Coalpac

Proprietors of Invincible Colliery
and Cullen Valley Mine

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1 May 2014

Mitchell Isaacs
Manager Strategic Stakeholder Liaison
Department of Primary Industries
NSW Office of Water
PO BOX 3720
PARRAMATTA NSW 2124

Dear Mitchell

Invincible Colliery (PA 07_0127) and Cullen Valley Mine (DA200-5-2003) Modifications

I refer to your letter dated 25 March 2014 regarding the review undertaken by NSW Office of Water of the Environmental Assessment for the above mentioned Modification applications. To assist in addressing water related matters identified in the above correspondence and following on from our meetings on the 3rd and 30th of April 2014, Coalpac engaged specialist independent consultants *Australian Groundwater and Environment* (AGE) and *WRM Water and Environment* (WRM) to prepare the required supplementary reports. A copy of the supplementary reports to the Environmental Assessment for groundwater and surface water are attached for your reference.

The following statements provide a summary of the key findings from the above assessments and provide further clarification of matters relating to water resources at Invincible Colliery and Cullen Valley Mine, these include:

- The 125 ML take of water from the northern portion of the Modification Boundary at Invincible Colliery is the estimated volume required to be extracted over a two year period and equates to approximately 62.5 ML per year on average. Coalpac holds sufficient water access licences under the *NSW Murray Darling Basin Porous Rock Groundwater Sources Water Sharing Plan* (WSP) that includes a share component of 106 ML/yr which will cover this annual volume of water take if required.
- There is no adverse impact anticipated to occur on the ecologically endangered Box Gum Woodland community as a result of groundwater drawdown from the proposed Modifications. The phreatic groundwater surface has been demonstrated to occur well below the locations where Box Gum Woodland occurs and the proposed Modifications will not have a significant impact on saturated aquifers which occur below the Lithgow Seam. There are no saturated aquifers known to occur above the Lithgow Seam;
- Further clarification of seepage rates and the application of Darcy's Law is provided in the attached supplementary groundwater report, AGE 2014;

- Four groundwater monitoring events have been undertaken to date and a fifth event is scheduled for completion in early May 2014. Coalpac will undertake further groundwater quality monitoring events as required to ensure a robust chemistry dataset is available;
- Coalpac will review and update the currently approved water management plans for Cullen Valley Mine and Invincible Colliery to address the water related matters identified throughout the environmental assessment process for the proposed Modifications. Appropriate trigger action response plans will be incorporated into these management plans utilising the groundwater quality chemistry dataset. The management plans will be prepared in consultation with Office of Water and other relevant stakeholders as required;
- The groundwater impact assessment has demonstrated that the proposed Modifications will have no impact on any existing neighbouring bores. Further details are provided in the attached supplementary groundwater report, AGE 2014.
- WRM 2014 (see attached) identified that in the absence of appropriate management and mitigation measures, Coalpac would likely require Water Access Licences for the average take of approximately 148 ML per year (243 ML/yr – 95 ML/yr) of surface water from undisturbed catchment areas under the *Macquarie Bogan Unregulated and Alluvial Water Sources Water Sharing Plan*. Coalpac's harvestable rights have been estimated to be 95 ML per year (See **Figure 1**).

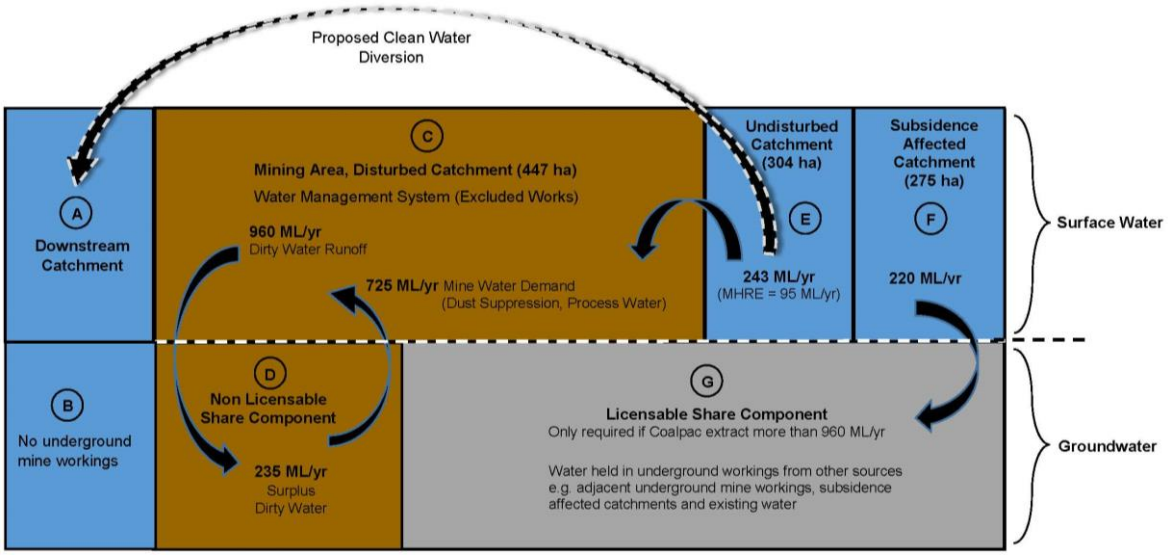

Figure 1: Cullen Valley Mine & Invincible Colliery Water Balance Schematic

- A number of management controls have been identified to divert clean water from undisturbed catchments around existing and proposed disturbance areas at Cullen Valley Mine and Invincible Colliery. The indicative locations of proposed diversion channels and pipes are shown on **Figure 2** (see attached). Coalpac understands that the installation of this clean water diversion infrastructure would obviate the need to acquire water access licenses under the *Macquarie Bogan Unregulated and Alluvial Water Sources Water Sharing Plan*.
- WRM 2014 (see attached) estimate that water directed to the Old Invincible and Invincible underground workings from the existing and proposed disturbance areas at Cullen Valley Mine and Invincible Colliery will exceed site water demand requirements. This will generate a surplus of 'dirty water runoff' stored in the mine water management system and underground workings of up to 235 ML/yr on average (see **Figure 1**).

Coalpac understands that 'dirty water' captured in the water management system from its mining activities is exempt from licencing under the *Water Management Act 2000*. As such Coalpac has access to sufficient water held in its water management system including the underground workings to meet its operational water demands (see **Figure 1**). Flexibility is required, via the proposed water pipeline between Invincible Colliery and Cullen Valley Mine, to transfer this surplus water between the mining operations as required.

- In the event that neighbouring underground mining operations cease extraction of sub surface water from the underground workings, water could potentially back up and flow into the northern portion of the Invincible Colliery Modification Boundary. The worst case scenario volume of water is estimated to be 1,382 ML and was discussed in the WRM report dated January 2014. Based on the surface water and groundwater assessments and flexibilities available to control and manage water in the mine water management system it would be unlikely that Coalpac would require any further water access licences to account for the take of any additional water resources.

It should be noted that on the 30 March 2014, the Federal Department of Environment made the decision that the Cullen Valley Mine and Invincible Colliery Modifications would not have a significant impact on matters of national environmental significance (including on both the ecology and water resources of the area) and would not require further approvals under the *Environmental Protection and Biodiversity Conservation Act 1999*. A copy of this referral decision is attached for your reference.

Coalpac look forward to working with the Office of Water to ensure any potential impacts to water resources are minimised.

Please contact me if you have any questions relating to the above on 6359 0600.

Yours faithfully
COALPAC PTY LIMITED

Ben Eastwood
Environmental Manager

N
W
E
S

MLA CVN

ML1557

Baal Bone Colliery

Cullen Valley Mine

ML1488

ML1455

Cullen Bullen

ML1638

ML1635

Invincible Colliery

MLA431

0m 500m 1000m

LEGEND

- Proposed Disturbance
- Coalpac Tenements With Surface Rights
- Catchments
- Coalpac Owned Land
- Coalpac Controlled Land
- Indicative Clean Water Diversion Pipes
- Undisturbed Land
- Disturbed Land
- Proposed Future Disturbance
- Rehabilitated Land

Invincible Colliery & Cullen Valley Mine Water Catchments

Coalpac Pty. Ltd.
Proprietors of Invincible Colliery and Cullen Valley Mine

Figure: 2

Drawn By:	Date:	Drawing No.:	Revision:	
D.E	01/05/14	23.4.13.WC-C	E	MGA Zone 56

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TJA/JST:tl
Project No. G1515/A.Coalpac Modification
30 April 2014

Coalpac Pty Ltd (Administrators Appointed)
SENT VIA EMAIL

Attention: Bret Leisemann

Dear Bret,

RE: INVINCIBLE COLLIERY AND CULLEN VALLEY MINE MODIFICATIONS SUPPLEMENTARY GROUNDWATER REPORT

1 INTRODUCTION

Coalpac Pty Ltd, Administrators Appointed (Coalpac) owns and operates the Invincible Colliery and Cullen Valley Mine. Each mine operates as a separate entity with separate planning approvals under the *Environmental Planning and Assessment Act 1979* (EP&A Act). Coalpac is seeking to modify both planning approvals under Section 75W of the former Part 3A of the EP&A Act.

Australian Groundwater Environment Consultants Pty Ltd (AGE) undertook a *Groundwater Impact Study, Invincible Colliery and Cullen Valley Mine Modification* dated February 2014[1] (AGE 2014) that supports the *Environmental Assessment Modifications to PA 07_127 and DA 200-5-2003 dated March 2014* which is currently being assessed by the NSW Department of Planning and Infrastructure. This assessment provides further clarification of groundwater related matters for the Modification of existing approvals at Invincible Colliery and Cullen Valley Mine following further consultation with NSW Office of Water and should be considered as a supplementary report to the above mentioned Groundwater Impact Study. Specifically this report provides further information relating to:

1. the predicted 125 ML water take from the Old Invincible underground workings in the northern mining area of the Invincible Colliery Modification;
2. the potential impact to Box-Gum Woodland communities from groundwater drawdown;
3. groundwater seepage analysis and calculations;
4. results of groundwater quality monitoring program, future sampling events, and sampling protocols;
5. development of water management plans, groundwater quality triggers, and trigger action response plans (TARPs);
6. details of groundwater licences held by Coalpac; and
7. the status of neighbouring registered bores.

[1] Australasian Groundwater and Environmental Consultants Pty Ltd, (2014), *"Groundwater Impact Study – Invincible Colliery and Cullen Valley Mine Modification"*, prepared for Hansen Bailey Pty Ltd, Project No. G1515/A, February 2014.

2 DISCUSSION

Each of the above groundwater related matters are discussed in more detail below.

2.1 Predicted Take of Water from Invincible Colliery Modification Area

The majority of the abandoned underground coal mine workings in the Old Invincible Colliery and Invincible Colliery are flooded with water. Water enters the underground workings from rainfall runoff through surface cracking (from subsidence of abandoned underground coal mine workings) in undisturbed catchment areas, seepage through rehabilitated areas, channelled by contour drains or pumped in as part of the mine water management system.

The transition between flooded and non-flooded underground workings is commonly referred to as the “tide mark”. Figure 10-3 from the Groundwater Impact Study AGE 2014 shows the current tide mark. The tide mark of the Old invincible Colliery and Invincible Colliery is, for the most part, currently located to the east (i.e. down-dip) and beyond the limit of the proposed open cut pits of the Invincible Colliery Modification. Therefore, the Eastern and Southern mining areas are not anticipated to intersect flooded workings, and are also not anticipated to intersect saturated aquifers[1].

A small area in the proposed Northern open cut pit area at Invincible Colliery may encounter partial saturation of the Old Invincible Colliery underground workings. Figure 2-1 shows this area in more detail.

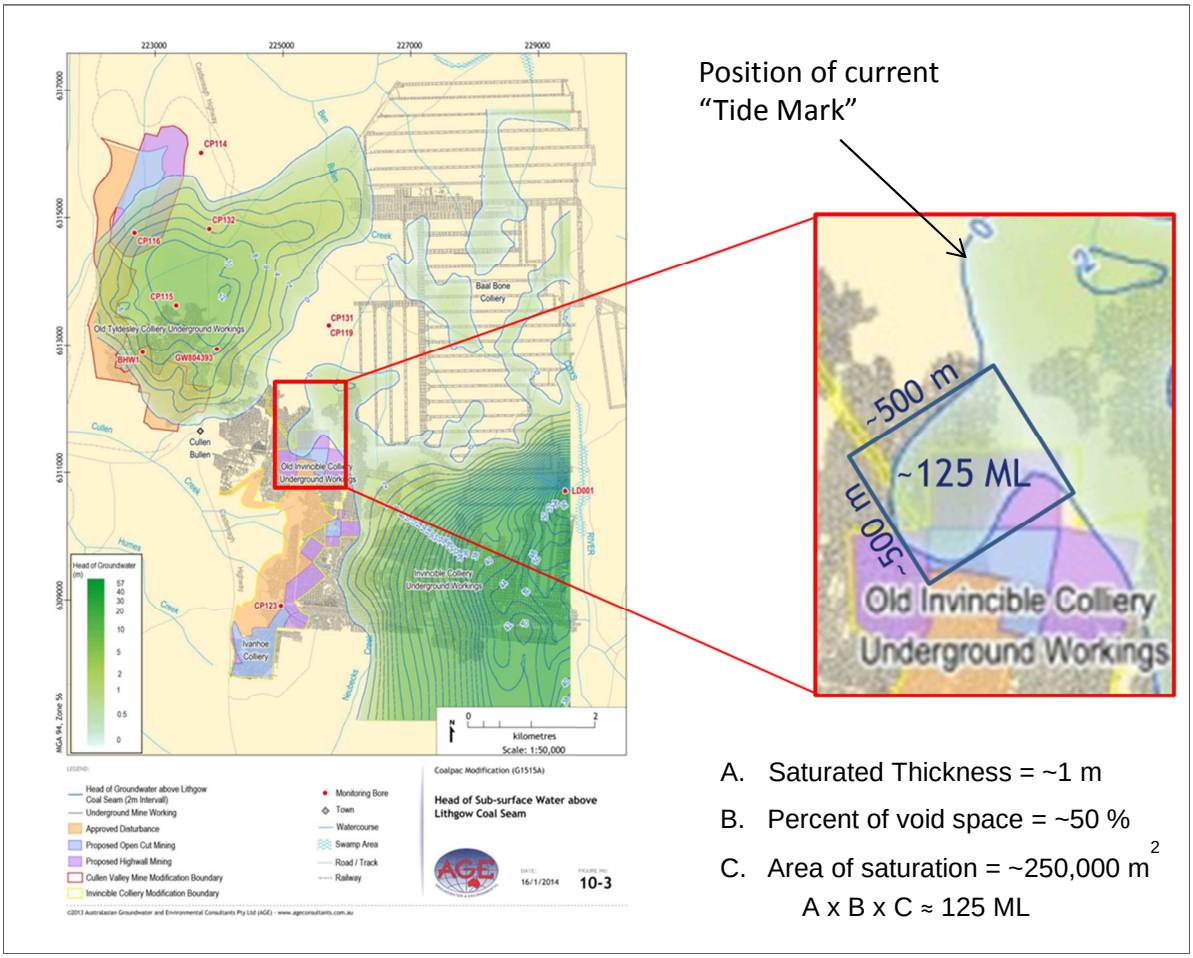

Figure 2-1: Area of Potential intersection of Flooded Workings

The coal seams throughout the Modification Boundary at Invincible Colliery have been folded, creating a network of broad and shallow depressions. These features are somewhat akin to a flattened egg carton, where the shallow depressions are defined from each other by low-profile structural highs.

One of these coal seam depressions is located in the northern portion of the Modification Boundary at Invincible Colliery. The blue polygon shown in Figure 2-1 defines the proposed open cut pit which is planned to mine down into the Lithgow Seam. The purple polygon shows the proposed highwall mining areas which are planned to extract all seams located above (the nearest seam is 15 metres above) the Lithgow Seam. The seams located above the Lithgow Seam are unsaturated.

The depression in the coal seam promotes the accumulation of a small, semi-isolated body of water in the underground workings. This water is considered to have limited connection with the main body of the flooded workings because of the structural highs that separate these areas.

The maximum depth of water within the depression is <1 m, found towards the middle of the depression. The underground workings have an average height of about 1.6 m in this area. Therefore, the underground workings within the depression will not be fully saturated.

A very shallow depth of water (<0.15 m) separates the depression from the main body of the flooded workings, located towards the east. The proposed northern portion of the Modification Boundary at Invincible Colliery is located near the outer limits of the depression, and is predicted to intersect a saturated depth of about 0.5 m within the flooded workings.

The total volume of water stored within the coal seam depression located near the proposed northern portion of the Modification Boundary at Invincible Colliery can be estimated by first calculating the open area of the depression and multiplying this area by the height of the water body within the workings. The depression is roughly square, having lengths equal to about 500 m. The underground workings were mined with bord and pillar methods, which left about 50% of the coal seam in-place to support the roof. Therefore, the total area of the open void within the depression is estimated to be 125,000 m^2. If a conservatively high saturated thickness of 1 m is used, the total volume of water stored within the underground workings in the depression located near the proposed northern portion of the Modification Boundary at Invincible Colliery is about 125 ML.

When open cut mining through this area, Coalpac will direct seepage water from the flooded underground workings (as well as rainfall runoff) towards sumps, where it will be pumped to holding dams which form part of the mine water management system that provides for recycling and transferring water for operational purposes. Groundwater assessments to date indicate that approximately 125 ML of water will need to be pumped to manage the seepage from the underground workings.

The 125 ML is predicted to be taken from the underground workings of the Old Invincible Colliery in the northern portion of the Project Boundary at Invincible Colliery for a period of approximately two years. The anticipated average water take from the underground workings will be about 62.5 ML/year. However, in years with high rainfall, the amount of water that is required to be taken may be higher than 62.5 ML/year. Coalpac hold licences to take 106 ML/year from the NSW Murray-Darling Porous Rock Groundwater Sources. The licence allocation is sufficient to cover the take of any additional water from the underground workings of the Old Invincible Colliery for years of higher rainfall.

A surface water study undertaken by WRM Water and Environment (2014)[2] identified that there will be a surplus inflow of dirty water from existing mining and infrastructure areas into the Old Invincible and Invincible underground workings of approximately 235 ML/yr.

The proposed pipeline connecting Cullen Valley Mine and Invincible Colliery will assist Coalpac in managing any non-licensable surplus inflow of dirty water in its water management system. As noted above this surplus has been estimated to be 235 ML/yr.

In the event that neighbouring underground mining operations cease extraction of sub surface water from the underground workings, water could potentially back-up and flow into the northern portion of the Invincible Colliery Modification Boundary. This has been discussed in the WRM report (Jan 2014)[2] and was estimated to be 1,382 ML over the period of the proposed Modification. In the unlikely event that this worst case scenario develops, there would be a number of potential management and mitigation measures available to Coalpac to account for this water take, these may include:

- Seeking a temporary transfer or acquire a suitable water licence from adjacent mining operations, assuming they do not need their allocation for this water at the time.
- Coordinating the continued release of this water by adjacent mining operations to ensure sub-surface water in the underground workings does not back-up and impact on Invincible Colliery.
- Treating and releasing this water to the downstream catchment, therefore not holding the water in the mine water management system.
- Not mining down to the Lithgow Seam in the northern portion of the Modification Boundary due to the flooding in the underground workings. As such, Coalpac would not intercept or take this water source.

The above management options demonstrate the flexibility and options available to Coalpac in the unlikely event that this worst case scenario develops.

Based on the above review and flexibilities available to control water in the mine water management system it would be unlikely that Coalpac would require any further water access licences to account for the take of any additional water resources.

2.2 Potential Impacts to Box-Gum Communities by Groundwater Depletion

Box-Gum Woodland has been identified outside the Modification Boundary at Cullen Valley Mine at four locations[3]. Figure 2-2 shows the four locations where this community has been found.

The depth to the groundwater table ranges between 20 m and 50 m beneath the topographic surface at each of the locations where the Box-Gum Woodland occurs. The depth of the water table at each location is summarised in Table 1.

[2] WRM Water and Environment Pty Ltd, (2014), "*Invincible Colliery and Cullen Valley Mine Modifications Supplementary Surface Water Assessment*", prepared for Coalpac Pty Ltd, Project No. 0718-01-G, April 2014.

[3] Cumberland Ecology Pty Ltd, (2014), "*Ecological Assessment – Cullen Valley Modification and Invincible Colliery Modification*", prepared for Hansen Bailey Pty Ltd, Project No. 13007RP3, February 2014.

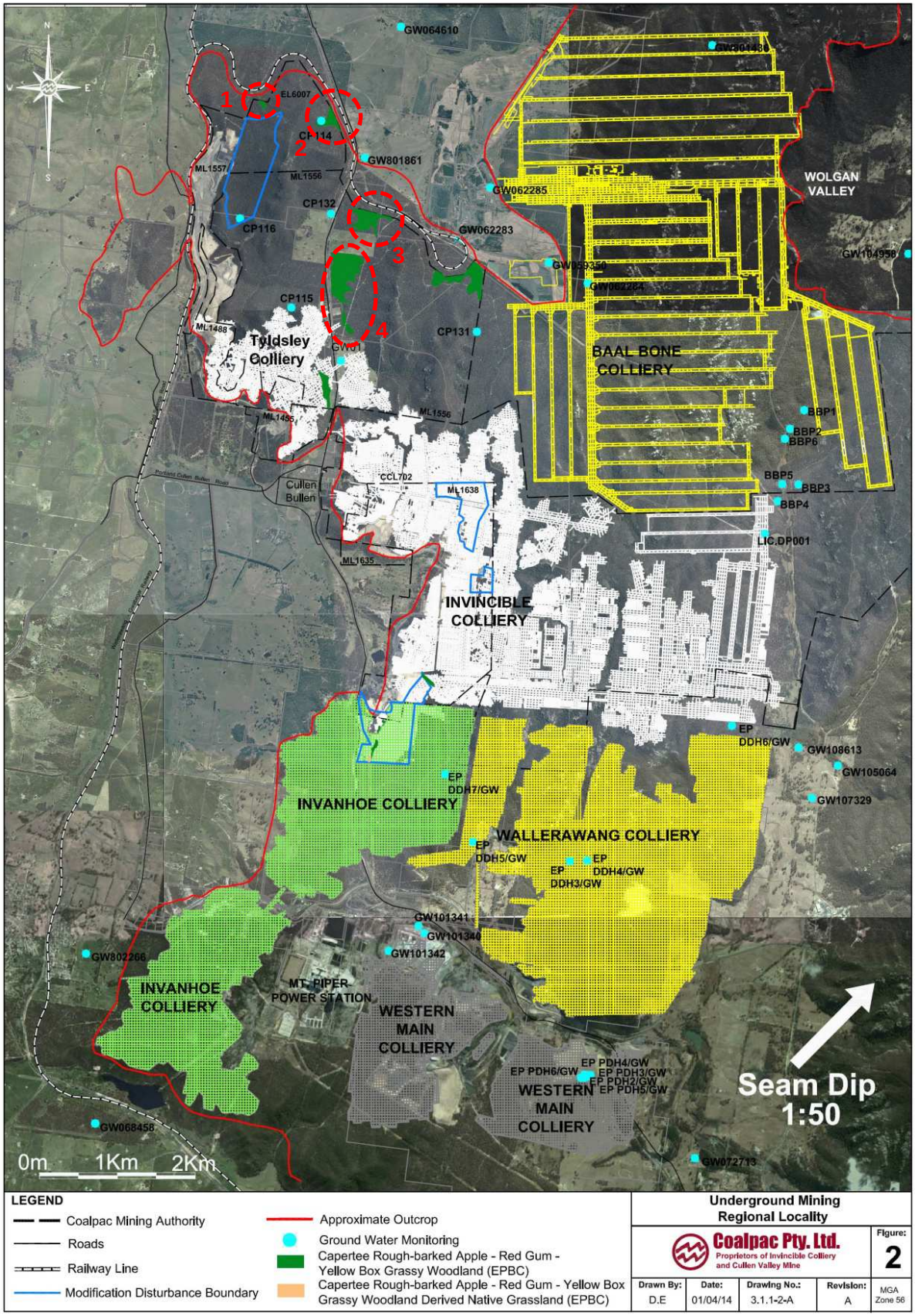

Figure 2-2: Modification Areas and Box-Gum Woodland Communities

Table 1: SUMMARY OF DEPTH TO GROUNDWATER					
Ref.	**Direction of Box Gum Woodland from Modification Boundary**	**Distance of Box Gum Woodland from Modification Boundary (m)**	**Topographic elevation (mAHD)**	**Phreatic surface elevation (mAHD)**	**Vertical distance between topography and phreatic surface (m)**
1	North	120	900	872	~30
2	North-east	590	920 - 900	869 - 862	~50 - 40
3	East	1,200	895 - 885	874 - 868	~20
4	South-east	1,050	935 - 900	892 - 876	~40 - 25

The vertical distances separating the topography and the groundwater table are therefore sufficient to prohibit the root system of the woodland community from directly tapping the regional groundwater table. Any perched groundwater that may be locally present will not be impacted by the proposed Modifications.

2.3 Clarification of Groundwater Seepage Analysis

The available data and previous groundwater assessments[1,4] indicate the Invincible Colliery will not intersect saturated aquifers. However, Cullen Valley Mine Modification Boundary is likely to intersect saturated aquifers of non-disturbed (i.e. not previously mined) coal. The coal seams located above the combined Lidsdale / Lithgow Seam are not saturated, as these upper coal seams typically crop out to the east, north, and west at short distances from the proposed mining area. Therefore, groundwater seepage from these coal seams into the open cut mining and highwall mining will not occur.

Figure 2-1 shows an area where the combined Lidsdale / Lithgow Seam horizon is predicted to be saturated in the southern half of the proposed open cut mine Modification Disturbance Boundary. This is based on the relationship between the elevation of the coal seams (interpolated between exploration drillholes) and the phreatic surface (interpolated between water level measurements taken from groundwater monitoring bores).

The maximum head of water above the base of the combined Lidsdale / Lithgow Seam horizon is estimated to be about 6 m in the far south of the proposed open cut area. The maximum head of water above the base of the coal seams is estimated to be about 9 m in the highwall mining area.

The rate of groundwater flow is proportional to the hydraulic gradient and permeability of the rock unit. In both cases these were low and therefore it was clear from an early stage the rates of seepage would be limited. Determining the seepage rate into the proposed open pit and highwall mine areas using analytical equations in a spreadsheet was considered appropriate given the relatively small pressure head above the mine areas (i.e. <10 m) and the limited intersection of saturated rock. Therefore more complex three-dimensional (3D) numerical modelling was not warranted.

[4] Australasian Groundwater and Environmental Consultants Pty Ltd, (2012), "*Coalpac Consolidation Project – Groundwater Impact Assessment*", prepared for Hansen Bailey Pty Ltd, Project No. G1515, March 2012.

Darcy's Law of fluid flow through porous media was used to estimate the rate of groundwater seepage into the Cullen Valley Mine Modification Boundary for the proposed open pit and highwall mining areas. Darcy's Law is based on first principles of fluid mechanics and states that:

> *'discharge rate (Q) of groundwater is proportional to the hydraulic conductivity of the material (K), the gradient in hydraulic head (i), and the cross-sectional area of discharge (A).'*

Darcy's Law is commonly expressed as:

$$Q = Ki\,A$$

Where:	Q	=	seepage from the coal seam face (m^3/day)
	K	=	hydraulic conductivity of the coal seam (m/day)
	i	=	steady state hydraulic gradient (dimensionless)
	A	=	cross-section area of coal seam aquifer (m^2)

Darcy's Law underlies all assessments of water flow in porous media. It is the basic principle of all predictive groundwater modelling, whether it is spreadsheet calculations, simplified 2D slice modelling, or complex 3D multi-layer modelling.

Other groundwater modelling methods such as 2D slice models (e.g. Seep-W) or 3D models (e.g. MODFLOW) would be unlikely to provide a significantly more accurate estimate of potential seepage rates for the Cullen Valley Mine Modification Boundary because:

- The geometry of the aquifer system is simple, it is a single confined to semi-confined aquifer which is well suited to being analysed by Darcy's Law.
- Groundwater seepage into the mine areas will be sourced solely from the combined Lithgow/Lidsdale Coal Seam, which is not subject to leakage from any other adjacent units.
- Values for hydraulic conductivity (permeability) of the Lithgow/Lidsdale Coal Seam are limited, but are available from tests undertaken at:
    - Cullen Valley Mine[5] ≈ 0.03 m/day to 0.07 m/day, derived by falling head tests;
    - Pine Dale Mine[6] ≈ 0.09 m/day, derived by falling head tests;
    - Springvale Colliery[7] ≈ 0.001 m/day to 0.01 m/day, test method unknown; and
    - Angus Place Mine[7] ≈ 0.01 m/day, test method unknown.
- Values for the storage coefficient of the Lithgow/Lidsdale Coal Seam are not available, which means a representative estimate would be assumed within all types of predictive modelling; and
- The rate of groundwater flow into the existing Cullen Valley Mine open cut mining areas must be low in order for evaporation to maintain the currently observed dry mining conditions.

[5] Australasian Groundwater and Environmental Consultants Pty Ltd, (2012), "*Coalpac Consolidation Project – Groundwater Impact Assessment",* Prepared for Hansen Bailey Pty Ltd, Project No. G1515, March 2012.

[6] Aquaterra Consulting Pty Ltd, (2010), *"Pine Dale Coal Mine Extension Groundwater Assessment",* prepared for Enhance Place Pty Limited.

[7] Aurecon Australia Pty Ltd, (2010), *"Assessment of Hydrogeological Impacts – Angus Place Project Modification",* prepared for Centennial Angus Place.

2.3.1 Range of Hydraulic Conductivity Values

The variability of the hydraulic conductivity of the Lithgow / Lidsdale Coal Seam is confirmed by the range of values obtained (mostly via slug testing) from surrounding mine sites. Similarly, packer test data for coal seams in the Upper Hunter region supports values over five orders of magnitude ranging from an upper limit of 5 m/day down to a lower limit of 0.00001 m/day, with a mean value of about 0.09 m/day[8]. Hydraulic conductivities for seam depths less than 50 m are noted to be generally higher than 0.01 m/day, while lower conductivities are indicated at increasing depths[8].

Therefore, a range of hydraulic conductivity values were used with Darcy's Law to assess the sensitivity of the predicted rate of groundwater seepage to varying permeability. The hydraulic conductivity values ranged between an upper limit of 0.2 m/day and a lower limit of 0.07 m/day, which are conservatively high compared to some of the test results obtained from surrounding mines. This means the predicted rate of seepage is likely to be over predicted using these values.

2.3.2 Prediction of Hydraulic Gradient & Drawdown Extent

If it is assumed that we are dealing with an aquifer in porous media and that the assumptions for the modified non-steady state equations apply, then the drawdown at any point within the area of influence at a given time (t) is given by:

$$s = \frac{2.3Q}{4\pi T} \log \frac{2.25Tt}{r^2 S}$$

The extent of drawdown (also referred to as the radius of influence) at any time (t) is the radius at which the drawdown is zero. For this to apply the log term must be zero (i.e. the value within the log term must equal 1). Thus, at the radius of influence[9]:

$$R(t) = 1.5\left(\frac{Tt}{S}\right)^{\frac{1}{2}}$$

Where:

	R_0	=	radius of influence for a given time (m)
	T	=	transmissivity of the coal seam (m^2/day)
	t	=	time (days)
	S	=	storage coefficient or specific yield, depending on the aquifer type (dimensionless)

From the above it can be seen that the radius depends only on time, transmissivity, and storage coefficient and is completely independent of discharge rate. The discharge rate determines the magnitude of the drawdown within the cone of depression but not the areal extent.

This is a simple means of determining the radius of influence and, if used with care and common sense, can be used to provide a reasonable approximation even for those aquifers which are not in porous media.

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[8] Mackie C, D., (2009), "*Hydrogeological Characterisation of Coal Measures and Overview of Impacts of Coal Mining on Groundwater Systems in the Upper Hunter Valley of NSW*", PhD Thesis, University of Technology, Sydney, N.S.W. Australia, January 2009.

[9] Bear, J., (1979), "*Hydraulics of Groundwater*", McGraw-Hill, New York, 569p.

The extent of drawdown was calculated for five time steps, these being after year 1, 2, 3, 50, and 100. A single representative value of hydraulic conductivity 0.09 m/day was multiplied by a coal seam thickness of 2.5 m to derive a transmissivity of 0.225 m^2/day. A storage coefficient value of 0.0025 was used to represent the confined to semi-confined nature of the shallow coal seam. Figure 2-3 presents the predicted distance-drawdown curves.

The results predict the extent of drawdown resulting from the proposed Cullen Valley Modification Disturbance Boundary will expand to about 500 m after about three years of mine operation. The hydraulic gradient produced by the drawdown will be about 0.012.

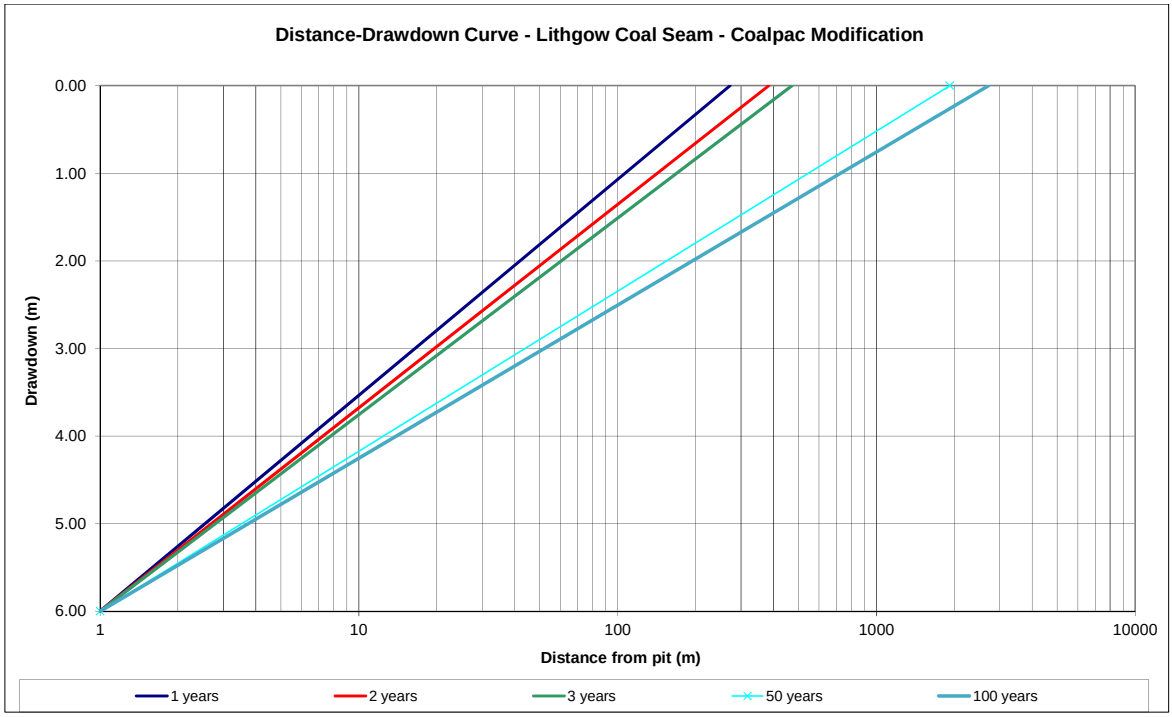

Figure 2-3: Distance Drawdown Relationship

2.3.3 Area of Seepage Face of Proposed Open Pit

The maximum length of the proposed open cut pit within the Modification Disturbance Boundary at Cullen Valley Mine is about 1.5 km. However, only the southern half of this area is anticipated to intersect saturated coal. Therefore, the maximum exposed length of saturated coal will be restricted to about 750 m. The Lithgow/Lidsdale Seam, at this location, has an average thickness of about 2.5 m. The seepage face on the exposed coal seam was assumed to be about 75% of the coal seam thickness, this being about 1.87 m high. Therefore, the cross-sectional area of the seepage face used within the Darcy equation was about 1,406 m^2.

2.3.4 Open Cut Seepage Calculations

The predicted groundwater seepage rate across the length of the open cut in the Modification Boundary at Cullen Valley Mine ranged from 0.4 ML/year up to 1.2 ML/year, as shown in Table 2. The range of predicted groundwater seepage rates into the open cut area were corrected for the effect of evaporation from the seepage face. A rate of 70% pan evaporation was applied to the seepage face to account for partial shadow effects created by the predominantly north-south orientation of the void wall. Evaporation from the seepage face is predicted to account for 100% of groundwater seepage as shown in Table 2. Therefore, evaporation from the seepage face is likely to produce a dry open cut mining area.

The highest seepage rate of 1.2 ML/day was selected as the predicted take of groundwater from a water licencing perspective. This predicted take is considered to be conservative and is likely to overestimate the actual seepage rate likely to be realised.

2.3.1 Highwall Seepage Calculations

The predicted groundwater seepage rate into the highwall drives ranged from 0.36 ML/year up to 1 ML/year, as shown on Table 3.

The Lithgow Seam is too thin to highwall mine in the Modification Boundary at Cullen Valley Mine. However, the Lidsdale Seam immediately above the Lithgow Seam is likely suitable for highwall mining method and the cutting height of the drive in this seam will be about 1.2 m. Each drive will be a maximum of 300 m long and about 3 m wide. Approximately 125 highwall drives will be mined along the 750 m saturated face of the Lidsdale Seam. Each drive will have a storage volume of about 1.08 ML.

The rate of groundwater seepage to the highwall mining drives was predicted using the Darcy Equation described in Section 2.3. The analytical assessment assumed that all highwall mining drives were installed simultaneously, as this assumption simplifies the predictive modelling effort and has the benefit of promoting conservative results.

In this case, groundwater seepage will occur through the end-face of each highwall drive and through the long-wall of the two outer-most drives. The surface area of each end-face is 3.6 m^2 and the length of each long-wall is 360 m^2.

The highwall seepage assessment used the same range of hydraulic conductivity values and the same hydraulic gradient used for the open cut seepage assessment.

The highest seepage rate of 1 ML/day was selected as the predicted take of groundwater from a water licencing perspective. This predicted take is considered to be conservative and is likely to overestimate the actual seepage rate likely to be realised from the highwall mining drives.

Table 2: SUMMARY OF OPEN CUT SEEPAGE RATE CALCULATIONS AND RESULTS						
Parameter	**Unit**	**Range of Input Parameters and Results**				
Hydraulic conductivity (K)	m/day	0.2	0.1	0.09	0.08	0.07
Maximum drawdown	m	6				
Radius of influence	m	500				
Steady state hydraulic gradient (i)	-	0.012				
Average thickness of coal seam	m	2.5				
Length of saturated coal seam	m	750				
Seepage face height	m	1.87				
Cross-section area of seepage (A)	m^2	1,406				
Predicted Seepage Rate to Proposed Open Pit (Q) – <u>not</u> corrected for evaporation	m^3/day	3.37	1.69	1.52	1.35	1.18
	L/s	0.039	0.019	0.018	0.016	0.014
	m^3/year	1232	616	554	493	431
	ML/year	**1.2**	**0.6**	**0.6**	**0.5**	**0.4**
Pan evaporation	mm/day	3.7				
70% pan evaporation	mm/day	2.6				
Evaporation from coal seam (750 m x 2.5 m)	m^3/day	3.64				
	ML/year	1.3				
Predicted Seepage Rate to Proposed Open Pit (Q) – corrected for evaporation	**ML/year**	**-0.10**	**-0.71**	**-0.78**	**-0.84**	**-0.90**
Comment	Evaporation from the seepage face is likely to remove all seepage water from the coal seam face before it can accumulate on the open pit floor as a pumpable volume					

Table 3: SUMMARY OF HIGHWALL MINE SEEPAGE RATE CALCULATIONS AND RESULTS						
Parameter	**Unit**	**Range of Input Parameters and Results**				
Hydraulic conductivity (K)	m/day	0.2	0.1	0.09	0.08	0.07
Radius of influence	m	500				
Steady state hydraulic gradient (i)	-	0.012				
Average thickness of coal seam	m	1.2				
Length of saturated coal seam	m	750				
Seepage face height	m	1.87				
Number of saturated highwall drives	No.	125				
Cross-section area of seepage face – drive end-face (A)	m^2	3.6				
Cross-section area of seepage face – drive end-face (A)	m^2	360				
Predicted seepage rate to all end-faces (Q)	m^3/day	1.08	0.54	0.49	0.43	0.38
Predicted seepage rate to outer wall of drive no. 1 (Q)	m^3/day	0.864	0.432	0.3888	0.3456	0.3024
Predicted seepage rate to outer wall of drive no. 125 (Q)	m^3/day	0.864	0.432	0.3888	0.3456	0.3024
Predicted Seepage Rate to Total Highwall Drives (Q)	m^3/day	2.81	1.40	1.26	1.12	0.98
	L/s	0.033	0.016	0.015	0.013	0.011
	m^3/year	1025	512	461	410	359
	ML/year	**1.02**	**0.51**	**0.46**	**0.41**	**0.36**
Comment	The highwall drives will be sealed after mining and allowed to flood with groundwater seepage					

2.4 Groundwater Quality Monitoring

Four groundwater sampling events to assess water quality in saturated aquifers have occurred to-date. Groundwater quality samples were collected at six-monthly intervals for the first year in February and August 2011. The frequency of sampling events was then reduced to annual sampling from 2012. The sampling frequency and the number of samples collected during each event are shown in Table 4.

Table 4: COALPAC GROUNDWATER SAMPLING EVENTS

Month / Year	Date	No. of Bores Sampled	Samples Collected From
February 2011	16/2/11	5	CP114, CP115, CP116, CP123, LD001
August 2011	17/8/11	5	CP114, CP115, CP116, CP123, LD001
February 2012	02/2/12	6	CP114, CP115, CP116, LD001, CP131, CP132
February 2013	06/2/13	5	CP114, CP115, CP116, CP131, CP132
	27/2/13	1	LD001

The next sampling event is scheduled for May 2014. NSW Office of Water suggested that a baseline groundwater chemistry dataset should ideally contain at least eight sampling events, prior to the commencement of project activities. It is recommended that Coalpac expand the baseline groundwater chemistry dataset.

The groundwater sampling to-date has been undertaken by Hydroilex Pty Ltd (Hydroilex) which specialise in groundwater sampling, analysis, and monitoring. The sampling methods, the quality assurance and quality control (QA / QC) procedures, and results are provided to Coalpac following each sampling event in groundwater sampling/analysis reports.

The general scope of work undertaken by the Hydroilex for each sampling event includes:

- inspection of borehole integrity;
- manual recording of the standing water level;
- downloading and analysis of automatic groundwater level logger data;
- purging of monitoring bores and collection of groundwater samples;
- recording water quality parameters in the field (i.e. pH, EC, Temp, Eh);
- submission of water samples to a NATA accredited laboratory for analysis; and
- review of water quality results and comparison against relevant standards, namely the ANZECC 2000 Freshwater Trigger Values.

The sampling methodology, QA / QC procedures, storage, transport and submission to the laboratory, and the analytical laboratory analyses comply with industry best practice and the following guidelines and standards:

- The Australian / New Zealand Standard Water Quality – “Sampling, Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples” (AS/NZS 5667.1:1998);
- The Australian / New Zealand Standard Water quality – “Sampling, Part 11: Guidance on sampling of groundwaters” (AS/NZS 5667.11:1998);

- Geoscience Australia, (2009), "Groundwater Sampling and Analysis – A Field Guide"; and
- Murray-Darling Basin Commission, (1997), "Murray Darling Basin Groundwater Quality Sampling Guidelines", Technical Report No. 3, Groundwater Working Group.

In summary, the sampling protocol included:

- purging three bore volumes prior to sampling;
- collecting samples with either a Grundfos MP1 submersible sampling pump (where flow rates were sufficient), or a stainless steel bailer (where flow rates were low);
- calibrating field probes prior to the sampling event;
- storage of samples in laboratory supplied bottles;
- acidifying samples to preserve the dissolved metal concentrations; and
- storing samples on ice until delivered to the laboratory.

The samples collected for each event are analysed for the following:

- Physical Parameters – pH, Electrical Conductivity, and Hardness.
- Major Ions – Sodium, Potassium, Calcium, Magnesium, Chloride, Sulphate, Bicarbonate, Carbonate, Nitrate, and Nitrite.
- Dissolved Metaloids – Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, and Zinc.

The QA / QC protocols used during the sampling are listed in Table 5.

Table 5: Field QA / QC

Sampling Team	The fieldwork was managed by Hydroilex. Project personnel comprised professionals and technicians trained in conducting groundwater investigations.
QA/QC System	All fieldwork was conducted in accordance with the Hydroilex Standard Sampling Procedure by professionals and trained technicians.
Chain of Custody Forms	All samples were logged and transferred under appropriately completed Chain of Custody (COC) Forms.
Preservation	All samples were delivered to the laboratory in appropriately preserved containers, with preservation consisting of packing samples in eskies with ice.

The laboratory (Envirolab Services Pty Ltd) used for the chemical analysis of samples is NATA accredited for the selected analyses. Laboratory QA/QC standards and results are documented in the laboratory reports.

The laboratory QA/QC indicators either, all complied with the required standards, or showed variations that would have no significant effect on the quality of the data or the conclusions of the water quality assessment. It is therefore concluded that, for the purposes of this study, the QA / QC results are adequate and the quality of the data is acceptable for use.

2.5 Water Management Plans and Trigger Action Response Plan

Coalpac has an approved Water Management Plan (WMP) in place for Invincible Colliery and the Cullen Valley Mine. Coalpac has committed to updating the currently approved WMP to ensure appropriate management and mitigation measures are implemented to minimise potential groundwater impacts. It is recommended that the WMP plan is prepared in accordance with relevant guidelines to the satisfaction of NOW. The WMP should detail programs to monitor the site water balance, surface water, and groundwater.

The draft WMP should also describe the methodology of establishing groundwater quality triggers and present a preliminary trigger action response plan (TARP). The water quality triggers and the TARP should be finalised after establishing a suitable and robust water quality baseline dataset.

2.6 Groundwater Licence Details

An updated summary of the Water Access Licenses (WAL's) for groundwater issued under the WM Act for Cullen Valley Mine and Invincible Colliery are summarised in Table 6.

Table 6: GROUNDWATER LICENCES

WM Act Licence Number	Bore Name	Share Component (ML)	Water Source	Water Sharing Plan
WAL27898	Tillies Bore	80	Sydney Basin MDB Groundwater Source	NSW Murray-Darling Porous Rock Groundwater Sources
WAL35978	Washery Bore	26		
WAL36458	Long Swamp	120	Sydney Basin Coxs River Groundwater Source	Greater Metropolitan Region Groundwater Sources

2.7 Status of Neighbouring Registered Bores

There are no privately registered bores located within the predicted zone of aquifer depressurisation surrounding the Cullen Valley Mine Modification Boundary. Figure 2-4 shows the location of neighbouring registered bores in more detail.

GW801861 was drilled as a test bore and it's licence has been cancelled. GW064530 and GW064531 are active and are used for stock and domestic purposes. Table 7 summarises details for each of these neighbouring bores.

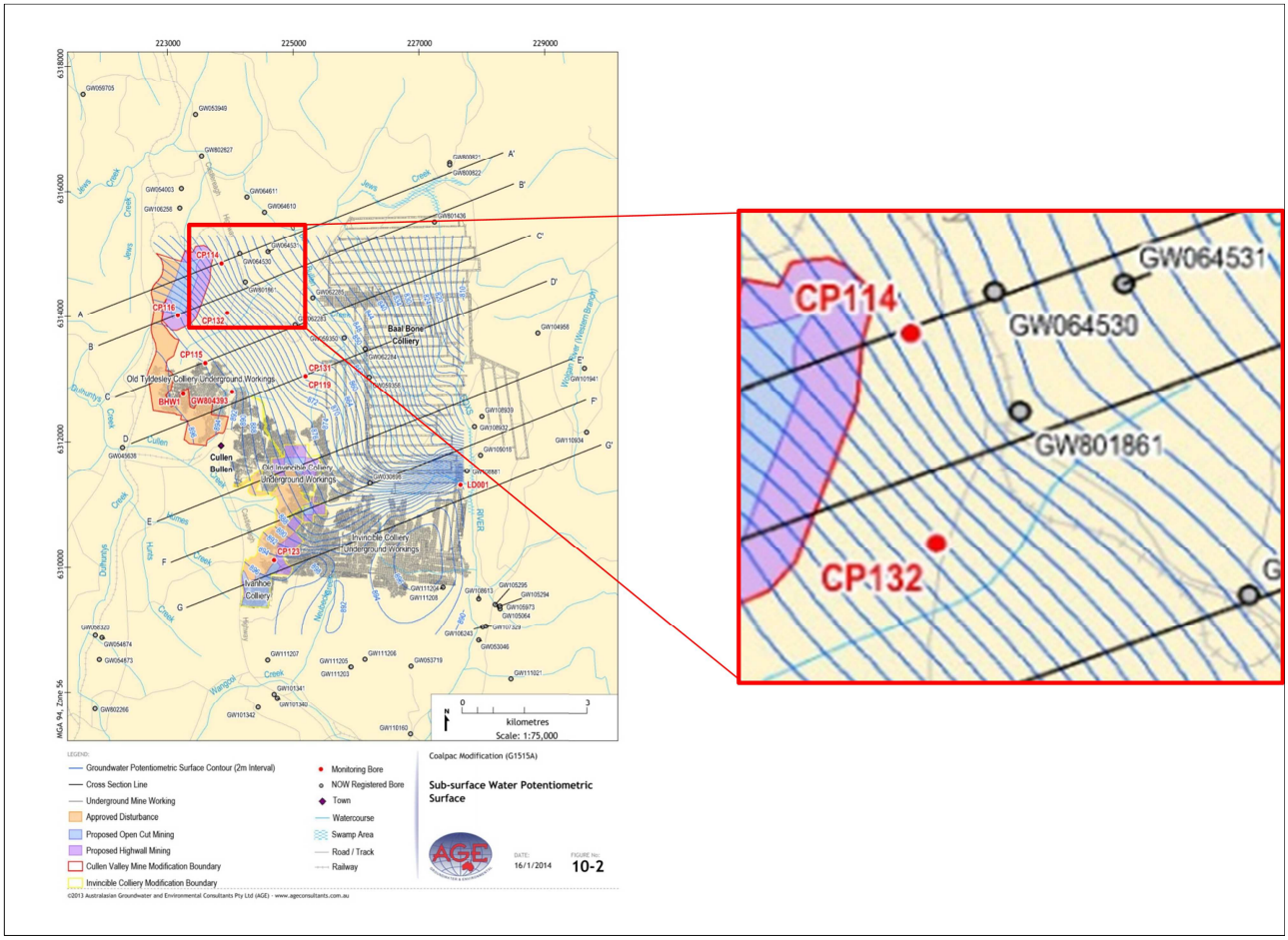

Figure 2-4: Neighbouring Registered Bores

Table 7: NEIGHBOURING REGISTERED BORES					
Work No.	**Year**	**Licence Status**	**Completed Depth (mbgl)**	**Water Bearing Zone (mbgl)**	**Water Bearing Formation**
GW801861	2002	Test Bore – Cancelled	72	62 – 64	Shale
GW064530	1987	Domestic/Stock – Active	85.4	66 – 68	Sandstone
GW064531	1987	Domestic/Stock – Active	48.8	40 - 42	Shale

The water bearing zone for these bores ranges between 40 mbgl and 68 mbgl, and the water is sourced from shale and sandstone units. These water bearing zones are located significantly deeper than the Lithgow Coal Seam, as illustrated in Figure 2-5 and Figure 2-6. Therefore, water levels within the registered bores are not predicted to be impacted by the open cut or highwall mining areas proposed for the Cullen Valley Mine Modification.

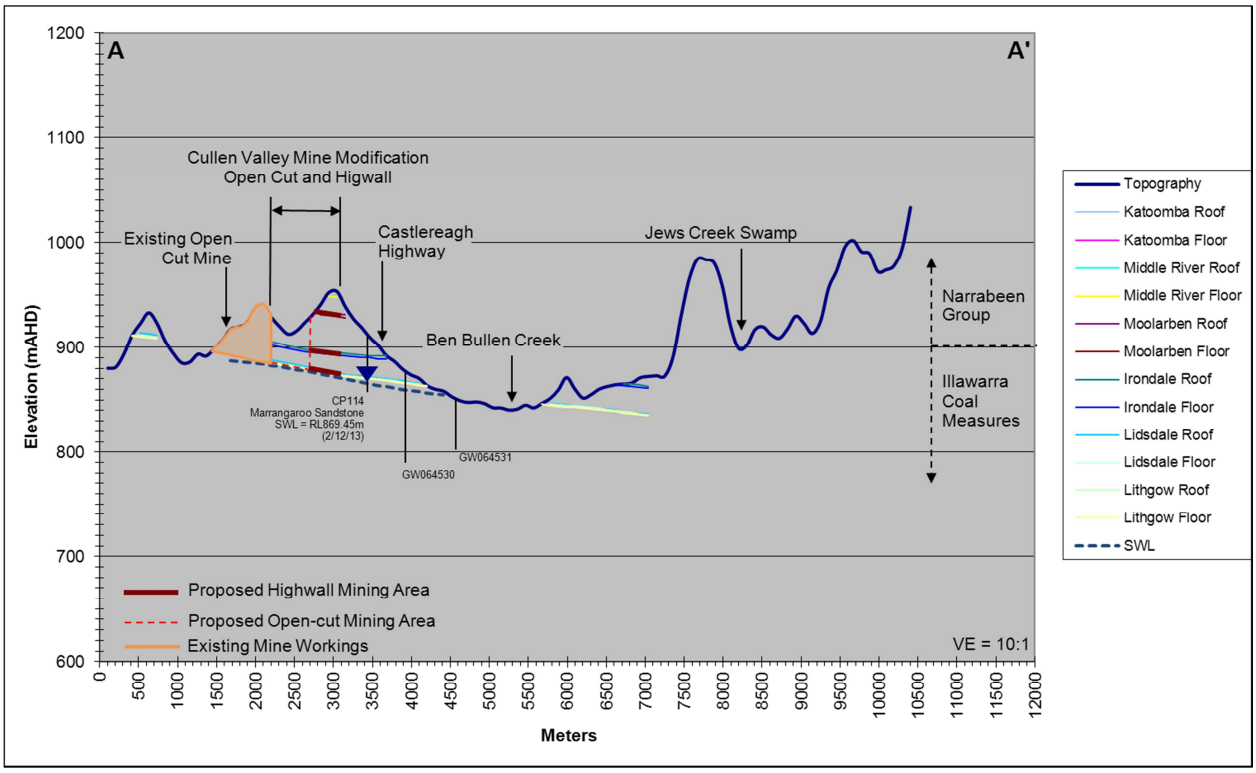

Figure 2-5: Cross-Section A-A`

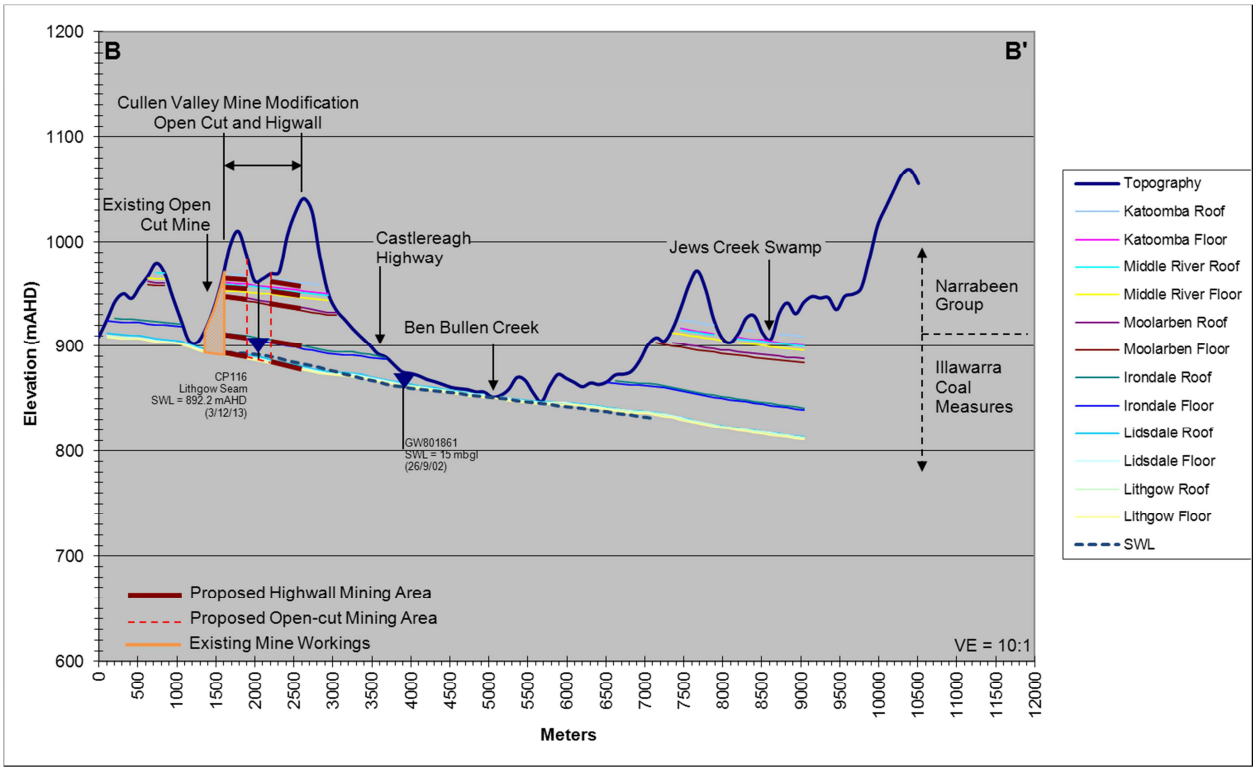

Figure 2-6: Cross-Section B-B`

3 SUMMARY AND CONCLUSIONS OF IMPACT STUDY

The proposed Modifications pose a low risk to the groundwater regime because:

- Only half of the proposed Cullen Valley Mine Modification Disturbance Boundary is likely to intercept a saturated coal seam, this being the Lidsdale / Lithgow Seam. All other coal seams are unsaturated;
- The Cullen Valley Mine Modification is predicted to generate a localised zone of depressurisation in the coal seams, but this is not expected to impact on adjacent neighbouring registered bores or other aquifers adjacent to the Modification Boundary;
- Predicted take of groundwater for the Cullen Valley Mine Modification Boundary is 2.2 ML/year at peak;
- The current predictions suggest that dry mining conditions will still prevail for the Cullen Valley Mine Modification due to evaporative losses;
- The Northern mining area proposed for the Invincible Colliery Modification will intercept sub-surface water in the Old Invincible Colliery underground workings. Mine dewatering of up to 125 ML is predicted in this area over a two year period for the Modification. The Eastern and Southern mining areas proposed for the Invincible Colliery Modification are unlikely to intercept saturated aquifers and flooded underground workings;
- The removal of up to 125 ML sub-surface water from the flooded workings of the Old Invincible Colliery will have a negligible impact on the remainder of the flooded underground workings;
- The backfilling of existing mining void areas across both mine sites and the creation of a free draining final landform at both Cullen Valley Mine and Invincible Colliery as proposed by these modifications will reduce the risk of poor quality water build up on either mine site and the potential for any surface water or groundwater contamination;

The current hydrogeological regime supports these conclusions because:

- Many of the coal seams are topographically elevated and located within the unsaturated zone (i.e. above the potentiometric surface), where much of the mining will be undertaken;
- The upper coal seams crop out at the ground surface in a number of locations, meaning they do not form continuous aquifers;
- The hydraulic gradients and hydraulic conductivities of the coal seam and sandstone aquifers are both low;
- The coal seam aquifers crop out to the east and west of the Modification Boundaries; and
- Groundwater levels have already been significantly drawn down to the east (down-gradient) of the Modification Boundaries by the Baal Bone Colliery.

Groundwater management has not been a major operational issue at Cullen Valley Mine and Invincible Colliery during their long history for the reasons outlined above. Hence, limited monitoring of groundwater levels and quality has been undertaken until recently. In the absence of abundant long-term groundwater data, a dedicated groundwater monitoring network was installed adjacent to Invincible Colliery and Cullen Valley Mine to enhance the collection of groundwater data, specifically to provide baseline groundwater data and for long-term data collection, assessment, and reporting.

Please do not hesitate to contact the undersigned if you have any queries, or if any clarification is required.

Yours faithfully,

TIM ARMSTRONG
Senior Hydrogeologist
Australasian Groundwater and Environmental Consultants Pty Ltd

0718-01-G3
1 May 2014

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Dear Ben,

SUBJECT: INVINCIBLE COLLIERY & CULLEN VALLEY MINE MODIFICATIONS SUPPLEMENTARY SURFACE WATER ASSESSMENT

1 INTRODUCTION

Coalpac Pty Ltd, Administrators Appointed (Coalpac) owns and operates the Invincible Colliery and Cullen Valley Mine. Each mine operates as a separate entity with separate planning approvals under the *Environmental Planning and Assessment Act 1979* (EP&A Act). Coalpac is seeking to modify both planning approvals under Section 75W of the former Part 3A of the EP&A Act.

WRM Water & Environment Pty Ltd (WRM) undertook a *Surface Water Impact Assessment, Cullen Valley Mine and Invincible Colliery Modifications* dated 28 January 2014 that supports the *Environmental Assessment Modifications to PA 07_127 and DA 200-5-2003* dated March 2014 which is currently being assessed by the NSW Department of Planning and Infrastructure. This assessment provides further clarification of water related matters for the Modification of existing approvals at Invincible Colliery and Cullen Valley Mine and should be considered as a supplementary report to the above mentioned WRM (2014) Surface Water Impact Assessment.

2 ASSUMPTIONS

The following key assumptions have been made for the purposes of this assessment:

- Coalpac landholdings and relevant surface mining authorities held by the company in the vicinity of Cullen Valley Mine and Invincible Colliery have been included for the purpose of calculating the harvestable right for Coalpac operations;
- There are few minor existing harvestable right dams located on Coalpac landholdings or mining authorities. That is, the majority of dams located on Coalpac landholdings and mine leases are those that form part of the mine water management system;
- Large areas of land to the south of Invincible Colliery are affected by pre-existing subsidence and surface cracking from underground Bord and Pillar mining in the abandoned Invincible Colliery and Ivanhoe Colliery underground workings. All runoff from undisturbed catchment areas affected by pre-existing subsidence is assumed to report directly to the flooded underground workings beneath the site, and does not drain into the Invincible Colliery water management system. As this undisturbed runoff is not captured by the mine water management system, and the subsidence cracking pre-dates Coalpac's operation of the Invincible Colliery, it is not considered to be a licensable take of surface water under this assessment. The catchment areas

impacted by subsidence surface cracking that direct water directly to the old historic underground mine workings are shown in Figure 1.

- Runoff from upstream undisturbed catchment areas in the southern portion of Cullen Valley Mine drains to soaks in the established rehabilitation areas at the site. It is assumed for the purpose of this report that runoff from these areas collects in the soaks and rehabilitation areas and infiltrates into the abandoned Old Tyldesley underground workings beneath Cullen Valley Mine, and is not captured by the mine water management system. As this undisturbed runoff is not captured by the mine water management system, it is not considered to be a licensable take of surface water under this assessment. Undisturbed catchment areas that drain to soaks in the established rehabilitation areas are shown in Figure 1.
- A volumetric runoff coefficient of 11.2% has been adopted for undisturbed catchment areas. This runoff coefficient has been calculated from the NSW Office of Water (NSWOW) Maximum Harvestable Rights Calculator as follows:
    - Maximum Harvestable Right Dam Capacity (MHRDC) is based on a dam or dams that capture up to 10% of average regional rainfall runoff of the property (NSWOW, 2010a)
    - MHRDC multiplier for Coalpac sites = 0.08ML/ha (obtained from NSWOW MHRDC Calculator);
    - MHRDC multiplier is equivalent to 10% average regional rainfall runoff, hence 100% average regional rainfall runoff for Coalpac sites is 0.8ML/ha or 80mm of runoff.
    - Average annual rainfall at the Coalpac sites is estimated to be 716mm based on long term dataset provided by SILO Datadrill;
    - Therefore the runoff coefficient for undisturbed catchments in the vicinity of the Coalpac sites is 80mm ÷ 716mm average annual rainfall = 11.2%;
- A volumetric runoff coefficient of 30% has been assumed for disturbed catchment areas;

3 HARVESTABLE RIGHTS ENTITLEMENT FOR EXISTING OPERATIONS AND PROPOSED MODIFICATIONS

Under the *Water Management Act 2000*, landholders in most rural areas are permitted to collect a proportion of the rainfall runoff on their property and store it in one or more dams up to a certain size. This is known as a 'harvestable right'. A dam can capture up to 10 percent of the average regional rainfall runoff for their landholding without requiring a licence.

For this assessment the land area required for the purposes of calculating the harvestable right is Coalpac landholdings and relevant surface mining authorities held by the company in the vicinity of Cullen Valley Mine and Invincible Colliery. For comparison purposes a second case was investigated with the following areas excluded from the harvestable right calculation:

- Existing disturbance areas under currently approved operations; and
- Undisturbed catchment areas that drain to pre-existing subsidence cracking at Invincible, or infiltration soaks at Cullen Valley.

Table 1 shows the total harvestable right for Cullen Valley Mine and Invincible Colliery for both cases, based on a MHRDC multiplier value of 0.08 ML/ha for the relevant area (refer Section 2).
The MHRDC calculation is summarised as follows:

- Case 1 – No excluded areas:
    - **MHRDC** = 0.08ML/ha x Coalpac Landholdings & Mining Authorities (ha) *[Calc. Ref. A]*;
- Case 2 – Removal of excluded areas:
    - **MHRDC** = 0.08ML/ha x Land Area for Harvestable Right Calculation less Exclusions (ha) *[Calc. Ref. D]*;
    - **D** = Total Landholding Area *[Calc. Ref. A]*– (Existing and Proposed Disturbance Area *[Calc. Ref. B]* + Undisturbed Area draining to subsidence / infiltration soaks *[Calc. Ref. C]*);

Table 1 Harvestable Rights Entitlement

Calc. Ref.	Description	Invincible Colliery	Cullen Valley Mine	Coalpac Total
A	Coalpac Landholdings & Mining Authorities (ha)	635	552	1187
B	Existing & Proposed Disturbance Area (Excluded Works) (ha)	229	218	447
C	Undisturbed Area draining to subsidence /infiltration soaks (ha)	80	32	112
D	Coalpac Landholdings & Mining Authorities less exclusions (ha)	326	302	628
Case 1 MHRDC	**Maximum Harvestable Right Dam Capacity (ML)**	**50.8**	**44.2**	**95.0**
Case 2 MHRDC	**Maximum Harvestable Right Dam Capacity (ML)**	**26.1**	**24.1**	**50.2**

4 WATER LICENSING

The *Water Management Act 2000* applies to surface waters within the Cullen Valley Mine and Invincible Colliery through the *Macquarie Bogan Unregulated and Alluvial Water Sources Water Sharing Plan*. Surface water at the Cullen Valley Mine and Invincible Colliery is regulated under this plan as part of the Turon Crudine River Water Source. Water volumes extracted from these catchments require a water entitlement (an unregulated river access licence).

Dams solely for the capture, containment and recirculation of mine affected water consistent with best management practice to prevent the contamination of a water source are "excluded works" and are exempt from the requirement for water supply works approvals and Water Access Licences (WALs) under the *Water Management Act 2000*. On this basis, water captured in the site water management structures, with the exception of rainfall runoff from undisturbed natural catchments, is not subject to licensing under the *Water Management Act 2000*. It should be noted that runoff intercepted by the mine water management system from undisturbed catchment areas which do not form part of the excluded works area is licensable under the *Water Management Act 2000*.

Portions of land at Invincible Colliery are affected by pre-existing surface cracking from underground Bord and Pillar mining in the abandoned Invincible Colliery and Ivanhoe Colliery underground workings. Anecdotal evidence indicates that much of the surface water runoff which drains through these previously mined areas does not report to downstream surface water management structures, and instead enters the sinkholes and fractures and reports directly to the abandoned underground workings. As such this report, consistent with previous studies (WRM, 2011 & 2014), has assumed that all runoff from subcatchments affected by subsidence cracking does not report to the mine water management system, and instead drains into the old underground workings.

Runoff from upstream undisturbed catchment areas in the southern portion of Cullen Valley Mine drains to soaks in the established rehabilitation areas. It is assumed that runoff from these areas collects in the soaks and infiltrates into the abandoned Old Tyldesley underground workings beneath Cullen Valley Mine, and is not captured by the mine water management system.

For the purposes of water licensing assessment, it is assumed that any capture of runoff from catchments draining to areas of pre-existing subsidence cracking near the Invincible Colliery, or to the soaks in the established rehab at Cullen Valley Mine are not subject to licensing requirements, as this water is not captured by the mine water management system, and the subsidence cracking and abandoned underground workings pre-date Coalpacs operation of these mines.

Runoff from undisturbed natural catchment areas intercepted by the Invincible Colliery or Cullen Valley Mine water management system would require licencing under the *Water Management Act 2000*. Figure 1

and Table 2 shows the undisturbed catchment areas that would be subject to licencing if captured, as well as the disturbed areas and the catchment area that drains to pre-existing subsidence cracking which are to be excluded from licensing requirements. Table 3 shows the estimated licensable and non-licensable volume of water captured within the water management systems at Cullen Valley Mine and Invincible Colliery.

The intercepted average, 90th percentile and maximum annual runoff volume has been estimated using average, 90th percentile and maximum annual rainfalls (from SILO Datadrill) of 716 mm, 939 mm and 1,260 mm respectively. A volumetric runoff coefficient of 0.112 has been used based on the runoff coefficient utilised for harvestable rights calculations at Cullen Valley Mine and Invincible Colliery, as described in Section 2.

Table 2 Catchment Areas

Description	Invincible Colliery	Cullen Valley Mine	Coalpac Total
Undisturbed Catchment Area captured by Mine Water Management System (ha)	224	80	304
Undisturbed Catchment contributing to flooded underground workings (ha)	192	83	275
Existing & Proposed Disturbance Area (Excluded Works) (ha)	229	218	447

Table 3 Surface Water Take

Annual Take (ML)			Invincible Colliery	Cullen Valley Mine	Coalpac Total
Licensable	Undisturbed catchment – captured by mine water management system	Peak	315	113	428
		90th percentile	235	84	319
		Average	179	64	243
Non-licensable	Undisturbed catchment - contributing to flooded underground workings	Peak	270	117	387
		90th percentile	201	87	288
		Average	154	66	220
	Existing and proposed disturbed area	Peak	865	824	1689
		90th percentile	645	614	1259
		Average	468	492	960

After taking into account the harvestable right entitlement at Cullen Valley Mine and Invincible Colliery for Case 1 in Table 1 (i.e. no area excluded), the remaining annual take of water requiring licensing for the peak, 90th percentile and average annual rainfalls, are provided in Table 4.

Table 4 Required Licensing (Accounting for Harvestable Rights Entitlement)

Annual Take (ML)		Invincible Colliery	Cullen Valley Mine	Coalpac Total
Undisturbed catchment	Peak	264	68	332
	90th percentile	184	40	224
	Average	128	20	148

5 IMPACT OF PROPOSED MODIFICATIONS ON LICENSABLE SURFACE WATER TAKE

The proposed Modification at Invincible Colliery will not increase the amount of undisturbed catchment runoff captured by the mine water management system, as the undisturbed catchment upstream of the proposed Modification mining areas already drains into the Invincible Colliery mine water management system. The undisturbed catchment area draining to the mine water management system at Invincible Colliery for both existing and proposed modification conditions is 224.4ha.

The proposed Modification at Cullen Valley Mine will increase the undisturbed catchment runoff captured by the mine water management system. Under existing conditions, the undisturbed catchment area draining to the mine water management system at Cullen Valley is 28.5ha, equating to a licensable surface water take of 23ML for an average rainfall year. The proposed Modification disturbance will increase the captured undisturbed catchment area to 77.9ha, resulting in an increase in the take of licensable surface water to 62ML.

6 LICENSING OF EXTRACTION OF WATER FROM FLOODED UNDERGROUND WORKINGS FOR MINE SITE DEMAND

It is understood that water extracted from the flooded underground workings to supply mine site water demands may be licensable under certain circumstances. The amount of water required to be extracted from the underground workings would be dependent on site rainfall and expected demands. Coalpac have previously provided the following information regarding water demands under normal operating conditions at Invincible Colliery and Cullen Valley Mine:

- Total Annual Water Demand at Cullen Valley Mine: 395ML/yr;
    - Dust Suppression: 386ML/yr;
    - Process Water: 9ML/yr;
- Total Annual Water Demand at Invincible Colliery: 330ML/yr;
    - Dust Suppression: 291ML/yr;
    - Process Water: 9ML/yr;
    - CPP Makeup Water: 30ML/yr;

Table 3 indicates that in an average year the mine water management systems at Cullen Valley Mine and Invincible Colliery would capture approximately 960ML of runoff per annum from disturbed catchments alone. Therefore, on average there will be a water surplus of approximately 235ML/yr captured by the mine water management systems. This additional surplus water is currently directed to the flooded underground workings via channelling or pumping for storage. This will continue to result in a net inflow of water to the flooded underground workings over the Modification period based on long term average climate conditions. Therefore no annual license would be required for extractions of water from the flooded underground workings, as inflows will, on average, exceed any extractions required to meet mine operational demands.

7 STRAHLER STREAM ORDER

Streams draining through the Project site have been classified under the Strahler stream order classification system, as shown in Figure 2. The stream order was determined based on 1:25 000 km topography maps. The Modification at Cullen Valley Mine intercepts 1st and 2nd order streams as defined by the Strahler stream order classification system. The Modification intercepts 3rd order streams in two locations at Invincible Colliery. It should be noted that that these 3rd order streams have already been disturbed by existing approved mining operations immediately downstream of the proposed Modification area.

8 MITIGATION AND MANAGEMENT OPTIONS

A number of strategies are available to offset the volume of undisturbed catchment runoff captured by the mine water management systems at Cullen Valley Mine and Invincible Colliery:

- Extraction, treatment and release of water stored in the flooded underground workings. Releases of water could be made following rainfall events, with release volumes equivalent to estimated flows from undisturbed catchment areas discharged from the site. Any releases of water from the flooded underground workings would need to be treated to ensure compliance with relevant water quality criteria under existing licenses and approvals.
- Construction of drainage channels to convey runoff from upstream undisturbed catchment areas around or through areas disturbed by mining activities, bypassing the mine water management system and releasing water into downstream watercourses.
- Construction of clean water capture ponds upslope of any mine disturbance areas and the installation of gravity fed pipes to transfer clean water directly to downstream watercourses. This strategy is recommended for catchment areas where the construction of clean water diversion channels may not be suitable.
- Note that the construction of clean water diversion works (channels or ponds) would possibly be considered as 'excluded works' under the *Water Management (General) Regulation 2011.* Any clean water diversion works would only be undertaken on 1st and a2nd order streams.

9 CONCLUSION

The assessment of required water licensing and harvestable rights entitlement at Cullen Valley Mine and Invincible Colliery shows that harvestable rights entitlement are not sufficient to cover the required licensing of water take due to capture of undisturbed catchment runoff in the mine water management system. For an average rainfall year, the operations would require water access licenses of 148ML under the *Macquarie Bogan Unregulated and Alluvial Water Sources Water Sharing Plan* if appropriate management and mitigation measures are not implemented. If the management and mitigation measures identified in this report are implemented, were appropriate, and clean water is diverted around 'excluded works' areas and is not captured by the water management system, then it is unlikely that any licence would be required under the above mentioned Water Sharing Plan.

No licenses would be required for extractions of water from the flooded underground workings, as pumped inflows into the flooded underground workings will, on average, exceed any extractions.

Please do not hesitate to contact me if you have any queries.

For and on behalf of
WRM Water & Environment Pty Ltd

Rhys Cullen
Senior Engineer

References:

WRM (2011) *Surface Water Impact Assessment for Coalpac Consolidation Project*, Report prepared by WRM Water & Environment on behalf of Coalpac Pty Ltd, November 2011.

WRM (2014) *Surface Water Impact Assessment, Cullen Valley and Invincible Colliery Modifications*, Report prepared by WRM Water & Environment on behalf of Coalpac Pty Ltd, January 2014.

Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources 2012, Accessed from http://www.legislation.nsw.gov.au/

NSW Office of Water Maximum Harvestable Right Dam Capacity Calculator, Accessed from http://www.water.nsw.gov.au/Water-Licensing/Basic-water-rights/Harvesting-runoff/Calculator/default.aspx

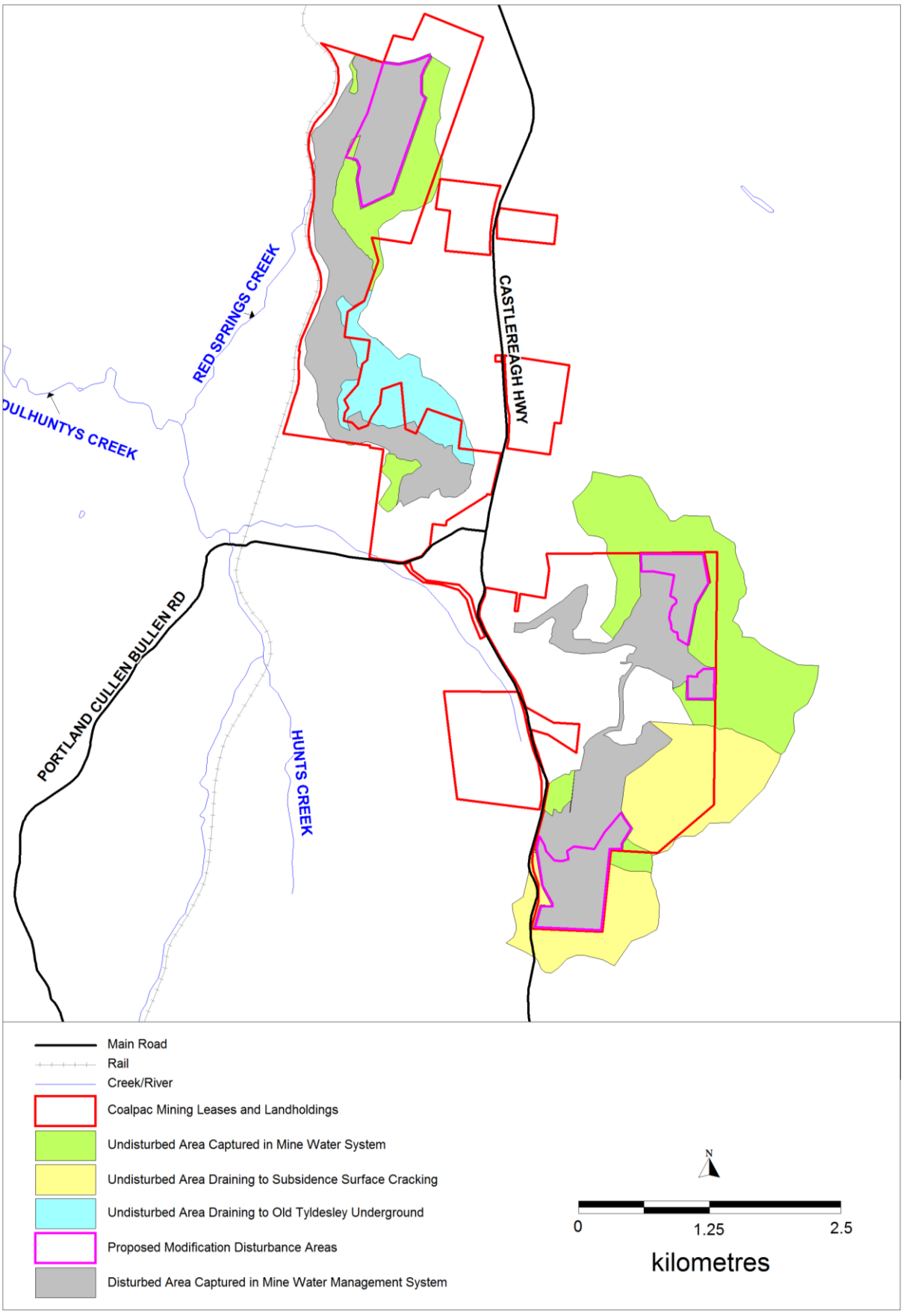

Figure 1 Harvestable Rights Land Area and Catchments for Invincible Colliery and Cullen Valley Mine

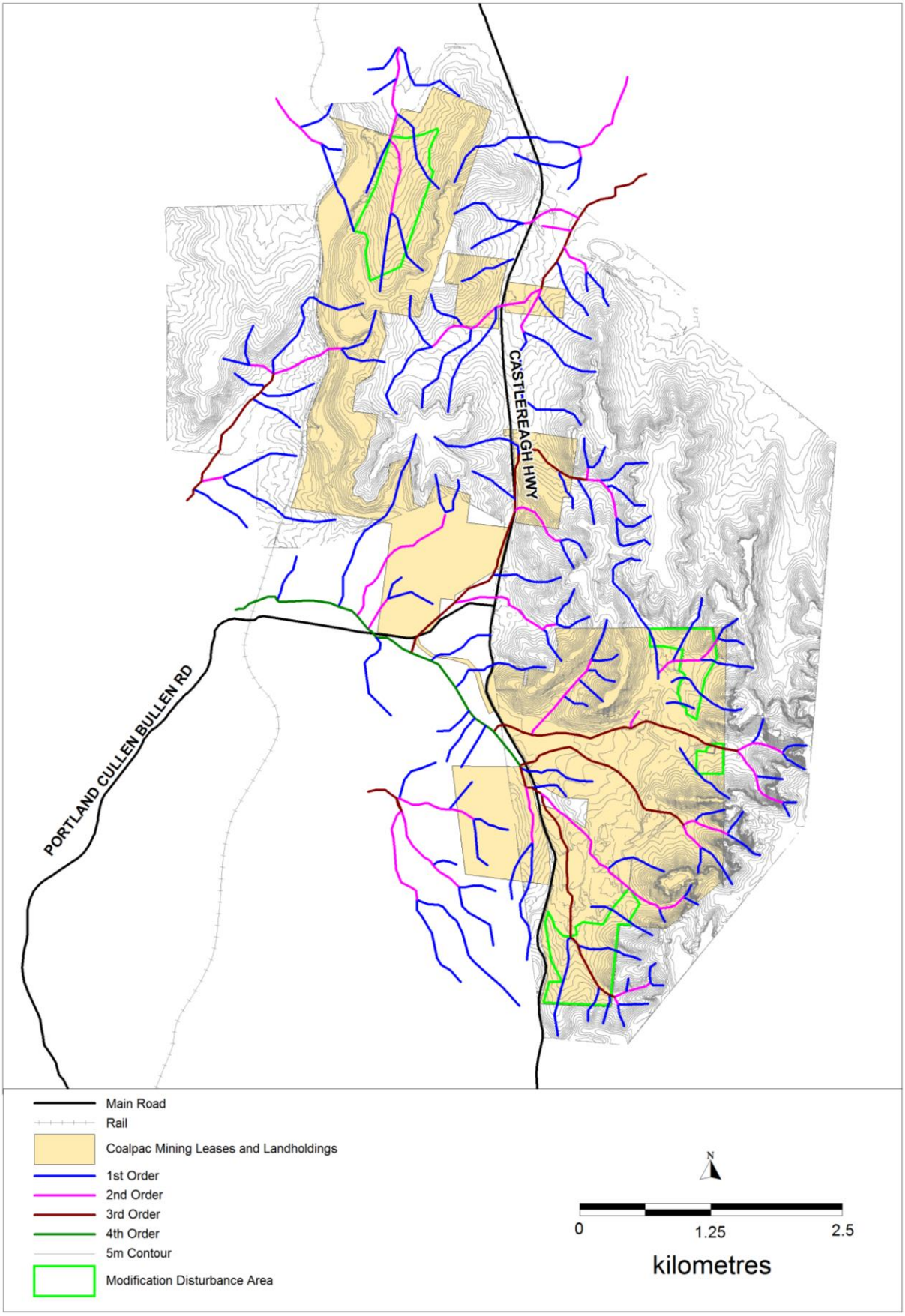

Figure 2 Strahler Stream Ordering at Invincible Colliery and Cullen Valley Mine

Australian Government
Department of the Environment

Notification of

REFERRAL DECISION – not a controlled action

Invincible Colliery Modification and Cullen Valley Mine Modification, Cullen Bullen, NSW, (EPBC 2014/7147)

This decision is made under Section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Proposed action

person named in the referral	**COALPAC PTY LIMITED** ACN 003 558 914
proposed action	Extension to Invincible Colliery and Cullen Valley Mine of 150 ha for open cut mining and 165 ha for highwall mining (combined totals for both extensions); backfilling and rehabilitation of the residual final voids resulting from existing mining operations and the rehabilitation of areas affected by subsidence from historic underground mining operations in the area to create a stable, free-draining final landform. As described in EPBC Act referral 2014/7147.

Referral decision: not a controlled action

status of proposed action	The proposed action is not a controlled action.

Person authorised to make decision

name and position	James Tregurtha Assistant Secretary South-Eastern Australia Environment Assessments
signature	
date of decision	30 **March 2014**