APPENDIX E:
ADDITIONAL INFORMATION PROVIDED BY CASLTLEREAGH COAL

1. Response to Department and Agency comments on RTS, dated 10 May 2017
2. Final Landform Options, dated June 2017
3. Additional assessment of impacts on conservation values, dated July 2017
4. Response to EPA comments on draft conditions, dated 18 October 2017

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Our Ref: 3622D

10 May 2017

Clay Preshaw
A/Director Resource Assessments
NSW Department of Planning and Environment
GPO Box 39
Sydney NSW 2001

Dear Clay

Re: Invincible Southern Extension Project, Additional Information Required for Assessment

The Department of Planning and Environment (DP&E) formally sought comments from Government agencies on the Response to Submissions (RTS) for the Invincible Southern Extension Project (the Southern Extension Project). In its correspondence of 3 April 2017, DP&E has sought formal response to a number of matters raised by government agencies.

It is noted that Lithgow City Council has not raised any additional issues, aside from entering into a Voluntary Planning Agreement (refer to **Section 1.3**) and the Department of Resources and Energy (DRE) reiterated its support for the Southern Extension Project.

The further additional information has been prepared by Umwelt (Australia) Pty Limited (Umwelt) on behalf of the proponent, Castlereagh Coal Pty Ltd (Castlereagh Coal), to address the matter raised.

This response outlines each issue raised by the DP&E and Government Agencies in bold italic text with the response to the identified issue provided in the text below.

1.0 Department of Planning and Environment

1.1 Mine Plan Justification

Further justification for the proposed mine plan is required including consideration of options to avoid open cut mining within 300 metres of pagodas and other associated geodiversity features, including escarpments.

This consideration should include the quantity of coal that would be sterilised, including 'nut coal', and the economic costs associated with avoidance. The justification may also include consideration of other operational constraints of avoidance including implications on scheduling and rehabilitation.

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As detailed in Section 3.6 of the Environmental Assessment (EA), and extensively throughout the RTS reports (notably Section 3.1 of the RTS Part A), the rationale for the Southern Extension Project is to ensure that the Manildra Group's Shoalhaven Starches plant at Bomaderry has a cost effective and reliable supply of nut coal, thereby ensuring the continued operation of the plant and the continued employment of its workforce. Sections 3.6 and 3.7 of the EA include a detailed discussion regarding the alternatives considered in meeting the energy supply requirements for Shoalhaven Starches and the mine design options considered in the development of the Southern Extension Project mine plan.

The need for a reliable and cost effective energy supply for the Shoalhaven Starches Plant is of critical importance in the context of continued upward pressure on the costs associated with energy supply for this operation. The coal price being paid for the specialty nut coal is significantly higher than Castlereagh Coal's expected costs of production for the same product as part of the Southern Extension Project. This is partly as a result of the nut coal being considered a niche product which requires different production and handling requirements which increases costs, coupled with the lack of suppliers of the product in NSW which is also considered to be a factor in pricing. Moreover, given that the market for this niche coal product is relatively small, the volume of coal required by Shoalhaven Starches would not be sufficient by itself to justify the continued operation of the existing suppliers in NSW. If market forces were to impact on existing suppliers this would be expected to have significant impacts for Shoalhaven Starches. It is for this reason that ensuring a certainty of supply is vital.

In addition, and as outlined in Section 3.6 of the EA, the supply of nut coal is one of the energy mix options for Shoalhaven Starches which also consists of electricity, gas and to lesser extent wood chips. Electricity is currently more expensive that coal or gas, and with short to medium term projections indicating a potential 60 per cent increase in gas prices by late 2017, there are significant cost pressures on Shoalhaven Starches, and other manufacturing operations in NSW. As such, without the ability to access a cost effective source of energy, such as that provided by the Southern Extension Project, there is significant pressure on the ongoing competitiveness of the Shoalhaven Starches Plant.

In this context, Castlereagh Coal have completed a detailed examination of the potential impacts associated with complete avoidance of mining with 300m of pagodas and other associated geodiversity features, including a cliff line, as requested by DP&E. The application of a 300m area of avoidance from these closest structures would result in an exclusion of mining along the proposed eastern extent of the Southern Extension Area (SEA) (refer to **Figure 1**). This exclusion of mining would also remove the north eastern extent of the proposed SEA, which is greater than 300m from these structures, as this area would not be efficient to mine with the exclusion of mining along the eastern boundary of the SEA.

In terms of the supply of nut coal, this would result in a reduction of approximately 29,000 tonnes (product) and 58,000 tonnes (ROM) of nut coal from the SEA, which represents approximately 10% of the total nut coal resource in the SEA. At supply rate of 85,000 tonnes per annum, this represents a reduction of approximately 30% of a year's supply to Shoalhaven Starches from the Southern Extension Project in isolation. This mine plan change would reduce the life of mine (mining at a rate to provide 85,000tpa nut coal and ramp down in final year) to three years. The loss of this target resource would significantly impact on the viability of the Southern Extension Project to provide the nut coal supply required for Shoalhaven Starches Plant.

In addition, the loss of this area of the SEA would also result in the reduction of approximately 249,000 tonnes of other ROM coal from the Southern Extension Project, which is proposed to be supplied to the Mount Piper Power Station. Importantly, it is noted that the submission from Energy Australia in support of the Southern Extension Project includes the following statement:

'Energy Australia owns and operates the nearby Mt Piper power station, which provides up to 15% of NSW's electricity. Invincible was one of four local mines that supplied coal to Mt Piper prior to 2013. Currently Mt Piper relies on coal supply from a single source, being the Springvale mine.

Mt Piper power station will directly benefit from the project by receiving relatively small volumes of coal from Invincible to supplement supplies from the Springvale mine. Diversity of coal supply remains a significant challenge for Energy Australia and a risk to Mt Piper contributing to provide secure and affordable electricity in NSW.

We also support efforts to maintain a strong and viable coal mining industry in the Lithgow region. A capable and functioning coal industry in the Lithgow region makes significant contributions to the local economy and provides mining and electricity generation jobs.'

The Energy Australia submission supports the discussion in Section 3.6 of the EA regarding the importance of diversity of supply options (both for Shoalhaven Starches and for the Mt Piper Power Station).

In the context of the overall benefits of the Southern Extension Project, the cost benefit analysis for the Southern Extension Project has been revised on the basis of excluding the coal resources from the within the excluded proportion of the SEA. The results for the revised Benefit Cost Analysis are shown in **Tables 1** and **2.**

Table 1: Net Benefits of the Project (with 300m pagoda exclusion) to NSW

Benefits	Total NPV ($'000)	Costs	Total NPV ($'000)
Direct benefits		**Direct costs**	
1. Net producer surplus attributed to NSW	$37.4		
2. Royalties, payroll tax and Council rates	$10.5		
3. Company income tax apportioned to NSW	$5.7		
Total direct benefits	**$53.6**	**Total direct costs**	**$0.0**
Indirect benefits		**Indirect costs**	
1. Net economic benefit to existing landholders	$0.0	1. Air quality	
2. Net economic benefit to NSW workers	$4.7	2. Greenhouse gas emissions	-$1.8
3. Net economic benefit to NSW suppliers	$16.9	3. Visual amenity	
3. Net economic benefit to Private Royalties	$0.0	4. Transport impact	-$0.2
		5. Net public infrastructure cost	
		6. Residual value of land	-$0.1
		7. Biodiversity impact	-$3.1
		8. Noise impact	$0.0
		9. Loss of surplus to other industries	
		10. Water	
		11. Aboriginal cultural heritage	
		12 Historical heritage	
Total indirect benefits	**$21.7**	**Total indirect costs**	**-$5.1**
Total economic benefit of project	**$75.3**	**Total economic cost of project**	**-$2.0**

Benefits	Total NPV ($'000)	Costs	Total NPV ($'000)
NPV of project - NSW Community ($'000)	**$73.3**		
BCR (benefit cost ratio)	**$37.7**		

Table 2 Net Benefits to the Local Region (with 300m pagoda exclusion)

Benefits	Total NPV ($'000)	Costs	Total NPV ($'000)
Direct benefits		**Direct costs**	
1. Net producer surplus attributed to Local Region	$0.0		
2. Royalties, payroll tax and Council rates	$0.0		
3. Company income tax apportioned to Local Region	$0.0		
Total direct benefits	**$0.0**	**Total direct costs**	**$0.0**
Indirect benefits		**Indirect costs**	
1. Net economic benefit to existing landholders	$0.00	1. Air quality	
2. Net economic benefit to workers in Local Region	$3.80	2. Greenhouse gas emissions	$0.00
3. Net economic benefit to suppliers in Local Region	$3.39	3. Visual amenity	
3. Net economic benefit to Private Royalties	$0.00	4. Transport impact	$-0.16
		5. Net public infrastructure cost	
		6. Surface water impact	
		8. Residual value of land	$-0.07
		7. Biodiversity impact	
		8. Noise impact	$-0.01
		9. Loss of surplus to other industries	
		10. Water	
		11. Aboriginal cultural heritage	
		12 Historical heritage	
Total indirect benefits	**$7.19**	**Total indirect costs**	**$-0.25**
Total economic benefit of project	**$7.19**	**Total economic cost of project**	**$-0.23**
NPV of project – Local Region ($'000)	**$6.95**		
BCR (benefit cost ratio)	**$30.90**		

Table 3 compares the net benefits to the state of the proposed Southern Extension Project with the benefits modelled for the Project with a 300m exclusion from pagodas structures.

Table 3 Comparison of cost benefit of Southern Extension Project and with 300m exclusion

	Benefits ($M)	Costs ($M)	Total economic benefit ($M)
Southern Extension Project - EA	$81.8	$2.2	$79.7
Southern Extension Project – with 300m exclusion	$75.3	$2	$73.3
Difference	-$6.5	-$0.2	-$6.4

As can be seen in **Table 3,** the Southern Extension Project, as proposed in the EA, delivers higher net benefits for the State than the Southern Extension Project would with the incorporation of the 300m exclusion. The benefits for the local region are also higher for the Southern Extension Project than the project with the 300m exclusion from pagodas ($8.77M versus $6.95M).

The reduction in mining area through applying 300m exclusion would also reduce the overburden material from this area of mining in the order of approximately 2.8M bank cubic metres (Mbcm), which is currently proposed to be utilised in achieving the proposed final landform for Invincible. As discussed in Section 3.7.1.1 of the EA, there is sufficient material currently available at Invincible to fill existing voids however the earthworks required to fill these voids would require the disturbance of areas where rehabilitation has already commenced in accordance with existing approvals. This would significantly delay the successful rehabilitation of these areas and the further rehandling of emplaced topsoil in these areas increases risks associated with erosion and degradation of the biological resources in the soil material.

The proposed mine plan for the Southern Extension Project is designed to maximise filling of existing voids early in the proposed mine life, with the creation of an integrated final landform which contains no voids. This is detailed in Section 3.5 of the EA. Accordingly the loss of this overburden material associated with the exclusion of mining activities within the SEA will reduce the effectiveness of utilising this material in the rehabilitation of Invincible.

Of critical importance, is that the location and design of the Southern Extension Project has sought, to the extent practicable, to avoid and minimise impacts on pagodas and other structures in proximity to Invincible. As discussed in Section 1.3 of the EA, previous assessment findings and submissions from agencies and other stakeholder groups were taken into account in selecting the SEA as the preferred mining area. Environmental constraints studies and mine design work were also undertaken to refine the mine plan for the SEA. As detailed in Section 3.7 of the EA, as part of the detailed constraints review, the Southern Extension Project has been located and designed to minimise impacts whilst still achieving the objective of a reliable supply of nut coal to Shoalhaven Starches. Key considerations included the location of the proposed mining to the south, which represents a less geo diverse landscape relative to the landscape to the north and east of Invincible, as well as a reduction in the north eastern extent of open cut mining in the SEA in this as previously proposed as part of the Modification 4 application (refer to Figure 1.3 of the EA).

In the context of pagodas and other geodiverse structures, the location and design of the Southern Extension Project results in just 6 hectares of the total 49 hectares (or 12%) of the SEA being located within 300m of these structures. As shown in **Table 4**, this represents a significant reduction in the areas of proposed mining within 300m of these structures relative to previous proposals (refer to **Figure 1**).

Table 4: Comparison of proposed impact areas

	Consolidation Project*	Modification 4 Project*	Southern Extension Project*
Total area of Proposed Open Cut Mining Disturbance	794 hectares	152 hectares	49 hectares
Proposed Open Cut Within 300m of Pagodas and Geodiverse Structures	456 hectares (57%)	57 hectares (37.5%)	6 hectares (12%)
Total Area of Proposed Highwall Mining	294 hectares	189 hectares	N/A
Proposed Highwall Within 300m of Pagodas and Geodiverse Structures	269 hectares (91%)	163 hectares (86%)	N/A
Total area of Proposed Mining Within 300m of Pagodas and Geodiverse Structures	724 hectares (66%)	220 hectares (65%)	6 hectares (12%)

*Numbers in brackets indicates percentage of proposed mining within 300m of pagodas or geodiverse structureS

Moreover, the detailed assessments completed for the EA provide the basis for further minimisation and mitigation of impacts of mining within 300m of these structures, including:

- The pagoda and cliff line structures in close proximity to the SEA have been subject to a detailed geotechnical assessment to determine stability and risk of impacts from blasting (refer to Appendix 9 of the EA) and to define conservative blast vibration criteria to ensure protection of these structures over the life of the Southern Extension Project. As detailed in Appendix 9 of the EA, these conservative blast criteria can be met through appropriate blast design, primarily through control of the blast size, along with comprehensive baseline and ongoing condition monitoring.

- The only pagoda structure within 300m of the SEA (located approximately 210m from the SEA) does not contain any suitable habitat for the Broad Headed Snake, with the closest record over 1km from the SEA. Notwithstanding this, the Biodiversity Offset Strategy for the Southern Extension Project conservatively assumes the presence of suitable summer foraging habitat within 500m of this, and other pagoda structures, which is proposed to be offset by Castlereagh Coal.

In consideration of the above matters, Castlereagh Coal submits that the currently proposed SEA represents a suitable mining area that has balanced the needs for economic and viable supply of nut coal whilst avoiding and minimising potential impacts to pagodas and other geodiverse structures.

1.2 Noise

The Department notes that the assessment has been undertaken in accordance with the Draft Industrial Noise Guideline rather than the Industrial Noise Policy.

As detailed in Section 6.9 of the EA, the Noise Impact Assessment (NIA) was undertaken in accordance with the Draft ING as it was expected at this time that this would be the applicable policy to manage noise over the life of the Southern Extension Project. Notwithstanding, in the absence of a final ING being released, the following details are provided in relation to the Industrial Noise Policy (INP) as it relates to the Southern Extension Project.

Given that the Draft Industrial Noise Guideline is not currently Government policy, the Department requires an assessment of the adopted background noise level and project specific noise level in accordance with the Industrial Noise Policy. This should consider background monitoring undertaken for previous proposals, to confirm assumptions in the assessment.

Unattended monitoring has been previously undertaken between 19 December 2005 and 31 December 2005 at the Billabong property (Residence 393) and the Hillview property (Residence 394) as documented in Environment Assessment of the Proposed Extension to the Invincible Colliery Open Cut Mine and Production Increase (R.W. Corkery & Co, April 2008). It is noted that during this period Invincible was under care and maintenance and therefore not significantly contributing to the background noise environment. As outlined in the NIA there have been no significant changes to the surrounding background noise environment in the time since completion of this monitoring.

Based on the previous unattended noise monitoring results, Project Specific Noise Levels (PSNL) has been derived for the Southern Extension Project in accordance with the INP (EPA, 2000) and is presented in **Table 5**.

Table 5 Revised Project Specific Noise Levels, dB(A)

Location	Time Period	Rating Background Noise Level	Intrusiveness Criteria (LAeq, 15 minute)	Amenity Criteria (LAeq, period)	Project Specific Noise Level (LAeq, 15 minute)
Billabong (Residence 393)	Day	35	40	50	40
	Evening	31	36	45	36
	Night	30[1]	35	40	35
Hillview (Residence 394)	Day	36	41	50	41
	Evening	30[1]	35	45	35
	Night	30[1]	35	40	35
All other Privately Owned Residences	Day	30[2]	35	50	35
	Evening	30[2]	35	45	35
	Night	30[2]	35	40	35

Note 1: Where the measured RBL in the region surrounding the Project Area is at or below 30 dB(A) the corresponding Intrusiveness Criteria has been set be 35 dB(A). This is the minimum possible Intrusiveness Criterion under the INP (EPA, 2000).

Note 2: The minimum RBL of 30 dB(A) specified by the INP (EPA, 2000) has been assumed for all other privately owned residences.

Consideration of all reasonable and feasible noise mitigation measures is required with regard to receiver 394, in accordance with the requirements of the Voluntary Land Acquisition and Mitigation Policy.

Reasonable and feasible noise mitigation measures were investigated and where possible implemented as part of the EA (refer to Section 6.9 and Appendix 10 of the EA). The design process for the Southern Extension Project included an iterative modelling process, which investigated fleet selection and optimisation to minimise noise impacts at the nearest privately owned residences. It was found that noise associated with the CAT 785 trucks, which were originally proposed to haul overburden, was identified as being a dominant noise source. Therefore, alternative CAT 777 (or acoustically similar) haul trucks have been incorporated into the design as a reasonable and feasible measure. The CAT 777 truck (or similar) is approximately 10 dB(A) quieter than the CAT 785 and would therefore result in significantly reduced overall noise emission from the Southern Extension Project. An optimised rate of haulage to the northernmost emplacement site was also incorporated into the design as a reasonable and feasible noise mitigation measure.

In addition to the mitigation measures incorporated into the design of the Southern Extension Project, Castlereagh Coal committed to meeting relevant noise criteria through implementing the following further reasonable and feasible operational mitigation measures in the EA (refer to Section 6.9.9 of the EA for full list of mitigation measures):

- the management of mobile machines during adverse weather conditions when wind conditions enhance the noise propagation towards sensitive receiver locations which would likely include:
    - where possible, not operating a dozer for shaping during rehabilitation at the northernmost emplacement site in the final year of the mine life
    - moving extraction activities to locations deeper in the mine pit during adverse weather conditions
    - shut down of some equipment and activities during adverse weather conditions, if required, in particular haulage of overburden to the emplacement areas.

The shutdown of equipment during adverse weather conditions provides various options for management of noise emissions from the Southern Extension Project. Examples of applying these operational controls are shown in the revised predicted operational noise levels in **Table 6** where the following fleet management have been implemented:

- For Daytime Stage 1 under adverse (3m/s NE) winds: shut down overburden shaping dozers, restrict operation of Water Cart in exposed locations, and relocate the pre-strip excavator and associated trucks into the pit and reroute overburden trucks to in pit dumping.
- For Daytime Stage 1 including Overburden Haulage to Eastern Void under calm conditions: shut down overburden shaping dozers, and restrict operation of Water Cart in exposed locations.
- For Daytime Stage 1 including Overburden Haulage to Eastern Void under adverse (3m/s NE) winds: shut down overburden shaping dozers, restrict operation of Water Cart in exposed locations, and reroute overburden trucks to in pit dumping.

Table 6 Predicted Operational Noise Levels, dB(A) with incorporation of example operational controls

Receiver No	Daytime, Stage 1 Mine Plan, LAeq,15min, dB(A)		Daytime, Stage 1 Mine Plan (includes Overburden Haulage to Eastern Void) LAeq,15min, dB(A)		Evening, Product Transportation LAeq,15min, dB(A)		Maximum Predicted Daytime Noise Level LAeq,15min, dB(A)	Maximum Predicted Evening Noise Level LAeq,15min, dB(A)
	Calm	3m/s NE Wind	Calm	3m/s NE Wind	Calm	3m/s NE Wind		
349	33	29	32	32	20	19	33	20
393 Billabong	35	32	35	38	25	23	38	25
394 Hillview	43	40	**43**	**43**	35	32	43	35
392	30	33	29	35	20	27	35	27
373	30	28	28	30	15	17	30	17
388	25	34	24	34	13	22	34	22
391	26	35	25	35	14	25	35	25
412	26	35	25	35	13	27	35	27
404	22	31	22	31	8	21	31	21
419	21	30	20	30	10	19	30	19
421	21	28	21	29	10	19	29	19
426	27	31	26	32	18	24	32	24

Based on the predicted noise impacts in **Table 6** with the example operational management options described above in place during adverse weather conditions, in accordance with the INP the Southern Extension Project is estimated to exceed the Project Specific Noise levels by 2dB or less at Receiver 394 (Hillview) during the daytime period. In addition, with the incorporation of these types of operational controls, noise prediction indicates that the relevant INP criteria can be met at all other surrounding private residences.

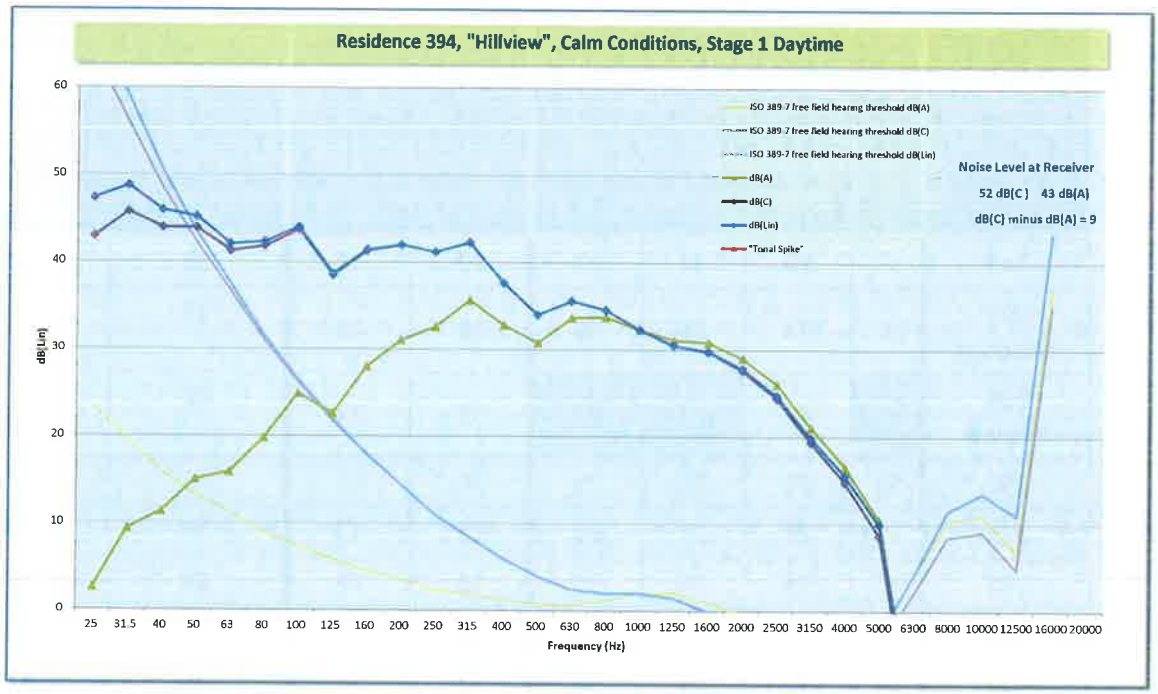
It is noted that the Voluntary Land Acquisition and Mitigation Policy (VLMAP) (DP&E, 2014) notes that noise levels 0 to 2 dB above the PSNL is considered to negligible and "would not be discernible by the average listener and therefore would not warrant receiver based treatments or controls." Given this negligible level of predicted exceedence, voluntary mitigation rights would not be required for Hillview (residence 394) in accordance with the VLAMP.

The Department requires an assessment of low frequency noise with respect to the proposal.

The NIA (refer to Appendix 10 of the EA) investigated the need to apply "Modifying Factors", in accordance with Section 4 of the INP (EPA, 2000) including the consideration of low frequency noise impacts.

The noise model results indicated that at the privately owned residential receivers, the application of modifying factors, including those associated with low frequency noise was not required. An example of the predicted third octave noise levels is shown below in **Figure 2** which clearly shows that no tonal or low frequency modifying factors are required as the "C minus A" criterion is well below the 15dB difference threshold.

Figure 2: Third Octave Analysis of Predicted Noise Levels at Residence 394, Hillview



1.3 Voluntary Planning Agreement

Castlereagh Coal should progress the negotiations with Lithgow City Council and provide a copy of a draft planning agreement to the Department as soon as practicable.

Castlereagh Coal has consulted with Lithgow City Council (LCC) in relation to the terms of entering into a Voluntary Planning Agreement (VPA) for the Southern Extension Project. On the basis of this engagement, Castlereagh Coal has formally approached LCC to enter into a VPA consistent with the terms outlined in **Appendix 1**. At its meeting of 8 May 2017, LCC resolved to support the draft VPA and have placed the draft VPA on public exhibition based on the terms outlined in **Appendix 1**.

2.0 Department of Primary Industries

DPI does not consider that sufficient evidence has been provided to support the claim that no groundwater entitlement will be required. Being located up the slope from an already depressurised aquifer system does not mean that the void won't be receiving groundwater inflows from further upgradient. The proponent should provide further detailed justification for the conceptual idea that the proposed Southern Extension will not have any groundwater inflows once the initial mine void water is pumped out.

This justification should be supported with a cross section and map showing expected and measured groundwater heights and flow, existing measured and predicted flooding of the Ivanhoe No.2 void and proposed finished levels of the Southern Extension floor.

As discussed in the EA, the only geological strata potentially operating as an aquifer in the area directly affected by mining in the SEA is the Lithgow Seam. With the exception of the barrier coal between the Ivanhoe No. 2 workings and the Invincible Open Cut, the coal in the Lithgow seam in the Southern Extension Area has previously been mined with only pillars remaining between the mined roadways. This also remains true for areas of the Lithgow seam up-dip from the proposed mining area. Accordingly, there is no continuous point of connection between coal pillars that will support transmission of groundwater through this strata in the proposed mining area or the area up-dip.

Notwithstanding the above, the rehabilitated former Ivanhoe Open Cut workings located to the west of Castlereagh Highway extend to the floor of the Lithgow seam and present a potential source of inflow or recharge to the underground workings in the Lithgow seam. Water infiltrating through the spoil in the rehabilitated landform (approximately 16.9 hectares) could flow into the former Ivanhoe No. 2 workings where these were intercepted by the Ivanhoe Open Cut Workings. This water will then flow down the mined road workings towards the SEA. This infiltration rate will be unaffected by the Southern Extension Project. The following graphic outlines the process to determine the conceptual flow rate for groundwater from the Ivanhoe open cut area.

The average annual volume of infiltration (and therefore water entering the former workings) has been estimated as follows:

Area x Average Annual Rainfall x infiltration rate =volume of water entering underground workings

Where:

- *Area* = 16.9 hectares
- Average annual rainfall = 762 mm
- Infiltration rate = 5% (conservative estimate)

Estimated average annual volume of water entering underground workings = 6.44 ML

Note: Under natural conditions (i.e. no former mining in the area and Lithgow seam outcropping on the surface), the following would be the expected groundwater recharge rate:

Area of exposed seam up dip of workings x Average Annual Rainfall x infiltration =volume of water entering Lithgow seam up dip of Southern Extension Area

Where:

- *Area* = Approximately 1.3km x 3m seam height = 3,900m2
- Average annual rainfall = 762 mm
- Infiltration rate = 1% (very conservative estimate)

Estimated (theoretical) annual up-dip recharge of water entering Lithgow seam =0.03 ML

Movement of infiltration water under current conditions

Under current conditions it is understood that this water, together with water intercepted through surface cracking above the underground workings, will pond in the low point of the Ivanhoe No 2 workings in the SEA until the water level reaches the ridgeline in the floor of the Lithgow seam to the south east. Once the water level in this part of the workings exceeds the ridge line, additional water entering this part of the workings will flow over the ridge line slowly filling up the lower parts of the Ivanhoe No. 2 workings to the south east. The monitoring of water levels in the Ivanhoe Underground Workings taken since November 2016 indicate that the ponded water level in the Ivanhoe No. 2 workings is at or slightly below the ridge line meaning new flows entering the workings are likely to flow over the ridgeline and flow to the south east.

Some of the ponded water will also move through the barrier coal to the north of the Ivanhoe workings where it will migrate as groundwater down-dip towards the north east. This water would then report to either the Invincible Open Cut or the Invincible Underground workings.

Movement of infiltration water under Southern Extension Project

Under the Southern Extension Project, the water running down the former roadways will no longer pool in the lowest point of the underground workings but will instead seep into the pit via the intercepted roadways in the western edge of the pit. This water will be either pumped from a sump in the pit to the Northern Dam (which is interconnected with the Invincible Underground workings) or it will naturally flow downhill towards the emplaced in-pit overburden where it seep through the spoil and ultimately into the Invincible Underground workings.

The key change between the existing conditions and the Southern Extension Project is that the water infiltrating through the Ivanhoe Spoil will no longer end up in the eastern section of the Ivanhoe No. 2 Workings as there will be no ponding in the SEA which would cause the infiltration water to flow over the ridge. The ultimate destination of the water will however remain essentially the same, that is, underground workings in the Lithgow seam.

Licensing

The infiltration into the Ivanhoe No. 2 workings via the Ivanhoe open cut is take of surface water associated with the Ivanhoe Operations. The Southern Extension Project will not increase the extent of this take which currently occurs.

To the extent that the reporting of this water to the Invincible Open Cut Pit would be licensable take of underground water (subject to the Sydney Basin MDB Groundwater Source (Sydney Basin MDB (Other) Management Zone)), it is noted that this water will be transferred to the Invincible Underground workings in the Lithgow seam which would have been the most likely ultimate destination for this water under current operating conditions. Accordingly, the Southern Extension Project is not considered to 'take' this water as the water will remain within the same aquifer system and subject to the same water sharing plan.

It is also noted that Shoalhaven Coal currently hold groundwater licence WAL 35978 which entitles Shoalhaven Coal to take 26 units of groundwater from the Sydney Basin MDB Groundwater Source (Sydney Basin MDB (Other) Management Zone). This is sufficient to cover this take should it be considered licensable.

Implications for Water Balance

The estimated 6.44ML of water entering the pit via the Ivanhoe No. 2 workings was not included in the Site Water Balance provided with the RTS Report B.

Notwithstanding, this volume represents less than 1% of inflows to the system in the 50th %ile model scenario (refer to Table 3.1 of Appendix 2 of the RTS Report B). This is well within the margin of error for the Water Balance and will have negligible impact on the overall water balance predictions.

The RTS indicates the seepage rate into the downgradient Baal Bone Colliery will increase by up to 15ML/yr. The proponent should undertake consultation with the operators of Baal Bone Colliery to confirm any potential licensing or management implications due to this impact.

As outlined in the RTS Part B, Castlereagh Coal will enter into consultation with the operators of Baal Bone Colliery in relation to water management upon approval of the Southern Extension Project. Details of required management will be detailed in the Water Management Plan for the Southern Extension Project, which will be developed in consultation with DPI Water.

It is also noted that Shoalhaven Coal currently hold groundwater licence WAL 35978 which entitles Shoalhaven Coal to take 26 units of groundwater from the Sydney Basin MDB Groundwater Source (Sydney Basin MDB (Other) Management Zone). This is sufficient to cover and additional take required by Baal Bone (estimated at 15 ML/annum) should Baal Bone have insufficient groundwater licences to cover the additional extraction required as a result of the Southern Extension Project (even with allowance for the inflows associated with mining in the Southern Extension Area (estimated at 6.44ML/annum) being considered to be licensable take).

DPI Water understands the current proposal will not directly increase the capture of surface water on the basis that currently all surface water from the proposed open cut area is captured by the existing subsidence cracks. Quantification however is requested in two areas of the water balance as listed below. This is to confirm water management due to the proposed open cut and to assist DPI Water in providing further advice on licensing requirements for the remainder of the site.

- ***Quantify the volume of runoff to be managed at maximum development within the southern extension area open cut and how this will be managed. This is a change from the current management of water infiltrating into the underground.***

- ***Quantify the volume of clean runoff entering the open cut or underground workings from the remainder of the site.***

As discussed in Section 2.2.1.2 of the RTS Part B, the Southern Extension Project does not result in any change to the catchment managed within the water management system compared to the existing or approved operations (as detailed on Figure 1.3 of the RTS Part B). It is noted however that some of the water falling within the Southern Extension Area would have infiltrated to the Ivanhoe No. 2 workings through subsidence cracks and not have reported to the current WMS. The annual volume of the water infiltrations to the Ivanhoe No 2 Underground workings is not known and near impossible to estimate with any degree of accuracy due to the ephemeral nature of the water courses.

From an overall licensing perspective in terms of take however, there is no material difference between the water 'take' from the Cullen Creek catchment under the existing approved operating scenario, the current care and maintenance scenario or the Southern Extension Project scenario as total of the 'loss' of surface water to the Ivanhoe No. 2 workings and the capture within the current WMS catchment area is the same as the total predicted capture within the WMS associated with the Southern Extension Project operating scenario.

The existing operations at Invincible were approved in 2008 with the full extent of existing approved operations approved on 12 August 2009.

The open cut footprint had reached its full extent (and the WMS catchment was at its full extent) by at least early 2012 and runoff from the SEA and upstream catchment (other than that intercepted via subsidence impacts) was captured and managed as part of the Invincible Water Management System from at least the mid-1980s.

As the catchment for the existing Invincible open cut water management system was at its full extent by the time the *Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources 2012* commenced and previous surface water capture within the water management system did not require licensing, it is considered that there is no additional surface water take as part of the Southern Extension Project that would require licensing under the *Water Management Act 2000*.

In relation to the point above all surface water is not captured through the subsidence cracks, rather the WMS catchment for the approved operations has been established, including existing clean water catchment, and will not be altered by the Southern Extension Project. Notwithstanding, it is noted that the runoff from the Southern Extension Area is significantly impacted by subsidence from the historical Ivanhoe No. 2 Underground workings; these latter impacts would have been occurring well before 2000 and the commencement of the *Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources 2012* in October 2014.

The water balance assessment prepared for the Southern Extension Project was based on the entire Southern Extension Area and the existing Invincible WMS and provide the maximum volume of water to be managed through over the life of the Southern Extension Project which includes water across the entire Invincible site. This water balance has also used conservative assumptions regarding run-off from the areas potentially impacted by subsidence.

Table 7 below has been extracted from the water balance model to identify the volume of clean water runoff entering the Invincible WMS under a range of statistical measures.

Table 7: Volume of Clean Water runoff into the Invincible WMS

Statistic	Volume (ML)
10th percentile	75
50th percentile	331
90th percentile	693

As identified above, the Invincible WMS catchment will not be altered by the Southern Extension Project.

DPI acknowledges the difficulty in installing clean water diversions in the terrain at the site. It is recommended, however, they be installed where possible to minimise the volume of clean runoff entering the disturbed areas and to maximise the available water downstream of the site.

As discussed in Section 6.3.5.1 of the EA, the Southern Extension Project will not increase the area of Cullen Creek catchment currently managed within the Invincible WMS. The existing WMS catchment includes the capture of runoff from areas of undisturbed catchment (predominately upstream from the Northern and Eastern Voids) and parts of the upstream catchment that are impacted by subsidence cracking which is believed to intercept a significant proportion of surface flows (refer to Figure 1.3 of RTS Part B).

While it is desirable to maximise the diversion of clean water around disturbed areas, considerations such as the impacts associated with the increased disturbance area necessary to achieve these diversions and the timing and cost of the diversion works need to be taken into consideration.

The terrain upstream of the Northern and Eastern Voids is not amenable to the installation of diversion channels around the existing disturbance areas and any diversions would require the construction of dams and water reticulation infrastructure and it is likely additional works at the discharge points down stream (in the current Invincible biodiversity offset areas) would also be required to manage erosion risks; these works would have additional disturbance impacts in currently undisturbed areas with associated biodiversity impacts and potentially impacts on items of Aboriginal heritage.

In addition the up catchment environment to the SEA consists of high slopes and would necessitate the design and implementation of extensive works to achieve clean water diversion, with associated areas of disturbance in these areas. As such, the installation of clean water diversions for the Southern Extension Project are not considered necessary or feasible, in consideration of the potential impacts of associated with the establishment of these controls in the up catchment environment.

In addition, an objective for the rehabilitation of the Southern Extension Project, and Invincible, is for the creation of free draining landform that will return the current WMS catchment back to Cullen Creek.

The proponent must update the Water Management Plan in consultation with DPI Water (water.referrals@dpi.nsw.gov.au) prior to commencement of activities.

This is noted. Castlereagh Coal has committed to the development of a Water Management Plan for the Southern Extension Project in consultation with DPI Water.

3.0 Environment Protection Authority

The EPA is concerned that there is likely to be a high level of uncertainty associated with these predictions as the substantial decrease in predicted volumes for Ivanhoe No.2 is based on limited data, as is the predicted storage volume within the existing Invincible underground workings, as the only groundwater monitoring bore is now discontinued (Australian Groundwater and Environmental 2016). As such, despite predictions that the will be no need to discharge groundwater to surface waters, the EPA recommends that should the MOD be approved, that it include a condition that:

Any water discharge from the mine, both prior to commencement of mining and during mining, must:

- ***meet the ANZECC (2000) guideline default values for upland streams in southeast Australia to protect 95% of species, or***
- ***meet different trigger values to the ANZECC (2000) default values that are site specific derived using the methods recommended by ANZECC (2000) that calculates local water quality criteria which are supported by a comprehensive surface water monitoring program.***

The comments from the EPA are noted.

With regard to the predictions regarding the volume of water in the workings, the calculated volume of water in the workings is not considered to be 'highly uncertain'.

It is noted that monitoring since the installation of the monitoring bore into the Ivanhoe workings has indicated that water levels have remained relatively static since the installation of the bore in late 2016.

These observations support the theory that the level of ponding in the Ivanhoe No.2 underground workings in the area to be intercepted by the mining in the SEA is limited by the ridgeline in the seam workings to the south east which is at approximately 901m AHD (refer to Section 2.1 in Appendix 1 of RTS Part B). The floor levels in the Lithgow Seam in this area are known to a reasonably high degree of accuracy and the volume of water calculated to be in the workings is based on these seam floor levels and conservative assumptions regarding mined seamed depth and recovery rates in the former Ivanhoe No 2 workings (refer to Section 2.1 in Appendix 1 of RTS Part B). To this end, the assumptions regarding the volume of water currently ponded in the Ivanhoe No. 2 Workings which requires transfer is considered to be accurate, if not slightly conservative.

Notwithstanding, as committed to in Section 2.3.1.3 of the RTS Part B surface water monitoring will continue to be undertaken at LD001, Main Water Storage Dam, BSW01 and BSW02 and will include the following analytes: pH, EC, TSS, TDS, SO_4, Ca, Mg, K, Na, Cl, Al, As, Co, Cu, Fe, Mn, Ni and Zn .

This monitoring at BSW01 and BSW02 will be undertaken at least monthly until sufficient samples have been collected to establish site specific triggers for the receiving environment in accordance with ANZECC methodology. Following the establishment of site specific triggers, monitoring of the analytes listed above at BSW01 and BSW02 will be reduced to quarterly sampling.

The water quality monitoring for the Southern Extension Project will be detailed in the updated Water Management Plan to be developed for Invincible. The updated Water Management Plan will be prepared in consultation with DPI Water and the EPA prior to submission of this plan for approval of DP&E.

It is noted that until this time Invincible will continue to be managed under the requirements of the existing EPL 1095. As detailed in Section 2.3.1.1 of the RTS Part B, an analysis of monitoring data in both Cullen Creek and the nearby Nubecks Creek indicates that the receiving catchment are characteristic of lowland streams, not upland streams, which needs to be considered as part of the determination of conditions on any approval for the modification application.

4.0 Office of Environment and Heritage

Additional surveys for Eucalyptus cannonii should be undertaken in the areas identified in accordance with the NSW Guide to Surveying Threatened Plants.

Firstly, the proponent has not undertaken the additional survey recommended by OEH to determine the total number of E. cannonii trees present. The proponent claims to have conducted surveys consistent with the NSW Guide to Surveying Threatened Plants (OEH 2016) guidelines however the proponents survey effort figure does not demonstrate the systematic parallel transects required by the guideline. The guidelines specifically state that the use of plots and random meander searches (both used by the proponent) are not adequate to meet the guideline.

As part of the ecological assessment for the Southern Extension Project, 13 plots and in excess of 30 kilometres of targeted or opportunistic walking surveys that were undertaken within the SEA (approximately 49 hectares in size) throughout the January and April 2016 survey periods. It is noted that almost all surveys undertaken to locate and map Capertee Stringybark (*Eucalyptus cannonii*) until now pre-date the publication of the *NSW Guide to Surveying Threatened Plants* (February 2016).

Notwithstanding, an additional survey for *E.cannonii* has been undertaken across the entire SEA on 5 April 2017 in response to the matters raised by OEH. Two ecologists walked parallel transects (maximum of 40 metres apart) across the SEA in accordance with the *NSW Guide to Surveying Threatened Plants* (OEH 2016) searching for *E. cannonii* (refer to **Figure 3**). For completeness, **Figure 3** includes all walking tracks completed for this species across the multiple survey periods, which clearly demonstrates coverage of the SEA.
Based on the most recent survey, an additional 12 *E.cannonii* individuals were recorded taking the total number recorded across the SEA to 36 (refer to **Figure 4**). The FBA calculator for the project has been amended with the additional records and the credits required to offset this species has changed from 312 to 468 (refer to the response below on the Biodiversity Offset Strategy). As described previously, preliminary offset surveys undertaken in the Hillcroft property(which is proposed as a BioBank site) is expected to generate sufficient credits for this species. Further detailed survey and assessment of the Hillcroft property in relation to *E. cannonii* will be undertaken during the development of the final Biodiversity Offset Strategy to confirm species credit offset requirements are satisfied.

E.cannonii will also be included in the seed mix for rehabilitation of the SEA and other areas of Invincible being rehabilitated. While this commitment to rehabilitation will not create any additional species credits due to it being largely located within State Forest land, it is noted that there are likely to be more individuals of *E. cannonnii* in the rehabilitated landform than are currently present ensuring there is no net loss in the number of individuals of this species in the SEA as a result of the Southern Extension Project.

Secondly, the proponent has not discussed or assessed the NSW Wildlife Atlas record that occurs within the site, suggesting that a known occurrence of E. cannonii has not been included in the credit calculations by the proponent.

As outlined in the Biodiversity Assessment Report (BAR) (refer to Section 2.3.1 of Appendix 6 of the EA), a review of the BioNet Atlas of NSW Wildlife was undertaken to help inform the survey requirements for the SEA. As part of this review it was identified that a single record of a single *E. cannonii* exists within the SEA. The location of this record was visited during the initial surveys of the SEA, however the species could not be located at this record. The record showed an accuracy of 10 metres and given its proximity to the power lines, an assumption that the tree had been felled or otherwise removed was made. Nonetheless, targeted searches, as outlined above, in proximity to that location were undertaken and 10 individuals were recorded within approximately 150 metres of this location. Accordingly, the previous records have been specifically considered and assessed as part of the BAR for the Southern Extension Project.

Thirdly, the environmental assessment completed for the Coalpac Consolidation Project indicated that it was likely that several thousand E. cannonii plants may occur within the larger Coalpac footprint. Whilst this was a larger footprint, the proponent has not attempted to use this information in the context of the current proposal, even though the BAR clearly states that the Coalpac document was reviewed during the preparation of the BAR.

The Consolidation Project ecological assessment (Cumberland 2012) was considered in the BAR (refer to Section 2.3.1 of Appendix 6 of the EA) and a thorough interrogation of this previous ecological assessment was undertaken prior to the completion of field surveys within the SEA. The review of this previous assessment identified that one *E. cannonii* plot was undertaken within the SEA however a review of the results from this plot (supplied in an appendix to that report) identified no *E. cannonii* as occurring in that plot within SEA. Umwelt did however undertake targeted assessment of the area in the vicinity of the plot location to determine if *E. cannonii* had in fact been recorded and omitted from the results presented in the Cumberland (2012) ecological assessment.

Whilst no *E. cannonii* were recorded at the plot location, Umwelt searches identified five individuals in proximity to the plot location.

In terms of the numbers of individuals considered to occur across the larger Consolidation Project area, the ecological assessment prepared by Cumberland (2012) used vegetation communities as a surrogate for habitat to calculate the possible extent of *E. cannonii* across this much larger study area. This is a common technique used on large scale projects where it is not practicable to sample the entire footprint. The densities used for their calculation were based on the results of sampling points completed at locations where the species was occurring. The results of our surveys undertaken as part of the BAR, and with the recent survey conducted on 5 April 2017, has provided extensive survey of the SEA for this species, which resulted in the identification of 36 individuals across the entire SEA.

The survey results also show that this species distribution across Plant Community Types (PCTs) is not uniform and that estimates based on extrapolations in this instance are likely to overestimate the occurrence of the species in the SEA. As such, the results of targeted surveys within the SEA have been used to inform the updated assessment (refer to **Table 8** below) and provide an accurate account of species numbers occurring in the SEA.

Map the full extent of Bursaria spinosa across the southern extension area, AND

- ***Undertake targeted surveys every two weeks from late August to late October to determine whether Bathurst Copper Butterflies are present in the southern extension area; OR***
- ***Assume the butterflies are present and determine the species credits required from the mapped extent of the habitat and offset the credits accordingly.***

The assessment completed for Bathurst copper butterfly and associated *Bursaria spinosa* habitat within the SEA indicates that it is highly unlikely that this species would occur within the SEA based on:

- The completion of previous opportunistic surveys for Bathurst copper butterfly within and surrounding the SEA through this assessment and previous ecological assessments completed in the area, which have not identified this species across 5 years of survey.
- Previous survey and mapping of the extent of *Bursaria spinosa* across the SEA, in addition to further detailed mapping completed in April 2017 which confirms *Bursaria* species was found at only four locations within the SEA, each of which were known from and surveyed for the BAR and the RTS (refer to **Figure 5**). The largest patch of *Bursaria* sp. recorded in SEA is approximately 1000m^2 (0.1 hectares) in area with the four patches combined being approximately 2000 m^2 (0.2 hectares).
- The closest record of Bathurst copper butterfly is located approximately 3.2km to the south of the SEA; this population, along with another recorded population located 3.5km to the southwest from the SEA are considered the northern extent of this local population. Based on the fact that this species has low dispersal ability and there is a significant ridgeline between these southern populations and the SEA, it is considered highly unlikely that the species would occur within the SEA or would populate the relatively small patches of *B. spinosa* located within the SEA.

Notwithstanding the above, further engagement with OEH in regard to the potential presence of Bathurst copper butterfly in the SEA has failed to reach a consensus on this issue. Following discussion with OEH and DP&E it was resolved that the species credit requirements for the Bathurst copper butterfly will be identified based on the potential habitat located within the SEA. Castlereagh Coal will commit to further survey work being undertaken in August to October 2017 in accordance with the targeted survey requirements identified by OEH in its correspondence of 24 March 2017. .

OEH and DP&E have agreed that if the targeted surveys during this period fail to locate the Bathurst copper butterfly, the credits will be removed from the FBA Calculator Assessment and the Biodiversity Offset Strategy will not require offsetting for this species.

Should the species be recorded during the 2017 targeted survey period, an offset strategy for the species will be prepared fulfilling the offset requirements under the NSW Biodiversity Offset Policy for Major Projects which can be undertaken using a combination of the following strategies:

- Securing required credits through an open credit market, off site
- Offsetting through a land based offset site secured by a BioBank Agreement
- If suitable offset are unavailable, contributing funds to supplementary measures in accordance with relevant conservation or recovery actions relevant to the species
- Contributing to the offsets fund.

Should the Bathurst copper butterfly be identified within the SEA, an agreed offset strategy in accordance with one or more of the above strategies will be agreed with OEH as part of the final Biodiversity Offset Strategy. .

Provide a detailed biodiversity offset strategy prior to any approval of the impact. The offset strategy should be consistent with the NSW Biodiversity Offsets Policy for Major Projects and accompanying Framework for Biodiversity Assessment

As a result of the additional targeted searches for *E. cannonii* within the SEA and the accepted approach of generating credits for the Bathurst copper butterfly, the credits generated in the FBA Calculator have been updated. **Table 8** below shows the ecosystem and species-credits required to offset the impacts of the Southern Extension Project and the credits generated at the proposed Hillcroft Offset site.

Table 8: Updated Offset Requirements and Credits Generated at Hillcroft Offset Site

Biometric Vegetation Type / Species	Credits Required	Likely Credits Generated (difference)
CW117 - Brittle Gum - Broad-leaved Peppermint - Red Stringybark open forest in the north-western part (Yass to Orange) of the South Eastern Highlands Bioregion	542.0	1586 (1044)
CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes	2893	3197 (304)
Hoplocephalus bungaroides broad-headed snake	388	None – refer to section below regarding the agreed approach to supplementary measures
Eucalyptus cannonii Capertee stringybark	468	Minimum 468[1]
Paralucia spinifera Bathurst copper butterfly	15	See Note 2
Petaurus norfolcensis squirrel glider	1047	2613 (1566)

1 – Preliminary offset surveys undertaken in the proposed Hillcroft property which is proposed as a BioBank site is expected to generate sufficient credits for this species. Further detailed survey and assessment of the Hillcroft property in relation to *E. cannonii* will be undertaken during the development of the final biodiversity offset strategy.

2 – subject to completion of further targeted surveys between August and October 2017.

The detail provided in the RTS (and updated above) clearly indicates that the proposed Hillcroft Offset site will provide adequate, and in most cases in excess, credits to comprehensively offset the impacts of the Southern Extension Project on vegetation communities and the squirrel glider. As there is significant cost involved in the development of a biobank site, it is requested that the Biodiversity Offset Strategy covering impacts to vegetation communities, *E. cannonnii* and the squirrel glider be completed to the required level of detail for OEH as part of a condition of project approval should the Southern Extension Project be approved. As noted above, this Biodiversity Offset Strategy will also need to cover offsetting requirements for the Bathurst Copper Butterfly should it be identified during the surveys to be undertaken between August and October 2017.

The offset requirements for the broad-headed snake are discussed in further detail below.

We also note that Hillcroft does not provide habitat for the Broad-headed Snake. OEH provided advice to Umwelt on 1 March 2017 following their request for information on existing offset strategies for this species with land-based offsets or supplementary offsets that have been endorsed by OEH.

OEH is willing to continue to work with the proponent to determine suitable supplementary measures for the species. However, as required by the Framework for Biodiversity Assessment all reasonable steps must first be taken to secure credits prior to supplementary measures being considered. OEH will only consider supplementary measures after the proponent has provided evidence that all reasonable steps have first been undertaken.

The lack of suitable habitat for the broad-headed snake within the proposed Hillcroft Offset site has been clearly identified in the RTS, along with the commitment to continue to consult with OEH to resolve the appropriate offsetting pathway for this species.

The assessment of the broad-headed snake within the BAR has used a conservative assessment approach considering the broad-headed snake is not listed in the TSPD as occurring within the Central West CMA and the potential winter habitat rocky areas identified within 500 metres of the did not provide specific rock on rock habitat for this species. The conservative approach to calculating species credit offset requirements was adopted due the history of past assessments of proposed mining projects at Invincible which had recommended offsets from pagodas, partly due to potential impacts on this species .

As noted by OEH, Umwelt are currently seeking to determine appropriate supplementary measures to offset potential impacts on the broad-headed snake. Land-based offsets have not been able to be secured at this stage and the credits listed on the Credits Wanted Register (first listed 28/04/2016) have not generated any additional interest. Umwelt has also followed up two Expression of Interest opportunities (EOI 93 and 207 as identified by OEH in the RTS) however both candidate sites do not contain the required habitat types. In addition to this, Umwelt has undertaken extensive desktop searches of real estate websites in the local area seeking properties containing the specific habitat requirements for this species. No suitable candidate properties have been identified through this process.

In the event that a suitable property was available, the process of surveying the site for this species would be extensive with the likelihood of detecting an individual within a suitable site considered to be very low. As known habitat is required to generate offset species credits for this species, considerable time and expense would be required to investigate potential offset sites with low likelihood of detection. In all likelihood, the expense required to survey potential offset sites which would generate sufficient credits for the potential impacts on this species associated with the SEA may well exceed to costs associated with purchasing the property and establishing the biobank site.

This requirement is considered to be both unreasonable and unfeasible for proponents, particularly in circumstances where the generation of credits is based on a precautionary approach such has been undertaken for this SEA.

In addition to the above, it is noted that there are vast areas of potential broad-headed snake habitat in the local area and broader region that are located within National Parks or in State Forest areas that are unlikely to be impacted by open cut mining or other disturbance in the future. In this regard, the further conservation of known habitat will have little or no net benefit to this species in the local area.

For these reasons, Umwelt are of the view that, in the absence of a formal offset fund, a supplementary measure, in the form of a financial payment based on calculated offsetting requirements, is a more appropriate method for offsetting the potential impacts to the broad-headed snake associated with the Southern Extension Project. These funds can then be used to further research into the species and/or undertake conservation works in other areas of the State where habitat loss poses are greater risk to the ongoing survival of the species.

To identify an appropriate value for the supplementary measure, Umwelt has reviewed publically available local property sales data in an attempt to derive an appropriate land value for a property that contains an area of potential broad-headed snake habitat that would be sufficient to generate the necessary credits to offset the impact associated with the Southern Extension Project. Calculations have estimated that approximately 56 hectares of broad-headed snake habitat would be required to generate the 388 offset species credits for the broad headed snake. A mixture of property types were identified comprising large rocky parcels with no improvements to parcels containing a dwelling and land cleared for agricultural purposes with only small areas of escarpment. As such, the range of sale prices varied greatly with the sale prices not necessarily reflecting the value of the woodland and rocky areas required to offset the impacts on the broad-headed snake. The review identified that acquisition price for parcels where agricultural land formed the majority of the property and or dwellings were present on the land resulted in an inflated cost for what is, other than for conservation purposes, unusable land. To overcome this, our analysis looked at multiple values for the land, considering the following variables:

- Sale price
- Land value without improvements (Valuer General 2016)
- Proportional value of the broad-headed snake habitat based on sale price
- Proportional value of the broad-headed snake habitat based on land value (Valuer General 2016).

A summary of the analysis is shown in **Table 9** below. Please note that the land value for the supplementary measure costs have been calculated using the calculation method shown in Appendix B of the NSW Biodiversity Offsets Policy for Major Projects.

Table 9 – Land Price for Supplementary Measure Calculation for Broad-headed Snake

Location	House	Ag Land	Size (hectares)	Year Sold	Area of Potential BHS Habitat (Hectares)	Likely BHS Credits generated	Price Sold	Land Value 2016 (Valuer General)	Supplementary Measure based on Land Value/Proportional Value of BHS Habitat
Bell	No	No	148	2013	148	1051	$620,000.00	$360,000.00	$132,902.00
Hartley Hyrock	No	No	200	2006	60	426	$38,500.00	$382,000.00	$104,377.46
Wolgan Valley	No	Yes	65	2016	45	320	$502,000.00	$229,000.00	$192,227.88
Glen Alice	Yes	Yes	775	2016	200	1420	$1,600,000.00	$1,195,000.00	$84,263.52
								Average	**$128,442.72**

Management costs in perpetuity also need to be factored into the cost of a supplementary measure. To calculate management costs, the Total Fund Deposit (TFD) spreadsheet was populated to reflect the offset requirement for the broad-headed snake. The TFD was then updated with a range of management measures reflective of the threats considered most applicable to this species. **Table 10** below outlines the management measures and their frequencies used to generate the in perpetuity management costs in the TFD.

Table 10 Management Measures for broad-headed snake

Management Measure	Cost Per Year ($)	Implementation Year	Frequency
Fence and Sign Maintenance	1,000	5	5
Weed and Pest Management	5,000	1	10
Snake Habitat Monitoring and Reporting	5,000	1	5

Using the above management measures and the standard cost associated with entering a Biobanking agreement, the TFD was calculated to be $174,052.

Considering the average land cost identified in **Table 9** ($128,443) and the TFD calculation above ($174,052), a supplementary measure figure of approximately $332,745 (including 10% administrative charge) satisfies the requirements of the NSW Biodiversity Offsets Policy for Major Projects and represents a substantial gain for the species when considering the condition of the habitat to be removed and the conservative approach that has been taken in regards to assessing this species for the Southern Extension Project. It is also noted that the above TFD calculations and average land costs have assumed the costs are only associated with biodiversity gains for the BHS and do not include the other credit value that is likely to be created in these offset areas associated with improved biodiversity outcomes for vegetation communities or other threatened species.

The above methodology and approach to the calculation of supplementary measures for this species has been discussed and broadly agreed with OEH noting that a calculation of supplementary measure values based on the value of the proposed Hillcroft site was not possible due to the lack of BHS habitat at that site.

In light of the conservative approach to this assessment and the implementation of the above extensive measures to seek and secure land based offsets for this species, it is proposed that the entirety of potential impacts to broad-headed snake will be offset through the use of supplementary measures. This would be documented in detail in the Biodiversity Offset Strategy for the Southern Extension Project.

5.0 Roads and Maritime Services

Roads and Maritime will not object to the proposed development subject to the following conditions being included in any consent issued in relation to this project:

- ***Prior to the commencement of any works approved by Modification 5, the proponent must enter into a Deed of Agreement with Roads and Maritime Services for the protection of the Castlereagh Highway. This Deed will, to the satisfaction of Roads and Maritime, include but not be limit to details of:***
    - ***The proponent's responsibility to prepare and implement a Road Dilapidation Report, Ground Control Management Plan, Blasting Management Plan and survey controls demonstrating how the development will be carried out in a manner that does not adversely impact on the Castlereagh Highway.***
    - ***The proponent's responsibilities in relation to monitoring and rehabilitating any impacts of the development on the Castlereagh Highway.***
    - ***The proponent's obligation to take out adequate insurance coverage for any impacts of the development on the Castlereagh Highway.***
    - ***The liability of the proponent for any damage or adverse impact to the Castlereagh Highway.***
    - ***Relevant indemnities.***
    - ***The procedure for communicating any information relevant to the protection of the Castlereagh Highway to Roads and Maritime.***
- ***Temporary closures of the Castlereagh Highway during blasting operations are to be carried out in accordance with a current Road Occupancy Licence from Roads and Maritime Services. Road Occupancy Licences are to be obtained prior to any closures of the Castlereagh Highway by contact the Field Traffic Manager on 02 6861 1461 or email, ROL.Western@rms.nsw.gov.au***
- ***Haulage operations coinciding with local student school bus pick up/drop off times are to be avoided.***
- ***In accordance with clause 16(1) of State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007, the applicant is to prepare and implement a driver code of conduct for the task of transporting materials on public roads.***

Castlereagh Coal will commit to the additional conditions as requested by Roads and Maritime Services as these measures are consistent with further engagement with Roads and Maritime Services and the commitments made as outlined in the RTS report.

Yours sincerely

Tim Crosdale
Group Manager

umwelt

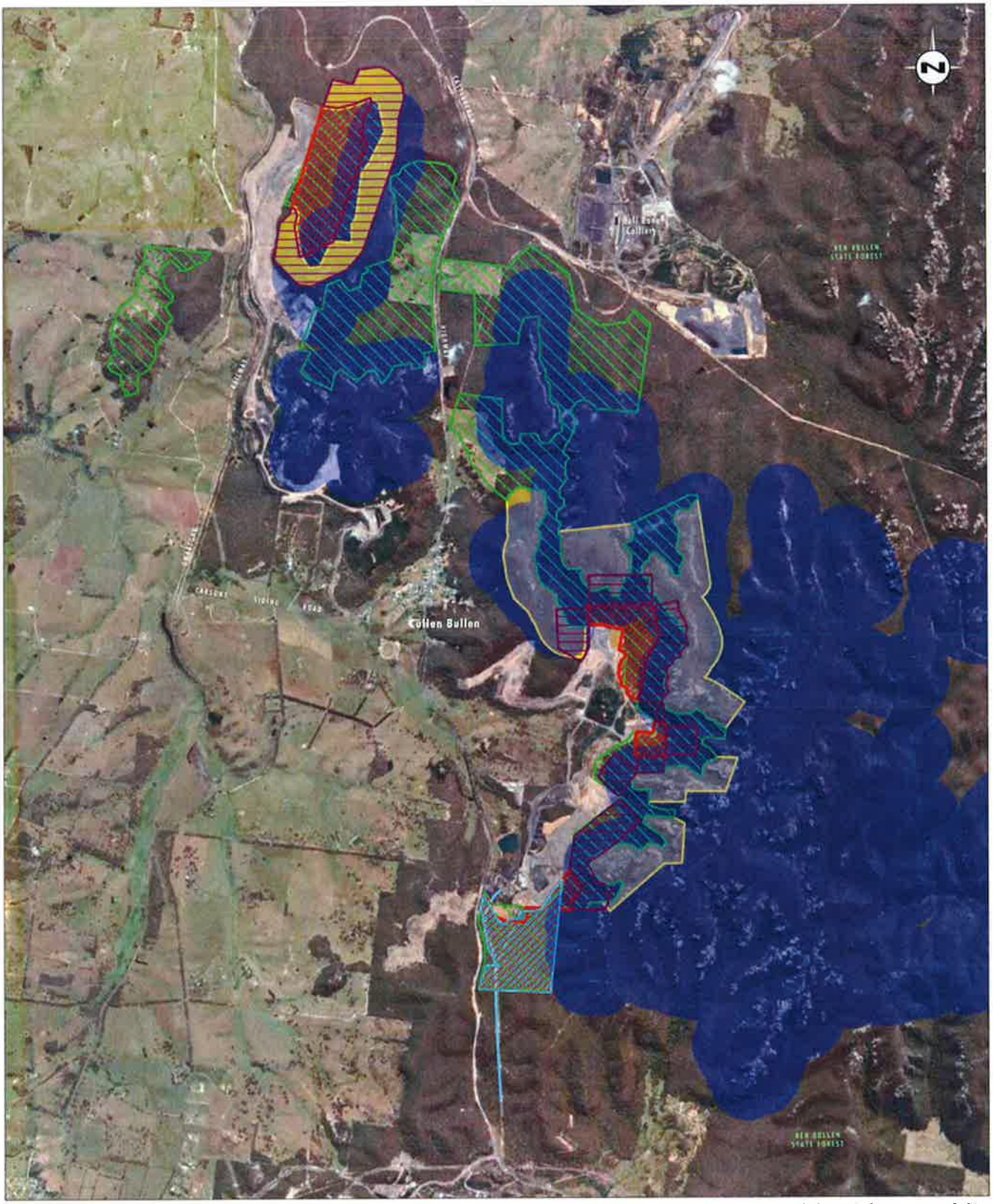


Image Source: Google Earth - CNES/Astrium (Mar 2015)
Data Source: Hansen Bailey (2012,2013)

0 0.5 1.0 2.0km
1:50 000

Legend

- 300m Pagoda Buffer
- Modification Project - Open Cut
- Modification Project - Highwall
- Consolidation Project - Conveyor
- Consolidation Project - Highwall
- Consolidation Project - Open Cut
- Southern Extension Project - Open Cut

FIGURE 1

Comparison of Mining Proposals in Proximity to Pagodas

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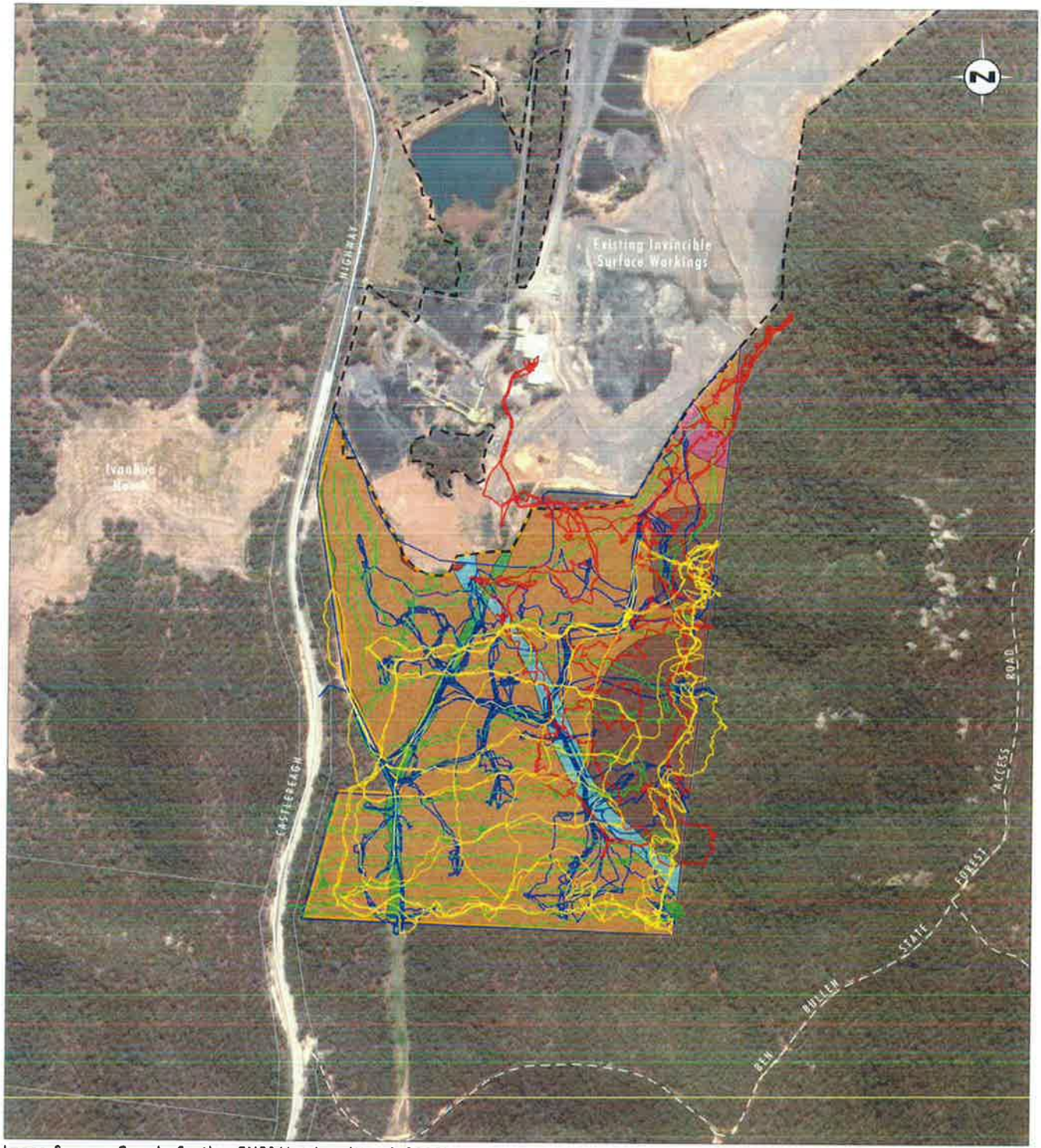


Image Source: Google Earth - CNES/Astrium (March 2015)
Data Source: LPI (2016)

0 100 250 500m
1:10 000

Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Cleared Area
- Zone 1 - CW117 - Brittle Gum - Broad-leaved Peppermint - Red Stringybark open forest in the north-western part (Yass to Orange) of the South Eastern Highlands Bioregion (Moderate to Good)
- Zone 2 - CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes (Moderate to Good)
- Zone 3 - CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes (Moderate to Good/High)
- Zone 4 - CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes (Moderate to Good/Moderate)
- Zone 5 - CW263 - Inland Scribbly Gum grassy open forest on hills in the Mudgee Region, NSW central western slopes (Moderate to Good/Other)
- Flora Survey Tracks
- April 2016 Tracks
- Additional Targeted Searches for *E. cannonii* and Bursaria
- November 2015 Diurnal Survey Tracks

FIGURE 3

Survey Tracks for *Eucalyptus cannonii* and Bursaria within SEA

File Name (A4): 3622_153.dgn
20170508 14:23

Image Source: Google Earth - CNES/Astrium (March 2015)
Data Source: LPI (2016)

0 100 250 500m

Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- *Eucalyptus cannonii*
- *Eucalyptus cannonii* (2017)

FIGURE 4

Eucalyptus cannonii Locations

File Name (A4): 3622_154.dgn
20170508 14 27

Image Source: Google Earth - CNES/Astrium (March 2015)
Data Source: LPI (2016)

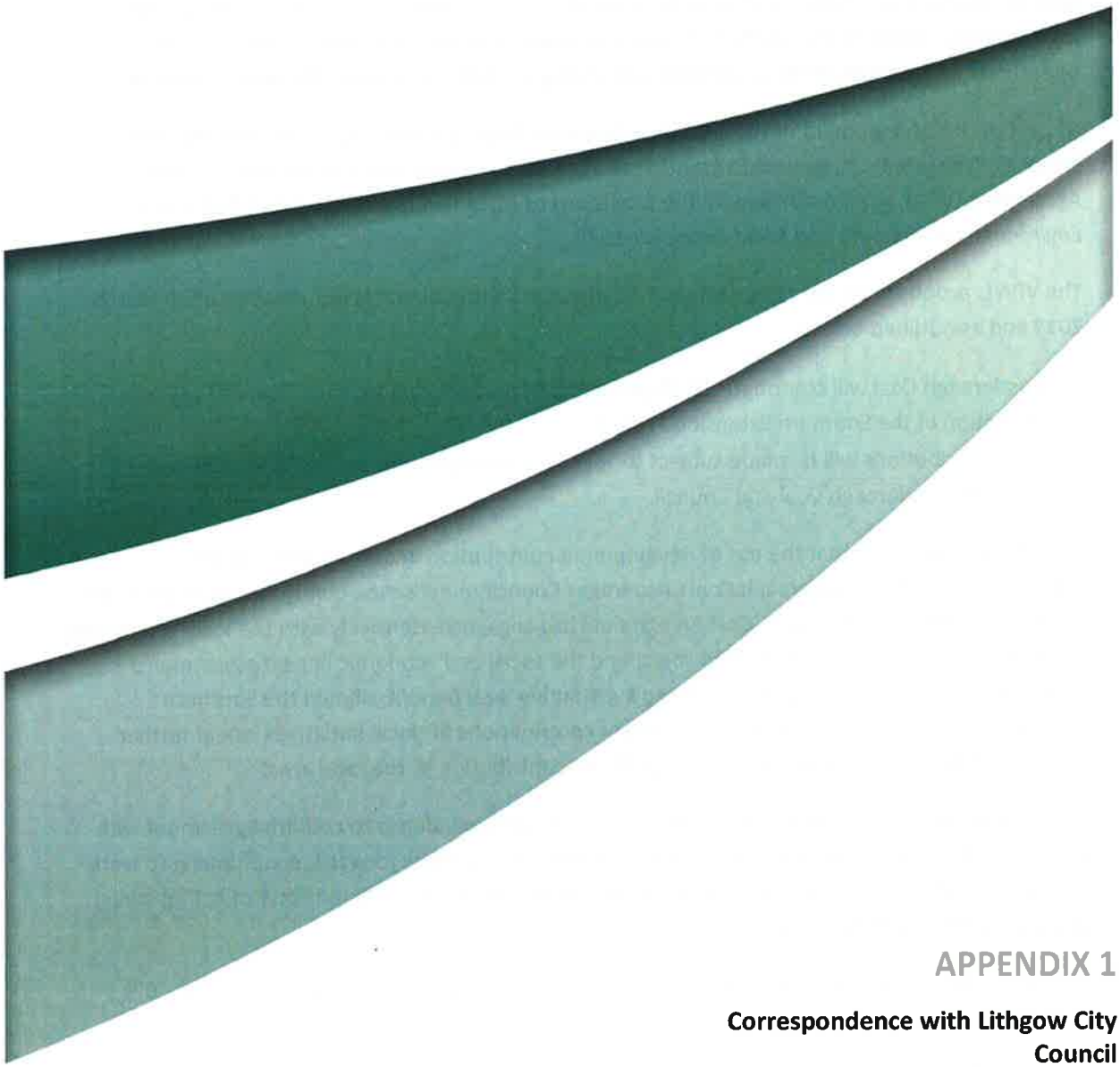
0 100 250 500m
1:10 000

Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Bursaria Areas

FIGURE 5

Areas of Bursaria sp.



APPENDIX 1

Correspondence with Lithgow City Council

Castlereagh Coal

Mr Andrew Muir,
Acting General Manager
Lithgow City Council
30th March 2017

RE: Voluntary Planning Agreement - Invincible Southern Extension Project (PA07_0127 MOD 5)

As Lithgow City Council (Council) is aware Shoalhaven Coal Pty Ltd (trading as Castlereagh Coal) are seeking approval to modify the Project Approval (PA 07_0127) for the Invincible Colliery. The modification, known as the Southern Extension Project, seeks an extension of the open cut operations to the south of the existing pit and mining infrastructure area at Invincible Colliery..

As part of the development of the Southern Extension Project, Castlereagh Coal formally notify Council of the intention, subject to granting of approvals, to enter into a Voluntary Planning Agreement (VPA), in accordance with the provisions of Division 6, Subdivision 2 of Part 4 of the *Environmental Planning and Assessment Act 1979*.

The VPA is proposed on the basis of the terms discussed with Council at our meeting of 28 March 2017 and as outlined below:

- Castlereagh Coal will contribute $0.05 per tonne of product coal for each financial year of operation of the Southern Extension Project
- The contributions will be made subject to specific provisions to be set out VPA to be agreed between Castlereagh Coal and Council.

Whilst it is understood that the use of development contribution under the VPA is subject to Council's prerogative, Castlereagh Coal encourages Council to utilise the contributions in the Cullen Bullen township and surrounds. Castlereagh Coal has engaged extensively with the local community in relation to the Southern Extension Project and the social and economic impact assessments undertaken for the Project have highlighted substantive local benefits should the Southern Extension project be approved. Council's use of contributions for local initiatives would further enhance and support Castlereagh Coal's significant contribution to the local area.

We request Council provide a formal response to this correspondence to confirm agreement with the terms of the proposed VPA at its earliest convenience. We look forward to continuing to work with Council to progress the formal terms of the VPA for the Southern Extension Project following approval of the modification application.

Should you have any questions or wish to discuss further please feel free to contact me on (02) 9879-9800

Yours Faithfully

Brett Moore
Castlereagh Coal

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Fax (02) 8003 9026
www.castlereaghcoal.com.au

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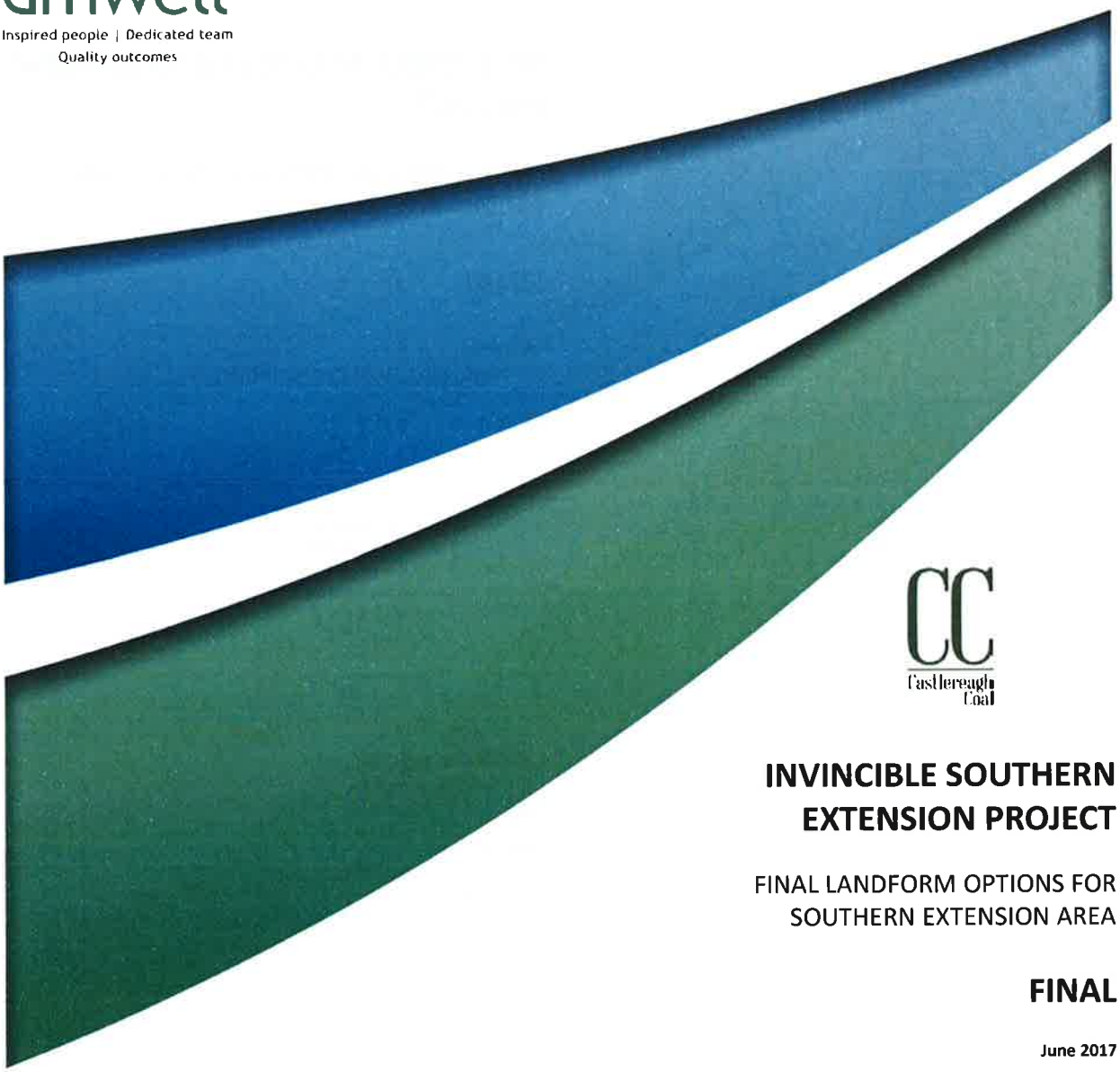

CC
Castlereagh Coal

INVINCIBLE SOUTHERN EXTENSION PROJECT

FINAL LANDFORM OPTIONS FOR SOUTHERN EXTENSION AREA

FINAL

June 2017

INVINCIBLE SOUTHERN EXTENSION PROJECT

FINAL LANDFORM OPTIONS FOR SOUTHERN EXTENSION AREA

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Castlereagh Coal

Project Director:	Tim Crosdale
Project Manager:	David Holmes
Technical Director:	David Holmes
Technical Manager:	Luke Bettridge
Report No.	R16_Final
Date:	June 2017

Newcastle

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Quality
ISO 9001

Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	**Date**	**Name**	**Date**
Final	David Holmes	14/6/2017	Tim Crosdale	14/6/2017

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Figures

Plates

Tables

1.0 Introduction

The conceptual final landform of the Southern Extension Area in the Environmental Assessment (EA) for the Southern Extension Project (shown in Figure 3.4 of the EA and reproduced as **Figure 1.1**) reflects rehabilitating this area to the pre-mining terrain to achieve a rehabilitated landform that has the same features as the pre-mining landform. The Department of Planning and Environment (DP&E) have identified the possibility of parts of the conceptual final landform in the Southern Extension Area (SEA) having slopes that may present difficulties for rehabilitation. The potential areas of concerns are shown in **Figure 1.1** and are based on DP&E's observations of past rehabilitation experience of the West Pit area (refer to **Figure 1.1**) in the north of the Invincible Open Cut mining area. The slope gradients in the Southern Extension Area associated with the EA Conceptual Final Landform are shown in **Figure 1.2.**

It is noted that the steep slopes which have been identified as being of concern to DP&E are not the deeply incised gullies associated with the pagoda formations to the west and north of Southern Extension Area. Unlike previous proposals for mining at Invincible, the Southern Extension Project does not involve mining into the incised gullies located between the pagodas and cliff lines.

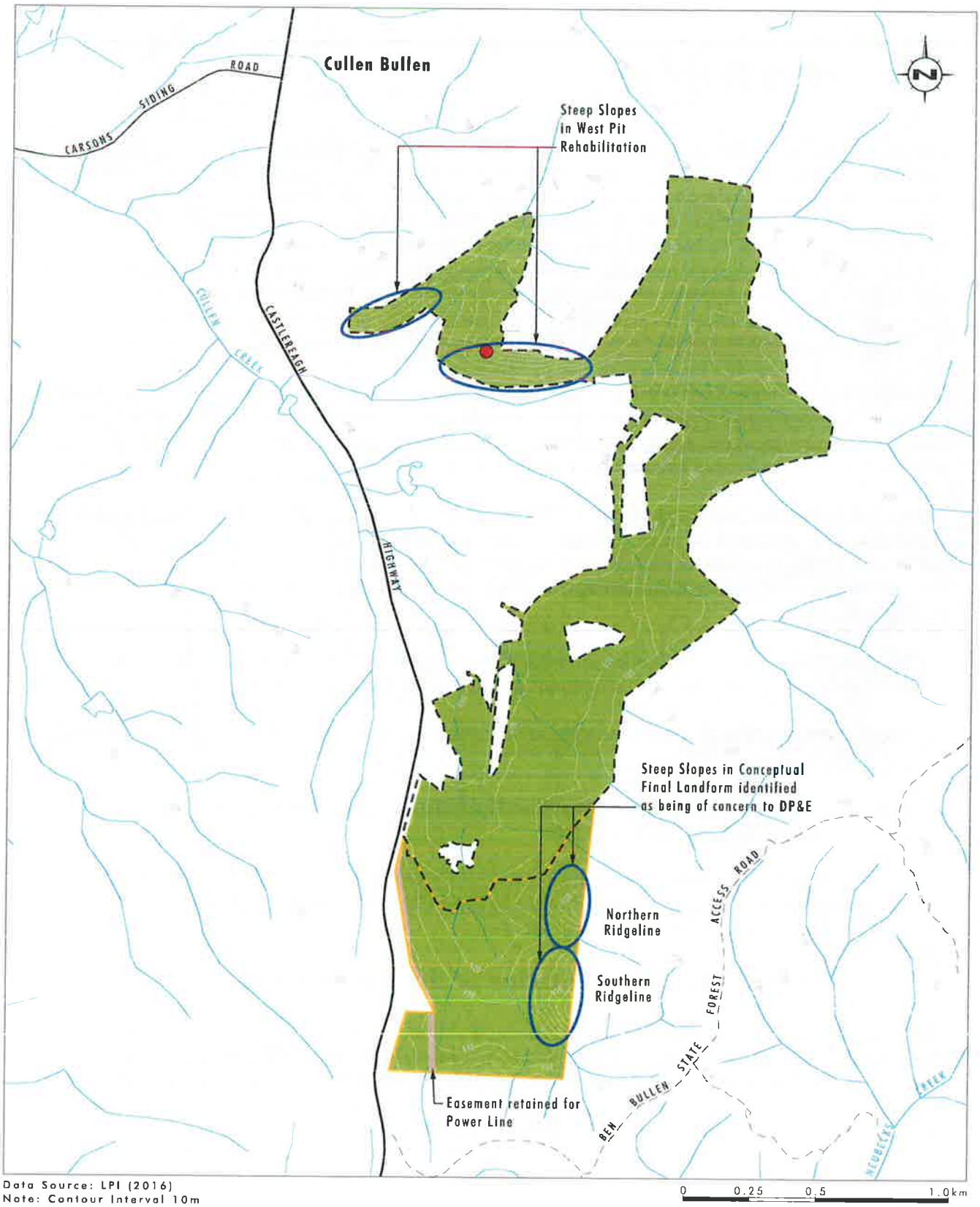
In response to the matters raised by DP&E in relation to areas of steeper slope in the proposed conceptual final landform as presented in the EA, a number of alternate final landform options have been identified for the Southern Extension Area for consideration. As requested by DP&E these alternate final landform options have been assessed and evaluated in this response, including (further detailed is provided in **Section 2.0**):

- Option 1: The proposed modification unchanged, including more justification about how the final landform could be achieved – this is referred to as the EA Conceptual Final landform in this response
- Option 2: No mining in the high slope areas at the eastern extent of the proposal – identified as Option 3 in this response; and
- Option 3: Other options (including highwall/s and/or options to reduce the gradient of slopes) – identified as Options 1 and 2 of this response.

In addition, relevant background and further discussion of the proposed conceptual final landform as presented in the EA, as well as other matters raised by DP&E including the overburden dump balance, is provided in response to the issues raised by DP&E.

1.1 Background to Rehabilitation of the West Pit Area

The West Pit was approved to be mined in 2008 under the current Project Approval, PA 07_0127 (Invincible Project Approval). The pre-mining terrain in this area was relatively steep and the mining resulted in a highwall height of up to 60 metres in places with associated horizontal distance of mining disturbance of as little as approximately 200-250m. **Plates 1.1** and **1.2** show rehabilitation (seeded in 2011 -12) in a section of the West Pit in 2017. The approximate locations of the photos are shown on **Figure 1.1**.



Data Source: LPI (2016)
Note: Contour Interval 10m

Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Rehabilitation - Woodland/Forest
- Grassed Powerline Easement
- Location of Photographs (Plates 1.1, 1.2)

FIGURE 1.1

Environmental Assessment
Invincible Conceptual Final Landform

File Name (A4): R13/3622_163.dgn
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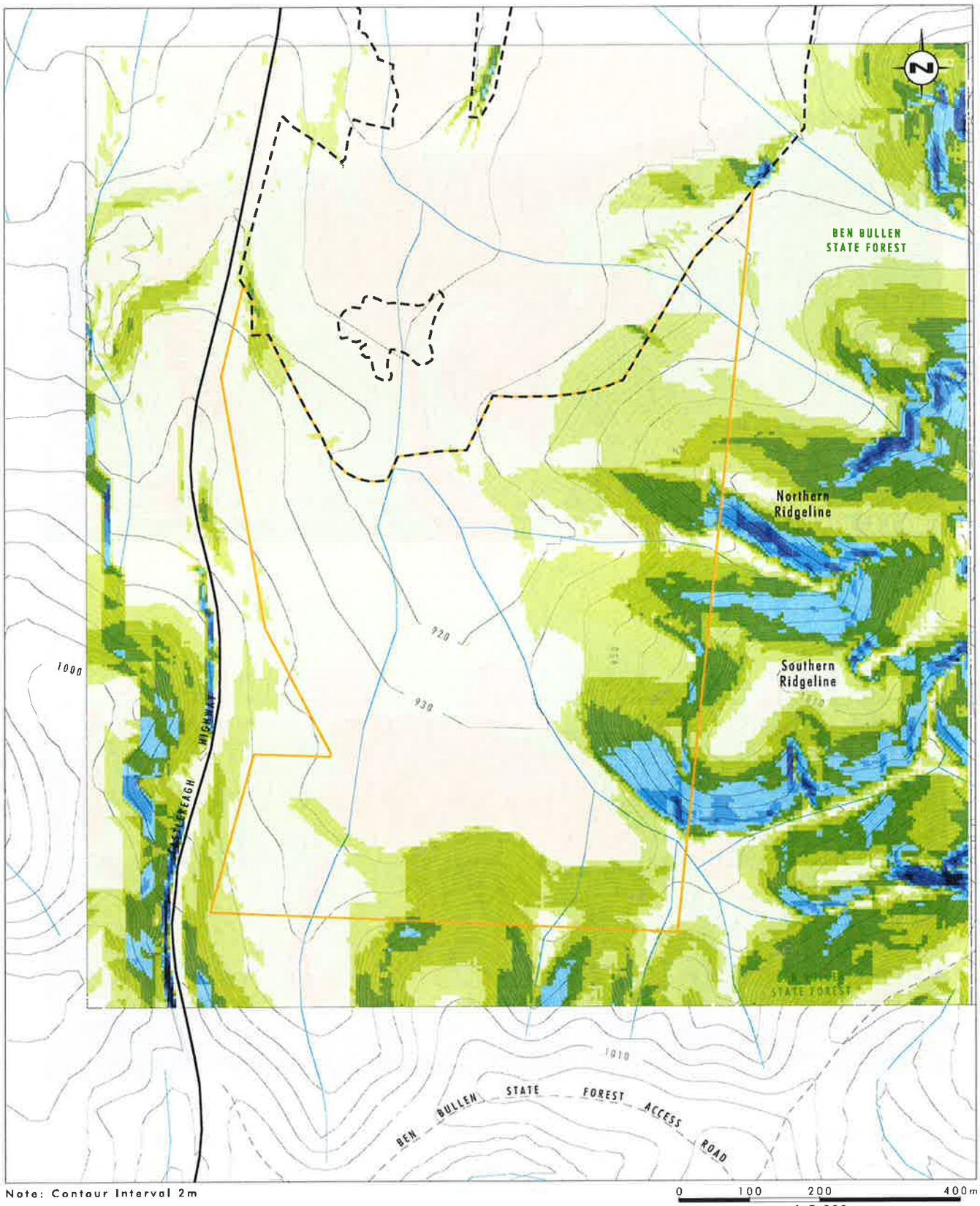


Note: Contour Interval 2m

0 100 200 400m
1:7 500

Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Range 0.00 - 5.00
- Range 5.00 - 10.00
- Range 10.00 - 15.00
- Range 15.00 - 20.00
- Range 20.00 - 25.00
- Range 25.00 - 30.00
- Range 30.00 - 35.00
- Range 35.00 - 40.00
- Range 40.00 - 45.00

FIGURE 1.2

EA Conceptual Final Landform

File Name (A4): R13/3622_166 dgn
20170614 10.58

Plate 1.1 Rehabilitation in West Pit (looking west)

Plate 1.2 Rehabilitation in West Pit (looking south-east)

The rehabilitated landform in the West Pit area has attempted to recreate the pre-mining terrain. **Figure 1.3** shows the rehabilitated West Pit Landform. Due to constraints presented by the offset area located to the immediate south of the West Pit area, the area to be rehabilitated was located in the mid slope area of the natural terrain which, in a natural concave/convex landform system meant that the area to be rehabilitated was located in the steepest area of the slope with limited or no ability to take advantage of less steep areas at the top and bottom of the slopes (refer to **Figure 1.4**) to improve slope design.

As a result, there was limited ability for dozers working on the rehabilitation to operate across the slope and topsoil material had to be pushed from the bottom to the top of the slope. In addition, the general steepness of the rehabilitated terrain presented difficulties for dozers working horizontally across the slope in some areas which limited contour drain installation. In areas the slopes were so steep that dozers could not operate on the slope at all and the final landform represents the natural angle of repose (approximately 37 degrees); in these areas, top soil was spilled down the dump face prior to seeding. Approximately 6 hectares of the West Pit area has slopes in excess of 25° with around half of this exceeding 30° (refer to **Figure 1.5**). As can be seen in **Plate 1.2** (which is indicative of the areas with poorer rehabilitation outcomes in the West Pit Area), these difficulties limited the ability to effectively spread topsoil material and retained timber across the entire rehabilitated area. The steepness also presented difficulties for the installation and maintenance of contours drains in the steeper areas. As can be seen in the foreground of **Plate 1.2,** there is some minor erosion developing in areas with less vegetation however there are no significant erosion concerns in this area (due largely to the relatively small catchment area of disturbed areas).

Despite these constraints on rehabilitation, as can be seen from **Plates 1.1** and **1.2**, revegetation of the west pit area is progressing.

The slow uptake of rehabilitation in the West Pit Area has resulted in extended visual impacts associated with past mining within the West Pit Area (partly exacerbated by the generally pale colour of topsoil material). As the West Pit Area is visible from the Castlereagh Highway for vehicles travelling north the visual impacts are prominent for this section of the Highway. The former mining within the West Pit Area is an example of past open cut mining within the gully formations within the areas surrounding the Invincible mine. As outlined above, mining within these areas has been specifically avoided as part of the Southern Extension Project.

As shown in **Plates 1.1** to **2.1**, vegetation has now started to take in parts of the area, including the steepest sections of the rehabilitation. The 2016 Invincible Annual Report (Umwelt 2017) contains a detailed assessment of the status of rehabilitation across the Invincible site and, while there are areas where infill plantings and additional revegetation efforts are required, the rehabilitation in the West Pit area is trending towards completion criteria despite the limitations presented by the terrain in this area.

1.2 Commitments in the Southern Extension Project EA

Section 6.18 of the EA details the rehabilitation strategy for Invincible as the Southern Extension Project. The overall objective is to rehabilitate the entire Invincible Mine site, including the Southern Extension Area, to create a final landform with no voids, consistent with the pre-mining landform and integrated with the surrounding terrain.

The key commitment regarding slope design is identified in the Secondary Domain (Post – Mining) rehabilitation objections (Table 6.37 in the EA) which provide:

> *Disturbed landform to be graded and shaped to reflect natural landforms and drainage contours. Revegetation to be undertaken through seeding and/or tube stock planting compatible with the surrounding land use.*
>
> *Post mining landforms to be geotechnically stable and non-polluting consistent with the proposed post-mining land use suitability.*

A conceptual Final Landform for the Project is shown in Figure 3.4 of the EA (refer to **Figure 1.1**) and rehabilitation strategy is shown in Figure 6.34 of the EA.

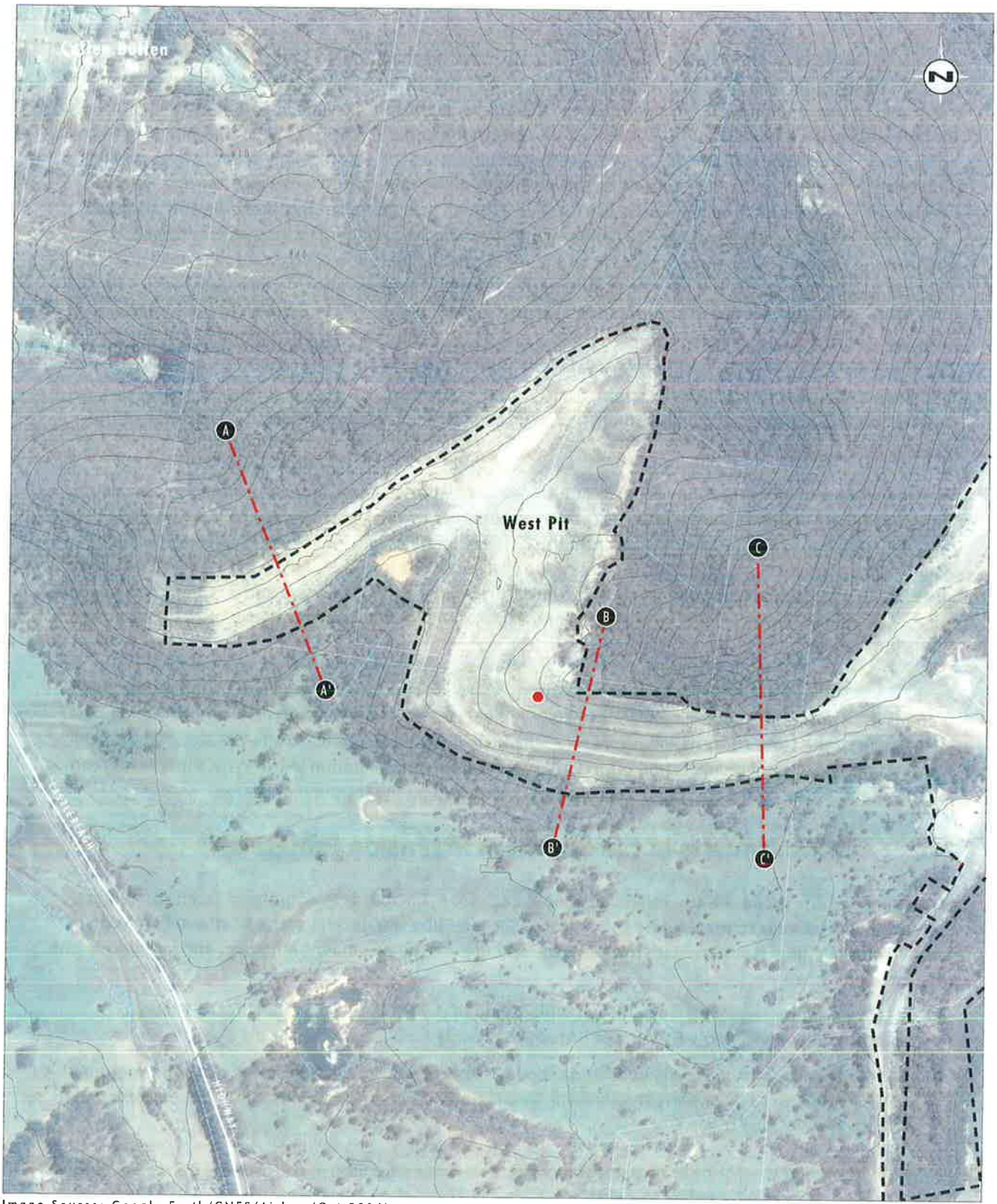


Image Source: Google Earth/CNES/Airbus (Oct 2016)
Data Source: LPI (2016)
Note: Contour Interval 10m

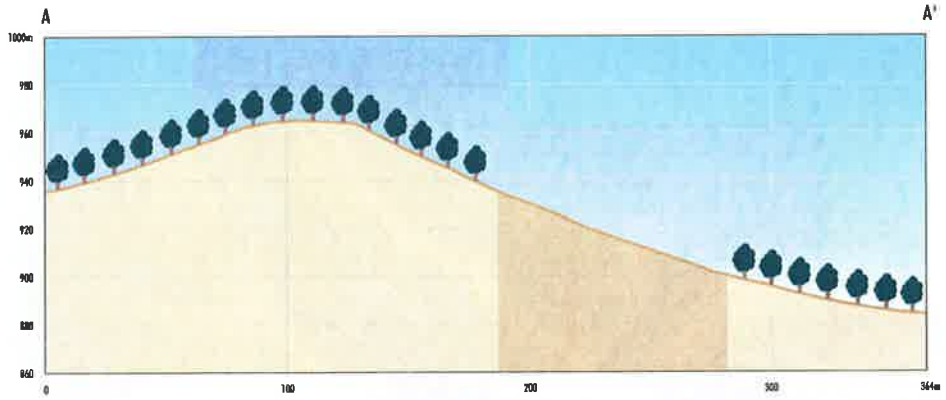
0 100 200 400m
1:7 500

Legend

- Existing Approved Mining Disturbance Area
- Section Locations
- Location of Photographs (Plates 1.1, 1.2)

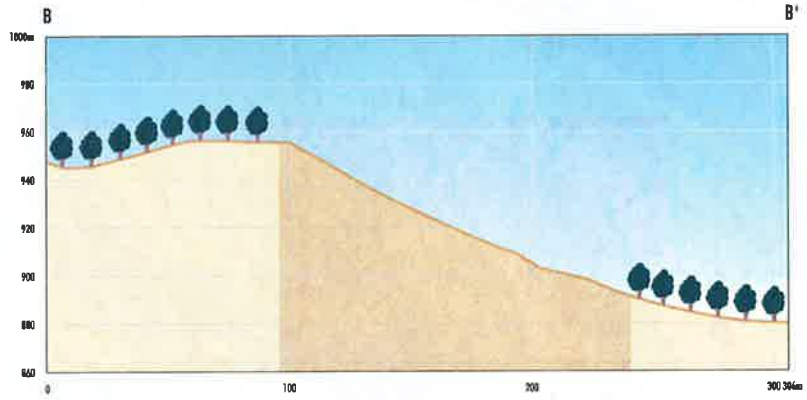
FIGURE 1.3

West Pit Landform



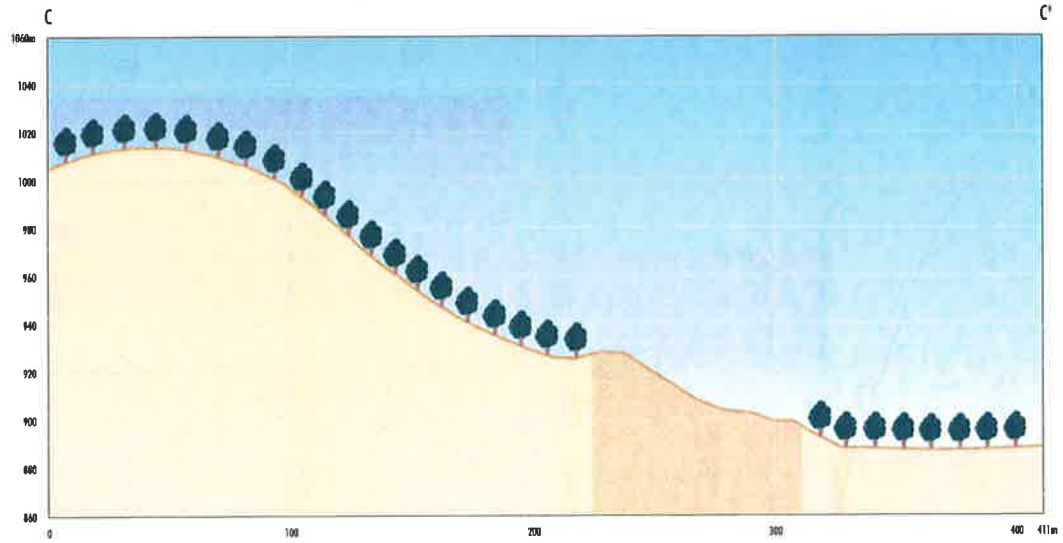
Section A-A'

1(H):1(V)



Section B-B'

1(H):1(V)



Section C-C'

1(H):1(V)

Legend

Existing Surface

Existing Vegetation

0 50 100 150m

1:3000

FIGURE 1.4

Rehabilitated Landform in West Pit Area

File Name (A4): R13/3622_165 dgn
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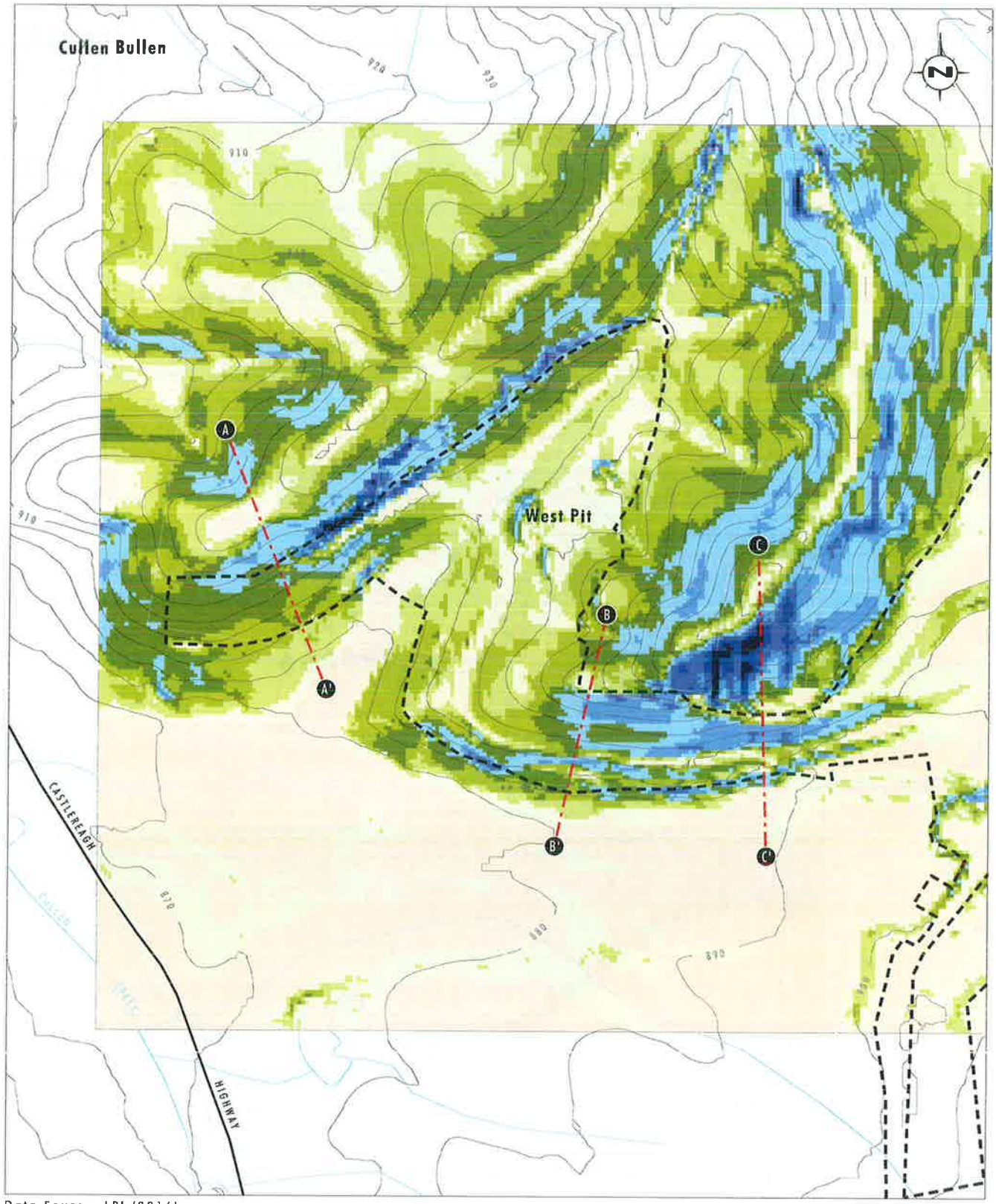

Data Source: LPI (2016)
Note: Contour Interval 10m

0 100 200 400m
1:7 500

Legend

- Existing Approved Mining Disturbance Area
- Section Locations
- Range 0.00 - 5.00
- Range 5.00 - 10.00
- Range 10.00 - 15.00
- Range 15.00 - 20.00
- Range 20.00 - 25.00
- Range 25.00 - 30.00
- Range 30.00 - 35.00
- Range 35.00 - 40.00
- Range 40.00 - 45.00

FIGURE 1.5

West Pit Landform Slope Classification

File Name (A4): R13/3622_168.dgn
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This landform is the same as the pre-mining landform in all areas except the very lower parts of the drainage line flowing north which has been reshaped due to this area being subject to significant gully erosion. The EA identified that detailed rehabilitation strategy for each domain and parts of each domain will be developed as part of the MOP approval process for the Southern Extension Project under the *Mining Act 1992*. The MOP will include detailed considerations of dump balance (refer to **Section 1.3** below), slope design, water management, topsoil spreading, revegetation strategies and ongoing monitoring and maintenance, and will be subject to further detailed review and approval from the Department of Resources and Energy (DRE). It is noted that DRE have not provided any objection to, or raised any issues, in relation to the proposed conceptual final landform for the Southern Extension Project in its submissions.

As discussed in **Section 1.3**, the dump balance indicates that, on the proposed mining strategy, there is sufficient overburden available to further revise final slopes in the detailed final landform design process. In areas where the reinstatement of the pre-mining landform would result in slopes which may pose difficulties for successful rehabilitation in those areas, the landform design can be revised to reduce slope lengths or incorporate benches through the use of the overburden to be sourced from the proposed mining in the Southern Extension Area. These options are discussed and evaluated further in **Section 2.0**.

1.3 Available Material for Rehabilitation

Appendix 1 of the Response to Submissions Report A includes a dump balance for the Southern Extension Project based on developing a landform consistent with the conceptual final landform shown in the EA (refer to **Figure 1.1**).

Table 1.1 Dump Balance

Conceptual Mine Plan Year	Scheduled Volume of Overburden from Southern Extension Area (Mbcm)	Available Overburden from Southern Extension Area for Rehabilitation (Mm^3)	Dump Room Required to Rehabilitate Site to EA Conceptual Final Landform (Mm^3)
1	3.6	4.5	4.6
2	3.8	4.8	4.8
3	3.8	4.8	5.1
4	3.8	2.1	2.2
Total	**1.7**	**16.2**	**16.7 (15.8*)**

*Number in parentheses excludes capacity of Northern Void (see Table 1.2 below). The majority of the Northern Void can be filled and rehabilitated to the EA Conceptual Final Landform design using existing overburden stockpiled around the Northern Void and does not rely on Overburden from the Southern Extension Area. The rehabilitation of the Northern Void using this overburden would require only minimal re-disturbance of existing rehabilitated areas.

The bulking factor associated with the removal of overburden from the Southern Extension Area means there is sufficient material to fill all voids in the existing Invincible open cut disturbance area (North Pit, East Pit and Renown/South Pit) and to complete the proposed rehabilitation of the Southern Extension Area back to a landform consistent with the pre-mining landform. The 'capacities' in each of the voids shown in **Table 1.2** reflects the volume of material required to create the conceptual landform design shown in **Figure 1.1.** In the case of the Southern Extension Area, this landform is largely identical to that which existed pre-mining.

Table 1.2 Void Areas to be Filled/Shaped

Area	Dump Capacity (Mm^3)	Comment
Southern Extension Area	14.0	Based on returning landform to that shown in Figure 3.4 of the EA (refer to **Figure 1.1**).
Renown/South Pit Void	1.3	
Northern Void	0.9*	Majority can be pushed from existing emplaced overburden around Northern void area.
Eastern Void	0.5	
Total	**16.7**	

*This capacity can be met through existing stockpiles of overburden around the Northern Void.

As can be seen from **Table 1.1**, there is approximately 0.4 million m^3 more overburden material generated by the Southern Extension Project than is required to develop the conceptual final landform identified in **Figure 1.1**. This additional material provides flexibility for improving slope design in different areas of the final landform and improves the 'tie-in' with the undisturbed areas upslope from the areas to be rehabilitated. These improvements can be in areas where this additional overburden can be used to reduce risks to rehabilitation success and improve final landform design area the areas of concern shown in **Figure 1.1** and the Northern Void area. Due to the relatively flat basin to the west of the northern and southern ridgelines (refer to **Figure 1.1**), there is scope to extend the foot of these slopes westwards through additional overburden emplacement to lessen the slopes associated with these features in the proposed conceptual final landform.

As discussed in Section 3.7.1.1 of the EA, the existing Invincible voids can be rehabilitated without overburden from the Southern Extension Areas however this would require disturbance of rehabilitated areas and significant earthworks. This would further extend the time to rehabilitate the existing disturbance area and the re-disturbance of existing rehabilitation presents risks to successful reuse of topsoil material from re-disturbed areas which would again need to be stripped, stockpiled and respread. Typically, it is considered that additional handling on this scale would result in poorer rehabilitation outcomes due to rehandle and disturbance of seed bank material that may be present.

2.0 Consideration of Final Landform Options for Southern Extension Area

The concerns raised by DP&E relate to the steeper south, south western facing slopes on the ridgelines in the eastern parts of the conceptual final landform proposed for the Southern Extension Area (refer to **Figure 1.1**). DP&E's focus on these areas is understood to relate to concerns that the rehabilitation of these areas may be subject to similar constraints as those which applies to the West Pit area. As noted in **Section 1.2**, the landform shown in **Figure 1.1** (see also Figure 3.4 from the EA) is conceptual only and is subject to detailed rehabilitation design considerations to be incorporated into the MOP. As discussed in **Section 1.3**, the surplus overburden generated by the Southern Extension Project provides the flexibility in revising the landform to achieve long term stable landforms across the Southern Extension Area and the remaining areas of the Invincible Open Cut disturbance area yet to be fully rehabilitated. The following sections discuss different options regarding possible landforms and evaluate the merits and disadvantages of each of the potential rehabilitation options, including the avoidance of mining of steeper slopes as requested by DP&E.

As detailed further below avoidance of mining of areas of the Southern Extension Area have been previously evaluated in response to previous issues raised by DP&E (refer to Additional Information Response dated 10 May 2017). This assessment clearly indicated that there would be a substantial impact on the volume of target nut coal, and other coal resources, within the Southern Extension Area which impacts the viability of the Southern Extension Project. As detailed in this additional information response, and extensively throughout the EA and previous Response to Submissions reports, the Southern Extension Project has been designed to avoid (where possible) and to incorporate measures to minimise and mitigate potential environmental impacts; this design has considered issues raised regarding previously proposed more extensive mining proposals at Invincible. Notwithstanding, the option of avoiding mining on existing steeper slope areas in the Southern Extension Area (which would require a more extensive area of exclusion of mining than contemplated in the 10 May 2017 Additional Information Response) has been evaluated in accordance with the DP&E request.

2.1 Final Landform Options Considered

Following discussions with the DP&E, three final landform options for the Southern Extension Area have been considered in addition to the Conceptual Final Landform as proposed in the EA.

EA Landform Conceptual Final Landform based on reinstating the pre-mining landform. This landform is shown in **Figure 1.1**.

Option 1 This is the EA Conceptual Final Landform with landforms developed to reduce slope gradients on the eastern side of the Southern Extension Area through the use of surplus overburden from the Southern Extension Project (refer to **Section 1.3**). The landform in the south and west of the Southern Extension area will be reinstated to a landform similar to the pre- mining landform. This option is shown in **Figure 2.1**.

Option 2 As per Option 1 however the rehabilitation of the southern ridge area would incorporate a 15-20 m high cliff line feature in the final landform which would be rerated through the retention of a section of highwall in this area. The inclusion of a cliff feature will reduce the vertical height of the slopes in to the east and south of this ridgeline which also results in these slopes having a reduced gradient.

The cliff feature is developed through retention of an upper section of the highwall in the final landform; this option does not result in any void being retained. The cliff line would be similar in height to canopy height for the proposed rehabilitation vegetation, meaning the mature rehabilitation vegetation will largely screen the cliff line. This option is shown in **Figure 2.2**.

Option 3a As per Option 1 but with mining of steeper sections of the southern-most ridge avoided. Due to constraints associated with mining in a constrained pit shell, avoiding mining in this area would also limit the efficacy of mining the area immediately south of the steep slope, resulting in the sterilisation of coal resources in this area. This Option is shown in **Figure 2.3**.

Option 3b As per Option 3a but mining of the steeper sections of both the northern and Southern ridgelines is avoided. Due to the constrains associated with mining the northern section (discussed in Part B of the Response to Submissions Report in relation to incorporating a 300m setback from pagodas and cliff lines), this option would result in the sterilisation of coal resources along the Eastern edge of the Southern Extension Area. This option is shown in **Figure 2.3**.

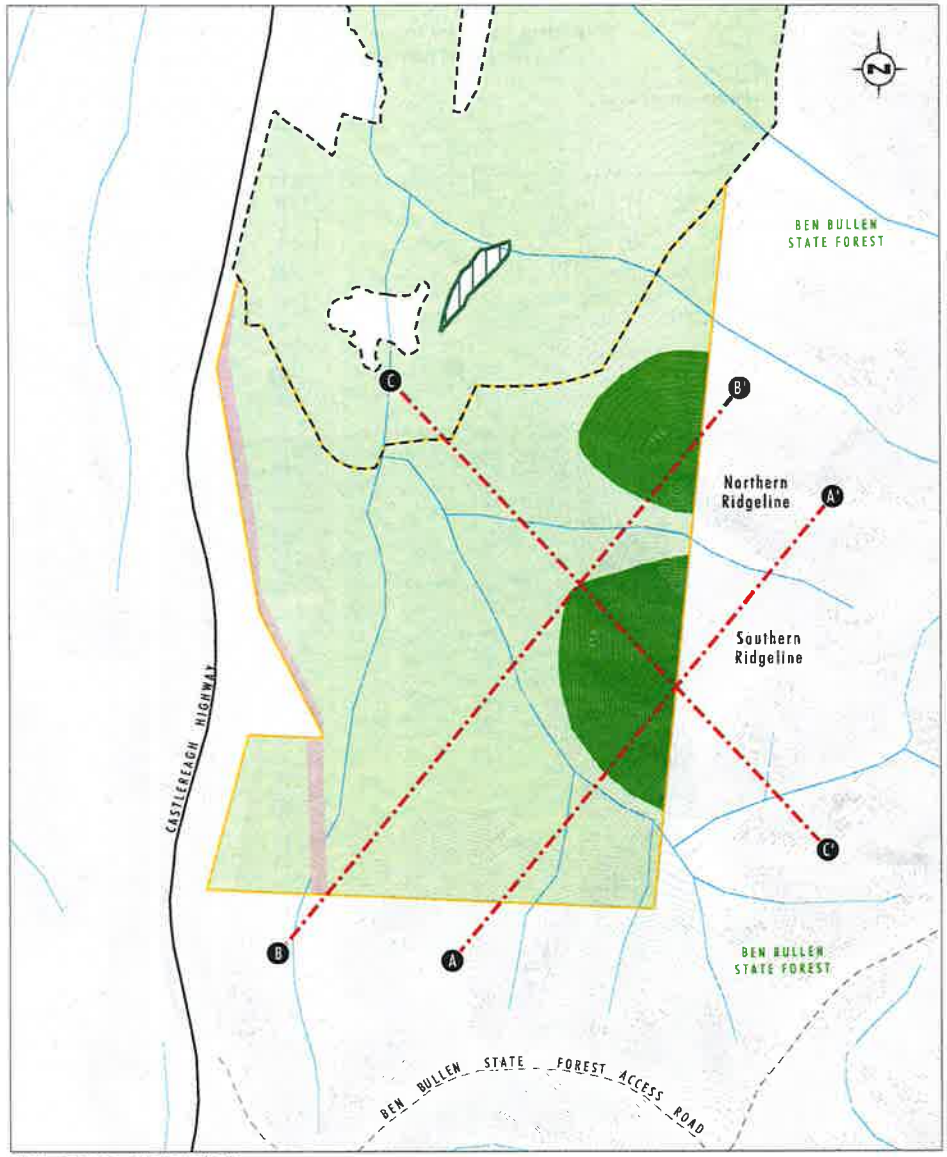
The slope gradients associated with each of the rehabilitated landform options are also shown in **Figures 2.1** to **2.3.**

Figures 2.4, **2.5** and **2.6** show landform cross sections for each option through the steeper sections of the northern and southern ridgelines in the Southern Extension Area. The sections from the EA Conceptual Final Landform (which are the same as the Pre-mining landform) are shown for reference.

As can be seen from **Figure 1.2** the slopes in the EA Conceptual Final Landform range up to 20° to 25° in places on the southern side of the northern ridgeline and the northern face of the southern ridgeline. The southern slope of the southern ridgeline includes short sections which exceed 25° however the majority of these slopes are less than 25° in slope. The slope length (top to bottom – ground length) in the steepest section of the northern ridgeline is less than 50 metres while the slope length on the northern and southern sections are each approximately 100m in length. The gradient of these slopes is consistent with those in the immediate area with many areas immediately east being significantly steeper than the conceptual final landform within the Southern Extension Area (refer to **Figure 1.2**). As noted earlier, these slopes represent the existing (pre-mining) slope gradient in these areas.

As discussed in **Section 1.3**, there is approximately 0.4 Mm^3 of overburden available to modify the EA Conceptual Final Landform to create a safe and stable landform and reduce the gradients of the northern and southern ridgeline areas. Consistent with current regulatory practice, this modification always contemplated the detail regarding the final landform being developed as part of the detailed MOP approval process for the Southern Extension Project under the *Mining Act 1992*. Option 1 reflects the landform likely to have been developed as part of this detailed MOP rehabilitation planning process.

Option 2 reflects a variation of this utilising a retained cliff line feature similar to that found in the surrounding landform (there is a similar sized natural cliff line (refer to **Plate 2.1**) located approximately 200m east of the Southern Extension Area (refer to **Figure 2.2)** which is lower in the landform than the proposed cliff line ; there are also numerous cliff lines in the surrounding area associated with pagoda formations or escarpment features. As can be seen from **Figures 2.2** and **2.4**, the retention of the cliff feature in the final landform for Option 2 allows the slopes in the rehabilitated landform below the cliff line to be reduced below 20°. The slopes created in Options 1 and 2 in the eastern parts of the Southern Extension Area are less than occurred in the pre-mining landform or occur immediately adjacent to the areas but the slopes remain similar to those in the southern and western parts of the Southern Extension Area and the north-facing slope of the northern ridgeline.



Note: Contour Interval 2m

Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Tableland Gully Mountain Gum Broad Leaved Peppermint Grassy Forest
- Exposed Blue Mountains Sydney Peppermint - Silvertop Ash Shrubby Woodland
- Grassed Powerline Easement
- 2012 Established Rehabilitation
- Section Location
- Range 0.00 - 5.00
- Range 5.00 - 10.00
- Range 10.00 - 15.00
- Range 15.00 - 20.00
- Range 20.00 - 25.00
- Range 25.00 - 30.00
- Range 30.00 - 35.00
- Range 35.00 - 40.00
- Range 40.00 - 45.00

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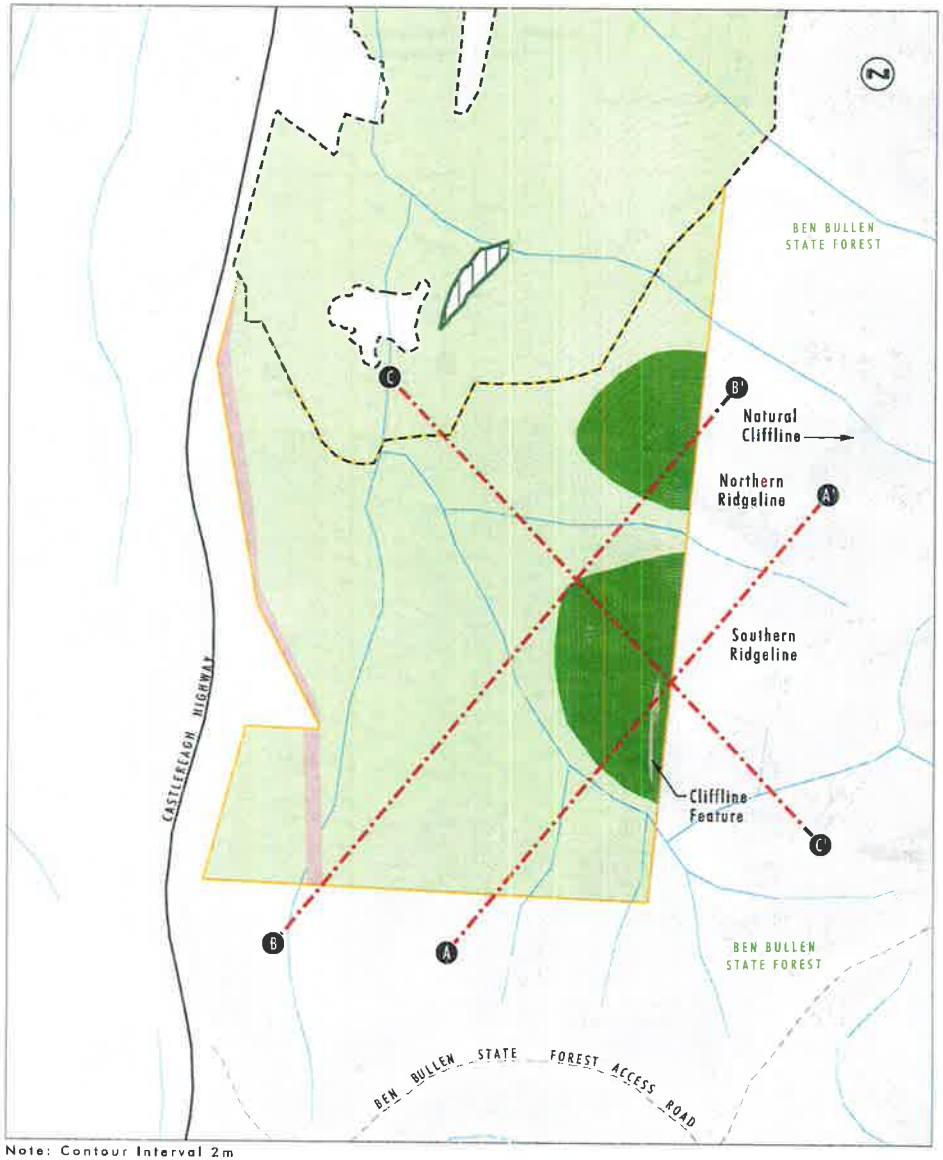
FIGURE 2.1

Conceptual Final Landform
Option 1: Reduced Slope Treatment



Note: Contour Interval 2m

Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Tableland Gully Mountain Gum Broad Leaved Peppermint Grassy Forest
- Exposed Blue Mountains Sydney Peppermint - Silvertop Ash Shrubby Woodland
- Grassed Powerline Easement
- 2012 Established Rehabilitation
- Section Location
- Range 0.00 - 5.00
- Range 5.00 - 10.00
- Range 10.00 - 15.00
- Range 15.00 - 20.00
- Range 20.00 - 25.00
- Range 25.00 - 30.00
- Range 30.00 - 35.00
- Range 35.00 - 40.00
- Range 40.00 - 45.00

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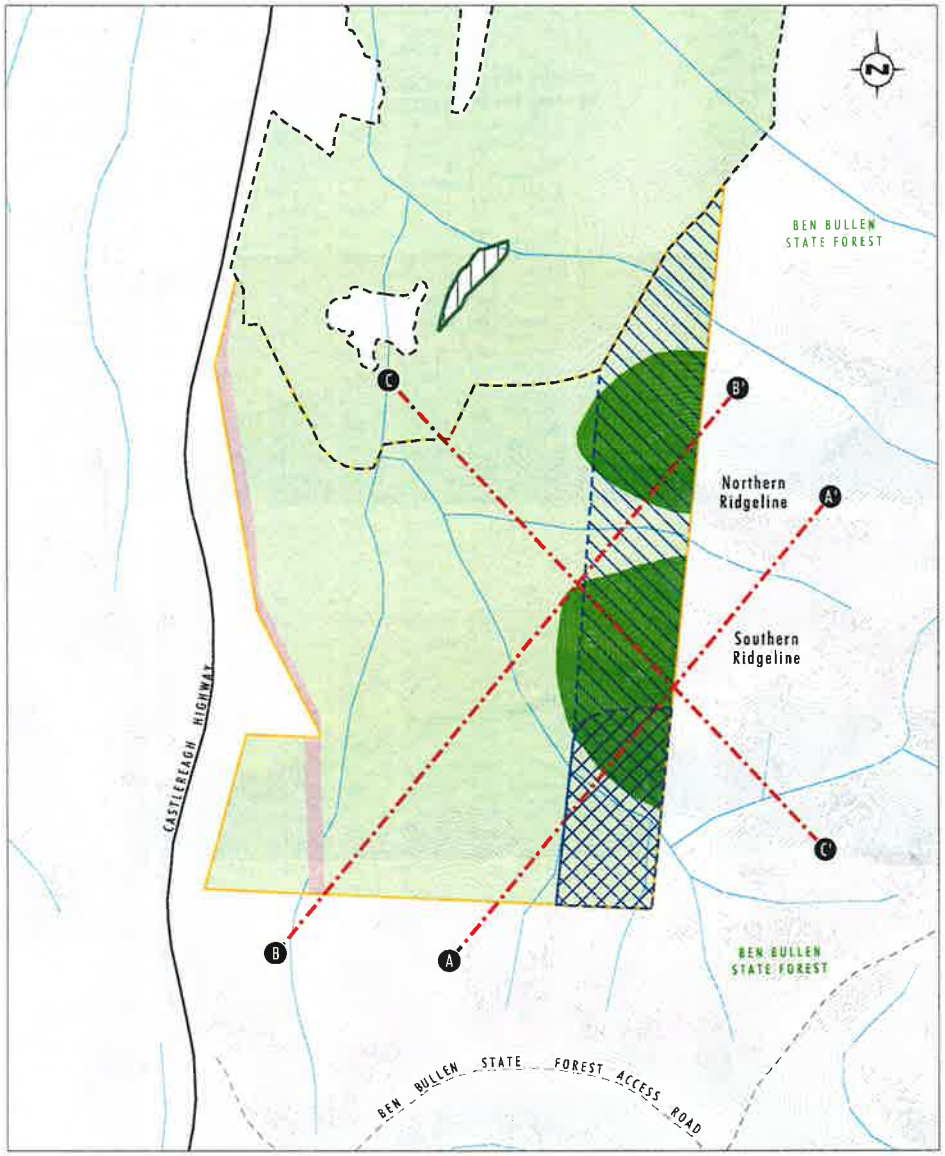
FIGURE 2.2

Conceptual Final Landform
Option 2: Reduced Slope Treatment with Cliff Line Feature



Note: Contour Interval 2m

Legend

- Existing Approved Mining Disturbance Area
- Proposed Southern Extension Area
- Tableland Gully Mountain Gum Broad Leaved Peppermint Grassy Forest
- Exposed Blue Mountains Sydney Peppermint - Silvertop Ash Shrubby Woodland
- Grassed Powerline Easement
- 2012 Established Rehabilitation
- Un-mined Area Option 3a
- Un-mined Area Option 3b
- Section Location
- Range 0.00 - 5.00
- Range 5.00 - 10.00
- Range 10.00 - 15.00
- Range 15.00 - 20.00
- Range 20.00 - 25.00
- Range 25.00 - 30.00
- Range 30.00 - 35.00
- Range 35.00 - 40.00
- Range 40.00 - 45.00

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FIGURE 2.3

Conceptual Final Landform
Options 3a and 3b: Reduced Mining Options

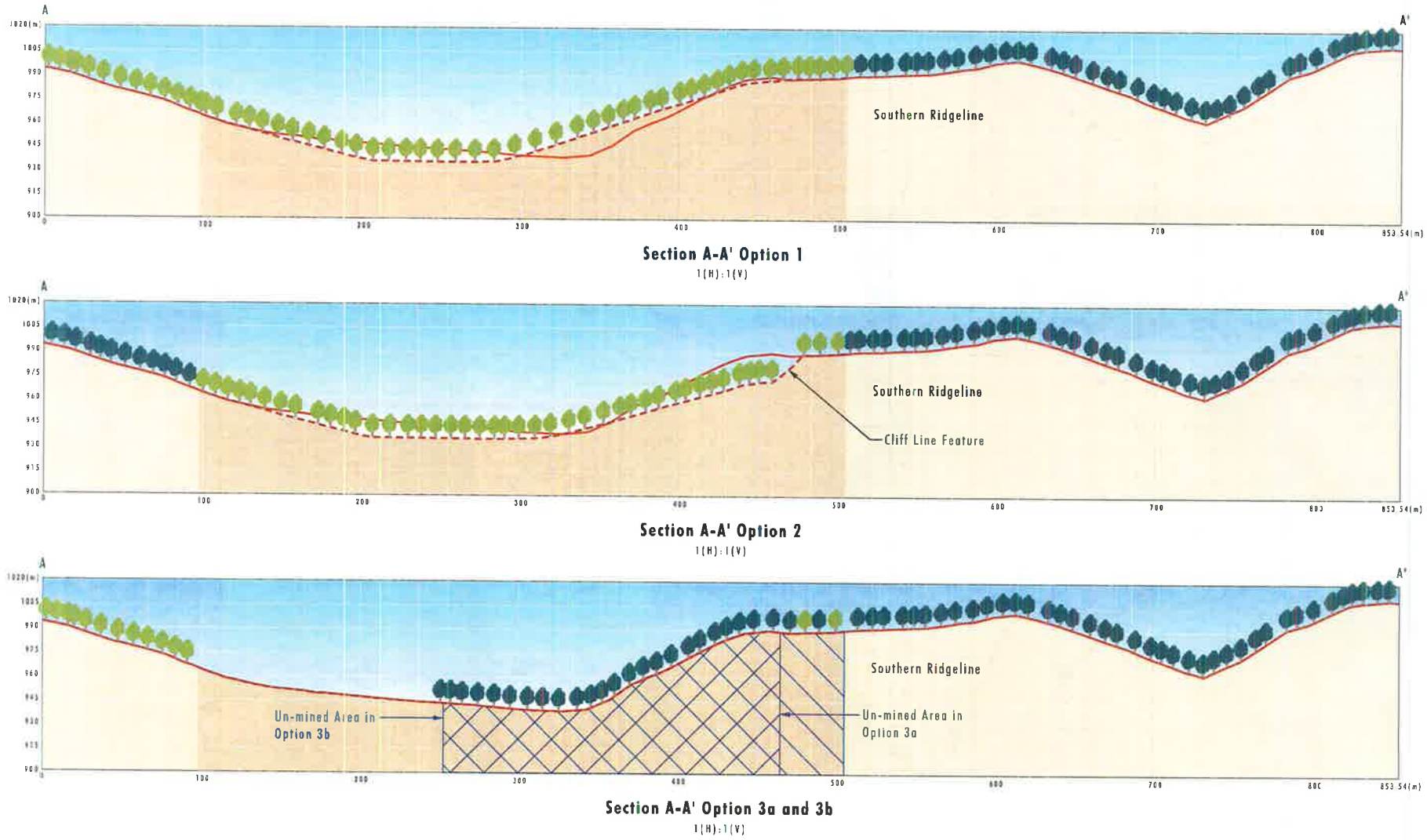

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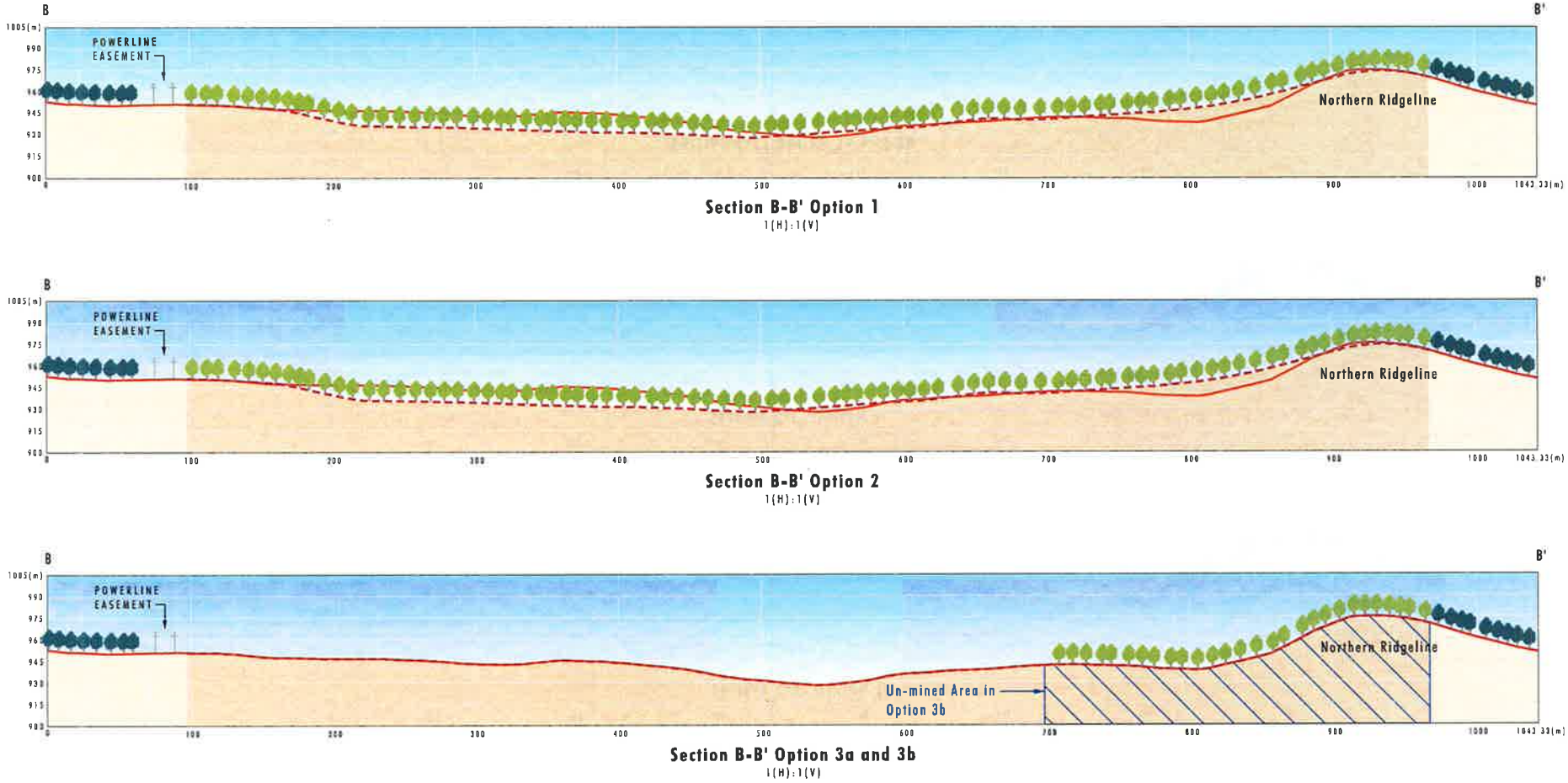
FIGURE 2.4

Comparison of Landform Options
Section A-A'



Legend

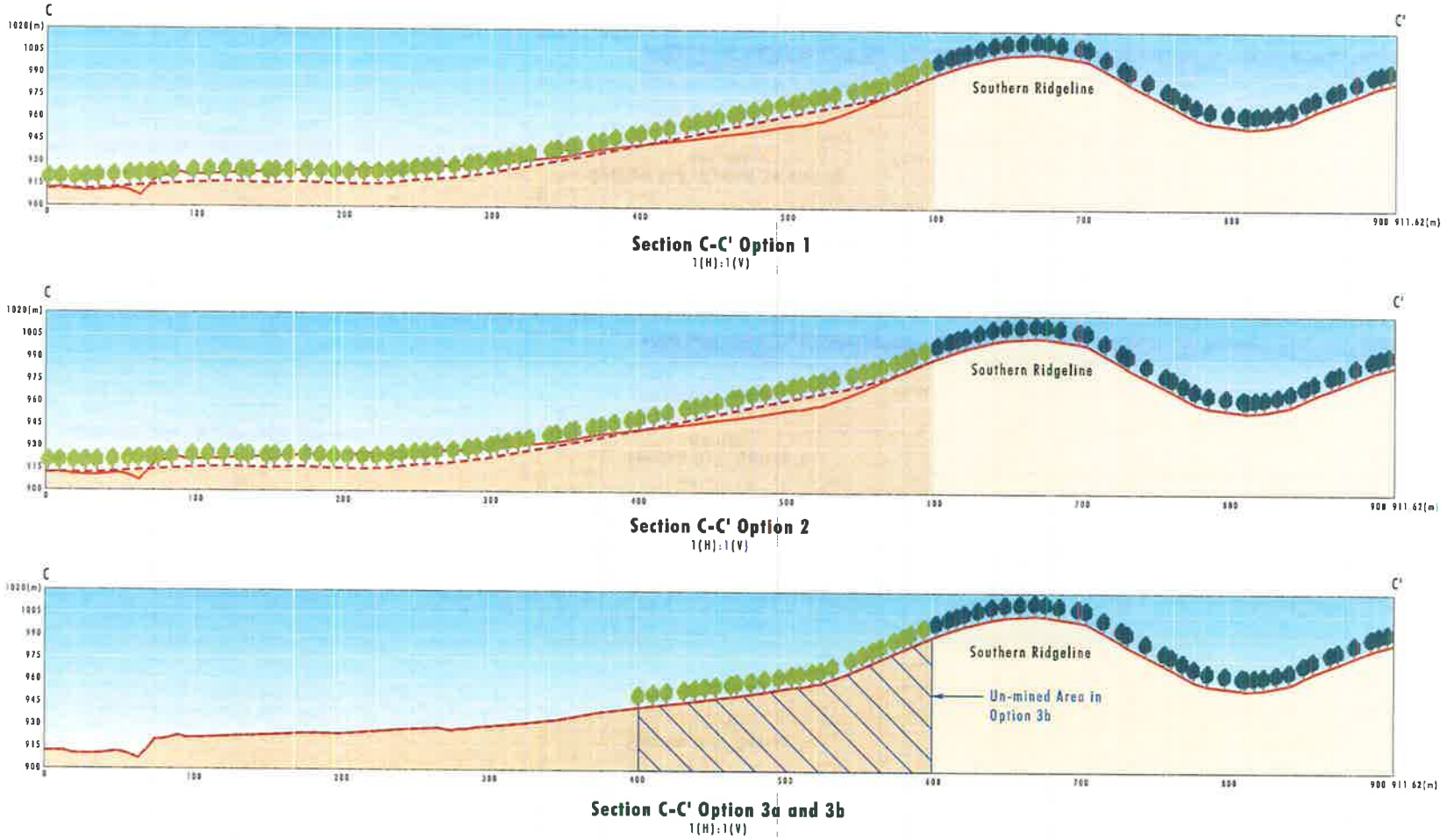
- Existing Surface/EA Conceptual Final Landform
- Proposed Surface
- Existing Vegetation
- Rehabilitated Vegetation
- Un-mined Area Option 3b

0 50 100 150m
1:3000

File Name (A3): R13/3622_161.dgn
20170614 13:45

FIGURE 2.5

Comparison of Landform Options
Section B-B'



Legend

- Existing Surface/EA Conceptual Final Landform
- Proposed Surface
- Existing Vegetation
- Rehabilitated Vegetation
- Un-mined Area Option 3b

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1 3000

File Name (A3): h13/3623_162.dgn
20170614 12 19

FIGURE 2.6

Comparison of Landform Options
Section C-C'

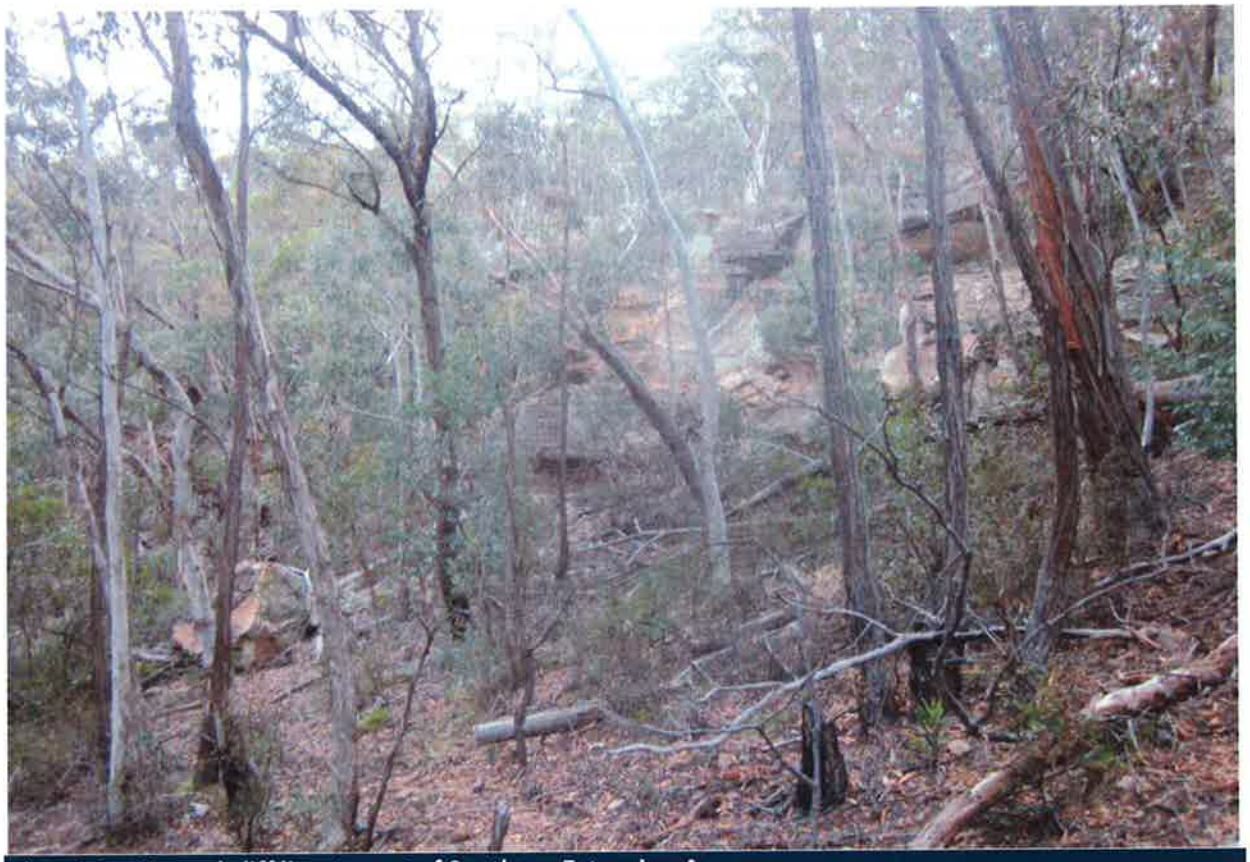

Plate 2.1 Natural cliff line to east of Southern Extension Area

Figure 2.3 identifies the areas that would need to be sterilised if the parts of the Southern Extension Area with natural slopes in excess of 20° are not mined (Options 3a and 3b). While the non-mining of these areas would avoid the need to rehabilitate steep slopes in the final landform, as is shown in Options 1 and 2, similar outcomes can be achieved through improved slope design without and impacts on resource recovery. As discussed in 10 May 2017 Additional Information Response), these non-mining options also come at the cost of reduced overburden volumes which poses constraints for the filling of the final voids associated with past mining at Invincible.

2.2 Differences to Rehabilitation in West Pit

Figure 1.5 shows the slope gradients for the West Pit area. The slopes in the steepest areas of the West Pit Area where there have been difficulties with rehabilitation include slopes of in excess of 35° in places. Slope lengths are limited to up to 140-150 metres. **Figure 1.4** shows cross sections of the rehabilitated areas within the West Pit area. Despite the steep slopes in the West Pit area, there has been limited erosion of these areas due to both the installation of contour drains and a catch drain above the rehabilitated areas which directs run-off from up slope away from the rehabilitated area (refer to **Figures 1.3** and **1.4**). As discussed in **Section 1.1**, the difficulties associated with rehabilitating the West Pit areas is largely associated with the inability to effectively spread topsoil across the steeper slopes. These difficulties were associated with the limitations posed by the terrain immediately uphill and downslope from the mined area (refer to **Figure 1.3**) which prevented different landform designs which could have reduced the slopes in the rehabilitated areas. Revegetation outcomes were also hindered through the limitations on spreading topsoil and logs and rocks across the final landform in steeper areas.

The EA Conceptual Landform is also shown for comparison purposes on each of the sections for Options 1, 2 and 3 in **Figures 2.4** to **2.6.** As can be seen by comparing **Figures 1.2** and **1.3,** with **Figures 2.1** and **2.2,** the slopes created in the Option 1 and 2 final landforms are significantly less steep than the landform created in the rehabilitation of the West Pit and the existing slopes in the Southern Extension Area (as reflected in the EA Conceptual Final Landform).

The rehabilitation of the areas of higher slopes associated with the ridgelines in the Southern Extension Area are not limited by the same practical difficulties that applied to the West Pit area. The areas to be rehabilitated in both the northern and southern ridgelines include both the upper slope and ridge cap itself as well as foot-slopes and flatter gully areas below the steeper slope sections. The additional area above and below the slope sections enable the emplacement of additional overburden material in the foot slope areas which enables the overall slope gradient to be reduced. The effect of this is shown in the Option 1 and 2 landform sections shown in **Figures 2.4** to **2.6**. The ability to emplace material below the slope and reduce slope gradients was not available for the West Pit area.

The availability of flat areas at the top and the bottom of the slope also provides greater flexibility for dozer movement up and down the slope than was available in the steepest areas of the West Pit. The reduced slopes in Option 1 and 2 also enable dozer movement across the slope which enables greater control over the construction of drainage structures. This flexibility also enables topsoil to be spread more effectively across the steeper sections.

The steep slope (greater than 20°) areas in the EA Conceptual Final Landform for both the northern and southern ridgelines in the Southern Extension Area are significantly smaller in size than the West Pit area. The most prominent steep slope area in West Pit covers an area of approximately 6 to 7 hectares; whereas in the Southern Extension Area these areas range from less than 0.5 hectares to approximately 1.1 hectares. The largest of these areas is the southern face of the southern ridgeline. Additionally, the steeper slope areas in the Southern Extension Area have little to no upslope catchment. These differences are significant in terms of rehabilitation outcomes as the reduced surface area means reduced run-off potential and therefore lower erosion risk. These small areas are also more practicable to target for specific rehabilitation treatment to manage erosion risks such as hydro-mulching.

Coupled with the overall lower gradients, the steeper slope areas in the Southern Extension Area EA Conceptual Landform are significantly easier to manage from a rehabilitation perspective than was the case for the West Pit. Notwithstanding the small sections of slope greater than 25°, the EA Conceptual Final Landform is able to be successfully rehabilitated even with the steep slopes retained due to the relatively smaller areas of steep slope and the availability of the flat areas above and below these slopes with would facilitate dozer movement up and down the slope.

2.3 Comparison of Options

Table 2.1 compares the different options being evaluated in relation to the key matters raised by DP&E including slope, opportunities to further improve the landform, resource recovery and visual impact.

Table 2.1 Comparison of Options

Option	Maximum slope in rehabilitated areas	Total Area > 20° (Ha)	Opportunities to further improve slope in detailed design phase	Consistent with surrounding landform	Impact on resource recovery of proposed Southern Extension Project	Impact on financial Viability of the Project	Visibility of areas with slopes > 15°	Comments
EA Conceptual Landform	30-35° in parts of south facing slope on southern ridgeline. Up to 25° in small sections on south facing slope on northern ridgeline and northern part of southern ridgeline.	Approx. 2.5 hectares	Yes. Opportunities to increase slope length and reduce gradient in all steep areas through final landform design and use of surplus overburden. Areas where this could be utilised include the southern face of the northern ridgeline, northern parts southern ridgeline and southern face of southern ridgeline.	Yes. Conceptual Final Landform is similar to existing terrain (refer to **Figure 2.4**). 'Tie-in' areas adjacent to sleep slopes have gradients in excess of that proposed in final landform.	Nil	Nil. As per Economic Assessment in EA.	Southern facing slopes not visible from Castlereagh Highway. Would be visible from Ben Bullen State Forest Access Road where powerline easement crosses road. Limited visibility of upper slope of northern face of southern ridgeline from Castlereagh Highway at distance of approximately 2.7 kilometres (refer to visual montage in Figure 6.33 of the EA).	The Conceptual Final Landform would return the landform in the Southern Extension Area consistent with the pre mining landform. While the steeper slopes retained in the landform would present technical challenges for rehabilitation, there are no significant practical issues limiting the rehabilitation of these areas and outcomes similar to that experienced in the West Pit area would not be expected.
Option 1 Revised Conceptual Final Landform.	<20°	Nil	Incorporated into revised Conceptual Final Landform Design and further detailed as part of the MOP process.	Yes. Conceptual Final Landform is similar to existing terrain (refer to **Figure 2.4**). 'Tie-in' areas adjacent to sleep slopes have gradients in excess of that proposed in final landform.	Nil	Nil. As per Economic Assessment in EA. The different final landform will have little to no impact on the cost of undertaking the Southern Extension Project as it can be achieved through use of overburden from the Southern Extension Area.	Rehabilitated areas would be visible from the Castlereagh Highway however the reduced slopes in the southern ridgelines would mean that much of the rehabilitated southern ridgeline would be obscured by the northern ridgeline from vehicles traveling south on the Castlereagh Highway	Together with Option 2, represent an option that addresses the issues raised by DP&E in relation to the EA conceptual final landform whilst avoiding impacts on resource recovery. Consistent with EA Conceptual final landform, Option 1 also ensures final landform can be rehabilitated across the entire project site without disturbance of existing rehabilitation areas.

Option	Maximum slope in rehabilitated areas	Total Area > 20° (Ha)	Opportunities to further improve slope in detailed design phase	Consistent with surrounding landform	Impact on resource recovery of proposed Southern Extension Project	Impact on financial Viability of the Project	Visibility of areas with slopes > 15°	Comments
Option 2 – Revised Conceptual Final Landform with cliff line feature	<20° + small cliff line	Cliff line only	Yes. Incorporated into revised Conceptual Final Landform Design and further detailed as part of the MOP process.	Yes. Conceptual Final Landform is similar to existing terrain (refer to **Figure 2.5**). Slopes in rehabilitated landform are similar to pre-mining slopes in southern and western parts of Southern Extension Area. 'Tie-in' areas have gradients in excess of that proposed in final landform. Cliff line feature is similar to the cliff line present to the northeast of the Northern Ridgeline (refer to **Plate 2.1**). Cliff lines are prevalent in the local area.	Nil	Nil to slightly positive. Any changes are unlikely to be noticeable in overall project financials	Southern facing slopes not visible from Castlereagh Highway. Southern slope on northern ridge and cliff line would be visible from Ben Bullen State Forest Access Road where powerline easement crosses road (refer to **Figure 2.3**), however this is not inconsistent with other features to the east Limited visibility of upper slope of northern face of southern ridgeline from Castlereagh highway at distance of approximately 2.7 kilometres. Upper section of cliff line feature will be visible from Castlereagh Highway at a distance of approximately 2.7 kilometres. As the cliff line is between 15 and 20 metres in height, views of the cliff line will be ultimately screened by vegetation growing below the cliff line similar to that which occurs at the cliff line shown in **Plate 2.1.**	As with Option 1,

Option	Maximum slope in rehabilitated areas	Total Area > 20° (Ha)	Opportunities to further improve slope in detailed design phase	Consistent with surrounding landform	Impact on resource recovery of proposed Southern Extension Project	Impact on financial Viability of the Project	Visibility of areas with slopes > 15°	Comments
3a	20-25° Southern facing slope in northern ridgeline	Approx. 1 ha.	Limited. Non-mining of eastern sections of Southern Extension Area reduces stripping ratios and reduces the volume of overburden available for landscaping.	Yes. Conceptual Final Landform is similar to existing terrain (refer to **Figure 2.4**). 'Tie-in' areas adjacent to sleep slopes have gradients in excess of that proposed in final landform.	Not mining the steeper south-facing slope of the southern ridgeline is likely to constrain mining in the south eastern corner of the Southern Extension Area. This would result in the sterilisation of resources in the approximately 5 hectare shaded area shown in **Figure 2.2**. Estimated loss of between and 10 and 20kt Nut coal Estimated loss of thermal coal of approximately 100 to 160kt.	The reduction in coal recovery will have significant flow-on effects for Shoalhaven Starches.	Areas not mined under this option are not visible from the Castlereagh highway. Southern facing slope of northern ridgeline not visible from Castlereagh Highway. Would be visible from Ben Bullen State Forest Access Road where powerline easement crosses road. Limited visibility of upper slope of northern face of southern ridgeline from Castlereagh highway at distance of approximately 2.7 kilometres.	Reduced mining area represents a substantial reduced economic benefit for Shoalhaven Starches and reduced economic benefits for the State and local region.
3b	<20°	Nil.	Limited. Non-mining of eastern sections of Southern Extension Area reduces stripping ratios and significantly reduces the volume of overburden available. Northern and Eastern Voids in existing open cut area will have greater reliance on dozer push and disturbance of existing rehabilitated areas to remove voids.	Yes. Conceptual Final Landform for areas outside the non-mining area are as per the pre mining landform.	Avoiding mining the steeper sections of the Northern Ridgeline would also result in sterilisation of coal north of the Northern Ridgeline due to mining constraints. This Option would sterilise more than 30kt of nut coal (product) and over 250kt of thermal coal.	The reduction in coal recovery will have significant flow-on effects for Shoalhaven Starches.	Under this option, there would be minimal views of the Southern Extension Project from the Castlereagh Highway. As outlined in the visual assessment presented in the EA, the level of visual impacts associated with the Southern Extension Area are not considered significant.	The impact of this option on resource recovery is more significant than the impacts associated with implementing a 300m setback from all pagodas (discussed in the 10 May 2017 response to DP&E providing additional Assessment Information). The reduced mining area would result in significantly reduced economic benefits for Shoalhaven Starches and reduced economic benefits for the State of in excess of $6.5 million dollars in NPV terms.

2.4 Discussion

Options 3a and 3b are not considered viable due to the resulting loss in nut coal, and other coal production and the significant impacts this has on the viability of the Southern Extension Project which would be greater than that associated with the incorporation of the 300m exclusion area discussed in the 10 May 2017 Additional Assessment Information. Option 3b in particular would have reduced benefits for the state of in excess of $6.5 million (in NPV terms). Both of these options also have implications for the successful rehabilitation of the remainder of the Invincible site due to the reduced stripping ratios and volume of overburden available to fill existing voids. As both Options 1 and 2 both result in final landforms that have slopes which address the issues raised by DP&E; in particular avoiding the rehabilitation constraints present in the West Pit area, and enable full extraction of coal resources from within the Southern Extension Area, the benefits afforded by Options 3a and 3b are not considered to outweigh the loss of nut coal resources associated with these non-mining options.

There is little difference between Options 1 and 2 in terms of rehabilitation outcomes with Option 2 resulting in lower slopes in the southern parts of the Southern Extension Area than Option 1 due to the benefits associated with the retained cliff line.

Option 1 achieves the benefits of full resource recovery and acceptable final landform slopes without the retention of a cliff line feature. Relative to Option 2, Option 1has similar rehabilitation outcomes but will have a larger area with slopes between 15° and 20°. These slope gradients are however similar to slopes in the surrounding landform and similar slopes have been successfully rehabilitated at Invincible in the past. In addition, as detailed in this response the retention of these lower gradients is not expected to present any significant practical limitations to achieving this final landform, particularly when compared to the issues of rehabilitating the existing West Pit area. In this way Option 1 addresses the issues raised by DP&E whilst also retaining resource recovery in the Southern Extension Area. Option 1 is considered to be the preferred final landform option relative to the other options considered due to the full recovery of nut coal resources and overall net public and private benefits.

While Option 2 includes a retained section of the highwall as a cliff line feature, the cliff line would be similar to natural cliff lines in the local area in terms of height and shape. The cliff line would be similar in height to the mature height of vegetation to be recreated in the rehabilitated area below the cliff line meaning views of the cliff itself would be largely obscured in the medium term (approximately 15-20 years). There is no formal policy regarding the retention of highwalls however there has been a general movement away from highwalls being retained in the final landform where possible. While this has merit in most circumstances, the Southern Extension Project is distinguishable from most other mining projects in that the nature of the surrounding environment means cliff lines are not inconsistent with the surrounding terrain. Additionally, the benefits that the retained cliff line provides in terms of slope and landform variability are positive (although noting that this is not essential in terms of rehabilitation success). The design of this cliff line feature means that there is limited visibility of the cliff from highly trafficked areas and the vegetation to be planted below the cliff line will obscure much, or all, of the cliff from view in the medium term. It is also noted that the cliff line is only being proposed in a small section of the final landform and is not a default rehabilitation option proposed for other areas.

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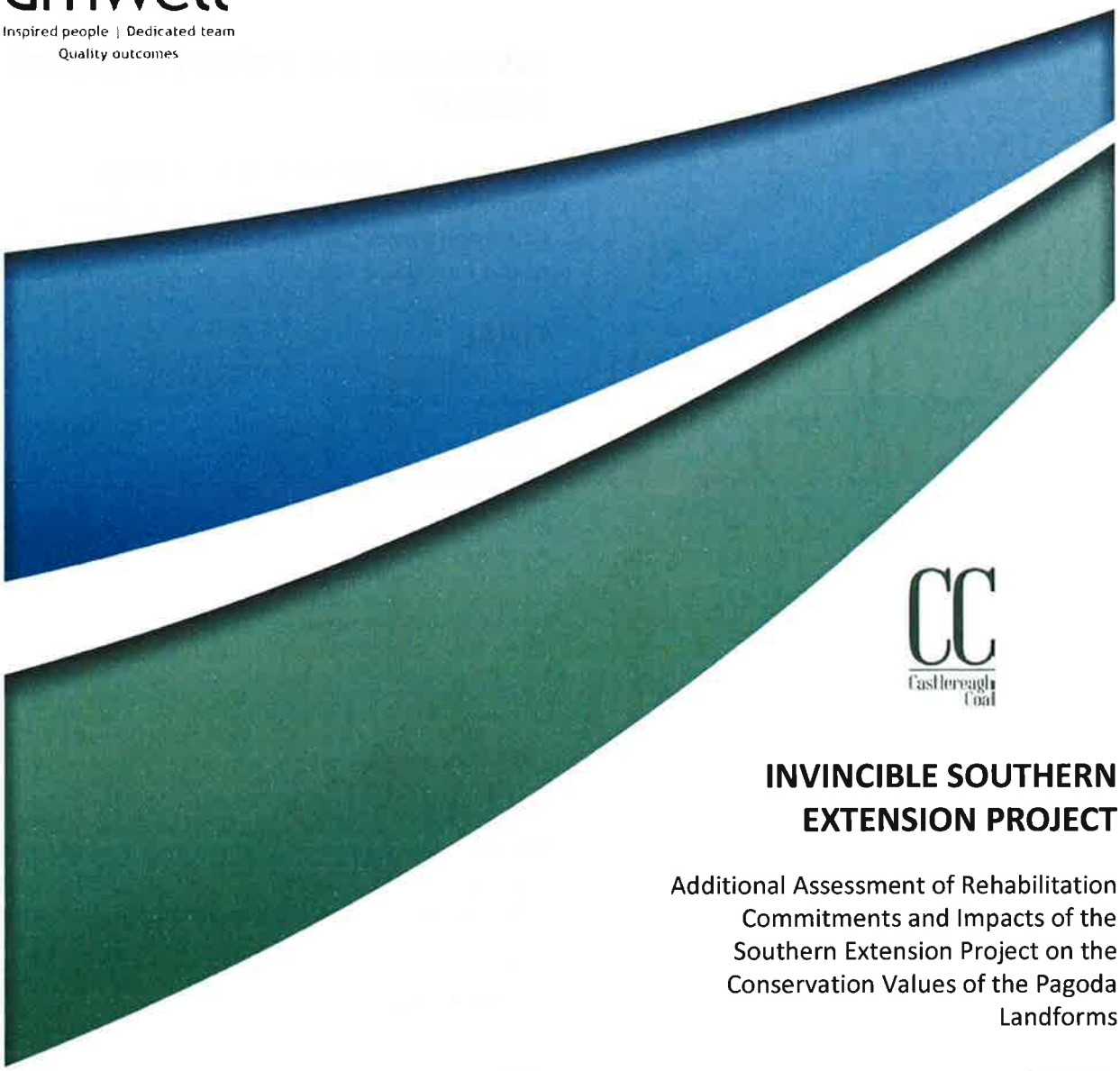

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Castlereagh Coal

INVINCIBLE SOUTHERN EXTENSION PROJECT

Additional Assessment of Rehabilitation Commitments and Impacts of the Southern Extension Project on the Conservation Values of the Pagoda Landforms

FINAL

July 2017

INVINCIBLE SOUTHERN EXTENSION PROJECT

Additional Assessment of Rehabilitation Commitments and Impacts of the Southern Extension Project on the Conservation Values of the Pagoda Landforms

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Castlereagh Coal

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Report No.	3622/R14
Date:	July 2017

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Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
FINAL	Tim Crosdale	31 July 2017	Tim Crosdale	31 July 2017

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1.0 Introduction

1.1 Background

The Department of Planning and Environment (DP&E) has sought further information regarding the mining of parts of the eastern area of the Southern Extension Area. DP&E have a recommendation as part of the draft conditions of consent for the restriction of mining within a significant proportion (approximately 14ha) of the proposed 49ha Southern Extension Area. The area identified in the draft recommendation aligns to an area identified as Final Landform Option 3b from the previous assessment of final landform options dated June 2017 (Final Landform Option report).

It is noted that Final Landform Option 3b was identified in response to DP&E's request to examine options for avoiding mining areas of steeper slope within the Southern Extension Area. As detailed in the Final Landform Option report the potential restriction of mining in this area would have a significant impact on the viability of the Southern Extension Project in terms of supplying target nut coal to Shoalhaven Starches. Further the additional overburden from this area would enable the achievement of a comparatively more effective final landform across the entire Invincible mine site. As has been reinforced through the Environmental Assessment (EA) and subsequent response reports, the achievement of a more effective final landform across Invincible is not a justification, nor a primary driver, for the Southern Extension Project, however there are substantial positive impacts associated with mining the full extent of the Southern Extension Area on achieving a stable final landform.

As detailed in Final Landform Options report, there are viable options for the further refinement of the conceptual final landform presented in the EA, that further reduce slopes within the Southern Extension Area to below 20° through the use of surplus overburden from mining within the Southern Extension Area (identified as Final Landform Option 1 within the Final Landform Options report). Final Landform Option 1 is the preferred final landform option for the Southern Extension Project.

Final Landform Option 1 demonstrates that with further refinement through detailed design, and approval through the Mining Operations Plan (MOP) process with the NSW Department of Energy and Environment, Division of Resources and Energy (DRE) (now the Division of Resources and Geosciences (DRG) in the DP&E), these slopes could be further refined to be generally less than 18° as was committed to in the EA (refer to Table 6.37 of the EA).

Of critical importance is the fact that DRG have not raised any issues in relation to the proposed mining and subsequent rehabilitation of the Southern Extension Area as detailed in the EA. In its latest submission on the Southern Extension Project, dated 29 March 2017, DRG (then DRE) stated:

> *"DRE has determined that the Proponent has adequately identified and addressed the assessed risks to environmental sustainability and that sustainable rehabilitation outcomes can be achieved as a result of the project.*
>
> *DRE has determined that sustainable rehabilitation outcomes can be achieved as a result of the project and that any identified risks or opportunities can be effectively regulated through the conditions of mining authorities issued under the Mining Act 1992.*
>
> *In particular, DRE is satisfied that the Project has the capacity of material to fill all current voids and the proposed southern extension and the site being reshaped and rehabilitated back to the required final land use outcome(s)."*

Notwithstanding, in response to the draft conditions of consent, DP&E has requested further justification for mining in these areas of proposed mining restriction having regard to the following issues:

- concerns regarding the ability to rehabilitate areas where pre-mining slopes exceed 20°
- the proposed restriction on mining of these pre-mining slopes of greater than 20° would also restrict:
    - disturbance to areas greater than 300m of a slaty pagoda formation, noting that the previous PAC Determination to refuse the Coalpac Modification Project had relied on comments from the earlier PAC Review Report on the Coalpac Consolidation Report relating to the imposition of setbacks to avoid impacts to pagoda structures and associated values, including impacts on the landscape values identified as warranting the 'highest level of protection'
    - visibility of the proposed Southern Extension Project from the Castlereagh Highway and
    - the overall cumulative effect of the above issues.

The above issues are dealt with directly in the EA for the Southern Extension Project. As extensively detailed in the EA and subsequent responses, the Southern Extension Project has been designed in consideration of the key determinative matters previously raised through PAC assessment and determinations on previous mining proposals at Invincible. Specifically, this has included the siting and design of the Southern Extension Project to minimise potential impacts on areas of comparatively diverse ecological and habitat value to the north-east of the existing Invincible mine site. Specifically this is detailed in Sections 1.3 (Project design), Section 3.7.3 (Design refinements of the Southern Extension Project), Section 6.2.3 (Compatibility with surrounding land uses), Section 6.8 (Blasting), Section 6.15 (Visual) and Section 6.18 (Rehabilitation) of the EA. These issues are further addressed in the Response to Submissions Report Part A, in particular Section 3.2 (Conservation).

Further information was provided to DP&E dated 10 May 2017, which included a detailed justification for mining within 300m of the closest pagoda structure, and other geo diverse features including an isolated cliff line. The proposed mining within 300m of the pagoda structure is justified on the basis that the proposed Southern Extension Project delivers higher net benefits for the State than the Southern Extension Project would with the incorporation of the 300m exclusion. In addition, the loss of the target resource in this area would significantly impact on the viability of the Southern Extension Project to provide the nut coal supply required for the Shoalhaven Starches Plant and limit the ability to supply Mount Piper with coal for energy production. Furthermore, the loss of the overburden as a result of restricting mining in this area would reduce the ability to utilise this material in the rehabilitation of the entire Invincible mine site as detailed in the EA.

It is important to note that the Southern Extension Project is substantially different to previous proposals for mining at this site. Specifically, the Southern Extension project involves:

- Open cut mining in a substantially smaller targeted area then previous proposals, being only 49 hectares (ha) of total disturbance area, 90% less than the 794 ha of disturbance previously proposed by previous proponents for the Consolidation Project and 60% less than the 152 ha proposed in the Modification 4 Project.
- Substantially less proposed open cut area within 300m of Pagodas and Geodiverse structures, being only 6 ha compared to the 456 ha proposed in the previous Consolidation Project and 57 ha in the Modification 4 Project.

The previous determination of the 300m setback was largely based on identified impacts to a range of threatened species, notably the Broad-headed snake. It is also of relevance to note, that the previous assessment and determination by the PAC was undertaken without the aid of a quantitative framework for the assessment of biodiversity impacts and associated mitigation options. For the Southern Extension Project this is now provided by the NSW Framework for Biodiversity Assessment process.

The Office of Environment and Heritage (OEH) have provided in principle agreement to proposed offsetting for potential impacts on assumed Broad- headed snake habitat, which is linked to the pagoda structures in proximity to the Southern Extension Area. Specifically, OEH submission on the EA dated 4 November 2016 stated:

> *"The Broad-headed Snake was not recorded within the Southern Extension Area. The BAR indicates that while winter refuge habitat does not occur within the Project Area summer foraging habitat does occur. As the closest known record is 1.5 kilometres to the north-east of the Project Area a precautionary approach has been adopted and it has been considered that the species may occur in what has been described as marginal habitat within the Southern Extension Area.*
>
> *Tree hollows within 500 metres of sandstone outcrops were buffered by 24 metres to map the potential summer habitat for the Broad-headed Snake within the Southern Extension Area.*
>
> *OEH supports the approach taken to determine the offset requirement for the species."*

Further to this, OEH provided confirmation in correspondence dated 2 June 2017 for the use and quantum of offsets for the Broad- headed snake, stating

> *"The total cost of the supplementary measure calculated and supported by OEH for the required 388 credits is $194,000."*

In this regard, the key merit issue underpinning the previous PAC's imposition of a 300m has been effectively dealt with as part of the Southern Extension Project.

1.2 Overview of Response

This report provides further information regarding the specific issues raised by DP&E and the project justification more broadly. Specifically, this report details the practicalities of the proposed rehabilitation of the full extent of the Southern Extension Area, to demonstrate that the mining and rehabilitation of the identified areas of steeper slopes can be achieved as the risks have been identified and can be managed, as previously agreed by DRG. Furthermore, the proposed mining of the full extent of the Southern Extension Area is considered to result in a comparatively more effective final landform, in the context of contributing to an improved final landform and minimising medium to long term landscape impacts relative to the existing approved final landform.

The report also examines the primary material that has given rise to the findings and recommendations made by the PAC in relation to the Coalpac Consolidation Project and the Coalpac Modification Projects. The report examines how this material relates to the protection of pagoda structures and associated landforms as it relates to the Southern Extension Project.

It is noted that whilst each of these former projects also included mining in the Southern Extension Area, there are significant differences between those earlier projects and the Southern Extension Project.

Differences in terms of the magnitude of potential impacts, nature of impacts and the assessment policies applicable to the approval projects means the driver for the 300m setback from pagodas for the earlier projects has limited applicability to the Southern Extension Project. As is outlined in subsequent sections, the Southern Extension Project's impacts on the high conservation value of the pagoda landforms are temporary and limited in terms of their magnitude over the short term.

2.0 Mining and Rehabilitation of Steeper Slope Areas.

In general terms, it is acknowledged that open cut mining in steep terrain has the potential to cause up-slope instability through the loss of buttressing. Mining of steep slopes can also present difficulties in re-establishing a final landform due to, predominately, erosive risks associated with the re-establishment of steep slopes in the final landform, but also physical constraints in recreating the final landform due to technical limitations for plant operating in steep slope environments. In the context of the Southern Extension Project these potential issues are discussed below.

2.1 Slope Stability Concerns

As has been demonstrated by the mining of the West Pit Area at Invincible, it is possible to mine steep slopes (defined as being greater than 20°) with no impacts on slopes up slope from the mined area. The Southern Extension Area does not present the same constraints as were present in the West Pit Area in terms of steep slopes above the mining area. The areas of steep slope within the Southern Extension Area, and the terrain directly above is generally flat or gently sloping as it forms part of the ridge crest. Parts of the Southern Extension Area will abut steep slopes (particularly the southern faces of the two ridges on the eastern side of the Southern Extension Area) however these areas do no slope towards the pit and instead slope towards the east-west running drainage lines. This is significant in that areas up slope from the pit edge in the Southern Extension Area do not rely on the buttressing provided by the downslope area being mined and therefore do not pose a risk of slumping towards the pit.

While the geotechnical stability of the slope would require monitoring, the past experience from mining at Invincible indicates there are no geotechnical concerns regarding the mining of a number of areas of steeper slope within the existing mined areas of Invincible. This conclusion is supported by the Geotechnical assessment provided with the Response to Submissions Report A for the Southern Extension Project, which determined that existing highwalls have all been identified as being geotechnically stable.

2.2 Ability to Rehabilitate the Southern Extension Area

Section 6.18 of the EA specifically details the rehabilitation strategy for the Southern Extension Project and includes specific criteria and objectives for this rehabilitation. Of note is the commitment that rehabilitation would result in slopes that do not (over the length of the slope) exceed 18°. This is consistent with other approved open cut mining proposals in NSW and would be achieved through further detailed planning and refinement of the conceptual final landform outlined in the EA and in accordance with the MOP/Rehabilitation Management Plan approval process with DRG.

The Final Landform Options report for the Southern Extension Area identified refined preferred final landform option (Final Landform Option 1) which results in slopes of less than 20° across the proposed final landform. While the pre-mining landform in these areas included slopes of up to 35°, the eastern parts of the Southern Extension Area contain higher stripping ratios (in the order of 10:1) meaning for the overall Southern Extension Project there is a surplus of overburden material relative to that required to rehabilitate the Southern Extension Area back to the pre-mining landform and to fully rehabilitate the remainder of the existing Invincible mine site with no or only minimal disturbance of existing rehabilitation.

This surplus can be used to extend the slope length of the rehabilitated ridgelines in the eastern parts of the Southern Extension Area such that the rehabilitated final landform can be developed to have slopes not exceeding 18° (refer to Final Landform Option 1 in the Final Landform Options report).

Final Landform Option 1 is technically feasible and can be achieved with low erosion risk through the incorporation of conventional drainage controls, which would be further detailed in relevant management plans for the Southern Extension Project (i.e. Water Management Plan and Rehabilitation Management Plan). As supported by the submission from DRG, the potential risks for achieving the proposed EA final landform across the Southern Extension Area have been identified and there is a high degree of confidence regarding the ability to successfully rehabilitate the eastern parts of the Southern Extension Area such that the final landform and vegetation communities in this area would be difficult to discern from the adjacent un-mined areas over the medium term (30-50 years) as committed to in the EA.

Rehabilitation of the former West Pit Area at Invincible was identified by DP&E as a reason why mining and rehabilitation may be problematic in the steeper parts of the eastern side of the Southern Extension Area. The issues associated with the rehabilitation of the West Pit Area are further assessed in the Final Landform options report. In summary, the key differences in the context of rehabilitation are:

- The presence of the conservation area (as established under the existing Invincible project approval) below the West Pit Area and the steep slopes above, coupled with the steep rehabilitated landform in this area presented operational constraints for the spreading of topsoil and salvaged timber and rocks. This in-turn resulted in slow establishment of vegetation in the reformed landscape. These physical constraints do not apply to the Southern Extension Area and the rehabilitated landform will have significantly lower slopes than the steepest areas in the West Pit Area (as detailed in the Final Landform Options report). The proposed slope design in Final Landform Option 1 is amenable to being properly worked with dozers and there is a high degree of confidence in the ability to rehabilitate these slopes.
- The West Pit Area is a prominent part of the visual landscape for vehicles travelling north along the Castlereagh Highway adjacent to the existing Invincible mine site. Exposed mining areas and the slow-to-rehabilitate West Pit Area are visually prominent and still remains so, several years after rehabilitation has commenced. This is contrasted to other lower slope areas of the West Pit where shrub and tree growth is already providing significant visual impact mitigation. As shown in Figure 6.33 of the EA, parts of the north facing slopes in the eastern areas of the Southern Extension Area will be visible for a short section of the Castlereagh Highway for vehicles travelling south, over 2 km north of the Southern Extension Area. While visible, these areas will occupy a significantly smaller field of view than the West Pit Area does for north travelling vehicles and will be less visually prominent.
- The north facing slopes in the Southern Extension Area, which would be visible, have generally lower slopes than the southern sides of the steep slope areas (around 15°) and the rehabilitation of these slopes poses less technical difficulties than the slightly steeper south facing slopes in this area. It is noted that the steeper southern facing slopes of the Southern Extension Area are not visible from areas surrounding the Southern Extension Area aside from intermittent views from the Castlereagh Highway and from isolated areas within the Ben Bullen State Forest. As detailed in the EA, these views are largely either shielded by existing vegetation along the Castlereagh Highway, or are less than the current visibility of the existing Invincible mine site. As the Southern Extension Project includes the progressive rehabilitation of the Southern Extension Area, the visual impacts associated with visible areas of the northern side of these slopes will be short term in duration and visual signs of mining in the Southern Extension Area from the Castlereagh Highway will be minimal within a short duration after mining is completed.

Visual impacts in relation to the conservation/landscape value of the pagoda landforms are discussed further in **Section 3.3**.

Overall, there are no technical reasons why the eastern parts of the Southern Extension Area cannot be rehabilitated successfully. As outlined previously, the submissions from the DRG, who regulate rehabilitation of mine sites under the *Mining Act 1992*, did not raise any concerns regarding the ability to rehabilitate the Southern Extension Area and did not raise any objections to the proposed Southern Extension Project subject to the following:

- *Progressive rehabilitation of disturbed area should be a requirement of the activity approval.*
- *Proponent to submit a Progressive Rehabilitation Proposal as part of Mining Operations Plan/Rehabilitation Management Plan outlining rehabilitation works to be undertaken during the term, including timeframes when activity will be undertaken. This should form part of a 'Statement of Commitments' for approval prior to commencement.*
- *Rehabilitation of the proposed Southern Extension Area and all existing disturbance areas at Invincible (by reshaping mining areas to remove voids and revegetating the reshaped landform with locally endemic woodland and forest communities) is to be detailed in a new Mining Operations Plan (MOP)/Rehabilitation Management Plan (RMP) prepared in accordance with the Division's Guidelines.*

As discussed in Section 6.17 of the EA, the detailed design of the final landform and rehabilitation practices require approval under the MOP/Rehabilitation Management Plan required under the Mining Leases applicable to the Invincible operations. The MOP/Rehabilitation Management Plan will include rehabilitation monitoring requirements and Trigger Action Response Plans appropriate to ensure timely action is taken in the event that rehabilitation practices do not fully meet desired outcomes. The MOP/Rehabilitation Management Plan must be approved by the Secretary of the Department of Planning and Environment prior to any mining operations in the Southern Extension Area commencing and this approval process would necessarily consider details of the approach to the rehabilitation of the eastern part of the Southern Extension Area.

Further, security will be required under the terms of the Invincible Mining Leases to cover the anticipated rehabilitation costs associated with the rehabilitation identified in the MOP. The approach to calculating anticipated rehabilitation costs was updated in 2017 and the approval process of the MOP for the Southern Extension Project will required an updated rehabilitation cost estimate for the entire Invincible site using the new approach. In addition to the above measures, annual reporting of rehabilitation is required under the terms of the Mining Lease and project approval and regular audits of operations by both regulators and independent auditors are carried out. The combined effect of these regulatory processes is that there is greater scrutiny over the implementation of rehabilitation commitments and appropriate mechanisms in place to ensure appropriate action is undertaken, if required.

2.3 Rehabilitation Implications for the Existing Invincible Disturbance Area.

The PAC Determination Report for the Coalpac Modification Report identified that that project could not be justified on the basis that it is required to meet the existing rehabilitation commitments for existing approved disturbance at Invincible. As the PAC noted, Coalpac (then) and Castlereagh Coal (now) are required to meet the rehabilitation requirements for the Invincible site irrespective of whether proposals for additional mining are approved. This has been understood and reinforced by Castlereagh Coal through the EA and again through the Response to Submissions Report Part A. Notwithstanding, the proposed mining of the full extent of the Southern Extension Project provides an opportunity for the development of an improved final landform across both the Southern Extension Area and the existing Invincible mine site.

This has a range of benefits such as improving the overall final landform across the Invincible site, as well as avoiding the need to disturb existing rehabilitated areas and other areas of approved disturbance at Invincible.

The following sections discuss the benefits associated with the Southern Extension Project and detail the impacts associated with meeting the existing rehabilitation commitments under the current Invincible Project approval, and the relative merits of Final Landform Option 3b as identified in the Final Landform Options report (and utilised by DP&E to define an area of striction on mining).

2.3.1 Relative Merits of Southern Extension Project on Rehabilitation Outcomes

While the Southern Extension Project is not required to rehabilitate the existing Invincible mine site, it will result in significantly better rehabilitation outcomes across the Invincible mine site, if the full extent of proposed mining within the Southern Extension Area is approved. The benefits in terms of rehabilitation outcomes are as follows:

- The surplus overburden (refer to **Section 2.3.3**) associated with mining the full extent of the proposed Southern Extension Area enables:
    - existing voids to be filled with minimal disturbance of established rehabilitation and avoids the disturbance of currently vegetated and undisturbed steep slope areas to the south of the Eastern Void, which is currently authorised under the existing consent (refer to **Section 2.3.2**)
    - reduced slope grades in rehabilitation areas across the Invincible mine site
- The removal of future and ongoing subsidence impacts in the Southern Extension Area associated with past mining in the Ivanhoe No. 2 Underground (as detailed in Section 3.7.1.2 of the EA) and
- The rehabilitation timeframe can be progressed in a timely manner due to it be undertaken progressively as part of the Southern Extension Project, which seeks to complete the filling of the exiting voids early in the life of the Project (aside from the Northern and Eastern voids which are required for operational water storage) as detailed in the EA.

While mining the Southern Extension Area involves additional disturbance, this disturbance is in areas that have lower biodiversity richness than the areas within and adjacent to the areas necessary to disturb as part of the approved Invincible rehabilitation. Further, the Southern Extension Project only involves additional disturbance in the Southern Extension Area and the small areas between the Southern Extension Area and the South Pit that is currently approved to be disturbed as part of the existing operations (refer to **Figure 2.1**). This is in contrasts to the Previous Coalpac Modification Project (and, to a greater degree, with the Coalpac Consolidation Project) which included mining to the east of the Eastern Void (refer to **Plate 1**) and north of the Northern Void comprising approximately 57ha of areas of higher biodiversity richness and considerable visual character. Unlike the previous projects and existing Invincible open cut mining areas, the additional impacts associated with the Southern Extension Project do not encroach further on the more spectacular and visually prominent pagoda formations (refer to **Plates 1, 2** and **3**). The pagoda formations to the east of the Southern Extension Area are much smaller in scale and are not visually prominent in the landscape. As can be seen from the Visual Montage in Figure 6.33 of the EA, there are no pagodas visible in the landscape to the south and east of the Southern Extension Area.

The Southern Extension Project does not encroach on the higher biodiversity value gullies in the escarpment located between the pagodas and clifflines. Further, the biodiversity impacts associated with this additional disturbance in the Southern Extension Area will be fully offset in accordance with the NSW Framework for Biodiversity Assessment process which includes specific considerations of potential impacts on threatened species (refer to **Section 3.2.2**).

Accordingly, while the better rehabilitation outcomes of the existing disturbance at Invincible comes at the expense of biodiversity impacts in the Southern Extension Area, the improved landscape outcomes in relation to higher conservation value areas is considered to outweigh these costs, particularly given the biodiversity impacts themselves are fully offset in accordance with the NSW Framework for Biodiversity Assessment process. To the extent that there are additional impacts on the landform adjacent to the pagoda landscapes to the east of the Southern Extension Area, these impacts will be temporary and will not impact on the long term conservation values of the Ben Bullen State Forest area.

2.3.2 Impacts Associated with Existing Rehabilitation Commitments

As discussed in Section 3.7.1.1 of the EA, if the Southern Extension Project does not occur, the existing disturbed areas of Invincible will be progressively rehabilitated over time and in accordance with existing commitments and approval. Due to the manner in which previous mining operations were undertaken at Invincible, there is currently insufficient overburden in emplacement areas to fill all of the voids currently present on the site without disturbing some of the areas that have already been rehabilitated. Reshaping and revegetation works to fully rehabilitate the site are likely to take several years. In general, the rehandling of topsoil associated with disturbance of already rehabilitated areas is a generally avoided practice due to typically poorer rehabilitation success following re-disturbance. The re-disturbance of existing established rehabilitation would be necessary for the rehabilitation of Southern/Renown Pits and the Eastern Void if the Southern Extension Project wasn't approved or if there is insufficient overburden from the Southern Extension Project due to restriction of mining within the Southern Extension Area.

Further, the current consent authorises disturbance in currently undisturbed areas to the south of the Eastern Void closer to the pagoda formations (refer to **Figure 2.1**). Due to the deficit of overburden, without the full extent of mining proposed for the Southern Extension Project, the completion of rehabilitation of the remaining voids in the existing Invincible mine site would:

- Involve further disturbance closer to prominent pagoda formations and
- Result in a combination of steeper slopes in the rehabilitated final landform and re-disturbed rehabilitation.

Much of the rehabilitation disturbance will occur around the Eastern Void (refer to **Plate 1**) however the already shaped areas that are awaiting topsoil spreading (refer to **Plate 2**) are also likely to require reshaping to obtain the material volumes necessary to rehabilitate the existing Invincible mine site. The slopes likely to be created under this rehabilitation scenario would almost certainly be similar to or greater than the slopes which DP&E have identified are of concern in the Southern Extension Area.

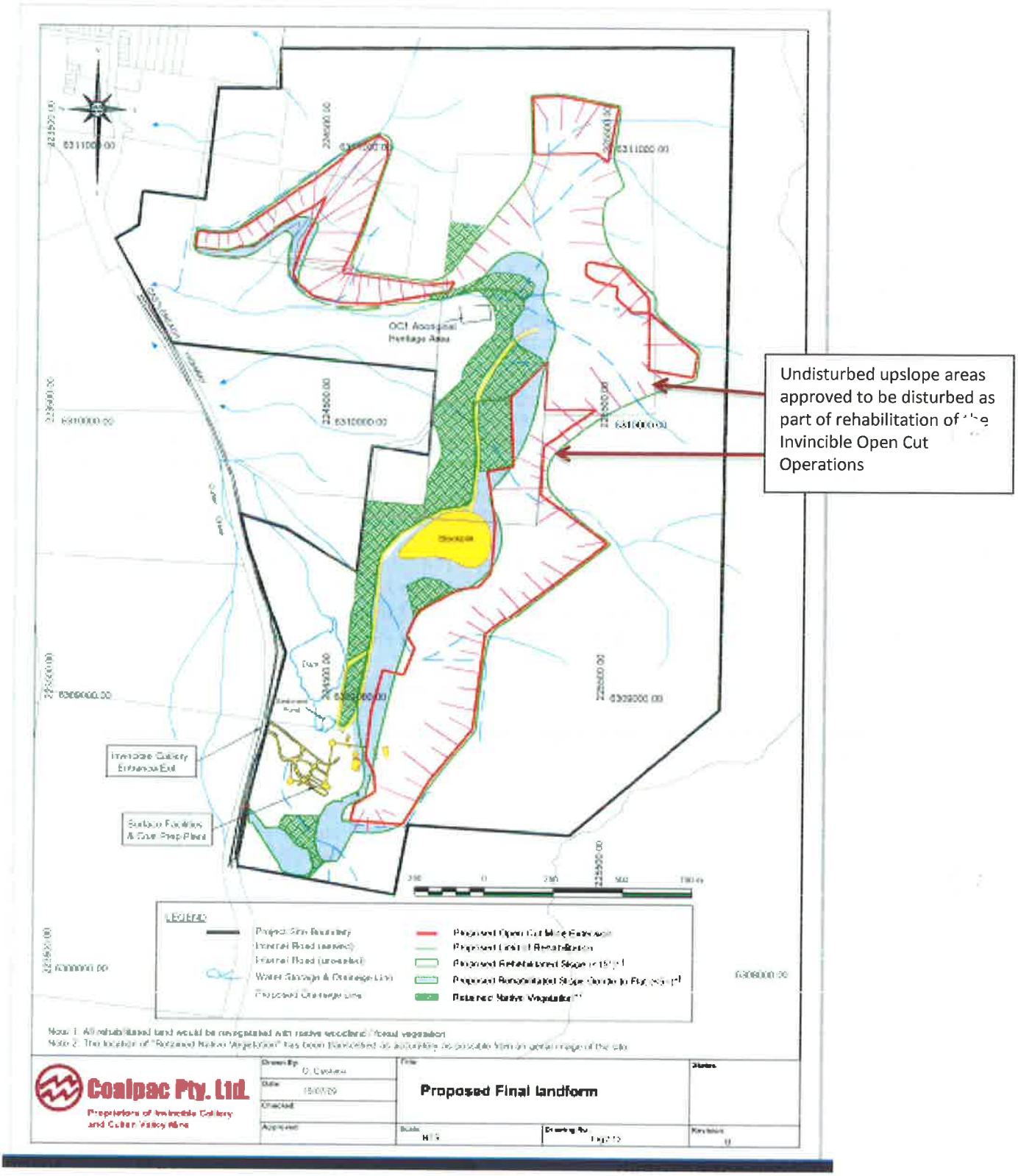

Figure 2.1 Approved Final Landform under Current Consent

■ Plate 1 - Eastern Void Area showing areas above approved for disturbance to achieve final landform under current consent

■ Plate 2: Shaped Overburden at Northern End of Renown/South Pit

As can be seen from **Plate 1**, **Plate 2**, and **Plate 3**, the un-rehabilitated open cut operations immediately to the east of these formations are visually incompatible with the landspace and conservation values identified by the previous PAC reports into the previous mining proposals at Invincible.

Due to constraints associated with past mining operations and rehabilitation by the previous owners, the rehabilitation of these areas if the Southern Extension Project does not proceed to its full extent will likely result in additional disturbance of vegetation in close proximity to these high value landscape features in accordance with the existing consent. Further, the deficit of overburden material is likely to require the creation of steep slopes in the landform with associated rehabilitation risks. Both outcomes will create additional and potentially prolonged impacts on the landscape and biodiversity values in this area to the east and north of the existing Invincible mine site, which have been identified as significant through previous assessments and PAC determinations (refer to **Section 3.0** for further details).

■ Plate 3: Pagoda Formations adjacent to Renown/South Pit Void

2.3.3 Final Landform Option 3b – Implications for Rehabilitation of Existing Invincible Disturbance Area

At the request of the DP&E, the Final Landform Options report considered an option of not mining the steeper parts of the Southern Extension Area. Final Landform Option 3a (not mining the steep slopes of the southern ridge) and Final Landform Option 3b (not mining the steep slope of both the northern and southern ridges) were considered. While these options only required mining to avoid slopes above 20°, the constraints imposed on mining associated with these exclusions effectively sterilised all mining in the Final Landform Option 3b exclusion area.

Not mining the Final Landform Option 3b exclusion area would sterilise approximately 92,000 t of Lithgow Seam coal (equating to approximately 46,000t of nut coal) and approximately 500,000t of thermal coal. The implications of this loss of coal are significant as the total target coal resource within the Southern Extension Area is 2.7Mt.

Further, the potential restriction on mining results in impacts on the viability of the Southern Extension Project and the ability to meet its primary objective of providing an effective supply of nut coal to Shoalhaven Starches Plant. Significantly it is noted that the loss of target nut coal, at supply rate of 85,000 tonnes per annum, represents a reduction of approximately 50% of a year's supply to Shoalhaven Starches from the Southern Extension Project in isolation.

This mine plan change would reduce the life of mine (mining at a rate to provide 85,000tpa nut coal and ramp down in final year) to less than three years should all nut coal be sourced from Invincible. Given that Shoalhaven Starches are faced with short to medium term projections indicating a potential 60 per cent increase in gas prices by late 2017, there are significant cost pressures on Shoalhaven Starches, and other manufacturing operations in NSW. As such, without the ability to access a cost effective source of energy, such as that provided by the full extent of the Southern Extension Project, there is significant pressure on the ongoing competitiveness of the Shoalhaven Starches Plant.

As identified in both the 10 May 2017 response regarding the 300m exclusion area and the Final Landform Options report, the exclusion of the eastern parts of the Southern Extension Area would have significant implications for the rehabilitation of the remainder of the Invincible site due to the reduced overburden available to fill the existing Invincible mine site and Southern Extension Area.

If the Final Landform Option 3b exclusion area was to be applied (as per the current draft DP&E recommendation), the impact on the final landform is significant as the total volume of available overburden reduces significantly (6 Mm^3). With a total waste volume of 7.9 Mbcm, this totals only 9.5 Mm^3 of spoil at a 20% swell. Specialist mine planning experts (Palaris) have reviewed the mine plan options and advise that the total waste required is shown in **Table 2.1** below and totals 11.5 Mm^3 for the remaining areas or a 10.6 Mm^3 if the Northern Void is rehabilitated through dozer push alone.

Table 2.1 Option 3b Rehabilitation Overburden Requirement

Area	Overburden Requirement (Mm^3)	Comments
Southern Extension Area	8.8	
Renown/South Pit	1.3	
Northern Void	0.9	Majority can be pushed by dozer using existing overburden.
Eastern Void	0.5	
Total	**11.5**	**10.6 Mm^3 required if all of Northern Void rehabilitated through Dozer Push**

If the Northern Void is able to be fully rehabilitated through dozer push, there is a shortfall of 1.1 Mm^3 across the entire site under Final Landform Option 3b. This is contrasted against the overall surplus of overburden from the full extent of the Southern Extension Area, which would be used to reduce the slopes within the conceptual final landform, whilst achieving an improved landform across the existing Invincible mine site.

While Final Landform Option 3b assists in meeting some (approximately 0.7 Mm^3) of the overburden deficit under existing rehabilitation commitments, the rehabilitation of the existing Invincible mine site under this scenario would necessitate similar rehabilitation requirements such as use of materials from approved additional disturbance areas to the east of the existing Invincible mine site and rehandle of existing rehabilitation as discussed in **Section 2.3.2** above.

2.3.4 Summary of Rehabilitation Benefits Associated with the Southern Extension Project

The rehabilitation outcomes achieved through the proposed mining of the full extent of the Southern Extension Area relative to the other options considered result in:

- Less additional disturbance around the more visually prominent and biodiversity rich areas of the pagoda landscape to the east of the Invincible mine site
- Earlier rehabilitation of the Invincible disturbance area to a landform that is similar to the pre-mining landform as detailed in the mining stage plans detailed in the EA
- Improved final landform and landscape outcomes, particularly in relation to areas adjacent to the higher biodiversity and visually prominent pagoda formations to the east of the existing open cut mining disturbance area
- Greater certainty in rehabilitation outcomes through integration with the proposed mining operations as part of the Southern Extension Project.

These outcomes are achieved at a lower cost to Castlereagh Coal as the rehabilitation costs form part of the overall operations, rather than requiring additional work which may not be fully covered by the income generated by mining under Final Landform Option 3b. As discussed in the EA, and further detailed in the response dated 10 May 2017, these rehabilitation outcomes are achieved at an overall cost benefit to the State and local region even taking into account the costs associated with rehabilitation and biodiversity offsetting costs.

3.0 Landscape Values and the Conservation Significance of the Pagoda Landscape

As outlined in **Section 1.0**, it is understood that DP&E have referenced previous assessment and determinations of the PAC in relation to past mining proposals at Invincible, as part of its draft recommendation to restrict mining in the eastern extent of the Southern Extension Area. In particular this has included reference to the overall landscape value of the pagoda landscapes in proximity to Invincible and previous determinations in relation to the appropriateness of setbacks to these features from mining.

It is imperative that the assessment of Southern Extension Project relates to the merits of the current proposed modification in the context of its overall benefits to the State. As established in Section 6.12 of the EA, and further detailed in a subsequent response dated 10 May 2017, the Southern Extension Project as proposed in the EA, delivers higher net benefits for the State than the Southern Extension Project would with the incorporation restrictions on mining as recommended by DP&E.

The relevant merit issues relating to the final landform required through mining the full extent of the Southern Extension Area have been addressed in detail in **Section 2.0**. In addition, the proposed rehabilitation through the mining of the full extent of the Southern Extension Area would result in a comparatively better final landform across the Invincible mine site through comparatively lower impacts on biodiversity and the surrounding landscape than the approved operations, as well as improve overall slopes across the entire landform – key issues raised by DP&E in relation to the full extent of mining across the Southern Extension Area.

Moreover, as detailed in Sections 1.3, Section 3.5 and Section 3.7 of the EA the design of the Southern Extension Project has considered the previous assessment and determination of previous mining proposals at Invincible to develop a project that balances impacts to identified values and features surrounding Invincible whilst still enabling a viable mining operation to meet the supply objectives for the Shoalhaven Starches Plant to be achieved.

Notwithstanding this approach to project design and assessment, this section provides further detail underpinning the relevant aspects of the PAC assessment and determinations for previous mining proposals at Invincible and their applicability to the Southern Extension Project as proposed in the EA.

The PAC Determination on the Coalpac Modification Report included the following discussion on the risks presented by previous mining proposals on pagoda landforms:

> ***Risks and Impacts from mining on the Pagoda Landform Complex***
>
> *The PAC Review identified a number of risks to the Pagoda Landform from mining. These risks were categorised as:*
>
> - *Risks to structures; from blasting, slope instability, subsidence and highwall pillar failure or other highwall impacts;*
> - *Risks to flora and fauna; including direct impacts, indirect impacts (such as noise, dust and lighting) and destruction of habitat; and*
> - *Risks to the visual value of the pagoda landform; from structural damage to the pagodas or cliffs, proximity of the open cut pits and clearing of forest below the pagodas and limitations to the rehabilitation in replacing key elements of the landform.*

The PAC Review gave careful and detailed consideration to each of these risks. Ultimately, the Review PAC recommended that:

- *highwall mining not be permitted under the pagodas or escarpment in the project area; and*
- *a minimum setback distance of 300 m be maintained from the open-cut highwall to the pagodas and the escarpments.*

The Review Report explains that a 300m setback would:

- *provide a significantly improved habitat buffer for listed threatened fauna species that use the pagoda landform;*
- *lessen the risk to the pagodas and escarpment from blasting and slope instability; and*
- *lessen the visual impact on the landform.*

3.1 What Constitutes a 'Pagoda Landform'

To understand the above recommendations in relation to their applicability to the Southern Extension Project, it is first necessary to identify what constitutes a Pagoda Landform as defined in previous PAC assessments, and understand the regulatory context in which the 300m set back was recommended by previous PACs.

A key issue for the refusal of the Coalpac Modification Project was the potential impacts of that project on the 'Pagoda Landform Complex'. The PAC Determination Report noted the following at page 9 of the Report (PAC, 2014):

Descriptions of the Pagoda Landform Complex and consideration of its significance are covered in detail in the PAC's Review Report and in the Department of Planning and Infrastructure's assessment of the previous Coalpac Consolidation Project. In short, the PAC's Review of the Coalpac Consolidation Project found that:

- *"the pagodas cannot be considered as structures in isolation ... they are part of a landform consisting of multiple pagoda structures and intervening sections of cliffs, with steep slopes and dissecting gullies below"*
- *The pagodas are "a unique landform on a world scale ... "; have limited distribution, "provide critical habitat for some flora species and key habitat features for threatened fauna"; and "contain significant items of Aboriginal cultural heritage"*
- *"the pagoda landform should be afforded special significance status and the highest possible level of protection". [PAC Review Coalpac Consolidation Project, p 76]*

The full text of the section of the PAC Review Report into the Coalpac Consolidation Report referred to in the above extract from the PAC Determination Report for the Modification Project is set out below:

6.2.2 Significance of the Pagodas Themselves and the Pagoda Landform

The pagodas cannot be considered as structures in isolation. As noted above, they are part of a landform consisting of multiple pagoda structures and intervening sections of cliffs, with steep slopes and dissected gullies below.

The paper by Washington and Wray (2011) clearly identifies the pagodas as a unique landform on a world scale, identifies that their distribution is limited to a small section of the western edge of the Great Dividing Range, and notes that significant mining-induced impacts have already occurred to many of the formations located outside of the reserve system. Protection of the pagodas in the vicinity of the proposed project has long been on the agenda of the conservation movement of NSW. The title of the proposed area for reservation (Gardens of Stone Stage II) indicates the importance attached to these features.

As noted above the pagodas also provide critical habitat for some flora species and key habitat features for threatened fauna including species identified under the relevant State and Commonwealth legislation. They also contain significant items of Aboriginal cultural heritage.

The Commission has previously canvassed the process for allocating levels of significance to particular natural features. [NSW Planning Assessment Commission 2010, Bulli Seam Operations Review Report, NSW Planning Assessment Commission, Sydney pp.101-102 which followed on from the work in Southern Coalfield Inquiry Report (NSW Department of Planning 2008)] *It noted that the process inevitably involves some degree of subjectivity, but that subjectivity decreases as the assessment approaches either end of the significance spectrum.*

Based on the scientific literature, the international significance of the pagoda structures, the importance of the habitat, multiple submissions on the EA and at the public hearings, and the Commission's own observations during both aerial and ground inspections, the Commission concludes that the significance of the pagoda landform is at the top of the scale and thus the pagoda landform should be afforded special significance status and the highest possible level of protection.

The Commission also notes that DRE supports this level of protection:

'...the applicant needs to demonstrate the rock pagoda features will not incur mining-induced damage and most importantly, pillar stability is such that there is no risk of further subsidence after mining is complete.'[DRE (Mine Subsidence Board), letter to PAC, 7 December 2012]

Recommendation 45: *The Commission recommends that the pagodas and the associated escarpments be considered natural features of special significance and that they be fully protected from any mine-induced impacts.*

The recommendation in Washington and Wray (2011) regarding conservation significance of pagodas is as follows (underlined sections are for emphasis):

However, just as Australia has been slow to acknowledge its wealth of biodiversity, the pagodas show that we have been similarly slow to recognise the significance of our geodiversity, and the platy pagodas are certainly a distinct and significant part of Australia's geodiversity. The formation of platy pagodas has yet to be full explained, but their geomorphic significance is not in doubt. We believe that pagodas and their associated sandstone landforms (such as slot canyons) are important and significant parts of the sandstone geodiversity of the Greater Blue Mountains World Heritage Area and adjacent unprotected areas. This is of significance given the Commonwealth Government plans to renominate this World Heritage Area for geodiversity in the future (currently it is listed only for biodiversity). Pagodas deserve full and expanded recognition as a significant part of the geodiversity and geoheritage of the Blue Mountains region. Their natural aesthetic beauty, their biodiversity, and their significant geomorphological values mean they deserve enhanced recognition and conservation into the future.[emphasis added]

As can be seen from the above two extracts, the Washington and Wray (2011) paper focusses on the significance of the pagoda structures and associated sandstone landforms such as slot canyons (as geoheritage and geodiversity features) rather than the broader landscape features referred to in the PAC Review Report into the Coalpac Consolidation Report. It is important to note here that the conservation values relate to their *"natural aesthetic beauty, their biodiversity, and their significant geomorphological values"*. While it is noted that a number of submissions on the previous Coalpac projects and the Southern Extension Project extend these conservation values to include the lower slopes and wooded slopes and alluvial flats below the pagodas, Recommendation 45 in the PAC Review Report into the Coalpac Consolidation Report is limited to the *'pagodas and the associated escarpments'*.

While it references the PAC Review Report into the Coalpac Consolidation Report as justification for its position, the PAC Determination Report into the Coalpac Modification Project significantly expands on the areas considered to comprise the Pagoda Landform and also warrant this high level of protection:

In finalising its assessment of the Coalpac Consolidation Project in 2013 the Department agreed with the PAC's findings and recommendation, stating:

> *" ... the Department believes that the PAC's classification of the pagoda landform as a natural feature of special significance is appropriate and agrees that these features warrant the highest level of protection." [Department of Planning and Infrastructure's Coalpac Consolidation Project Director-General's Environmental Assessment Report, June 2013 p 36]*
>
> *"the Department is satisfied that the only reasonable way to define the pagoda landform complex must include the pagoda rock formations on the plateaus, the wet gullies, and the wooded slopes below the pagodas. In other words, the pagodas cannot be considered in isolation. Consequently, the Department does not accept the definitions used by Coalpac for SPLs* [Significant Pagoda Landforms] *and Sandstone Outcrops. Instead, the Department believes that the definition of the pagoda landform should be generally consistent with the areas mapped as "pagoda country" by Washington & Wray which includes the various components that make up the pagoda landform complex (i.e. pagodas, gullies, and slopes)."*
>
> *The Office of Environment and Heritage (OEH) has also consistently acknowledged the importance of the pagodas. In 2012 the OEH provided mapping of the pagoda landforms and escarpments, as geodiversity features. This mapping acknowledges all the features, i.e. it did not classify or distinguish the features. The OEH considered a range of potential standoff distances, based on different known habitat requirements.*
>
> *The Commission accepts the findings of the 2012 PAC Review, the OEH and the Department of Planning and Infrastructure's 2013 Assessment Report, that the pagoda landform complex is a natural feature of special significance and that the features warrant the highest level of protection, i.e. they should be fully protected from risks of mine induced impacts."*

The Department's definition of pagoda landforms is much broader than that adopted by PAC Review into the Coalpac Consolidation Project. The PAC identified the pagoda landform as entailing cliffs, with steep slopes and dissecting gullies below; that is, the steep tallus slopes below the pagodas and cliffs and the incised gully areas between these formations. Prior to the Department's revised recommendation report, the Pagoda landscape did not extend to wooded slopes beyond those immediately below the pagodas and clifflines. At no point has a formal definition extended to slopes and terrain unrelated to the pagoda formations or associated clifflines, i.e. it does not extend to ridge lines extending from terrain containing pagodas where there ridges are not considered tallus nor are they associated with gullies dissecting the pagoda formations. Additionally, the reference to steep slopes does not capture all steep slopes in reasonable proximity to pagodas, the steep slopes must be associated with the pagoda formation itself to form part of the escarpment feature associated with pagoda features.

The above distinction is important in the context of the Southern Extension Project as the Southern Extension Area does not include any pagodas nor does the area contain any dissecting gullies between pagoda formations. While the eastern part of the Southern Extension Area does include a ridge which contains a pagoda higher in the landform, the Southern Extension Area does not include any tallus or steep slopes immediately below or associated with the pagodas. The ridge lines and drainage lines in the eastern part of the Southern Extension Area are not unique in the broader terrain and are not at all dissimilar to dry woodland ridges and ephemeral gullies located throughout the broader Blue Mountains region. This is to be contrasted to the terrain immediately to the east of the existing Invincible mine site which could be characterised as containing features which would meet the definition of the pagoda landform; indeed, parts of the already mined areas associated with the Eastern Void would arguably be considered to form part of the Pagoda Landform (refer to **Plate 2**).

The Southern Extension Area itself does not contain any features *'that warrant the highest level of protection'* as defined in previous PAC assessments and determinations. To the extent that the Southern Extension Area is adjacent to areas of the Pagoda Landscape, the features of this landform do not contain the incised gullies and other geodiverse features associated with pagodas to the north and east of Invincible. As discussed further below, the impacts of the Southern Extension Project on the values of the landform immediately adjacent to the Southern Extension Area have considered the previously defined 300m setback (refer to **Section 3.2.1**), are fully offset (refer to **Section 3.2.2**), are managed though the application of conservative blast impact criteria (refer to **Section 3.2.3**), and have limited visual impact relative to other areas (refer to **Section 3.3**).

3.2 Pagoda Setbacks

3.2.1 Assessment of Biodiversity Impacts Associated with Previous Mining Proposals

The terrain associated with the pagoda and cliffline structures is a good example of the features that are associated with the high biodiversity value of pagoda landscapes, namely the pagodas and clifflines themselves and the steep slopes and wetter incised gullies between the formations. These areas are to be distinguished from the areas to the immediate east of the Southern Extension Area which, although containing pagoda structures, do not contain the same degree of biodiversity richness due to the lack of incised gullies between the formations and that the pagodas themselves are not prominent in the landscape.

Recommendation 47 from the PAC Review into the Coalpac Consolidation Project provided as follows:

> *"to provide adequate protection for threatened species and other fauna that use the pagoda landform, a minimum setback distance of 300m be maintained from the open-cut highwall to the pagodas and the escarpments. This will provide a significantly improved habitat buffer for the listed threatened species that utilise the pagoda landform..."*

The PAC Determination Report for the Coalpac Modification Project summarised the PACs consideration of the Coalpac Consolidation Project as follows:

> *The PAC Review gave detailed consideration to the flora and fauna associated with the Pagoda Landform Complex and also sought and received further information from the NSW Office of Environment and Heritage. In relation to the Coalpac Consolidation Project, the PAC found that:*

- *"The pagoda landform in the project area provides essential habitat components for a number of listed threatened fauna species and is potential habitat for some non-listed species that are of public significance, such as the Superb lyrebird;*

- *These species use both the pagodas and the lower gully and forest floor areas for their breeding, shelter and foraging needs on either a seasonal or daily basis;*

- *... a full 500m setback (as per TSDP [Threatened Species Profile Database] requirements) would eliminate much of the open-cut ... This suggests that open cut mining may not be the optimum use for this area which has high scenic, conservational and recreational value."* ***[PAC Review Coalpac Consolidation Project, p 89]***

Ultimately the PAC Review recommended that "to provide adequate protection for threatened species and other fauna that use the pagoda landform, a minimum setback distance of 300m be maintained from the open-cut highwall to the pagodas and the escarpments. This will provide a significantly improved habitat buffer for the listed threatened species that utilise the pagoda landform..." [PAC Review Coalpac Consolidation Project, Recommendation 47, p 91]

One of the key threatened species considered in relation to the habitat value of the pagoda landforms was the Broad-headed Snake (Hoplocephalus bungaroides). The Broad-headed Snake is listed as an Endangered Species in the NSW Threatened Species Conservation Act 1995. This species is also listed as vulnerable under the Australian Government's Environment Protection and Biodiversity Conservation Act 1999.

The OEH submission referred to above related to the consideration of the Coalpac Consolidation Project on biodiversity impacts in 2012. This assessment process predated the current NSW Framework for Biodiversity Assessment process and required the standoff zones considered on the habit features of certain threatened species, in particular the Broad-headed snake. The 300m setback recommendation ultimately identified by the PAC was based on potential impacts on the foraging habitat of Broad-headed snake which is typically restricted to 300-500 m from its winter habitat which can include features associated with pagodas. Threatened bat species which also reside in fissures and overhangs in the pagodas also have a foraging range similar to that of the Broad-headed snake (these habitat requirements are discussed in detail in the Biodiversity Assessment Report in Appendix 6 of the EA).

It must be stressed here that these standoff zones considered for the Coalpac Consolidation Project by OEH related to potential impacts on threatened species; the stand-off distance did not define the pagoda landform complex boundaries. That 300m setback was recommended as a standoff distance for the Coalpac Consolidation Project was largely based on the magnitude of impact from this Project on areas of potential habitat for the key threatened species being considered. **Table 3.1** compares the impact areas associated with the Coalpac Consolidation Project, Coalpac Modification Project and the Southern Extension Project. As can be seen the Coalpac Consolidation Project included potential disturbance of approximately 456ha of land within 300m of mapped geodiverse features, which is an order of magnitude above the relative area of the Southern Extension Area within 300m of the closest pagoda and isolated cliff line features.

Table 3.1 Comparison of Proposed Impact Areas

	Consolidation Project*	Modification 4 Project*	Southern Extension Project*
Total area of Proposed Open Cut Mining Disturbance	794 ha	152 ha	49 ha
Proposed Open Cut Within 300m of Pagodas and Geodiverse Structures	456 ha (57%)	57 ha (37.5%)	6 ha (12%)
Total Area of Proposed Highwall Mining	294 ha	189 ha	N/A
Proposed Highwall Within 300m of Pagodas and Geodiverse Structures	269 ha (91%)	163 ha (86%)	N/A
Total area of Proposed Mining Within 300m of Pagodas and Geodiverse Structures	724 ha (66%)	220 ha (65%)	6 ha (12%)

*Numbers in brackets indicates percentage of proposed mining within 300m of pagodas or geodiverse structureS

Given this magnitude of impact, potential impacts on local populations of threatened species reliant on these areas for foraging habitat were likely to be significantly impacted by Consolidation Project, particularly given the disturbance, in some cases, removed potential habitat on all sides of the geodiverse features. While the impacts associated with the Coalpac Modification Project were less than the Consolidation Project, approximately 57 ha of that project that were within 300m of the pagodas. Again, this is a potentially significant impact on local populations of the threatened species considered by OEH in their 2012 advice.

Notwithstanding the application of a setback approach to managing impacts associated with the earlier mining proposals, the significantly reduced scale of impacts associated with the Southern Extension Project relative to the earlier mining proposals considered by the PAC and the availability of an agreed framework to quantitatively assessment biodiversity impacts mean that a standard 300m offset from pagodas for the purpose of mitigating biodiversity impacts has limited applicability to the Southern Extension Project. More specifically, the applicability of a 300m setback to the Southern Extension Project has been detailed in the previous 10 May 2017 submission to DP&E, which is outlined in the following section

3.2.2 Assessment of Biodiversity Impacts Associated with the Southern Extension Project

Aside from one instance, the limit of disturbance associated with mining in the Southern Extension Area is set back at least 300m from all pagoda formations. The setback from one single pagoda was reduced to approximately 210 m following further investigations which identified that winter habitat features for the Broad-headed snake were generally absent at this pagoda feature (refer to Appendix 6 of the EA).

Potential impacts on the Broad-headed snake associated with the Southern Extension Project have been considered in the Biodiversity Assessment Report in accordance with the NSW Framework for Biodiveristy Assessment process. The offset requirements for the Broad-headed snake are based on potential foraging habitat within 500 m of all potential winter habitat (i.e. pagoda structures). Notwithstanding the general absence of winter habitat for the species at the nearest of the pagodas, the Biodiversity Assessment Report (BAR) have conservatively assumed that this pagoda does provide potential habitat for this species and applies a 500m foraging habitat for consideration under the FBA. The approach to assessing offset requirements in relation to the Broad-headed snake are discussed in Section 6.0 of the BAR (Appendix 6 of the EA) and Response to Submissions Part A. This approach to the assessment of any potential residual impacts on this key species has been supported by the OEH in their submission on the Southern Extension Project including the subsequent extensive consultation and agreement relating to the proposed offsetting for the Broad-headed snake (refer to **Section 1.1**).

Potential impacts on other threatened species, including the Large-eared pied bat, are calculated as inputs to ecosystem credit requirements in accordance with the NSW Framework for Biodiveristy Assessment process. The determination of the number of ecosystem credits required due to impacts associated with a project has regard to a range of factors including impacts on threatened species, vegetation communities and the landscape values of the area being impacted. The offset requirements are identified through credits requirements determined based on thorough quantitative biometric survey techniques. This quantitative process replaces the previous qualitative process for biodiversity assessment and mitigation and provides that if the proponent can obtain and surrender the appropriate credit requirements determined by the BioBanking Credit Calculator, the proponent is considered to have fully offset all biodiversity impacts. The Credit requirements for the Southern Extension Project are identified in Table 8 of the Additional Information provided to the Department of Planning on 10 May 2017. These offset credit requirements can be fully satisfied through the proposed Hillcroft BioBanking Site and the Supplementary Measures for the Broad-headed snake.

3.2.3 Protection of Pagodas and Associated Landscapes from Blasting Impacts and Ensuring Slope Stability

3.2.3.1 Management of Potential Blasting Impacts

Further, as discussed in Sections 3.7 and Section 6.8 of the EA, extensive project design consideration has been undertaken to minimise any potential impacts on pagoda structures from blasting. The pagoda and cliff line structures in close proximity to the Southern Extension Area have been subject to a detailed geotechnical assessment to determine stability and risk of impacts from blasting (refer to Appendix 9 of the EA). The geotechnical assessment identified conservative blast vibration criteria designed to ensure protection of these pagoda structures and clifflines over the life of the Southern Extension Project. As detailed in Appendix 9 of the EA, these conservative blast criteria can be met through appropriate blast design, primarily through control of the blast size, along with comprehensive baseline and ongoing condition monitoring. Accordingly, setbacks from the pagodas and clifflines are not necessary to manage potential blast impacts, as they can be actively managed to manage impacts to the pagoda and cliff line structures in closest proximity to the Southern Extension Area.

3.2.3.2 Slope Stability

Unlike previous proposals, the Southern Extension Project does not include any highwall mining or underground mining; as such, the Southern Extension Project will not have any subsidence impacts on the pagodas.

As discussed in **Section 2.1** and **Section 2.2**, the Southern Extension Project does not present slope stability risks for areas upslope of the proposed highwall crest.

3.3 Visual Impacts

The pagodas and associated landforms are visually spectacular. The 'natural aesthetic beauty' of the pagoda formations was specifically identified by Washington and Wray (2011) as a reason warranting a high degree of protection for these features. As identified in the PAC Determination report on the Coalpac Modification Project, mining presents a range of potential risks to the visual character of the defined pagoda landform, including:

- through structural damage to the pagodas or cliffs
- proximity of the open cut pits and clearing of forest below the pagodas
- limitations to the rehabilitation in replacing key elements of the landform.

As discussed in **Section 3.2.1**, the Southern Extension Project differs from the previous mining proposals at Invincible in that it does not include further encroachment on the defined pagoda landscape.

The Eastern Void and Renown Pit/Southern Void areas of the existing Invincible mine site are located closest to the prominent pagoda formations to the east of the current Invincible workings (refer to **Plate 1** to **Plate 3**). These pagoda areas are visually prominent in the landscape and are considered to be some of the more visually spectacular landforms visible from the Castlereagh Highway. The pagoda formations to the east of the Southern Extension Area are much smaller in scale and are not visually prominent in the landscape. As can be seen from the visual montage in Figure 6.33 of the EA, there are no pagodas visible in the landscape to the south and east of the Southern Extension Area. In this regard, the Southern Extension Project, while extending the overall area of disturbance associated with mining, does not itself have a significant impact on the visual character of the pagoda landform, as there are only limited opportunities where the additional disturbance can be viewed in the context of broader pagoda landform, including from the ridge line to the south of the Southern Extension Area and publically accessible elevated areas in Ben Bullen State Forest. In both circumstances, the existing mining disturbance remains visually prominent and is more proximate to the visually spectacular elements of the pagoda landform which give rise to the conservation value of the pagoda formations.

Overall, the Southern Extension Project is considered to have limited impact on the visual attributes of the pagoda landscape. These impacts will be temporary in nature and the improved rehabilitation and landform outcomes for the existing disturbance areas associated with the Southern Extension Project while have a net positive benefit for the visual character surrounding the more visually spectacular components of the pagoda landform in both the short term (through reduced disturbance) and the long term (through improved landform design). These benefits are considered to outweigh the relatively minor temporary visual impacts associated with the additional disturbance of mining the full extent of the Southern Extension Area.

3.4 Overall Impacts on Conservation Values

Impacts on conservation values must be considered in terms of both short term and long term impacts. In considering these impacts, the specific short term and long term conservation values of a particular landform need to be identified and considered. **Table 3.2** identifies the short term and long term benefits associated with the conservation of the pagoda landforms in the context of the Southern Extension Project.

Table 3.2 Conservation Values Associated with Pagoda Landforms

Benefit	Details	Comments
Biodiversity Values	Breeding and foraging habitat. High levels of biodiversity due to diversity of habitats and vegetation communities associated with the variable landform.	Southern Extension Project does not impact on higher biodiversity areas as previously identified through specific definitions utilised to inform previous PAC assessment and determinations. Short term biodiversity impacts are fully offset in accordance with FBA requirements which have been agreed in principle by OEH. Negligible long term impacts as the Southern Extension Area and existing disturbance areas are rehabilitated to vegetation communities and landforms consistent with the pre-mining environment. There is potential for the offset areas associated with past Invincible approvals to be added to future areas reserved under the *National Parks and Wildlife Act 1974* which would increase the area of lower slopes under conservation.
Geomorphic and geoheritage values	Unique slaty pagoda formations are conserved for both future study and recreational enjoyment.	The areas in proximity to the Southern Extension Area do not share the specific geodiverse features characteristic of areas to the north and east of Invincible as previously identified through the technical studies informing previous PAC assessments and determination. The location of the Southern Extension Project and incorporation of specific blast management measures minimise any impacts (short or long term) on the pagoda structures
Visual Amenity	Pagoda formations and complexes which are prominent in the landform have aesthetic appeal.	The Southern Extension Project will not impact on the pagoda structures themselves or the pagoda landscape. The mining in the Southern Extension Area will have limited impacts on the aesthetic appeal of pagoda landscape due to the absence of visually prominent pagodas in the immediate vicinity of Southern Extension Area.

Benefit	Details	Comments
Recreational values	Bushwalking, birdwatching, photography	The Southern Extension Project itself would have limited impact on recreational activities. Short term impacts would be limited to the exclusion from the Southern Extension Area and temporary exclusion zones associated with managing flyrock risk from blasting. Long term impacts overall neutral to positive given the improved rehabilitation outcomes for existing disturbance areas and the removal of subsidence cracking and potholes in the Southern Extension Area which are currently potentially hazardous and have potential to expand in the medium to long term.
Tourism	The visually spectacular pagoda formations and associated biodiversity values have potential to act as drawcards for domestic and overseas tourists.	To the extent that the Southern Extension Project would operate as a deterrent to tourism, the disturbance and visual impacts associated with the existing open cut mining would operate as a greater deterrence due to its proximity to the more visually spectacular and prominent pagoda formations. As discussed in this response, the Southern Extension Project will have net positive benefits on the rehabilitation of the existing disturbance areas meaning any impacts on tourism values will be negligible or slightly positive in both the short and long term.

Overall, the Southern Extension Project will have some limited short term impacts on the visual amenity associated with the pagoda landforms and result in a small loss of biodiversity values associated with disturbance in the Southern Extension Area. Both impacts are temporary and the biodiversity impacts will be fully offset in accordance with the NSW Framework for Biodiversity Assessment process. The Southern Extension Project is also predicted the have positive short term impacts on the visual amenity of the existing Invincible mine site and the adjacent pagoda landforms due to the comparatively more effective rehabilitation outcomes relative to the Final Landform Option 3b alternative as currently recommended by DP&E.

The Southern Extension Project will have overall neutral to positive long term benefits due to the commitment to fully rehabilitate the Southern Extension Area and the improved rehabilitation outcomes for existing Invincible mine site provided by the additional overburden generated by the Southern Extension Project. Once fully rehabilitated, the Southern Extension Area and existing Invincible mine site will have landform characteristics consistent with the pre-mining landform.

4.0 References

Washington & Wray The Geoheritage and Geomorphology of the Sandstone Pagodas of the North-western Blue Mountains Region (NSW)

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18 October 2017

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Director
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Department of Planning and Environment
GPO Box 39
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Dear Clay

Re: DRAFT Response to issues raised by EPA in letter dated 13 September 2017

The following details are provided to respond to issues raised by the EPA in their letter dated 13 September 2017. These issues can be broadly split into four areas:

- Water Balance Issues
- Concerns about the uncertainty in underground storage volume predictions
- Interactions with Baal Bone and
- Restrictions on Discharges

In this letter, the EPA's comments are identified in *bold italics* with our response following.

It is noted that previous responses have been provided to DP&E addressing the previous issues raised in EPA correspondence dated 15 November 2016 and 21 March 2017, through the Response to Submissions Report dated March 2017, and further additional responses requested by DP&E dated 10 May 2017.

1.0 Water Balance Issues

Water Balance doesn't accurately predict what will occur when mining starts

As detailed in the EA, the Water Balance Model was developed to understand what the worst case discharge requirements would be in the event that the Invincible underground workings are completely full with no capacity to capture any additional water captured as part of the Southern Extension Project. This approach was undertaken to provide a comprehensive assessment of a potential worse case discharge scenario for the Southern Extension Project. As detailed further in **Section 2.0,** this assumption is considered to be overly conservative as there is significant space available within the former Invincible underground workings to enable effective management of water within the Invincible water management system.

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Until water levels in the Invincible underground workings reach 995m AHD, discharges from the site (other than spills from sediments dams) can be avoided through management of water levels in the Main Storage Dam. These management measures are discussed further in **Section 4.0** below.

As there is excess capacity in the Invincible Underground Workings to store the water currently stored in the Ivanhoe No. 2 workings (refer to **Section 2.0**) the worst case scenarios for discharges will not apply when mining commences. Accordingly, the water balance model used for assessing discharge requirements did not model the Stage 1 mining scenario. Additionally, the Stage 2 Mine Plan used in the water balance model represents a worst case scenario for the water balance model as there is a larger area of mining related disturbed land and accordingly a larger area of disturbed catchment.

In addition to assuming additional underground storage is not available the model also adopted the following conservative assumptions in assessing potential discharge volumes:

- annual seepage from Invincible Workings into the seam and towards Baal Bone was assumed to be the low estimate of seepage (105ML/year in a predicted range of 105ML-315ML/year) and
- run-off from areas upslope from disturbed areas were also treated as being disturbed for the purposes simulating potential inflows to the underground via subsidence cracking (see further details on this approach below).

The absence of modelling of the first year of operations therefore does not affect the assessment of potential worst case discharge impacts associated with the Southern Extension Project. Further to this, as detailed in **Section 4.0**, additional management measures will be incorporated into the management of the Main Water Dam in the initial stages of the Southern Extension Project to capture and store water within the water management system. These management measures will be detailed in a Water Management Plan to be developed for the Southern Extension Project.

No assessment or estimate of catchment runoff flowing to sinkholes or underground workings

There is no specific estimate of catchment flowing to sinkholes or underground workings as not all cracks and sinkholes can be accurately mapped. As water being intercepted by sinkholes is effectively stored in the Invincible water management system (the Invincible underground workings and connected areas of open cut), surface water being intercepted by surface cracking and sinkholes has been modelled through applying increased rainfall runoff assumptions in areas where the sinkholes and cracks may occur.

This effect has been simulated in the Water Balance Model in Appendix B to the Response to Submissions Report B through the treatment of upslope areas as disturbed where there is potential for surface to workings connective cracking. This approach effectively models inflows to the water balance model from subsidence related cracking as being similar to run-off rates from disturbed areas. The volumes of water modelled as being intercepted in this way are treated as part of the broad 'run-off' prediction in the model outputs and there is no differentiation between subsidence related interception and run-off from mining project related disturbance. This treatment is appropriate given the heavily interconnected nature of the Southern Extension Project related disturbance areas and the underground workings. In reality, the volume of water intercepted via subsidence cracking and sinkholes in areas upslope from actual mine disturbance areas will be significantly lower than modelled as these areas are vegetated and will have lower run-off rates. In addition, uptake of soil moisture from vegetation will also in reality further minimise direct loses through the soil profile into subsurface cracking. Accordingly, as discussed in Appendix B to the Response to Submissions Part B, the predicted 'run-off' in the model overstates the inflows to the system from rainfall that may occur from sinkholes and surface cracking from former unground workings within the catchment.

2.0 Volume of Water in Ivanhoe No. 2 Workings

Predicted volumes of Ivanhoe No. 2 is based on limited data

As is discussed in detail in the AGE Report attached to the Response to Submissions Report Part B, two bores were installed in December 2016:

- BHTH-12 was installed to intersect the Ivanhoe No 2 Workings.
- BH2 was installed in the coal barrier between the Ivanhoe No 2 Workings and the Invincible underground workings.

The purpose of BHTH-12 was to measure the head of water in the Ivanhoe No. 2 workings and, through this measurement, calculate the likely volume of water to be dewatered to enable mining of the Southern Extension Area. BH2 was installed to assess whether there was movement of water from Ivanhoe No 2 towards Invincible underground workings. A single bore in the Invincible underground workings in the area selected is considered to provide a highly accurate direct measure of water levels in the entire workings due to their connectedness through the old workings. **Figure 1** provides a stylised cross section of a bore into flooded workings demonstrating how workings are flooded and why a single bore can be an accurate source of data for water levels in interconnected workings.

The measured water levels used to calculate water levels in the Response to Submissions Part B were based on two monthly recorded measurements. The observed maximum level used for these calculations was 900.8m AHD and a conservative estimate of 901m AHD was used for volume calculations. Using the Lithgow seam floor data used for the previous Coalpac assessments and the measured water level data, it was calculated that there was approximately 367 ML of water in the underground workings. This was well below the calculated 1,585 ML of available storage in the Invincible underground workings and, based on these calculations, there was no requirement to discharge water removed from the Ivanhoe No. 2 workings to surface water system downstream from Invincible. Accordingly, as outlined in the Response to Submissions Part B report the initially proposed discharge of water from the former Ivanhoe No 2 workings prior to mining within the Southern Extension Area was removed from the Project as this water would be stored within the former Invincible underground workings.

Moreover, in previous assessment of water levels and volumes in the former Ivanhoe No 2 workings in the Response to Submissions Part B report, the inherent conservativeness of the water volume predictions has been detailed. Coupled with this Castlereagh Coal have maintained a commitment for ongoing monitoring of water levels within the established bores to provide for further detailed mine planning and review prior to the commencement of mining in the Southern Extension Area.

It should be noted that a further detailed review process would always have been undertaken prior to any dewatering of Ivanhoe No. 2 workings due to the safety risks associated with working with stored water in old workings. This is a requirement for safely operating the mine and would be completed in consultation with the Resources Regulator, and is outlined in detail in **Section 2.8** below.

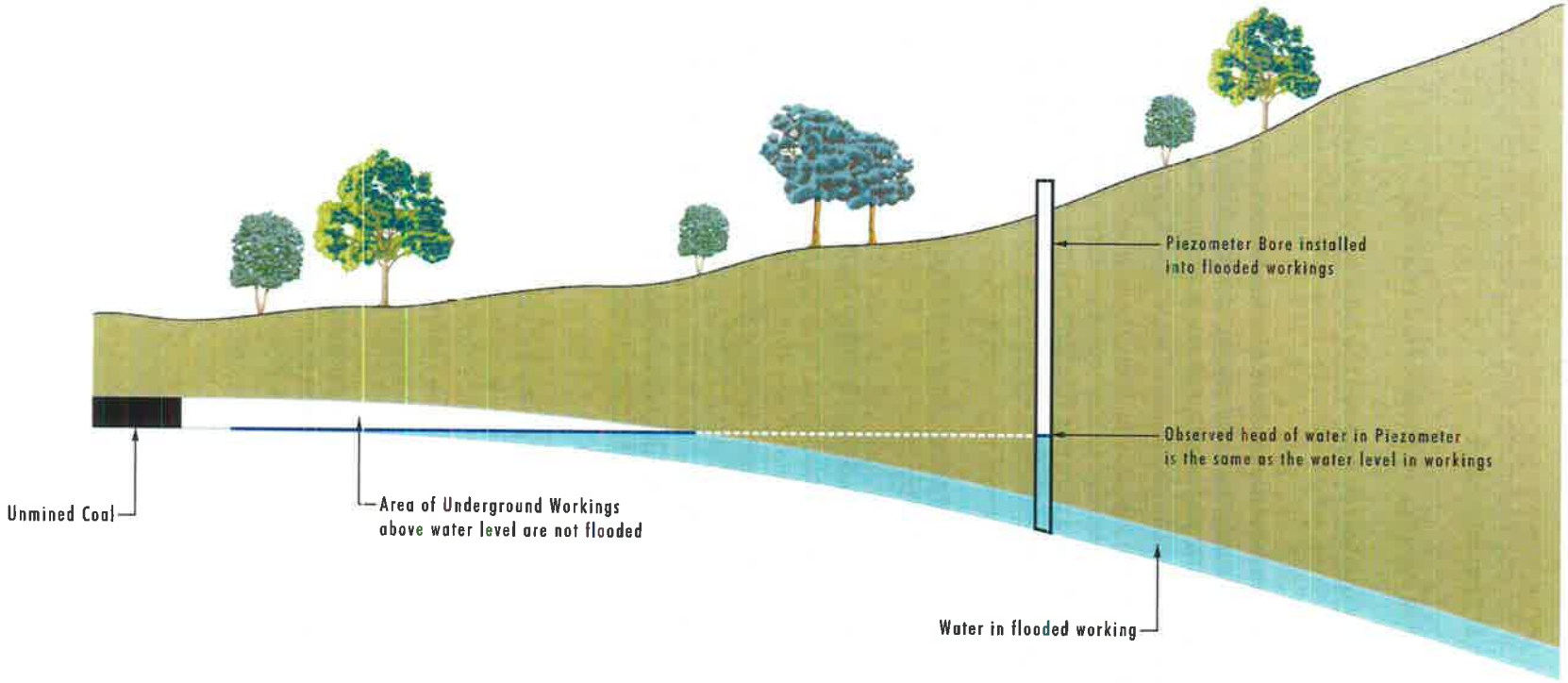


FIGURE 1

Measurement of Water in Underground Working

Following the EPA letter dated 13 September 2017, the data used to assess the stored water in the Ivanhoe No. 2 workings has been further reviewed and updated to provide further certainty to the calculation of water volume in these workings that would require dewatering for the Southern Extension Project. In addition, the assessment of the volume of available storage in the former Invincible underground workings has also been reviewed.

This review considered:

- additional monthly monitoring data from BHTH-2 and BH1 to September 2017 (additional 10 months of monthly monitoring data) including data corrections based on review of sampling methodologies
- seam floor height data from Coalpac data held by Castlereagh Coal
- Record Tracings of both Invincible (held by Castlereagh Coal) and Ivanhoe No 2 workings (held by the Resources Regulator)
- Bore data from previous exploration drilling
- Lidar data for ground levels where previous drilling had occurred.

As part of this review the following was identified:

- were irregularities in the methods used by contractors in measuring water levels in BHTH-12 and BH2 which have been corrected
- there were differences between seam data used for the previous Coalpac groundwater assessments and surveyed seam floor levels in Record Tracings. These differences extended to both the Ivanhoe No. 2 workings and the Invincible underground workings.

The outcomes of the above review are:

- The measured water level in the bores was approximately 0.35m higher than was considered in the Response to Submissions Report B and
- There is more stored water in the Ivanhoe No. 2 workings than was calculated in the Response to Submissions Report B (in the order of 701 ML relative to 367 ML reported in the Response to Submissions Part B report – this volume is still significantly lower than the conservative estimate calculated in the Environmental Assessment and well within the available storage within Invincible underground workings)
- There is more storage available in the Invincible underground workings than had previously been calculated (in the order of 2,048 ML relative to 1,585 ML reported in the Environmental Assessment (Appendix 5) and the Response to Submissions Part B report (Appendix A)).

Overall, while the review has identified additional water in the Ivanhoe No. 2 workings, it does not alter the conclusions regarding potential surface and groundwater impacts or water management in the Response to Submissions Part B report. That is, there is sufficient space within the Invincible underground workings to store water to be dewatered from the Ivanhoe No 2 workings to enable mining of the Southern Extension Area.

This is detailed further in the following sections.

2.1 Monitored Water Levels in BHTH-12

As shown on **Chart 1**, the monitoring data has indicated that water levels in the Ivanhoe workings had remained relatively static over the 10 month monitoring period to within the range 901.19m AHD to 901.36m AHD.

A check against rainfall data (refer to **Chart 1**) indicated no correlation between the minor observed fluctuations and water levels. This indicates that any inflows to the system are effectively balanced by seepage from the system towards the Invincible and Wallerawang workings.

The observed water levels in BH2 similarly showed little movement and, as discussed in the Response to Submission Report B Appendix A, indicate seepage from the Ivanhoe No. 2 workings towards Invincible.

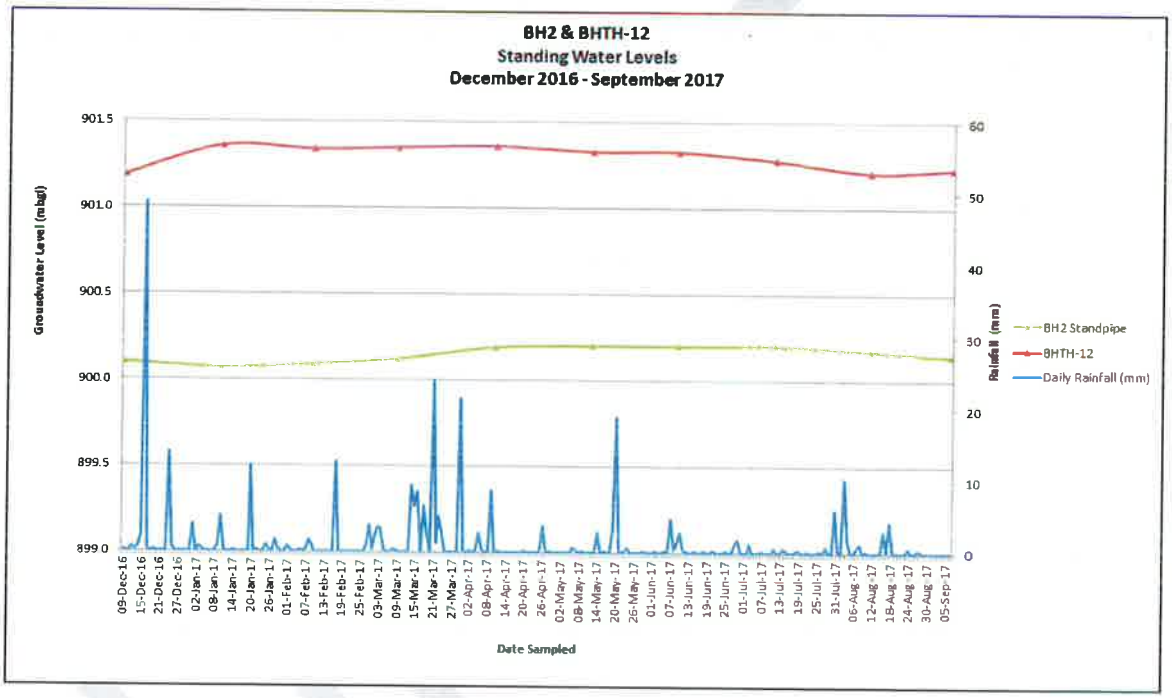


Chart 1 – Standing Water Levels observed in BH1 and BHTH-12

These longer term measurements provide a high degree of confidence in the level of water in the Ivanhoe No. 2 Workings. As shown in **Chart 1**, the maximum observed level over the 10 month monitoring period was 901.36m AHD. The most recent reading (7 September 2017) was 901.23m AHD. For the purpose of conservatively estimating storage volumes in the Ivanhoe No 2 workings, a water level of 901.5m AHD has been assumed. This is 0.5m above the inferred water level height in the calculations outlined in the Response to Submissions Part B assessment and 0.14m above the highest water level observed in the Ivanhoe No. 2 workings.

2.2 Accuracy of seam level data

The accuracy of water volume predictions is heavily dependent upon the floor seam data and mine workings data used in calculations. Record Tracings have previously been used to assess the extent of workings and the data previously used was considered to have sufficient coverage to calculate water volumes at a conceptual level. As noted above, the Record Tracings for the Ivanhoe No. 2 workings have been obtained to review previous assumptions.

The Record Tracings for Ivanhoe No. 2 obtained from the Resources Regulator contain not only the surveyed extent of mine workings but also surveyed seam floor levels. An extract from the northern section of the RT for the Southern Extension Area is shown in **Figure 2**. As Record Tracings are survey accurate, this seam floor data was digitised and compared to previous seam floor data held for the area. The surveyed seam floor levels were also checked against bore log data to verify the seam floor level data accuracy. This comparison identified discrepancies between the Coalpac Data previously used and that contained in the Record Tracings.

Figure 2 - Extract from RT34 Ivanhoe No. 2 Workings

Given the accuracy of the Record Tracings, updated estimates of the extent of water in the Ivanhoe No. 2 workings have been completed. This process has identified that the area of workings flooded is larger than previously understood with the extent of flooding extending to the southern extent of the workings and not just the north eastern corner as had previously been understood. The extent of inferred flooding is shown in **Figure 3.**

2.3 Adjustments to Mine Plan as a result of record tracings data

On the basis of the additional data obtained through the Record Tracings, a remnant barrier of coal in the south-eastern corner of the Southern Extension Area operates as a dam for water stored below RL 898m AHD, south of this barrier (refer to **Figure 3**). Based on this information, this barrier will be retained and not be mined as part of the Southern Extension Project, subject to further detailed mine planning and approval process with the Resources Regulator (refer to **Section 2.8**). The retention of the barrier to the south east will reduce the volume of water to be removed and ensure that the outcomes of the assessment are met (i.e. water from Ivanhoe No 2 workings is captured and stored within the former Invincible underground workings). It is noted that this will result in some Lithgow and Lidsdale seam coal in this area being sterilised.

2.4 Revised calculation of water stored in Ivanhoe No. 2 to be removed for Southern Extension Project

As with previous calculations, conservative estimates have been used to calculate the volume of stored water. The following assumptions have been used for the revised calculations:

- Workings are flooded to RL 901.5m AHD (refer to **Figure 3**). That is, the 'beach' level in the underground workings will occur at a seam floor depth of 901.5m AHD (maximum observed water levels in the past 10 months of monitoring was 901.36m AHD).
- Dewatering will be required to a 'beach' level of 892.5 m AHD.
- Conservative void space assumptions in the Ivanhoe No 2 workings including:
    - 2 metre working height in Ivanhoe No. 2 workings (anecdotal evidence suggests the working height may only have been 1.7m)
    - There has been 64% recovery of coal in the mined areas of Ivanhoe No. 2 workings.
    - All workings in area of flooding below 899.5 and above 892.5 m are assumed to be flooded floor to ceiling. 50% of the total void space in the areas where seam floor levels are between 899.5 and 901.5m AHD are partly flooded and the voids in these areas are assumed to hold 50% of the volume that is held in the fully flooded sections. Following dewatering, up to 50% of the total void space in the areas where seam floor levels are between 890.5 and 892.5 (refer to **Figures 3** and **4**) will contain water which will also be removed.
- The existing coal barrier in the Ivanhoe No 2) workings (as shown in **Figure 3**) will initially be retained, meaning water below 898mAHD to the south of the barrier will not need to be dewatered (refer to discussion in **Section 2.5**). For the purposes of calculations, water above a head of 898m AHD in the areas south of the Barrier (i.e. areas with a seam floor level of between 896AHD and 898mAHD) will be removed as part of the dewatering process. Following dewatering, approximately 50% of the water currently in the void space in the areas where seam floor levels south of the Barrier are between 896m AHD and 898m AHD (refer to **Figures 3** and **4**) will be removed.

In areas of the Ivanhoe No. 2 workings where the Lithgow seam floor is below 899.5m, goaf areas may have water levels extending above the historical working height into the goaf up to 901.5m AHD. For the purposes of the calculations, there is no allowance for higher flooding depths in goaf areas on the basis that any voids or cracks above the 2m assumed ceiling height where water may penetrate would have a corresponding reduction in available storage area in the workings below as a result of the roof material which has collapsed into the void. **Table 1** summarises the calculations of water stored in the Ivanhoe No 2 workings that will need to be dewatered to enable the areas of Southern Extension Area to be mined:

Table 1 Calculation of water to be removed from Ivanhoe No. 2 workings

Area	Area (ha)	Area (m^2)	Assumed void space	Void Space requiring dewatering	Assumed working height (m)	Volume to be removed (ML)
Area A	19.2664	192664	64%	50%	2.00	123.31
Area B	31.7526	317526	64%	100%	2.00	406.43
Area C	11.089	110890	64%	50%	2.00	70.97
Area D	15.6537	156537	64%	50%	2.00	100.18
Total						**700.9**

Based on these conservative assumptions, the volume of water required to be removed from the Ivanhoe No. 2 workings to enable extraction of the proposed Southern Extension Area is 701 ML.

2.5 Retention of Barrier in South Eastern corner of Southern Extension Project

As noted above, the review of the RTs has identified an internal barrier in the Ivanhoe No. 2 workings (refer to **Figure 3**). As also noted above, this process of further detailed mine planning and removal of old workings would be subject to the approval processes of the Resources Regulator (refer to **Section 2.8**). The original mine plan for the Southern Extension Project would have resulted in the partial removal of this barrier however, if retained, the barrier would limit the amount of water needing to be removed from the Ivanhoe No 2 workings. It is proposed to retain a 50m barrier in this area in both the Lithgow and Lidsdale Seams (refer to **Figure 3**). The effect of the retention of the barrier is that water in the Ivanhoe No.2 workings will have a static head at RL 898m AHD to the south of the barrier; and as such water stored below RL 898mAHD to the south of the barrier will be retained in the workings.

2.6 Accounting for groundwater inflows to Ivanhoe No. 2 workings

Any future inflows to the workings south of the barrier in excess of seepage from the workings will report as pit inflows (i.e. the water will 'overflow' the barrier and flow north towards the workings in the Southern Extension Area). However, as discussed in the response to the additional issues raised by DPI Water in the letter dated 10 May 2017, the natural infiltration rate into the Lithgow Seam is extremely low and is unlikely to result in any material inflows into the Invincible water management system.

In addition, inflows to the Ivanhoe No. 2 workings from subsidence cracking and sinkholes are limited to areas with shallow depth of cover. For the Ivanhoe No 2 workings, these areas are largely confined to the proposed Southern Extension Area. As these areas will be mined, there will be no contribution to stored water levels in the Ivanhoe No. 2 workings from subsidence cracking. All other inflows are accounted for in the site water balance.

It is also noted that the water levels monitored at BHTH-12 have remained relatively static in the 10 months of monitoring. This would indicate that any inflows are currently in balance with seepage outflows. This suggests that any inflows to the Ivanhoe No.2 workings south of the Southern Extension Area will not result in any material additional inflows to the Invincible workings beyond that associated with the initial dewatering.

umwelt

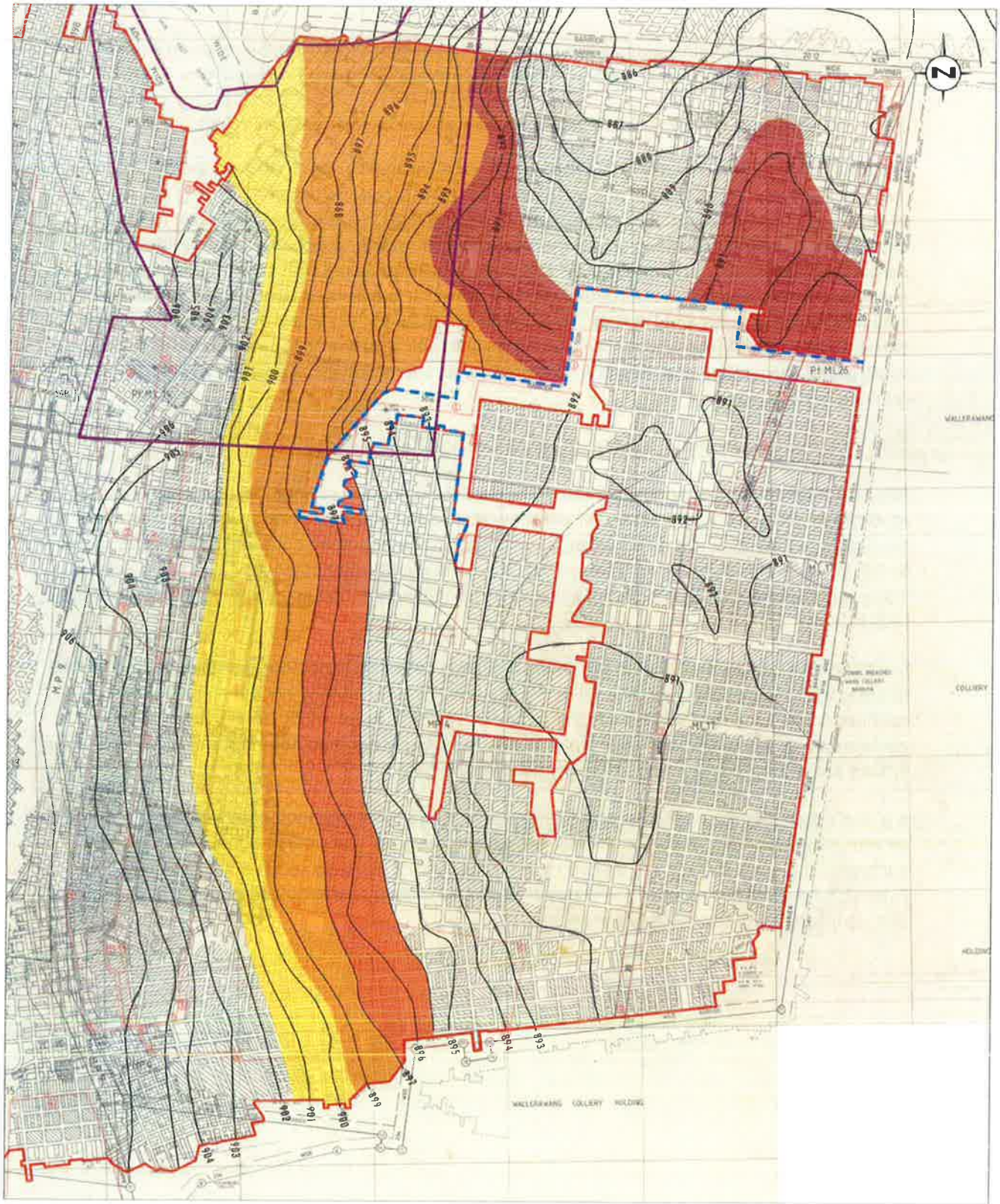


Image Source: Resources Regulator (2017)
Note: Contour interval 1m (AHD)

0 100 250 500m
1:10 000

Legend

- Ivanhoe No.2 Extent of Underground Workings
- Proposed Southern Extension Area
- Area A - Partially Flooded
- Area B - Full Dewatering
- Area C - Partial Dewatering
- Area D - Partial Dewatering
- Coal Barrier to be Retained
- Lithgow Seam Floor Contour

FIGURE 3

Ivanhoe No.2 Dewatering Areas

File Name (A4): 3622_172.dgn
20171017 16:50

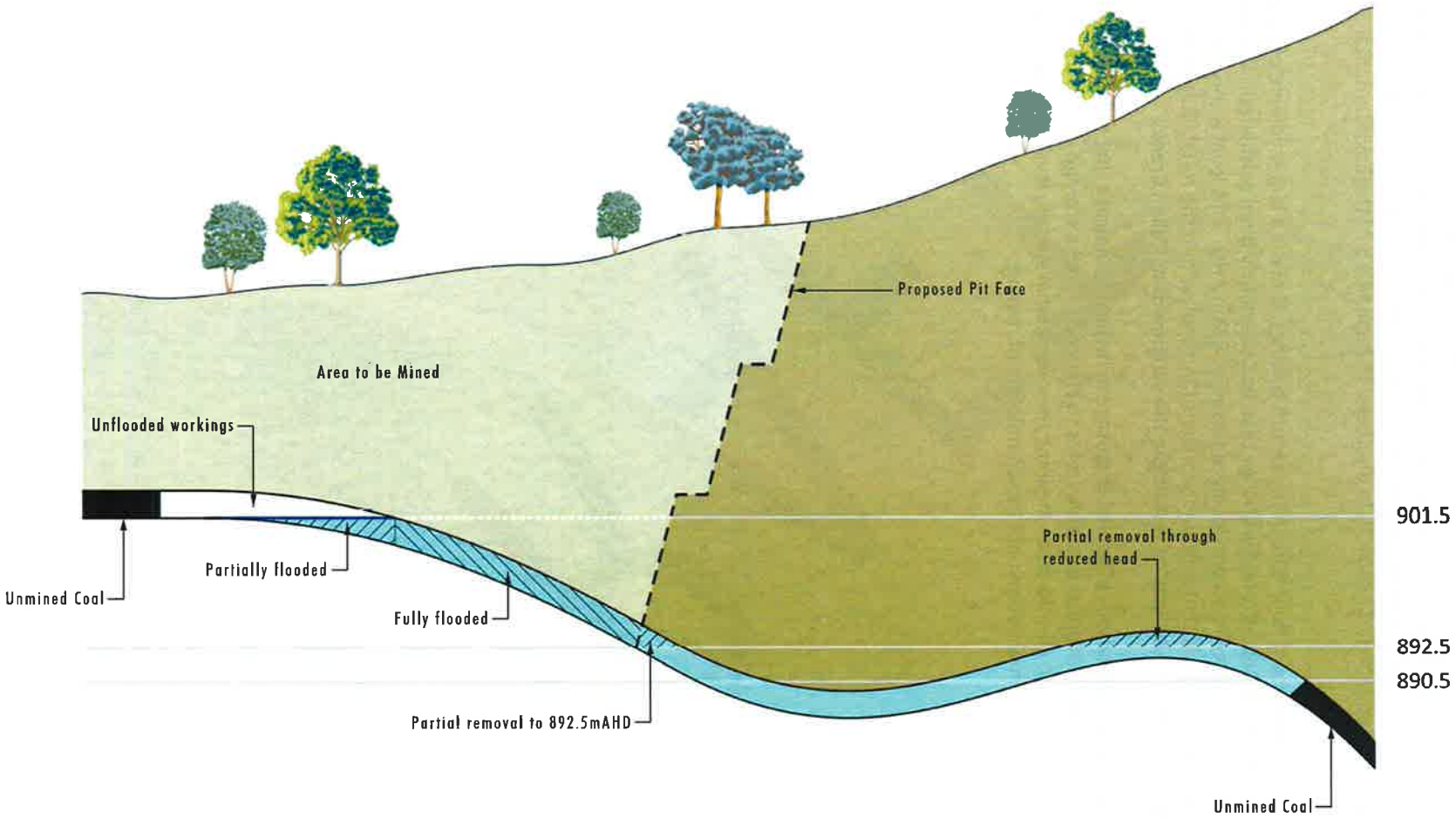


FIGURE 4

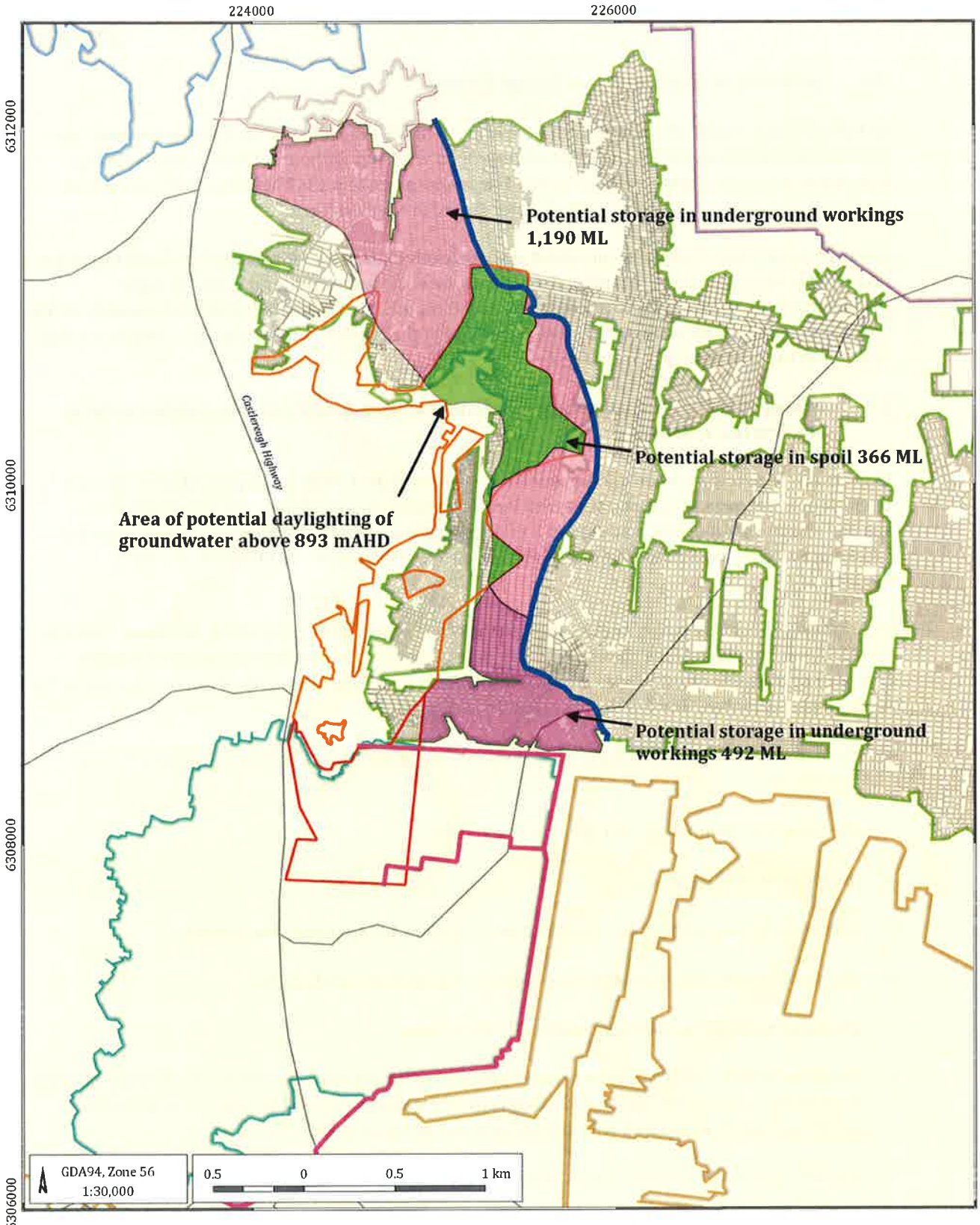
Calculation of Water to be Removed

2.7 Revised calculation of available storage in Invincible underground workings

The review of the Record Tracings for the former Invincible underground workings also identified discrepancies in the seam floor data previously used to assess available storage in these workings. The seam floor data in the Invincible Record Tracings also explains the discrepancy between the observed tide mark and the floor seam data discussed in Appendix 5 of the Environmental Assessment.

Based on the surveyed seam floor data in the record tracings, there is a larger volume of available storage in the Invincible underground workings than had previously been calculated. The maximum long term storage level remains as previously assessed at 893m AHD. This level is the point at which water stored in the Invincible underground workings (and spoil within the rehabilitated Invincible open cut workings) would 'daylight' as a spring in the catchment of Cullen Creek.

Revised conservative calculations of available storage in Invincible indicate that there is approximately 2048 ML of storage available (refer to **Figure 5**). These storage volumes assume overburden is emplaced in all void areas meaning the operational storage levels are conservative as the Northern Void will remain open until the completion of mining.



LEGEND

- Invincible UG water level 2014
- Coal barrier RT0034
- Proposed southern extension
- Invincible Colliery Open Cut - existing mine disturbance area
- Open cut area (366 ML)
- Potential storage (492 ML)
- Potential storage area (1,190 ML)

Colliery locations

- Baal Bone Colliery
- Invincible Colliery
- Ivanhoe Colliery
- RT108 Colliery
- Tyldesley Colliery
- Unknown

Invincible Southern Extension Project (G1817B)

Potential storage available using 2014 Invincible Colliery water level

AGE

DATE 17/10/2017

FIGURE No: 5

N:/Groundwater Jobs/G1817.Umwelt Invincible Project/3_GIS/Workspaces/Working/02_01_G1817B_Flooded_workings_interpreted_2017.qgs

2.8 Summary of reviewed Water Storage Balance

At the commencement of operations there will be 2048 ML available for the transfer of water from Ivanhoe No.2 workings to the Invincible underground workings without impeding future mining operations in the Southern Extension Area. This is approximately 1347 ML more than is required based on the conservative calculation of water stored in Ivanhoe No. 2.

As noted earlier, the changes in calculated storage levels in the each of Ivanhoe No. 2 and Invincible do not alter the conclusions regarding potential surface and groundwater impacts or water management in the Response to Submissions Part B report. That is, there is sufficient capacity in the Invincible Underground workings to store water within the Ivanhoe No 2 workings to enable mining to occur in the Southern Extension Area.

2.9 Management of risk that storage calculations underestimate volume of stored water in Ivanhoe No. 2 workings

Barriers are required between underground mine workings and other underground and open cut operations to manage risks associated with inrush from flooded workings. The risk of inrush is a specific matter that must be managed in a Principal Hazard Management Plan required under the *Workplace Health and Safety (Mines and Petroleum Sites) Regulation* 2014 (WH&S Mines Regulation).

The removal of barriers is also declared to be a high risk activity that is regulated by clause 33 of the WH&S Mines Regulation (see clause 29 of Schedule 3). Prior to the removal of any barriers, the Operator of the mine must provide a notice to the Resources Regulator at least 3 months prior to the removal of the barrier. The notice must include (clause 33(2):

- the nature of the proposed high risk activity, including particulars of how the activity is to be carried out,
- the proposed commencement date for the activity,
- the location of the activity,
- any information or documents required by Schedule 3 in relation to the activity,
- the hazards identified as having the potential to arise from the activity,
- an assessment of the risks associated with the activity,
- the relevant parts of the safety management system for the mine or petroleum site that describe the systems, procedures, plans and other control measures that will be used to control risks to health and safety associated with the carrying out of the activity.

The specific matters required by and Schedule 3 clause 29(2) are:

- details of how risks from the activity will be managed,
- survey plans certified by an individual nominated to exercise the statutory function of mining surveyor at the mine.

The removal of the barrier between the Invincible open cut and the Ivanhoe No 2 workings will trigger these requirements. The information used to inform these management measures are the Record Tracings reviewed for the purposes of the calculations in this letter.

The risk of inrush will be mitigated through the commencement of mining in the area to the west of the flooded extent of workings (i.e. the north western part of the Southern Extension Area). By mining down to the workings which are identified as having a seam floor height above the measured water level on BHTH-12, rather than simply removing the barrier, the risk of inrush is avoided. Mining can then progress eastwards towards the workings known to contain water with the barrier between the workings progressively removed until the extent of flooding is reached. Once mining reaches the monitored extent of flooding (currently below the 901.5m AHD seam floor level) dewatering will be required to progress mining in an easterly direction.

With this approach to mining adopted, there is no risk of inrush. The only risks are therefore the potential for there to be more water in the Ivanhoe No. 2 workings to be dewatered than there is storage available (i.e. it is possible, though considered remote, that there are inaccuracies in the Record Tracings or assumptions that mean there could be more water in the underground workings than has been calculated or there is less storage available than has been calculated). The use of conservative assumptions mitigates against this risk however additional management measures will be implemented to manage the risk of there being insufficient storage in Invincible underground workings. These measures include the following:

- Prior to any mining of areas which would require the removal of the coal barrier between Ivanhoe No 2 and Invincible below a RL of 901.5m AHD (or such higher level as identified through the monitoring of BHTH-12), approximately 200ML will be transferred from the Ivanhoe No. 2 workings to the Invincible workings.

- The water levels in BHTH-12 and the Northern Void will be monitored during and following the transfer.

- A revised calculation of stored water and available storage will be undertaken at the completion of the transfer to confirm storage levels in both Ivanhoe No 2 and Invincible are behaving as predicted. This volume of water is well within the calculated available storage in Invincible and will not pose a risk of Invincible discharging this water to the downstream surface water system.

- Should the monitoring indicate that the volumes of water in Ivanhoe No. 2 are greater than can be stored in Invincible, the mine plan will need to be revised to reduce the volume of water to be dewatered.

As noted above, the conservativeness in assumptions used and the increased accuracy of the seam floor data used in the calculations mean the risk of the above scenarios eventuating are considered to be low. The proposed approach to managing risks around the volume of stored water is effective in managing any environmental risks associated with an under-prediction of stored water volume.

In the unlikely circumstance that a modification of the mine plan may be required, this represents an operational/ production risk to Castlereagh Coal rather than a risk to the environment.

Accordingly these measures will further ensure that the water removed from the Ivanhoe No. 2 workings will not be directly discharged from the site and will be managed as part of the overall stored water volume in Invincible.

These measures will be further detailed in a Water Management Plan to be developed for the Southern Extension Project.

3.0 Predicted seepage to Baal Bone

The EPA incorrectly states that inflows to Baal Bone are predicted to increase by 315 ML/year. As detailed in Appendix A of the Response to Submissions Report B, there is an existing level of seepage from Invincible towards Baal Bone and the predicted seepage rate would increase by between 5 ML/year and 15 ML/year to between 105 ML/Year and 315ML/year on the basis of the increased storage of water in the former Invincible workings. This increase of seepage toward Baal Bone of between 5 to 15 ML/year represents less than 1% of annual dewatering volumes from Baal Bone and is well within the approved volume of licences held by Baal Bone.

4.0 Discharges

The EPA has identified that any discharges from the site would be required to meet the default ANZECC criteria.

As previously noted in the Response to Submissions Part B, and subsequent responses to DP&E in relation to previous matters raised by the EPA, the background concentrations of several analytes in receiving waters downstream from the site are higher than default criteria. Monitoring during currently approved wet weather discharge events has not demonstrated any observable impact on downstream water quality.

Approximately 12 months of monitoring data from receiving waters in now available and, when sufficient data has been obtained, a variation to the EPL to reflect site specific criteria will be sought. In the interim, operations will be managed to avoid discharges from the Main Water Storage Dam that would be in breach of s.120 of the *Protection of the Environment Operations Act 1997* and would be managed to meet the default ANZECC criteria as specified in the EPA letter. We note however that the EC in receiving environment currently exceeds the upland river criteria and any limits imposed on the EC levels in discharge waters should be based on the EC levels of the receiving waters rather than the arbitrary upland rivers criteria.

The following management measures are proposed to manage these risks of discharges being in breach of licence conditions:

- Water levels in the Main Water Storage Dam will be managed to ensure sufficient freeboard is available to mitigate the risk of spill in high rainfall events. This can be done by pumping from the Main Water Storage Dam to the Northern Void when water levels in the Dam exceed the permitted freeboard. This free board would be managed based on weather forecasts and predicted usage demand from the Coal Preparation Plant.

- The Main Water Storage Dam will only receive water from the Northern Void when storage levels drop below the volume necessary for the CHPP and other operational purposes. This will be managed on a daily basis with additional freeboard maintained when water in the Main Water Storage Dam is sourced from the Northern Void.

The above measures (and freeboard and pump rules developed for the Main Water Storage Dam) will be documented in the Walter Management Plan to be developed for the site and would remain in place prior to the agreement on discharge criteria on the EPL for Invincible. These rules will be informed by the Site water balance which will also be documented in the Water Management Plan.

As detailed in the Environmental Assessment for the Southern Extension Area, sediment dams are designed to operate in accordance with the principles set out in the Blue Book (Landcom, 2004 and DECC 2008). These dams will manage run-off from disturbed areas and are designed to manage risks to the downstream environment associated with runoff from such areas. Consistent with the Blue Book design principles, these dams are designed to spill during large rainfall events which exceed the design criteria for the dams.

Following rainfall events, these dams are pumped dry by transferring the water to the Northern Void or the Invincible Underground Workings. The existing sediment dam system at Invincible has been successfully managed water quality risks to the environment.

5.0 References:

Landcom, 2004. Managing Urban Stormwater – Soils and Construction, Volume 1, 4th Edition.

Department of Environment and Climate Change (DECC), 2008. Managing Urban Stormwater – Soils and Construction, Volume 2E – Mines and Quarries.

Yours sincerely

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