*		
10	Appendix A Predicted Impacts to Natural Features p. 3	• *Further significant impacts to threatened species, particularly Littlejohn's Tree Frog, Giant Burrowing Frog and Giant Dragonfly (Niche 2019, Table 14).*	Dendrobium Mine was approved by the then Minister for Planning and Urban Affairs in 2001 (DA 60-03-2001), with a major modification in 2008. The Project was subject to a comprehensive state and federal government assessment which included submissions by Government Agencies, non-government agencies and community. The assessment and subsequent approval considered the potential for adverse environmental impacts and provides strict performance measures for Dendrobium Mine. South32 complies with the performance measures of the Consent and secondary approvals. During the EIS process and subsequent modifications, members of the public and non-government agencies provided input on the mining development. Potential adverse impacts from the Mine were considered and assessed by the Approvals Authority. The Consent granted approval for Dendrobium Mine, including the environmental impacts. South32 complies with the conditions of the Consent and secondary approvals. In April 2015, the Dendrobium Mine Consent was modified by adding Condition 15 to enable the provision of Strategic Biodiversity Offsets, whereby South32 could provide land that has conservation values which exceed the conservation values required to meet relevant offsetting requirements prescribed in a condition of an approval, and that the excess conservation values could be relied upon to meet future offsetting requirements under the Dendrobium Mine Consent and the Bulli Seam Operations Consent (08_0150). The Maddens Plains Offset Area was transferred to the NSW National Parks and Wildlife Service to provide physical offsets for impacts to vegetation communities and species, in addition to research funding. South32 continues to fund and support research into a regional understanding of the context and cumulative impact of the Dendrobium Mine on populations of Littlejohn's Treefrog and Giant Dragonfly. At the	

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			time of writing, the 2018 – 2019 survey reports for both species are being developed. Littlejohn's Tree Frog monitoring will continue as a part of South32's ecological monitoring program. The ongoing monitoring of pool water depth and tadpole presence will provide data to determine whether observed impacts are likely to have a long-term impact on the local population of this species.	
11	Appendix A Predicted Impacts to Natural Features p. 3	• *The Prediction of likely connective fracturing between surface and seam (HydroSimulations 2019) means this water will be permanently lost to the system and the ecosystem functionality of the system will be permanently altered.* • *Illawarra Coal suggest that surface fracturing and dilation will develop only in the top 10-20m of the bedrock. This is contrary to packer testing results from WC21 which show continuous cracking down boreholes over 50m of depth. The company and its consultants state "On the basis that there is no connective fracturing to any deeper storage, it is likely that surface water flows will re-emerge at the limits' of the fracturing and dilation" (MSEC 2019, Niche 2019). However, the simulated extent of connected fracturing provided by HydroSimulations shows that fracturing above the mine will intersect with the surface at points above LW20 and is expected to intersect with the downward extent of surface fracturing the across the full length of LW20 and several points along LW21 (HydroSimulations 2019, Appendix D). These predictions are contrary to the above statement.*	Following comments in PSM (2017) and others, the groundwater modelling has simulated the conservative assumption of seam-to-surface connection above 305 m wide longwalls, which includes all Area 3B panels and with vertically connected fracturing up to H (Tammetta, 2013) for narrower panels (as per Appendix D of HydroSimulations, 2019). Commentary has been provided previously on why we consider this overly conservative, however the concept of seam-to-surface connection in Area 3B is the prevailing view by WaterNSW, DPIE and others, and South32 has adopted this assumption in groundwater modelling. Further, the modelling includes the use of particular model boundary conditions ("Drains") to represent connected fracturing, which the model peer reviewer indicated would also be conservative. Recent analysis of actual surface water flow reductions around Area 3B (refer to Response to Table A1, ID - 14) indicates that the groundwater modelling predictions of HydroSimulations (2018, 2019) are conservative compared to that inferred, and that re-emergent flow between headwater catchments and downstream sites is a plausible (e.g. between DC13 + DCS2 and DCU). Packer testing along WC21, shows deformation and fracturing throughout the profile. PSM (2017) and others consider this indicative of vertically-connected fracturing, while we consider that while it shows fracturing, the degree and orientation of connection is uncertain. Tracer tests (PB, 2015) and tritium analysis do not support the concept of rapid connection through the profile. The panels in Area 3B are 305 m wide, while Longwalls 20 and 21 are proposed to be 256 m wide, with similar depth of cover (see Table 1-1 of HydroSimulations, 2019). Therefore,	PSM (2017) *Height Of Cracking – Dendrobium Area 3B Dendrobium Mine*. Report prepared for DPE. Tammetta (2013) *Estimation of the Height of Complete Groundwater Drainage Above Mined Longwall Panels*. Groundwater - Vol. 51, No. 5.

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			there is a lower potential for seam-to-surface connection at Longwalls 20 and 21 than in Area 3B. These findings suggest that the comments by MSEC and Niche are appropriate, and that the simulation of hydrogeological processes by HydroSimulations (2019) is conservative.	
12	Appendix A Predicted Impacts to Natural Features p. 3 - 4	*Upland Swamps* • *Information presented in the Terrestrial Ecology Assessment (Niche 2019) is contradictory as to whether fracturing is likely in Den09 and Den141. Table 1 (p.4) states that fracturing could occur in Den09, whereas Table 12 (p.36) states that fracturing of bedrock is not expected to occur in that swamp. For Den141, Table 1 makes no mention of the possibility of fracturing but Table 12 predicts fracturing of bedrock may occur.*	The Terrestrial Ecology Assessment (Niche 2019) has been amended to address this comment. While some subsidence impacts are possible, these are unlikely to be significant within Swamps Den09 and Den141.	Niche (2019) *Dendrobium Longwalls 20-21 Terrestrial Ecological Assessment*, Prepared for South32 Illawarra Coal 16 August 2019.
13	Appendix A Predicted Impacts to Natural Features p. 4	• *The likelihood of connective fracturing with deeper storage or the mine has important long-term consequences for upland swamps, either through permanent loss of inflows from upstream or permanent loss of the shallow groundwater in swamp sediments that supports the ecosystem function of all upland swamps.*	Fracturing of the bedrock has been observed in the past, as a result of longwall mining, where the tensile strains have been greater than approximately 0.5 mm/m or where the compressive strains have been greater than approximately 2 mm/m. Swamps Den142 and Den144 are located along the upper reaches of streams WC25 and WC20, respectively, at distances of 70 m and 50 m from the proposed longwalls. These swamps are predicted to experience conventional tensile strains of 1 mm/m and compressive strains of 3 mm/m due to valley closure effects. Fracturing could therefore occur in the bedrock beneath these swamps. The estimated fracture widths in the bedrock beneath the Swamps Den142 and Den144, based on the maximum predicted conventional tensile strain of 1 mm/m and a typical joint spacing of 10 m, is in the order of 10 mm. Wider fractures could develop if the compressive strains due to the valley closure effects result in localised failure of the bedrock. Fracture widths in the order of 20 mm to 50 mm have been observed due to valley closure effects at similar distances from previous longwall mining. It is possible that a series of smaller fractures, rather	

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			than one single fracture, could develop in the bedrock. Fracturing would only be visible at the surface where the bedrock is exposed, or where the thickness of the overlying soil is relatively shallow. Swamps Den142 and Den144 are predicted to experience upsidence movements of 40 mm and 50 mm, respectively. These valley related upsidence movements could result in the dilation of the strata beneath these swamps. It has been previously observed that the depth of fracturing and dilation of the uppermost bedrock, resulting from valley related movements, is generally in the order of 10 m to 15 m. The dilated strata beneath the drainage lines, upstream of Swamps Den142 and Den144, could result in the diversion of some surface water flows beneath parts of these swamps. The drainage lines upstream of these swamps flow during and shortly after rainfall events. See response provided in Table 2, ID – 2 for discussion regarding potential surface fracturing. The potential for connective fracturing with deeper mine storage is detailed in response Table 2, ID – 11.	
14	Appendix A Predicted Impacts to Natural Features p. 4	• *The Terrestrial Ecology Assessment (Niche 2019)' incorrectly states that the upland swamps in the study area are not part of a threatened ecological community (TEC) listed under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). While not being part of the Temperate Highland Peat Swamps on Sandstone TEC, all mapped upland swamps in the Dendrobium Mine domain are part of the Coastal Upland Swamp TEC that is listed as Endangered on the EPBC Act.*	The Terrestrial Ecology Assessment (Niche 2019) has been amended to address this comment.	Niche (2019) *Dendrobium Longwalls 20-21 Terrestrial Ecological Assessment*, Prepared for South32 Illawarra Coal 16 August 2019.
15	Appendix A Predicted Impacts to	*Threatened Frogs* *Significant impacts are likely on populations of Littlejohns Tree Frog, Red-crowned Toadlet and Giant Burrowing Frog as a direct result of this proposal (Niche*	See response provide in Table A2, ID – 10 regarding approved impacts. The predicted impacts to aquatic habitat which is used by Littlejohn's Tree Frog have been offset through the following mechanisms:	

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	Natural Features p. 4	*2019, Table 14). This is via changes to flow regimes, loss of surface flow and water retention within breeding pools. Changes in upland swamps are likely to impact the species via influencing downstream pool availability or permanency or through changes in sheltering habitat within swamps.*	1. Subject to Condition 14 of Schedule 3 of the Development Consent South32 has transferred 33 ha of land adjacent to the Cataract River to WaterNSW to provide suitable offsets for loss of water quality or water flows to WaterNSW caused by its mining operations. 2. Maddens Plains Biodiversity Offset Area. 3. South32 continues to fund and support research into a regional understanding of the context and cumulative impacts of the Dendrobium Mine on populations of Littlejohn's Tree Frog.	
16	Appendix A Predicted Impacts to Natural Features p. 4	• *5.6km of watercourses are assessed as being prone to subsidence impacts (Niche 2019). Many stretches of creeks within the study area were not directly surveyed for frogs, so the predicted significant impacts are likely to be a minimum estimate.* • *Surveys -located over 275 tadpoles of Littlejohns Tree Frog across seven pools in WC20, downstream of upland swamp Den144 (Niche 2019). Given the prediction for connective fracturing in the bedrock of that swamp and in the stream bed (HydroSimulations 2019), this important breeding habitat is likely to be permanently lost because of mining of LW20.*	Table 4 of the Terrestrial Ecology Assessment (Niche 2019) identifies and summarises the extensive surveys which have been conducted within Dendrobium Area 3 and surrounds. Table 5 further details the survey efforts as part of the SIS (Biosis 2007), including the diurnal herpetofauna search of Swamp Den144. Table 14 (and other sections of the assessment) document the process of impact assessment for Littejohn's Tree Frog during the SIS indicating that a significant impact was expected for the species.	Biosis (2007) *Dendrobium Area 3 Species Impact Statement*. October 2007. Niche (2019) *Dendrobium Longwalls 20-21 Terrestrial Ecological Assessment*, Prepared for South32 Illawarra Coal 16 August 2019.
17	Appendix A Predicted Impacts to Natural Features p. 4	• *The cumulative impact of the Dendrobium Mine on threatened frogs continues to grow, with these predicted losses adding to the documented loss of kilometres of similar habitat in Areas 2, 3A and 38.*	See response provided in Table A2, ID – 10.	
18	Appendix A Predicted Impacts to	*Giant Dragonfly* • *The assessment for this species is inadequate as there were no targeted surveys or assessment of impact of the proposal undertaken for the Giant*	Table 14 (and other sections of Niche [2019] document the process of impact assessment for Giant Dragonfly during the SIS indicating that a significant impact was expected for the species. Table 14 states:	Niche (2019) *Dendrobium Longwalls 20-21 Terrestrial Ecological*

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	Natural Features p. 4	*Dragonfly as part of the Terrestrial Ecology Assessment (Niche 2019) despite potential habitat being present in the study area.*	*Habitat likely to be impacted from the current proposal is limited to one swamp (Den 09) with potential foraging habitat (i.e. within 500 m of a swamp with breeding habitat) within the study area. Swamps with preferred breeding habitat for this species (Den07, Den124) do occur on the edges of the 600 m study area but are not expected to experience subsidence impacts from the proposal.* Given no or negligible impacts are expected for areas of breeding habitat for this species (e.g. Swamps Den07 and Den124) and minimal impacts are expected for foraging habitat, it is considered that targeted surveys for this species are unlikely to be of any value, especially given the difficulty of detecting the species within potential foraging habitat. It is noted that clarification around impacts to swamp Den09 have been provided (see comment Table A2, ID – 12).	*Assessment*, Prepared for South32 Illawarra Coal 16 August 2019.
19	Appendix A Adaptive Management to Avoid Predicted Significant Impacts p. 4	*Having advanced knowledge of likely significant impacts is a strong trigger for adaptive management to reduce those impacts. Illawarra Coal have not provided reasons for the currently proposed longwall layout or explained how it avoids or mitigates impacts to significant natural features. The only rationale presented is to emphasise the socio-economic benefits of the mine.* *OEH recommends that alternative mine proposals that are less likely to have the impact of the proposal. We note Wollongong Coal's recent decision to move to first workings mining that results in negligible surface subsidence across the mining domain. This method has no impact of surface water resources, upland swamps or habitats for threatened species including frogs and the Giant Dragonfly, all of which are present above the proposed first workings.*	See response provided in Table A2, ID – 1.	
20	Appendix A	*The performance measures suggested for use in Area 3C by Illawarra Coal in Table 5-1 (p.15) of the SMP are poorly defined and are not specific or measurable. Given the predictions outlined above for significant,*	Surface water flow TARPs are currently being reviewed in light of recent improvements to stream gauging and past experience of implementing TARPs.	Watershed Hydrogeo (2019) *South32 Illawarra Coal Dendrobium*

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	Performance Measures and TARPs p. 5	*permanent impacts to natural features, measurable performance measures are required to enable the regulator to clearly identify impacts that are allowable under the SMP and development consent.* *The Independent Expert Panel for Mining in the Catchments has identified that the Dendrobium Mine TARPs related to surface water and upland swamps are ineffective (IEPMC 2018). Performance measures and associated TARPs for use in Area 3C need to be comprehensively reviewed with involvement of appropriate agencies and independent peer review prior to approval being granted.*	As part of the revised surface flow TARP discussions with WaterNSW and DPIE, the performance measures are being reassessed and quantified. A discussion paper (Watershed Hydrogeo 2019) was submitted to WaterNSW and DPIE and a workshop held 25 July 2019. It was agreed at the workshop that DPIE and WaterNSW would provide any feedback on the discussion paper and that S32 would revise the WIMMCP accordingly.	*Area 3B Discussion of Surface Water Flow TARPs July 2019*.
21	Appendix A Performance Measures and TARPs p. 5	*Watercourses* *OEH supports the development of specific, meaningful and measurable performance measures for streams in the Dendrobium 3C Area. The performance measure and triggers in the associated TARP need to be related to the materiality of flow loss. Terms such as 'negligible' and 'minor must be defined in quantitative terms.*	See response provided in A2, ID – 20.	
22	Appendix A Performance Measures and TARPs p. 5	*Upland Swamps* *The IEPMC recognises that TARPS, which are linked to performance measures, do not reflect the groundwater-dependence of the upland swamp ecosystem. Monitoring of groundwater using piezometers in swamps is already carried out broadly in Dendrobium Mine domains and should be utilised in informing environmental consequences of mining by inclusion of a specific performance measure relating to changes in groundwater within swamps. OEH suggests that this should be consistent with the definition of 'Negligible environmental consequences' from the Biodiversity Offsets Policy for Major Projects (Upland Swamps, specifically:*	The TARPs for groundwater changes in swamps for Dendrobium Area 3C are detailed further in the in the SIMMCP: Level 1: Groundwater level lower than baseline level at any monitoring site within a swamp (in comparison to reference swamps); and/or Rate of groundwater level reduction exceeds rate of groundwater level reduction during baseline period at any monitoring site (measured as average mm/day during the recession curve). Level 2: Groundwater level lower than baseline level at 50% of monitoring sites (within 400 m of mining) within a swamp (in comparison to reference swamps); and/or	South32 (2019) *Dendrobium Area 3C Swamp Impact, Monitoring, Management And Contingency Plan*, September 2019.

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		• *Negligible change to the shallow groundwater regime of a swamp compared with control swamps; and/or* • *Negligible change to the composition or distribution of swamp dependent vegetation communities.* *The IEPMC recognised that the nature of existing performance measures and TARPs in relation to swamps were slow to respond to mine impacts and would not be detected until much later. Groundwater monitoring with piezometers has the benefit of allowing detection of mine impacts immediately and being measurable and quantifiable.*	Rate of groundwater level reduction exceeds rate of groundwater level reduction during baseline period at a 50% of monitoring sites (within 400 m of mining) within the swamp. Level 3: Groundwater level lower than baseline level at >80% of monitoring sites (within 400 m of mining) within a swamp (in comparison to reference swamps); and/or Rate of groundwater level reduction exceeds rate of groundwater level reduction during baseline period at >80% of monitoring sites (within 400 m of mining) within the swamp.	
23	Appendix A Performance Measures and TARPs p. 6	*Threatened Species* *There is no performance measure for threatened species in the SMP, despite the significant impacts predicted to occur on threatened frogs and the likelihood of impacts, as yet unassessed, on the Giant Dragonfly. The Dendrobium development consent (Schedule 3, Condition 7e, f) requires that a monitoring, management and contingency plan for terrestrial flora and fauna and ecology (including all threatened species assessed as being likely to be significantly affected) is included in the SMP. We do not consider that this has been adequately done for this SMP and reiterate the offer to be involved in a technical review via a formal working group.*	The TARPs included in Appendix A Table 1.2 of the WIMMCP relate to identifying, assessing and responding to potential impacts to aquatic ecology and threatened frog species (including impacts greater than predicted) from subsidence in Dendrobium Area 3C. Pool water level, interconnectivity between pools and loss of connectivity, and alteration of habitat are considered. These TARPs have been prepared using knowledge gained from previous mining in other areas of Dendrobium. Littlejohn's Tree Frog monitoring will continue as a part of South32's ecological monitoring program. The ongoing monitoring of pool water depth and tadpole presence will provide data to determine whether observed impacts are likely to have a long-term impact on the local population of this species. The predicted impacts to aquatic habitat which is used by Littlejohn's Tree Frog and Giant Dragonfly have been offset through the following mechanisms: 1. Subject to Condition 14 of Schedule 3 of the Development Consent South32 has transferred 33 ha of land adjacent to the Cataract River to WaterNSW to provide suitable offsets for loss of water quality or water flows to WaterNSW caused by its mining operations. 2. Maddens Plains Biodiversity Offset Area.	Watershed Hydrogeo (2019) *South32 Illawarra Coal Dendrobium Area 3B Discussion of Surface Water Flow TARPs July 2019.* South32 (2019) *Dendrobium Area 3C Watercourse Impact, Monitoring, Management And Contingency Plan*, September 2019.

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			3. South32 continues to fund and support research into a regional understanding of the context and cumulative impact of the Dendrobium Mine on populations of Giant Dragonfly and Littlejohn's Tree Frog.	
24	Appendix A Performance Measures and TARPs p. 6	*Connective Fracturing* *The Independent Expert Panel for Mining in Catchments (IEPMC 2018) considered that it is very likely that there is connective fracturing at Dendrobium Mine. They estimated that 6GL (or 3.5ML per day) can be regarded as diverted water runoff that would have otherwise reported to Wongawilli Creek or either Cordeaux or Avon reservoirs. Given the permanent impacts that connective fracturing has on watercourses, upland swamps, threatened species and water storages, a meaningful and measurable performance measure is required to identify how much connective fracturing is permitted, measured by average water diversion per day.*	In regard to potential losses of surface water to the groundwater system, the IEP estimates historic losses of between 2.1 ML/day to 3 ML/day (refer to Section 4.5.1 of the Initial Report). It is unclear how these values have been derived. South32's groundwater modelling indicates losses have been 0.9 ML/day, peaking at 1.6 ML/day. These modelling estimates include conservative assumptions, including the modelling assumption that water is always present in the drainage lines overlying the longwall panels, whereas, in reality many of these drainage lines are ephemeral. It is noted the IEP commends the significant effort that has been undertaken to develop the Dendrobium Mine Regional Groundwater Model: *There have been major efforts over the last decade by both Dendrobium Mine and Metropolitan Mine to employ up-to-date 3-dimensional groundwater models and best practice modelling methods undertaken by specialists, with expert peer review.* In addition, the IEP's upper estimates would mean 40 to 50% of groundwater inflow to mine workings is from surface water. Although there is some uncertainty with water fingerprinting (methods to measure the source of water) science, this level of modern water entering the mine is not supported by water geochemistry. The regional groundwater model remains the best available integrated tool to estimate surface water losses, as it is informed and constrained by site specific data (e.g. groundwater inflows, groundwater levels, pre- and post-mining porosity and permeability data etc). The results of the groundwater model are likely to be conservative and overstate losses, for the reasons outlined above.	IEPMC (2018) *Initial Report on Specific Mining Activities at the Metropolitan and Dendrobium Coal Mines.* Watershed Hydrogeo (2019) *South32 Illawarra Coal Dendrobium Area 3B Discussion of Surface Water Flow TARPs July 2019.*

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			As stated in Table A2, ID – 20, surface water flow TARPs are currently being reviewed in light of recent improvements to stream gauging and past experience of implementing TARPs. As part of the revised surface flow TARP discussions with WaterNSW and DPIE, the performance measures are being reassessed and quantified. A discussion paper (Watershed Hydrogeo 2019) was submitted to WaterNSW and DPIE and a workshop held 25 July 2019. It was agreed at the workshop that DPIE and WaterNSW would provide any feedback on the discussion paper and that S32 would revise the WIMMCP accordingly.	
25	Impacts to Wongawilli Creek p. 6	*Impacts to Wongawilli Creek* *… does not cause subsidence impacts at Wongawilli Creek other than "minor impacts". Minor impacts are not defined in a measurable way to allow meaningful assessment against the consent condition.*	The performance measure for Wongawilli Creek is defined as: *Operations shall not cause subsidence impacts at Wongawilli Creek other than "minor impacts" (such as minor fracturing, gas release, iron staining and minor impacts on water flows, water levels and water quality);* Mining results in more than "minor" environmental consequences in Wongawilli Creek are defined in the WIMMCP which include: • fracturing within Wongawilli Creek resulting in diversion of surface flow such that >10% of the pools have water levels lower than baseline period; • measured surface water flow reduction in Wongawilli Creek at its confluence with Cordeaux River that is greater than predicted by modelling (to the satisfaction of the Secretary) that cannot be attributed to natural variation; • gas release results in vegetation dieback that does not revegetate; • gas release results in mortality of threatened species or ongoing loss of aquatic habitat; • iron staining and associated increases in dissolved iron resulting from the mining is observed in water at Wongawilli Creek downstream monitoring site Wongawilli Ck (FR6); • ±3 standard deviation change (positive for EC, negative for pH and DO) from the baseline mean, for a minimum of two consecutive monitoring events that cannot be attributed to natural variation.	South32 (2019) *Dendrobium Area 3C Watercourse Impact, Monitoring, Management And Contingency Plan*, September 2019.

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26	Impacts to Wongawilli Creek p. 6	*The Dendrobium 3C WIMMCP (South32 2019c) maximum predicted valley closure at Wongawilli Creek of 200mm and 210mm for LW 20 and 21 respectively. This is likely to result in fracturing and drainage of the bedrock and pools in Wongawilli Creek, which in turn is likely to exceed the performance measure of "minor impacts".* *A number of tributaries to Wongawilli Creek have been impacted already or are predicted to be impacted by LW17 (WC21, WC15, WC12 and WC?), resulting in fracturing and loss of flow and pool holding. The cumulative impact of subsidence to these tributaries and the predicted further impacts to Wongawilli Creek itself from LW 20 and 21, is likely to result in exceedance of the "minor impacts" performance measure.*	See response provide in Table A2, ID – 7 regarding Longwalls 20 and 21 potentially exceeding performance measures. Flow does re-emerge albeit towards the lower reaches of WC17. At WC17 surface flow is present as far upstream as Pool 9 (Figure 2, available at the end of Table A4) (latest inspection 25/07/2019). Flows appear to be visually similar at Pool 9 on WC17 for pre and post mining, see Figure 2, available at the end of Table A4. Predictions of reductions in surface water flow from the Dendrobium Regional Groundwater Model and reported in HydroSimulations (2019) include cumulative (whole-of mine) and incremental Longwall 20 and 21 cases. That is, the cumulative case includes the effects of Area 3A and 3B longwalls, followed by the proposed extraction of Longwalls 20 and 21. Refer also to the response to Table A1, ID - 14, regarding the conservatism of groundwater model predictions (HydroSimulations, 2018/2019) compared to those inferred from analysis of stream flow data and analysis.	HydroSimulations (2019) *Dendrobium Mine Longwalls 20 and 21 Groundwater Assessment* For Illawarra Coal Pty Ltd prepared by NPM Technical Pty Ltd, trading as HydroSimulations. Report: HS2019-19.
27	Impacts to Wongawilli Creek p. 6	*The potential for faults/dykes/lineaments to interact with subsidence have not been adequately assessed in the SMP. These geological structures are mapped directly underneath Wongawilli Creek in the vicinity of LW20 and LW21 and these structures could also present avenues for direct connection of surface waters in Wongawilli Ck to the mine.*	See response provided in Table A2, ID – 4.	
28	Swamp Monitoring p. 6	*OEH does not consider that adequate baseline monitoring of upland swamps has been undertaken. At a minimum, swamp shallow groundwater and groundwater piezometers should be installed in those swamps predicted to experience greater than negligible environmental consequences. Swamps Den09, Den141, Den142, and Den144 should be monitored in this way and be collecting data at least 2 years before*	See response provided in Table A2, ID – 5.	

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		mining impacts are expected. Currently only 2 swamps (swamps 2 and 7) have piezometers installed.		
29	Swamp Impacts and Offsets p. 6 - 7	*The SIMMCP considers that Swamp 9, 142 and 144 are predicted to experience bedrock fracturing and shallow groundwater impacts.* *SIMMCP states that the approved Dendrobium and Bulli Seam Strategic Biodiversity Offset (South32 2016) fulfils the swamp offset requirements for Area 3C. However, that document only included four swamps (2, 6, 7 and 9) in Area 3C that were identified as being offset by the land at Maddens Plains. Swamps Den142 and Den144 are predicted to have greater than negligible and minor environmental consequences in the SMP and should also be offset if mining results in a greater than negligible impact.* *Under the Biodiversity Offsets Policy for Major Projects (Upland Swamps) the primary monitoring method to detect impacts is hydrological monitoring using piezometers. It appears that only Den02 and Den07 have piezometers installed. At a minimum, OEH requests that swamps Den142 and Den144 have piezometers installed to monitor the impacts of these two longwalls. Given a greater than negligible environmental consequence is predicted for these swamps and they are not identified as being part of the Strategic Biodiversity Offset, Illawarra Coal should be asked to demonstrate how they can offset their loss should the predicted impacts be realised.*	The SIMMCP has been amended to address this comment. While some subsidence impacts are possible, these are unlikely to be significant within Swamp Den09. The SIMMCP states: *Swamps 142 and 144 are located along the upper reaches of streams WC25 and WC20, respectively, at distances of 70 m and 50 m from the proposed longwalls. These swamps are predicted to experience conventional tensile strains of 1 mm/m and compressive strains due to valley closure effects of 3 mm/m. Fracturing could therefore occur in the bedrock beneath these swamps.* South32 will engage in discussions with DPIE and OEH to address OEH's comments on this matter and (if a result it is determined) will provide offsets for Swamps Den142 and 144 in accordance with the Addendum to NSW Biodiversity Offsets Policy for Major Projects: Upland swamps impacted by longwall mining subsidence (OEH 2016). Shallow groundwater piezometers will be installed in Swamps 2, 5, 7, 9, 124, 140, 141, 142, 144 and 145 (as stated in Appendix 1, Table 1.1 Dendrobium Area 3C SIMMCP) to allow for appropriate baseline data collection.	South32 (2019) *Dendrobium Area 3C Swamp Impact, Monitoring, Management And Contingency Plan*, September 2019. Office of the Environment and Heritage (2016) *Addendum to NSW Biodiversity Offsets Policy for Major Projects - Upland swamps impacted by longwall mining subsidence*.

Table A3 **Planning and Environment Resources Regulator** (Dendrobium Mine - Area 3C Longwalls 20 and 21 Subsidence Management Plan - Resources Regulator Review and Comments [letter dated 20 June 2019])

ID	Section	Comment	Response / Correction	Reference
1	Limitations to Effective Mitigation, Remediation and Rehabilitation p. 2	*The Resources Regulator is concerned that the proposed mitigation, remediation and rehabilitation measures may not be able to satisfactorily remediate the following impacts which could feasibly occur as a result of mining of Longwalls 20 and 21:* • *connectivity between near surface groundwater and deep groundwater, and* • *long term swamp viability of Swamps, particularly Den 142 and Den 144, if impacted by a reduction in near surface groundwater levels.* *It is noted that swamps Den 142 and Den 144 have Performance Measures in the Development Consent …* *The Resource Regulator recommends that the Longwall 20 and 21 SMP approval, if granted, include measures requiring the above two potential impacts to be, in order of preference, 1) avoided, or 2) successfully remediated, or, if deemed acceptable, 3) appropriately offset.* *All other potential/likely impacts are either not likely to be significant in terms of environmental impact (e.g. rockfalls, surface cracking) or are able to be remediated (e.g. cracking within drainage lines resulting in loss of surface flows to shallow subsurface).*	Mine layouts for Longwalls 20 and 21 have been developed using an Integrated Mine Planning Process (See Table A1,ID - 1] for additional details). This process considers impacts to the mining operation as well as environmental impacts when designing mine layouts. Where impacts cannot be avoided or successfully remediated as is the situation for *connectivity between near surface groundwater and deep groundwater*, offsets have been provided to compensate for these potential impacts. Subject to Condition 14 of Schedule 3 of the Development Consent: *The Applicant shall provide suitable offsets for loss of water quality or loss of water flows to Water NSW storages, clearing and other ground disturbance (including cliff falls) caused by its mining operations and/or surface activities within the mining area, unless otherwise addressed by the conditions of this consent, to the satisfaction of the Secretary. These offsets must:* *a) be submitted to the Secretary for approval by 30 April 2009;* *b) be prepared in consultation with Water NSW;* *c) provide measures that result in a beneficial effect on water quality, water quantity, aquatic ecosystems and/or ecological integrity of Water NSW's Special Areas or water catchments.* South32 transferred 33 ha of land adjacent to the Cataract River to WaterNSW to meet the above condition. There are no performance measures in the Development Consent for Swamp Den142 or Den144. Schedule 3, Condition 5 states: *The Applicant must ensure that subsidence does not cause erosion of the surface or changes in ecosystem functionality of Swamp 15a and that the structural integrity of its controlling rockbar is maintained or restored, to the satisfaction of the Secretary.* Where potential impacts to swamps cannot be avoided suitable offsets will be provided as detailed in the SIMMCP (South32 2019). South32	Office of the Environment and Heritage (2016) *Addendum to NSW Biodiversity Offsets Policy for Major Projects - Upland swamps impacted by longwall mining subsidence*. South32 (2019) *Dendrobium Area 3C Swamp Impact, Monitoring, Management And Contingency Plan*, September 2019.

ID	Section	Comment	Response / Correction	Reference
			will engage in discussions with DPIE and OEH to address biodiversity offsets and (if a result it is determined) will provide offsets for Swamps Den142 and Den144 in accordance with the *Addendum to NSW Biodiversity Offsets Policy for Major Projects: Upland swamps impacted by longwall mining subsidence* (OEH 2016).	
2	Mine Safety p. 2	*The Resources Regulator Mine Safety Operations has reviewed the SMP and notes one significant flaw in the SMP document in relation to the Built Features section. The document makes no mention of a 330kV power-line that is clearly visible on aerial imagery, nor is the power-line shown on the Surface Features - Plan 2, dwg no. DEN-01-7116. However, the accompanying subsidence consultant's report does include an assessment of the subsidence impacts to the power-line as well as a recommendation:-* *" ... that TransGrid undertake a structural analysis of the transmission towers. If adverse impacts are anticipated, then these could be managed using strategies similar to those adopted where similar transmission lines have been directly mined beneath or adjacent to by previously extracted longwalls elsewhere in the NSW coalfields."* *The mine operator should preferably revise the SMP document to include the 330kV power-line and amend Plan 2 to show this infrastructure.* *The mine operator should undertake the recommendations of their consultant and develop any necessary management strategies arising from this in consultation with the infrastructure owner.* *Development of relevant management strategies and consultation with the infrastructure owner will be necessary under the mine operator's obligations under WHS law generally. Specifically, such management strategies will be reviewed by the Resources Regulator through the provisions relating*	The SMP and Surface Features - Plan 2, dwg no. DEN-01-7116 have been updated to include the 330 kV power line. South32 will consult with TransGrid to manage any potential subsidence impacts on their infrastructure. The descriptions, predictions and impact assessment for the 330 kV transmission line and the 33 kV powerline are provided in Sections 6.2 and 6.3, respectively, of the subsidence report MSEC978.	MSEC (2019) *Subsidence Predictions and Impact Assessments for Dendrobium LW20 and LW21.* Report Number MSEC978 | Revision E. South32 (2019) *Dendrobium Area 3C Subsidence Management Plan.* September 2019.

ID	Section	Comment	Response / Correction	Reference
		to High Risk Activity (HRA) Notification for longwall extraction. Consequently, it is therefore not necessary that development and documentation of such management strategies be completed for an SMP approval at this stage, but will be required for submission of an HRA notification for the longwalls in question.		

Table A4 **Planning, Industry and Environment** (Dendrobium Long Walls 20 -21, Aboriginal Cultural Heritage Assessment Report [letter dated 8 July 2019])

ID	Section	Comment	Response / Correction	Reference
1	Archaeological assessment has identified sites within the LW20-21 600m boundary p. 2	*The ACHAR and Archaeological report are inconsistent in the number of sites recorded in the study area, with both eight and nine sites reported at numerous places in the documents (e.g. Niche 2019a, p.4 and Niche 2019b, p.6). These inconsistencies must be corrected. Our understanding is that there are 10 AHIMS sites mapped within the LW20-21 600m boundary, and that one of these sites is incorrectly mapped. This suggests a total of nine sites occur within the study area.*	Footnotes have been added to relevant sections of the Aboriginal Cultural Heritage Assessment (ACHA) and Archaeology Report (AR) outlining why sites have been excluded from Aboriginal site counts (e.g. Brown Road site 33 (AHIMS ID# 52-2-0458). Additional detail explaining site count inconsistences has been added to page 2, Section 2.3, of the ACHA (Niche 2019).	Niche Environment and Heritage (2019) *Aboriginal Cultural Heritage Assessment*. Prepared for South32 Illawarra Coal Operations, September 2019.
2	The level of effective survey coverage of the LW20-21 extraction area is unclear p. 2	*We are concerned that there may be Aboriginal heritage sites within the extraction area that have not been identified. The sampling strategy targeted recorded sites rather than systematically sampling the LW20-21 area (Niche 2019b, p.20). Niche assert that there were several previous surveys in this area, however, no maps or detail of previous survey transects are provided. The applicant may be able to address this by mapping previous survey efforts in the LW 20-21 extraction area, or by conducting a systematic survey of the LW 20-21 extraction areas.*	The study area (as shown on Figure 2 of the ACHA [Niche 2019]) has been adequately surveyed during the Dendrobium Area 3 Archaeological and Cultural Heritage Assessment (Biosis, 2007). Figure 4 and Section 7 of the Dendrobium Area 3 Archaeological and Cultural Heritage Assessment (Biosis, 2007) provide details of the survey methods and coverage.	Biosis (2007) *Dendrobium Area 3 Archaeology and Cultural Heritage Assessment.* Report of BHP Billiton, August 2007. Niche Environment and Heritage (2019) *Aboriginal Cultural Heritage Assessment*. Prepared for South32 Illawarra Coal Operations, September 2019.
3	The location of site 52-2-0458 requires additional investigation p. 2	*It is not clear how Niche (2019a and b) has concluded that site 52-2-0458 is outside the LW20-21 area. The AHIMS site card describes the site location as '300m north of the junction of the Fire Road 6F and the small road joining it to 6C'. Mapping in the ACHAR suggests this location would still be within 600m boundary of the LW20-21 extraction area. The applicant should*	AHIMS site ID# 52-2-0458 could not be relocated during site survey; therefore, the site card grid reference could not be amended. The survey coordinates were recalculated to account for previous changes in coordinate systems since the site was first recorded in 1979. The field survey covered surrounding ridgelines and re-traced the site access description outlined in the site card. Despite the additional effort,	

ID	Section	Comment	Response / Correction	Reference
		provide further evidence as to the actual location of site 52-2-0458. The location of site 52-2-0458 should be identified on the ground and the AHIMS site card updated appropriately. *Relevant to this discussion is AHIP 1098243 / 3081 that was issued to Illawarra Coal Holdings Pty Ltd/ BHP Billiton in 2009 (for eight years). This permit allowed harm to both sites 52-2-0458 and 52-2-1647 of the sites considered by Niche for LW20-21. The mapping in this AHIP shows site 52-2-0458 at approximately the same location as that mapped on AHIMS.*	Browns Road site 33 (AHIMS ID# 52-2-0458) could not be relocated. Based on survey coverage of the area, it was concluded that Brown Road site 33 (AHIMS ID# 52-2-0458) was not located within the Subject Area.	
4	Baseline recordings should be updated for all sites within the LW20-21 600 m boundary p. 2	*Some sites within the LW20-21 extraction area only have older (e.g. 1989) baseline recordings. Niche report that these sites could not be relocated, or were grinding groove sites covered by high levels of vegetation and leaf litter. However, relying on older baseline recordings means if changes are observed during monitoring it may be difficult to determine whether these are caused by the LW20-21 mining. We recommend updated baseline recording for all nine sites within the 600m boundary of the LW20-21 extraction area. We also recommend the 'Aboriginal heritage site information' sheets include the dates of all known site recordings, so it is clear which sites have been subject to more recent recordings relative to the proposed LW20-21 extraction works.*	Due to thick vegetation and leaf coverage of the rock platform at Donalds Castle Creek Site 2 (AHIMS ID3 52-2-1563), this Aboriginal cultural heritage site could not be recorded as part of this assessment. Browns Road Site 18 (AHIMS ID #52-2-1633) was not located at the eastings and northings on the AHIMS site card. The entire ridgeline was surveyed to relocate this site and it was not able to be found during this assessment.	
5	Impact assessment suggests the recorded sites are unlikely to be harmed by LW20-21 p. 2 - 3	*The subsidence impact assessment by MSEC (2019 pp.63-64) states that the Aboriginal heritage sites are not expected to be impacted by the LW20-21 extraction. However, the MSEC report only refers to seven sites. The assessment of Aboriginal heritage impacts (MSEC 2019, p.63) should be revised so it is consistent with the numbers and types of sites reported by Niche (2019a and b) and to ensure all Aboriginal heritage sites have been assessed for the subsidence risk. Niche (2019. P.31) further argues*	The MSEC report (2019) has been updated accordingly.	MSEC (2019) *Subsidence Predictions and Impact Assessments for Dendrobium LW20 and LW21*. Report Number MSEC978 | Revision E.

ID	Section	Comment	Response / Correction	Reference
		that the proposed extraction will not contribute to adverse cumulative impact on the Aboriginal cultural heritage of the region. *It is not clear from the information provided with the request for Aboriginal heritage comments whether any additional surface infrastructure is required. If additional ground surface works are needed the Department should seek information from the applicant about the Aboriginal cultural heritage assessment of those areas.*		
6	Aboriginal community consultation has been conducted p. 3	*There are nine Registered Aboriginal Parties (RAPs) for this project. Overall the consultation process appears to substantially comply with the requirements of clause SOC of the National Parks and Wildlife Regulation 2009. However, we have questions about two consultation matters:* • *It is not clear whether Newton Carriage was consulted. The NTSCORP identified Mr Carriage as someone who had requested to be consulted separately to the South Coast Native Title Claimants.* • *The ACHAR (Niche 2019a, p.17), consultation log and consultation documents show inconsistent dates for the consultation period for at Stage 3, assessment methodology. The NPW Regulation requires RAPs are given a minimum of 28 days to provide comment on a methodology. We suggest the applicant clarify how the consultation process has met the statutory timeframes.*	Newton Carriage has his own group, Nundagrri. Mr Carriage was consulted through contact with Nundagrri during stage one of the consultations (6 September 2018). Mr Carriage did not respond to requests for registration for this assessment. The consultation log has been amended with the correct dates. The project methodology was sent to the Registered Aboriginal Parties on 27 September 2018.Consultation closed 28 days later on the 18 October 2018. This consultation process has therefore met statutory requirements.	
7	Minor edits p.4	• *Incorrect reference to '2004 consultation requirements' that should be updated to read '2010 consultation requirements' (Niche 2019, p.13).*	The reference has been updated in Niche 2019.	Niche Environment and Heritage (2019) *Aboriginal Cultural Heritage Assessment*. Prepared for

ID	Section	Comment	Response / Correction	Reference
				South32 Illawarra Coal Operations, September 2019.
8	Summary of Recommendations p. 4	• *Correct the inconsistencies in reporting (Niche 2019a and b) on the number of recorded Aboriginal heritage sites within the LW20-21 extraction area and 600m boundary.*	See response provided in Table A4, ID – 1.	
9	Summary of Recommendations p. 4	• *Provide evidence of appropriate levels of effective survey coverage across the LW20-21 extraction area and 600m boundary.*	See response provided in Table A4, ID – 2.	
10	Summary of Recommendations p. 4	• *Provide evidence that site 52-2-0458 is outside the LW20-21 area. The applicant should update the AHIMS site card with the correct grid reference.*	See response provided in Table A4, ID – 3.	
11	Summary of Recommendations p. 4	• *Provide updated baseline recording for all nine sites within the 600m boundary of the LW20-21 extraction area.*	See response provided in Table A4, ID – 4.	
12	Summary of Recommendations p. 4	• *Explain whether Newton Carriage was consulted, as recommended by NTSCORP.* • *Clarify how Stage 3 of the consultation process has met the statutory timeframes.*	See response provided in Table A4, ID – 6.	
13	Summary of Recommendations p. 4	• *Revise the Aboriginal heritage impacts in the subsidence report (MSEC 2019, p.63) to be consistent with the numbers and types of sites reported by Niche (2019a and b) and to ensure all Aboriginal heritage sites have been assessed for subsidence risk.*	The MSEC 978 report has been updated accordingly.	MSEC (2019) *Subsidence Predictions and Impact Assessments for Dendrobium LW20 and LW21*. Report Number MSEC978 | Revision E.

ID	Section	Comment	Response / Correction	Reference
14	Summary of Recommendations p. 4	• *Note that any additional surface infrastructure must have been subject to an Aboriginal cultural heritage assessment.*	Any additional surface infrastructure will be assessed for Aboriginal cultural heritage values as appropriate.	

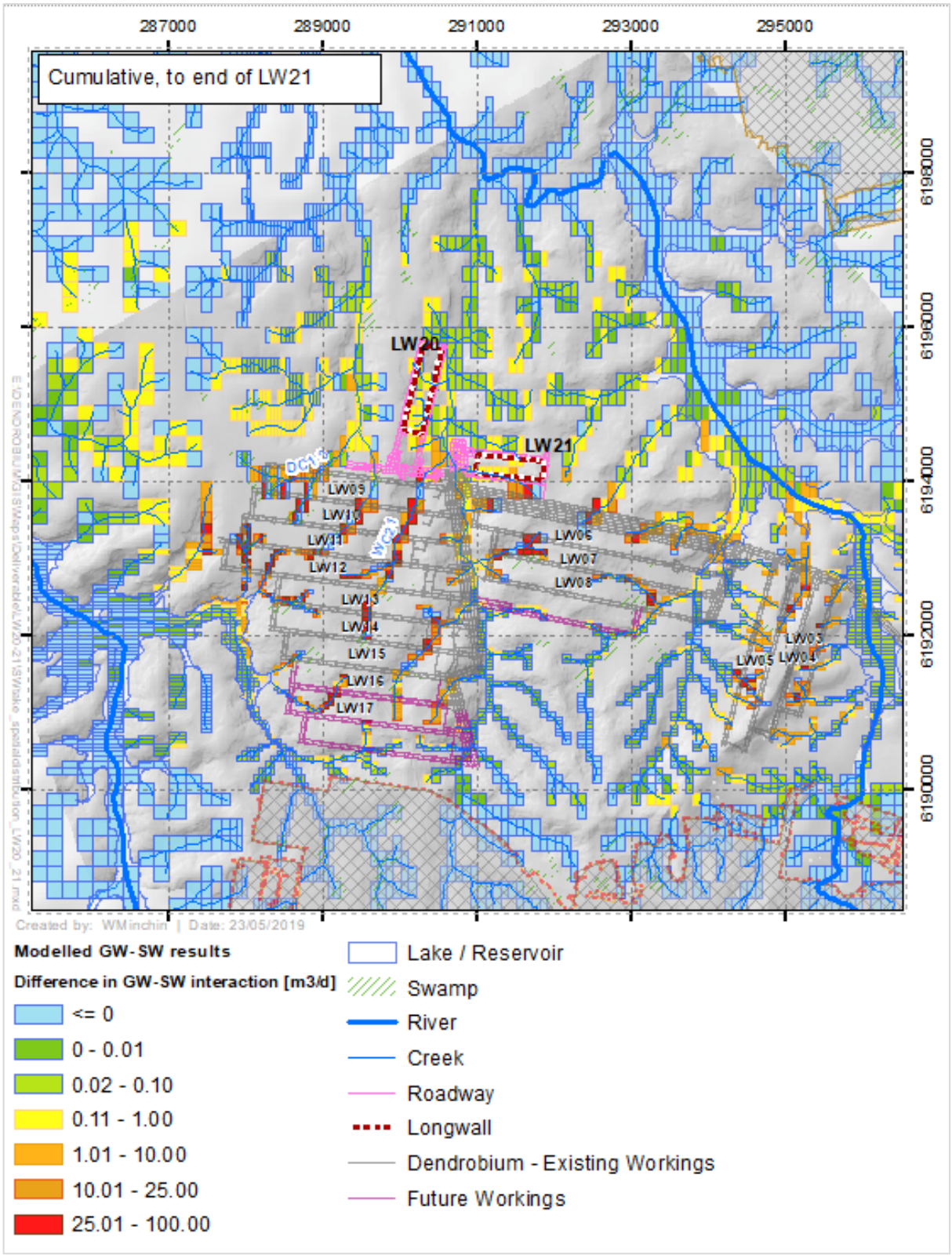

Figure 1 Spatial distribution of modelled surface water reduction (cumulative to end of Longwalls 20 and 21)

Figure 2 Flow at Pool 9 on WC17 pre-mining (left) and post-mining (right).