RYLSTONE REGION
COAL FREE
COMMUNITY

Rylstone Region Coal Free Community

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PRIA Submission - Groundwater

Draft

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Acknowledgement of Country

The RRCFC acknowledges that we live and work on Wiradjuri Country.

We acknowledge the Wiradjuri peoples as the traditional custodians of the land, and pay our respects to Elders past, present and future.

Executive Summary

2020 Strategic Statement and the PRIA process

The NSW Government June 2020 Strategic Statement on Coal Exploration and Mining outlines the NSW Government's approach to transitioning to renewable energy and supporting the economy and aims to improve certainty about where mining should not occur. It identified 14 potential future coal exploration release areas (NSW Government, 2020). The Hawkins and Rumker potential release areas were identified in this Statement; the Ganguddy-Kelgoola area, which sits adjacent to the Hawkins and Rumker areas, is also identified in this statement.

Following the release of the Strategic Statement, the NSW Government Advisory Body for Strategic Release has requested the Hawkins and Rumker areas be put through the Preliminary Regional Issues Assessment (PRIA) process (Department of Planning, Industry and Environment (DPIE), 2021). Ganguddy-Kelgoola is expected to go through the PRIA process in the near future once further exploration is completed.

The PRIA process, also set out in the Strategic Release Framework (NSW Government, 2020), is an initial assessment of social, environmental and economic matters relating to areas that could be released for exploration. In theory, it involves engaging with interested and potentially impacted stakeholders to identify issues for consideration.

RRCFC's Groundwater Submission

This report is the Rylstone Region Coal Free Community's (RRCFC's) submission to the PRIA process for the Hawkins and Rumker areas covering *Groundwater*. Separate submissions for a range of other issues are also being submitted by the RRCFC. RRCFC 's submission recognises that coal exploration is a precursor to coal mining, this and therefore, it is predominantly the mining phase that is considered herein this submission.

Locality, position in the upper catchments of the landscape and values

Apart from direct runoff following substantial rainfall, or when soils are already saturated following earlier rainfall, most streamflow in the subject creeks and the Growee River arise from Groundwater outflow where the water table and creek lines intersect.

The Hawkins and Rumker areas both straddle the Great Dividing Range, with each having a portion of their catchments falling east, into the Upper Hunter catchment, and west, into the Cudgegong River and Lawson Creek catchments. Being at or near the heads of the waterway catchments, the majority of the waterways within the Hawkins and Rumker areas are first order and second order streams. These are small waterways, generally characterised by moderate to very steep slopes. Many of these are ephemeral waterways, with quick flowing waters following rainfall events and periods of dry in between when the water tables' groundwater is lower than the waterway. Most streamflow is sourced from groundwater seepage and some springs.

The only third order stream is the Growee River.

Mining risks and impacts

If mining occurred via underground methods in this area it is believed that it would initially be small open cut operations on the surface of exposed Permian coal measures in the larger valley bottoms. These limited operations would be followed by extensive underground operations under the sandstone plateau, commencing from the initial open-cut box-cut where Triassic sandstone caps the coal measures.

Risks from cracking and consequent modification of the stratigraphy and landform, and resulting detrimental ground and surface water impacts, is unacceptably high. Any open cut mine would present an extremely significant and irreversible interruption of the surface water flows. Underground mining has very significant impacts on groundwater flow and then surface water streams which are predominantly fed by groundwater seepage. Water dependent ecosystems, including threatened species and endangered ecological communities, will be very significantly impacted.

There are rural properties, farms and small businesses throughout each of the Hawkins and Rumker areas. There are also a number of other properties between Rylstone Dam and Windamere Dam which rely on the water within the Cudgegong River for their water supply. These existing land uses and businesses are all sustainable long-term business and rely on the ground and surface water resources within these catchments. All of these businesses are put at risk forever if mining operations are permitted. Mines use or destroy the existing ground and surface water resources. In these upper catchment areas there are no alternatives.

All water impacts will be acutely felt in the driest years. This area has been subject to a cycle of droughts as has the rest of Australia. Recently, it was also subject to the Gospers Mountain fire and the Kerry Ridge fire sweeping through many of the subject properties during the Black Summer fires. In many parts of the region, there was not sufficient water locally to fight the fires. To put at risk any of the precious water in these catchments is completely unacceptable for the local community, as is requiring the community to bear the high social costs of a short-term mining project.

As Mid-Western Regional Council recently advised DPIE, the recent drought has demonstrated water is a highly valuable resource and it does not support any potential threat to the existing town water supplies or the amount of ground and surface water available for rural property owners for domestic and agricultural purposes.

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1 | Introduction

1.1 Preliminary Regional Issues Assessment (PRIA) Process

The NSW Government's Advisory Body for Strategic Release has asked the NSW Department of Planning, Industry and Environment (DPIE) to prepare a Preliminary Regional Issues Assessment (PRIA) (DPIE, 2021a) to consider the benefits, opportunities, risks and constraints of releasing two adjacent areas located near Rylstone in the Mid-Western Regional local government area (LGA).

These areas are shown in Figure 1 and include:

- Hawkins - an area of 14,900 ha located directly north of Rylstone, and
- Rumker - an area of 17,800 ha located directly northeast of Rylstone.

An initial broad scale exploration drilling program and desktop assessment of resource potential undertaken by the Division of Mining, Exploration and Geoscience within the Department of Regional NSW identified coal resources within the Hawkins and Rumker areas that could be mined (DPIE, 2021a).

In June 2020, the NSW Government released the Strategic Statement on Coal Exploration and Mining (NSW Government, 2020). The Strategic Statement outlines the NSW Government's approach to transitioning to renewable energy and supporting the economy and aims to improve certainty about where mining should not occur. It identified 14 potential future coal exploration release areas (NSW Government, 2020).

Adjacent to Hawkins and Rumker potential release areas is the area of Ganguddy–Kelgoola, which is also planned to go through the PRIA process once further government directed exploration drilling is completed there (NSW Government, 2020).

1.2 PRIA Preparation

The PRIA process is also set out in the Strategic Release Framework (NSW Government, 2020). It is an initial assessment of social, environmental and economic matters relating to areas that could be released for exploration. In theory, it involves engaging with interested and potentially impacted stakeholders to identify issues for consideration.

DPIE has engaged Resource Strategies to undertake "preparation of a Preliminary Regional Issues Assessment document in relation to a defined area that could be released for coal exploration" for a sum of $167,156 (NSW Government eTendering, 2021).

On its website Resource Strategies (2021) says it facilitates development approvals for major mining and associated infrastructure projects. This company prepares comprehensive and timely environmental assessment documentation with the assistance of recognised experts across all environmental fields.

The DPIE approves and/or modifies the PRIA and submits it to the ABSR, which considers potential release areas, reviews reports and recommends assessment of the release of an area for resource exploration. The ABSR makes recommendations to the Minister for Regional NSW. These are considered by Cabinet and, if approved, the Minister for Regional NSW releases an area for exploration and invites companies to apply for an Exploration Licence.

1.3 Rylstone Region Coal Free Community

1.3.1 RRCFC

The Rylstone Region Coal Free Community (RRCFC) is a group of like-minded local residents and supporters of the Rylstone Region, committed to stopping further exploration of coal and approval of mines in our region. Our aim is to protect the land, heritage, culture and community for now and future generations. The RRCFC is self-funded and not affiliated with any political party.

1.3.2 Purpose of this report

This report the RRCFC's submissions to the PRIA process on *Groundwater*. Separate submissions for a range of other issues are also being submitted by the RRCFC. The RRCFC recognises that coal exploration is a precursor to coal mining, and therefore it is predominantly the mining phase that is considered in this submission.

This submission principally considers the groundwater and consequent influence on surface water of the Hawkins and Rumker potential release areas (herein referred to as areas). The Hawkins and Rumker areas both straddle the Great Dividing Range, with each having a portion of their catchments falling northeast, into the Upper Hunter catchment, and southwest, into the Cudgegong River and Lawson Creek catchments. The majority of the waterways within the Hawkins and Rumker areas are first order and second order streams.

These waterways are sensitive and fragile environments. Given the scale of underground mining that will likely be proposed should exploration drilling and market conditions prove viable coalmining is feasible, any underground and associated initial open-cut mine would present an extremely significant and irreversible change to groundwater flows and water properties. Underground and associated open-cut mining has major impacts on groundwater, streams, alluvial aquifers and alluvial soils. Underground mining in the Southern coalfields has amply demonstrated the inevitable severe impacts on the ground and consequent surface water resources in the comparable Hawkins and Rumker areas.

Rylstone Dam is the sole water supply for the populations of Rylstone, Kandos, Charbon and Clandulla. Downstream of Rylstone Dam is Windamere Dam, which supplies Mudgee's town water. The Rumker area sits over, or would interrupt flows from, 21 percent of the Rylstone Dam catchment area. This is a drinking water supply for local communities and should be treated with the same sanctity and respect that Sydney's drinking water catchments are.

The RRCFC believes the cost to the water resources of this region is too high. It is the RRCFC's strongly held view that the PRIA should find that the environmental constraints in Hawkins and Rumker areas are insurmountable and cannot be sustainably managed during any mining activity. Consequently, coal exploration should not proceed in the Hawkins and Rumker areas.

2| Existing environment

2.1 Climate, land use and water quality review

A review of changing land use in an uncertain climate and how it impacts on surface water and groundwater in the Goulburn River catchment was undertaken by Julia Imrie (2019) as part of her doctorate thesis. In this, Imrie says:

> "This review identifies the large-scale ocean-atmosphere interactions that drive climate variability in eastern Australia and details the projections of global climate models on future changes to climate in the general Hunter and Goulburn River region. Seasonal rainfall characteristics and year to year variability is strongly influenced by the El Niño (and La Niña) Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD) with decadal variability the result of the Pacific Decadal Oscillation (PDO).
>
> "Long term, large swings in flood and drought-dominated regimes identified in the Hunter have been shown to correspond to negative and positive phases of the PDO.
>
> "In the general area of the Goulburn River catchment climate trend maps show an increase in annual warm season rainfall since 1920, most noticeable during the warm season, with a more recent decrease since 1970 in annual cool season rainfall. The projected increases in evapotranspiration differ from observed global decreases in pan evaporation.
>
> "The generation of spatially interpolated monthly rainfall and pan evaporation using ANUSPLIN allows the analysis of the long term trends in the regions climate and impacts on catchment yield and water use. This method overcomes bias from spatial and temporal data gaps in climate records. Monthly interpolated rainfall and stream discharge data can be ranked as percentiles for different time periods to provide the range of normalised departures from average conditions. Longer 5-year running periods are suitable for analysing decadal flood and drought periods and capturing delayed inflow from groundwater systems.
>
> "Another hydrological model that can be used to assess the elasticity of stream flow measures the sensitivity of stream discharge to changes in precipitation. Annual average precipitation and discharge data over 20-year running periods are used to explore the influence of climate change on stream discharge. This method can also be used to indicate changes in land use such as increased groundwater extractions from connected systems or regular mine water discharges.
>
> "Models investigating increasing stream salinities and dryland salinity in the Murray Darling Basin have used the ratio of chloride inputs in catchment rainfall, to stream outputs. The assumption that rainfall-deposited cyclic salts of marine-aerosol origin were the main source were questioned when chloride ratios greater than one were detected in upland catchments. Mineral weathering and water–rock interactions in the regolith were found to also contribute solutes to stream salt loads.
>
> "Analysis of major ion concentrations ratios in surface and groundwater provide hydrochemical signatures that are useful for characterising and grouping aquifers, identifying parent geology and investigating surface and groundwater interactions.
>
> "This review revealed surface and groundwater chemistry is influenced by parent geology in the Goulburn catchment, which is the principal driver of salinity. Fault lines and fractures linking saline groundwater to the surface flows are a possible mechanism contributing to elevated levels of stream salinity.

"Monitoring of water quality in the Goulburn and Hunter Rivers has generally concentrated on EC and pH; however the chemical composition of saline discharge water from mining can differ significantly to what naturally occurs in surface waters. The relative proportion of ions in saline waters as well as other co-occurring environmental stressors can have a combined greater effect on ecosystem health than total salinity and requires further research.

"Changes in hydrological connections and water quality can affect GDEs that form an important part of the catchment's biodiversity as well as providing important ecosystem services within riparian and hyporheic zones.

"More than 50% of river flow in the Goulburn River is estimated to be baseflow groundwater discharge. Numerous methods have been applied to measure the baseflow component of streamflow with varying advantages, limitations and levels of accuracy.

"Methods rely on the availability of accurate, long term stream discharge and groundwater data. There is a general paucity of reliable long term stream gauge records available for the Goulburn catchment, partly due to the nature of the control structures and limited number of gauging sites. Monitoring data will need to be augmented with a targeted investigation of key surface and groundwater sites along the river and its tributaries and supplemented with available industry reported data where possible.

"Numerical groundwater modelling can provide a relatively transparent method to explore interactions between key variables influencing complex groundwater systems. This relies on a range of measured and assumed input parameters and set boundary conditions plus access to reliable site-specific hydrogeological data. Government and industry data from groundwater monitoring in the Ulan area may be able to provide sufficient input information (Imrie, J, 2019)."

2.1 Hawkins and Rumker areas

The Hawkins and Rumker areas both straddle the Great Dividing Range, with each having a portion of their catchments falling northeast, into the Upper Hunter catchment, and southwest, into the Cudgegong River and Lawson Creek catchments (Figure 1).

In total, there are 7,910ha of the upper Hunter catchment affected by the proposed mining, 14,965ha of the upper Lawson catchment creeks and 10,700ha of catchment that flows into the Cudgegong River. The details are provided below.

The Rumker area sits over, or would interrupt flows from, 21 percent of the Rylstone Dam catchment area.

2.1.1 Hawkins

Hawkins straddles two upper catchment areas: the Upper Hunter and the Upper Lawson Creek catchments.

- The Upper Hunter catchment portion of Hawkins is 4,787ha, with Ginghi Creek and Growee Creek rising in mountainous terrain and flowing northeast into the Bylong Valley.
- The Upper Lawson Creek catchment portion of Hawkins is 10,123ha in which there are numerous waterways. These include Breakfast Creek and Reedy Creek, which cross Hawkins after rising in Rumker, and Greenhills Swamp Creek, Long Gully, Horse Gully, Hawkins Creek and Lawson Creek, all of which rise in Hawkins. The Lawson Creek catchment waterways

generally flow in a westerly direction, where Lawson Creek eventually joins the Cudgegong River below Mudgee.

2.1.2 Rumker

Rumker straddles three upper catchment areas: the Upper Hunter, the Lawson Creek, and the Cudgegong River catchments.

- The Upper Hunter catchment portion of Rumker covers an area of 6,123ha. It includes Sapling Creek, Sawyers Creek, Jumper Creek and Spring Log Creek, which rise in mountainous terrain and flow northeast into the Growee River in the Bylong Valley.
- In the Lawson Creek catchment portion of this Rumker, Breakfast Creek and Reedy Creek rise, then flow west into the Hawkins area. This covers an area of 4,842ha.
- In the Cudgegong River catchment, Coxs Creek and Dairy Swamp Creek rise, with their confluence on the southern boundary of Rumker before flowing into Rylstone Dam. This is an area of approximately 5,858ha. Another 1,022ha of Rumker drains into the Cudgegong below Rylstone Dam, where it flows west into Windamere Dam.

Additionally, there is an area of 5,554ha upstream of Rumker which drains through Rumker and into the Cox's Creek catchment and down to Rylstone Dam.

The majority of the waterways within the Hawkins and Rumker areas are first order and second order streams. These are small waterways, generally characterised by moderate to very steep slopes. Many of these are ephemeral streams, with quick flowing waters following rainfall events and periods of dry in between. The only third order stream is the Growee River.

2.2 Landform Morphology

Much of the Hawker – Rumker areas are Triassic "Narrabeen" Group sandstone plateau areas. There are a small number of tuffaceous (volcanic ash) claystone strata, which are aquicludes. These Triassic sedimentary rocks overlie the Permian "Illawarra" Coal Measures. These measures are principally mudstones, tuffaceous claystones, sandstones, conglomerates and a few coal seams.

The Triassic sandstones are generally jointed and porous aquifers. Large amounts of rainfall runoff are stored in these sponge-like rocks when not fractured by coal mining subsidence. This sandstone dominated landscape has valleys in some places, dissected by waterway development. Dissection causes exposure of the underlying Coal Measures which consequently floor the deep valleys and underlie the talus slopes beneath the sandstone escarpments.

2.3 Groundwater Outflows - Natural springs

To understand the full extent of springs that may be present in the Hawkins and Rumker areas, use was made of the work by Cardno (2020), which presented some mapping of springs within the Bowden's Prospect study area. This report indicated that there were 29 springs present within an approximately 320ha area. Extrapolating this to the 32,700ha of the Hawkins and Rumker areas, it would be reasonable to conclude that there would be over 3,000 springs within the proposed release area. Seepage areas are widespread where the water table intersects the surface, usually along waterway edges. Springs can be regarded as obvious groundwater exit points, while seepages are less prominent. Springs and seepages are at each end of the one spectrum, with only a wide "grey" area delineating the two.

2.4 Ground and Surface Water Quality

Wells and bores access groundwater below the water table. About twenty are registered within the Hawkins and Rumker areas. Some records are kept in accordance with government groundwater use regulation. Water quality from these bores is reputedly high.

There is not readily available water quality data for the small waterways within the two areas proposed for coal exploration. However, given that the majority of the waterways are in moderate to good condition, that a high proportion of the catchments have native vegetation present and that much of the riparian corridors of the waterways have native vegetation present, it is reasonable to assume that the water quality within the waterways would be moderate to good (SJ Landscape Constructions, 2002; Earthscapes 2021).

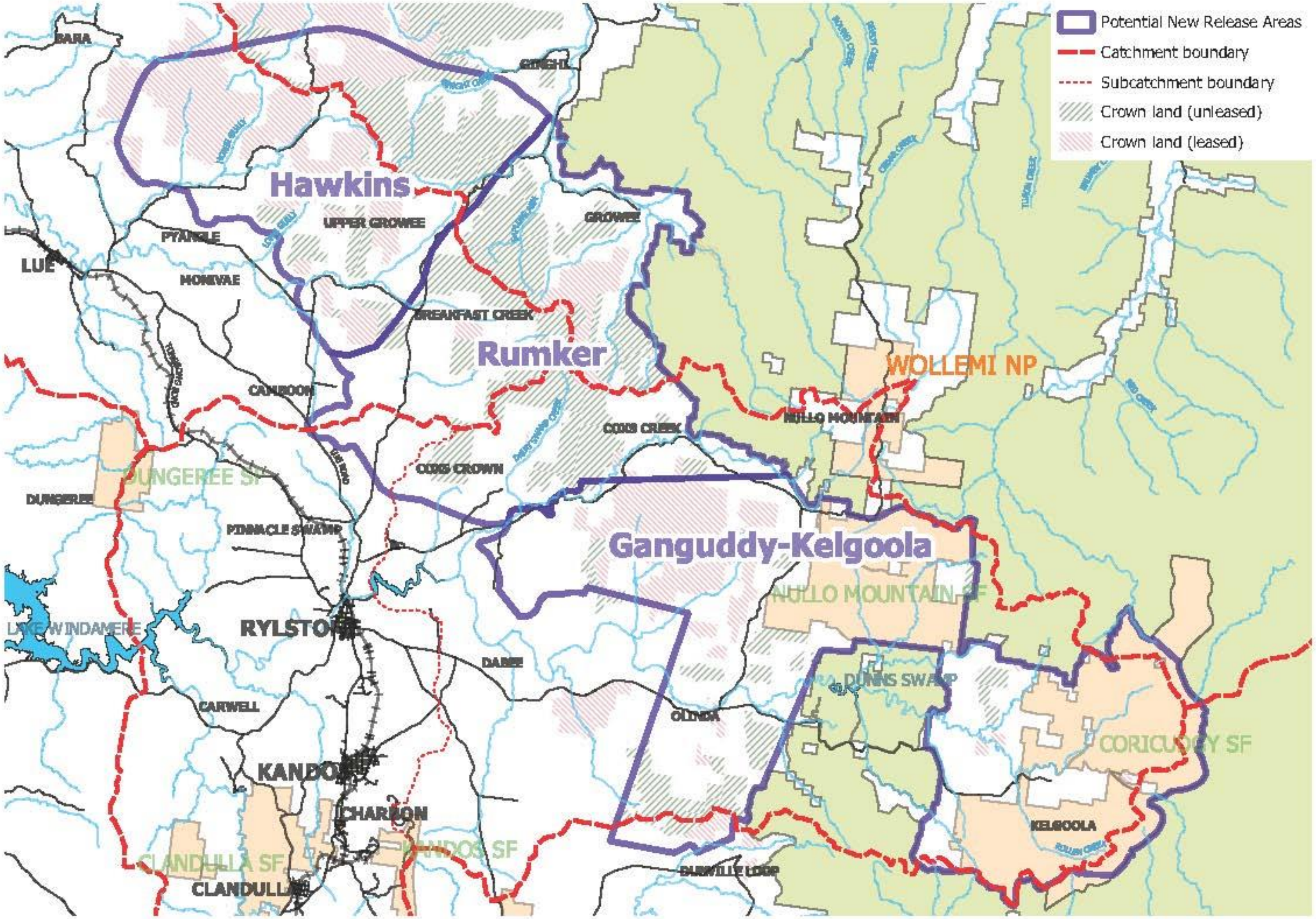

Figure 1 Water catchments within proposed exploration areas

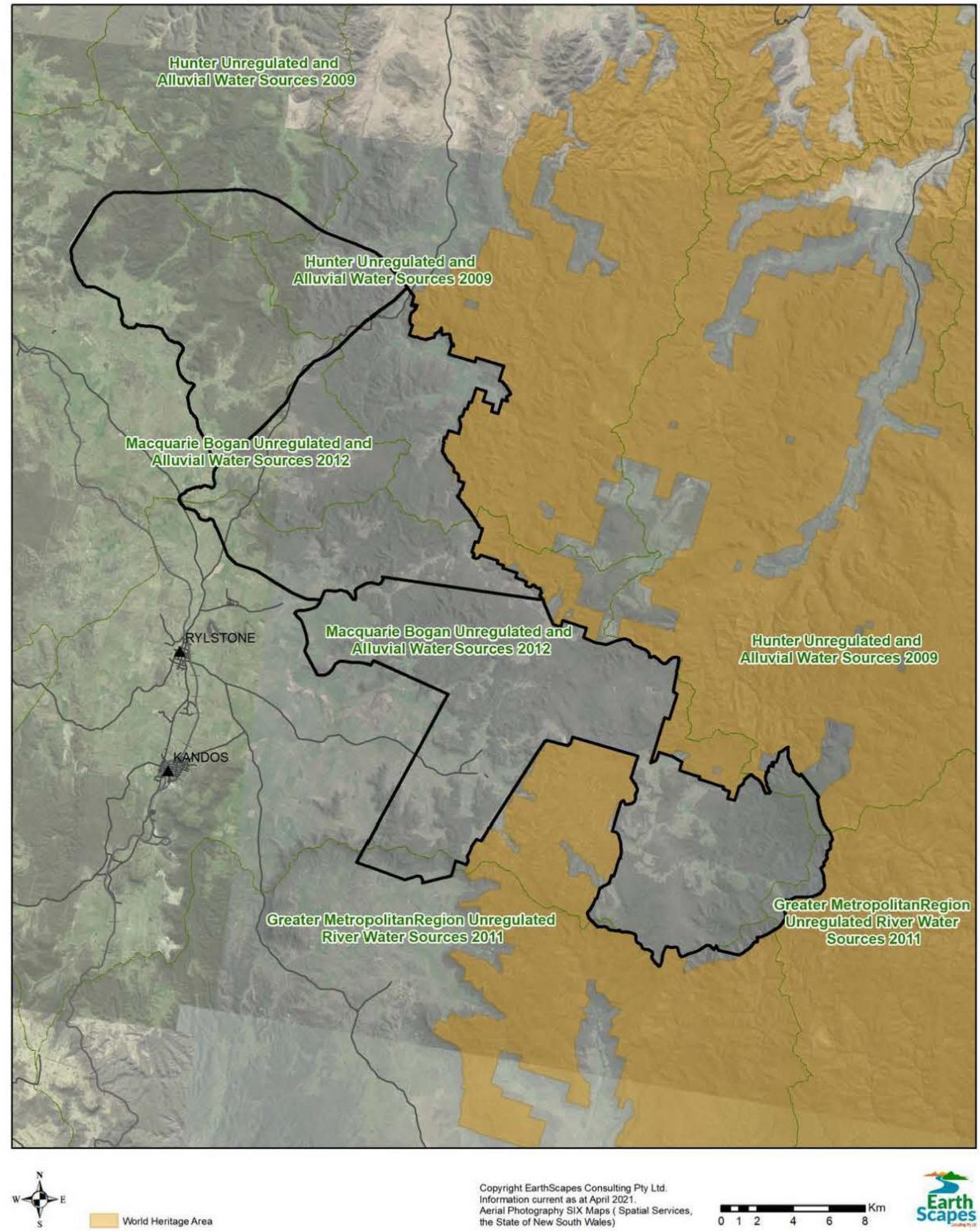

Figure 2 Surface Water Sharing Plan Areas
Source: Earthscapes, 2021

3| Water Uses

3.1 Rural communities

There are farms and small businesses throughout the Hawkins and Rumker areas, undertaking business activities including: grazing, cropping, orchards, vineyards, plantation forests, native forestry, sheep, cattle, horse and alpaca studs, poultry egg production, mineral water supplies, an olive press which presses for many olive growers in NSW, and boutique brewers. Tourism-based businesses include: accommodation (farm stays, bed and breakfast, rural and wilderness retreats), artisanal workshops, arts and crafts, Aboriginal cultural and heritage tours, and many more.

These land uses and businesses are all sustainable long-term businesses, and all rely on the water resources within these catchments.

There are also a number of other properties between Rylstone Dam and Windamere Dam which rely on the water within the Cudgegong River for their water supply and business viability.

4| Potential mining impacts

4.1 Impacts from underground mining

Impacts can be divided into three broad categories which reflect the time lag between mining and impact (Commonwealth of Australia 2015):

- First order impacts refer to the immediate impacts of subsidence (also called subsidence effects) such as cracking, shearing, tilting and reopening bedding planes and joints.
- Second order impacts refer to the impacts that result from subsidence effects, such as changes to hydrology from altered groundwater or surface water flow paths and water quality impacts.
- Third order impacts are the result of changes to hydrology and water quality, such as streambed erosion and ecological responses.

Third order impacts can lag significantly from the first and second order impacts. Figure 3 shows a conceptual timeline describing the temporal differences in first, second and third order impacts.

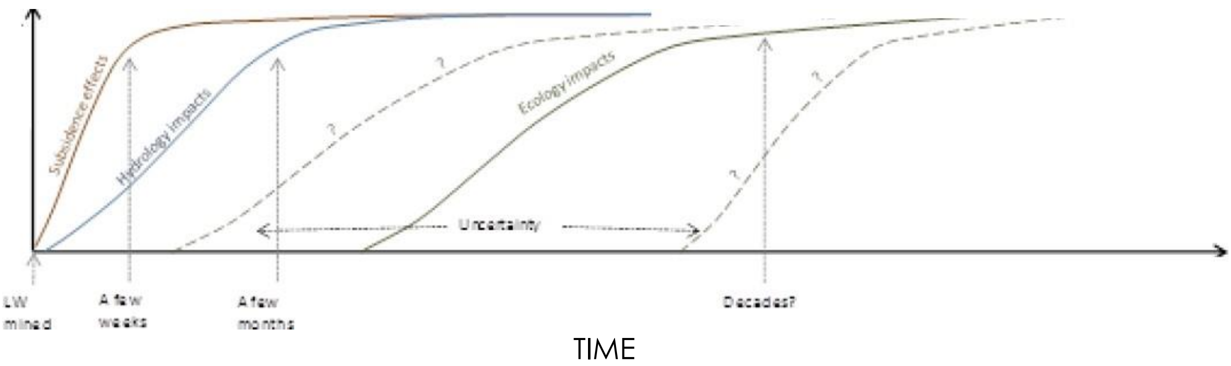

Figure 3 Conceptual timeline showing time lags between first, second and third order impacts
[Source: Commonwealth of Australia 2015]

The potential impacts of coal exploration and mining activities are:

- Interruption of catchment flows: the construction of mines within the Hawkins and Rumker areas would irrevocably change the existing catchment ground and surface water flows, regardless of what type of mining was proposed.
- Unsustainable water use. Mining operations use a huge amount of water. This is unsustainable in any location but particularly so in upper catchment areas such as Hawkins and Rumker areas.
- Reduction in ground and surface water flows. The interruption of catchment flows and the unsustainable volume of water used by mines would interrupt the natural hydrological cycle. This will lead to a loss in surface water quantity and significant groundwater contamination in underground mining subsidence cracked rock strata in the catchments.
- Erosion and sedimentation due to exploration and mine construction activities. This includes disturbance of creeks, rivers and floodplains due to bulk earthworks and construction of infrastructure and open-cut pits.
- Surface water contamination arising from coal washing operations and potential for untreated discharges being released into drinking water catchments.

4.1.1 Numerical groundwater modelling

Numerical models provide a relatively transparent method to explore interactions between key variables influencing complex groundwater systems. Their role is to assess likelihood within uncertainty limits based on reliable data. Models using site-specific inputs and parameters are useful tools for exploring various scenarios and potential outcomes but should not be mistaken as a tool to predict the future (Doherty, 2011).

Groundwater modelling relies on a range of measured and assumed input parameters and boundary conditions. Parameters such as hydraulic conductivity can vary by several orders of magnitude due to the natural complexity of geological strata across a landscape and modeller preference. Numerical groundwater models are primarily calibrated by comparing modelled changes in hydraulic heads, with measured change over a specific time. Once verified using groundwater monitoring data they are used to predict further changes in hydraulic head over different time periods and management conditions. This necessitates a network of piezometers, accurate spatial and temporal data over sufficient length of time to incorporate long time lags inherent in the dynamic response of groundwater to development common in catchment-scale groundwater systems.

The mining industry and governments rely on complex modelling to predict mining impacts on groundwater sources and stream baseflow at various spatial and temporal scales. Calibration of mining impact assessment models is considered by some modellers to be insensitive to changes in recharge values below 10% (Pearse Hawkins et al., 2015). However small changes can significantly alter recharge volumes for regional water sources. Herczeg and Love (2007) identified recharge rates as critical input to numerical models when developing groundwater management policies over time and space along with predicting the impact of groundwater extraction on head pressures and lagged discharge to streams. Herczeg and Love (2007) highlighted the many uncertainties in numerical modelling and warn against using it to predict recharge citing it as 'an inverse approach to back calculate recharge'.

Mining drawdown and depressurisation of groundwater can change the natural groundwater flow pattern and discharge location. Figure 4 compares potential changes in groundwater flow between porous rock, alluvium and surface streams - pre-mining and during mining (Imrie, 2019; Ross and Webb, 2015).

> *"Numerical groundwater modelling simulating long term coal mining impacts in the Ulan Wollar area predicts that it will be over 300 years before regional groundwater level substantially rebound to pre-mining levels (MER, 2015; Middlemis and Fulton, 2011). These numerical models rely on a range of assumptions, boundary conditions and estimated hydraulic conductivities of the main hydrogeological units or strata layers. They involve the adjustment of strata hydraulic properties and regional rainfall recharge rates until a plausible match is achieved between the observed groundwater levels and the predicted groundwater levels at the same location. The mining industry maintain their models can be validated over time by calibrating observed changes to groundwater levels with predicted depressurisation of the strata, and re-adjusting the model when necessary. It is also argued that groundwater modelling cannot be verified and is therefore of dubious value, alternatively it is also said that without some form of modelling it is impossible to foresee the future behaviour of groundwater systems (Barnett et al., 2012)."*

From Imrie, J, 2019 "Changing land use in an uncertain climate; surface water and groundwater, Goulburn River"

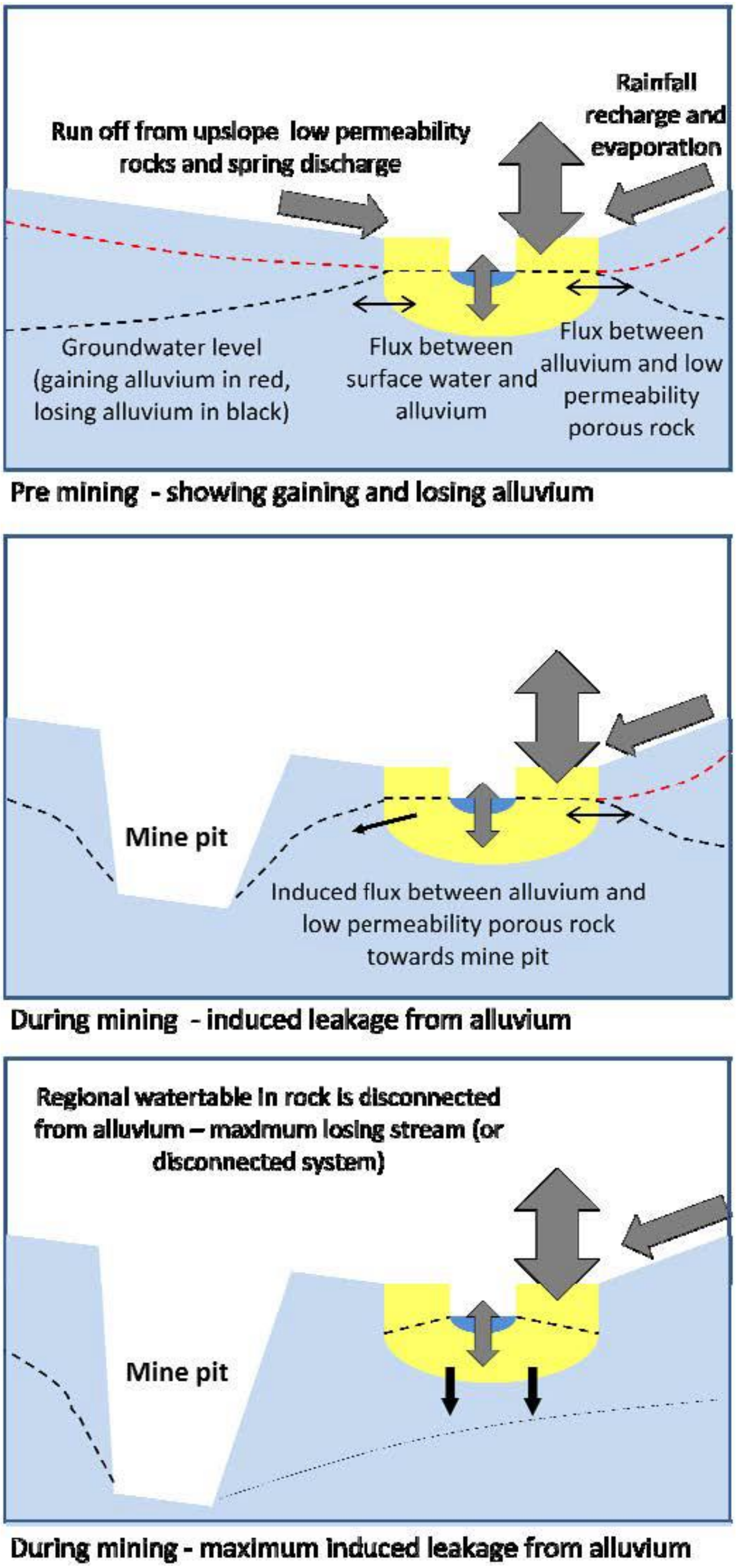

Figure 4 Potential groundwater induced leakage and interception due to mining

(Source: Ross and Webb, 2015 in Imrie, 2019)

4.1.2 Limited spatial and temporal groundwater data

Numerical groundwater modelling can provide a relatively transparent method to explore interactions between key variables influencing complex groundwater systems. This relies on a range of measured and assumed input parameters and set boundary conditions plus access to reliable site-specific hydrogeological data. To be of any value, the outputs of modelling methods are dependent on the availability of accurate and long term input. There is a general paucity of data available for these catchments, partly due to the nature of the control structures and limited number of gauging sites. For example, to the north in the Ulan Moolarben areas:

- There is very limited spatial and temporal groundwater data available for the Goulburn catchment.
- Pre-mining spot EC data in the upstream section of the Goulburn showed a mean EC that was only 55% of the currently regulated upper salinity discharge limit for mine discharge of 900µS/cm. Adopting this higher limit automatically ensured that salinity in the upper Goulburn River would always exceed pre-mining levels during mine discharge especially in drier times when almost all river flow is due to mine discharge. The impacts of changing mine discharge and salinity regulations are evident in the river salinity record. The specific salt yield of mined areas discharging into the river is eleven times that of the catchment. Regulations and monitoring have only focused on EC as the key determinant of water quality. This assumes that only the total salt concentration rather than the composition of salt is environmentally important."
- Suggestions for future research and improved regulations are given. The key to controlling saline discharge in the catchment is controlling sub-catchment geology-specific water abstraction in tune with the large swings in climate generated by large-scale ocean-atmosphere interactions. It is also important that regulations governing groundwater interception and mine water-make and discharge recognise surface-groundwater interactions and pre-mining stream geochemistry"

From Imrie, J, 2019 "Changing land use in an uncertain climate; surface water and groundwater, Goulburn River"

4.1.3 Groundwater Dependent Ecosystems

Groundwater dependent ecosystems (GDEs) along with water quality, are regarded by the international community as an important determinant of biodiversity for inland waterways (Imrie, J, 2019; Carr and Rickwood, 2008; Murray et al., 2003).

GDEs, while often geographically limited in scale, are a valuable part of Australian biodiversity providing essential ecosystem services (Tomlinson, 2008; Murray et al., 2003; Brunke and Gonser, 1997; Sophocleous, 2002; Nevill et al., 2015).

GDEs include any ecosystem that depends on groundwater at any time or for any duration in order to maintain its composition and condition (Serov et al., 2012). This may vary from highly specialised species and communities sensitive to any change in the groundwater regime (quality, level, direction flow etc.) to more opportunistic dependence during extreme conditions such as droughts.

GDEs are grouped into three main types:

- ecosystems dependent on surface expression of groundwater such as springs, seeps, wetlands and river baseflows;
- ecosystems dependent on subsurface presence of groundwater including terrestrial vegetation where groundwater is within the root zone of the plants;

- ecosystems that reside in alluvial and fractured rocks aquifers, karsts and the hyporheic zones of rivers supporting unique microorganisms such as stygofauna (Richardson et al., 2004).

GDEs can be good indicators of the presence of groundwater, as well as its depletion. An interruption in groundwater discharge, water quality or distribution will disrupt a GDEs flora communities and fauna assemblage (Serov et al., 2012; Boulton and Hancock, 2006; Murray et al., 2003).

Changes to terrestrial vegetation will be observable, though may at first be limited. If impacts are continued the ecosystem becomes progressively degraded, loses resilience and becomes susceptible to cumulative pressures that threaten survival. However, the full impact of changes to groundwater can take several years to be fully apparent, at which time the impacts are usually irreversible (Hancock et al., 2005b; Nevill et al., 2015).

The evolution, persistence and resilience of GDEs are affected by the physical, biological and chemical characteristics of groundwater. These include hydrological and geomorphological linkages such as the temporal and spatial aspects of flow paths as well as hydrogeological variables such as rock matrix structure, geo-chemistry and soluble minerals.

Microbial biological processes can have a major influence on groundwater quality and connectivity. Biogeochemical processes in the hyporheic zone influence the chemistry of surface and groundwater interaction (Sophocleous, 2002). For example subsurface GDEs fauna or 'stygofauna' consume biofilms, maintain interstitial pore openings and flow paths and physically transport material through the groundwater environment (Hancock et al., 2005b; Serov et al., 2012; Boulton et al., 2010).

Lamontagne et al. (2003a) investigated the significance of nutrient cycles in groundwater-surface water interactions in sand-bed streams of Wollombi Brook. The study found elevated nutrient levels in the alluvial groundwater interfered with hyporheic exchange of surface and groundwater that affected GDEs biogeochemistry, salinity levels, density stratification and anoxia of stream flows.

The critical role of hydrological connections for sustaining river landscapes particularly small streams during drought was studied in the Widden catchment, a southern tributary of the Goulburn, by Keene et al. (2007). They concluded that a sustained stream baseflow over dry periods supported the ecological function of the hyporheic zone (saturated sediments below and adjacent to river channels) by directly linking surface water to alluvial aquifers underlying the riparian zones and the regional groundwater system.

Different stakeholders attribute different values to GDEs. Murray et al. (2003) suggests an assessment of 'value' requires a multidisciplinary triple bottom line approach linking environmental, economic and social/cultural aspects. It is important that groundwater policy and management considers the needs of GDEs, including subterranean, as the role of groundwater in maintaining the health of rivers, streams and associated vegetation is often underestimated or ignored (Nevill et al., 2015).

From Imrie, J, 2019 "Changing land use in an uncertain climate; surface water and groundwater, Goulburn River".

5| Discussion of Risks

5.1 Interruption of catchment flows:

The construction and operation of mines within the Hawkins and Rumker areas would irrevocably change the existing catchment flows, regardless of whether the coalmining is underground or open-cut.

DPIE's PRIA information (DPIE, 2021a) is based on the proposition that the mining underneath the Triassic sandstones predominant in the Hawkins-Rumker areas would take place at depth underground.

Underground coal mining leads to fracturing of the hard rock layers that confine the ground water. Significant fracturing will occur, establishing a very large number of water conduits. This leads to vastly increased opportunity for contact of groundwater with sulphur, salts, toxic metals including zinc, copper, lead, and other heavy metals. These elements are all found in small but nonetheless significant quantities in the hydrocarbon and sulphur-rich coal seams or the other sedimentary rock strata which compose Coal Measures (Wright, I, 2012). These measures are principally composed of mudstones, claystones, sandstones, and conglomerates, as well as occasional coal seams. All these rock types contain small but measurable quantities of the toxic metals listed above. Heavily fractured rock strata readily release these contaminants when the groundwater dissolved sulphur becomes a weak Sulphuric Acid. The contaminated groundwater may then seep directly into stream flow, or via alluvial aquifers with consequent seepage into surface water flow (Smith, S. 2009).

Coal deposits in the principal valleys which are floored by Permian Coal Measures are at shallow depths by comparison. It is anticipated these sediments exposed by valley development could be mined with open cut techniques.

Any open cut mine would be an extremely significant interruption of the catchment flows. However, Triassic sandstone covers the majority of the potentially economically viable coal seams that may be explored and potentially underground mined by longwall operations in the Hawkins and Rumker areas. Consequent subsidence cracking of the overlying rock strata will irrevocably change the groundwater recharge of surface streams. The many springs and seepage along all creek lines will suffer dramatic change in discharge timing and quantity, acidity, salinity, and various toxic metals content.

The magnitude of changes in groundwater and consequent surface flows is dependent on the extent to which subsidence changes the structure of the strata overlying the mined coal seams (Frazier et al. 2010; MSEC 2006; Commonwealth of Australia, 2015).

The level of the impact is dependent on the depth of cover, degree of subsidence, and the substrate, slope, and geomorphology of the surface water environment (Frazier et al. 2010; MSEC 2006; Commonwealth of Australia, 2015).

Many examples of such coal mining impacts have been studied in the Southern Coalfields, including the Sydney Metropolitan water catchments between Helensburgh and the Illawarra Escarpment. Other mines in the Southern Highlands – Thirlmere - Burragorang, have all had very significant deleterious impacts on groundwater and resultant changes to surface streams.

Similar very significant problems have been recorded in the Western coalfields in the Ben Bullen State Forest areas, and in the Lithgow, Newnes – Clarence, Upper Grose River-Canyon Colliery – Katoomba districts.

The groundwater systems are such that they should never be disturbed and certainly not subjected to subsidence cracking of the host rock strata. No form of mining is free from risk to the unique ecology of riparian habitats and threatened species found within them. Mining in the nearby Newnes Plateau area has proven this beyond doubt (Gregory 2021).

Centennial Coal has admitted its mining operations at its Springvale Mine in the Plateau contributed to the drying out of the Carne West swamp. There is concern that continuing to mine in this area, as is proposed in the Gardens of Stone stage 2 mine, would have a similar outcome for about 300 remaining hectares of swamps, and this could affect the supply of Sydney's drinking water to Warragamba Dam. Centennial Coal's environmental assessment (EA) found "subsidence-related impacts are expected" at several swamps within the catchment area for the Angus Place Mine (Gregory 2021). The NSW Liberal party is blaming their own government's "erroneous" environmental approvals processes for allowing Centennial Coal to longwall mine below swamps, home to endangered ecosystems and has clearly said there is no social licence for undermining these sensitive areas (Gregory 2021).

These effects have long been recognised by the NSW Government. The NSW Department of Environment and Climate Change (DECC) noted that longwall mining subsidence is frequently associated with cracking of valley floors and creeklines, with subsequent effects on surface and groundwater hydrology (Smith 2009). Of particular concern is the potential for longwall mining to affect upland swamps. Upland swamps, particularly peat swamps, are important to catchment hydrology and ecology because they absorb water and allow runoff for long periods after rainfall has ceased. Rock strata and surface feature (clifflines, pagoda, streambeds) cracking as a result of longwall mining subsidence can have a variety of impacts on riverine features or attributes. These include:

- Loss of groundwater springs and seepages leading to reduction of surface flows following water table lowering or complete loss;
- Consequent loss of aquatic or instream habitats. Complete drying of river pools or wetlands has occurred. The loss of these surface features is probably irreversible in most cases;
- Loss of connectivity between pools as surface water is lost to subsurface flows
- Loss of water quality (Increased iron oxides, manganese, sulphides, salts, metals, and lower dissolved oxygen)
- Simplification of remaining instream habitat due to the growth of iron-oxidising bacteria which can also be seen as a rusty-coloured mass in the water

The DECC considered that much of the impact / damage to natural features from longwall mining is unacceptable as many are irreversible and contrary to the principles of ecologically sustainable development. Of key concern to DECC was that subsidence due to longwall mining has had significant impacts on groundwater, river health, and water dependent ecosystems, including threatened species and endangered ecological communities.

It is consequently inconceivable that the NSW Government will even contemplate the possibility of important riparian habitats in the Hawkins and Rumker areas being destroyed.

Observations of effect of mining on the Newnes Plateau Swamps post the 2019/20 Black Summer bushfires show the impact of the longwall mining-related groundwater loss leading to lowering of water tables. Subsequent fire impacts in these swamps provide dramatic evidence of the irreversible damaging impacts of longwall mining. Unlike the reference swamps, the undermined swamps failed to respond to good rains since January 2020, with almost no resprouting of typical and often long-lived, resprouter sedgeland and shrub species. These outcomes destroy any hope that future rainfall might allow some semblance of the pre- mining conditions to return. These groundwater-dependent peat swamps are scarce and already face a rapidly changing climate. Dead swamps provide clear evidence of the impacts of longwall mining. No more swamps should be allowed to be destroyed. (Baird I.R. and Benson, D. 2020; Jonkers, C. and Favell, J. Lithgow Environment Group - pers. comm 2010)

This submission has established that the montane bogs, montane fens and hanging swamps present in Coxs Creek, Reedy Creek and Breakfast Creek and other associated systems in the Hawkins and Rumker areas are all an important part of the complex of endangered montane mire communities distributed across the tablelands and adjacent ranges of and are referrable to the Montane Peatlands and Swamps Endangered Ecological Community (EEC) listing under the NSW Biodiversity Conservation Act 2016 and the Temperate Highland Peat Swamps on Sandstone Commonwealth Environment Protection and Biodiversity Conservation Act 1999 listing.

The meadows, sphagnum bogs, wetlands and associated ecosystems of Coxs Creek, Reedy Creek and Breakfast Creek are unique, being at lower elevations and the western extents of these endangered ecological communities. **The impact of mining cannot just be offset through the Biodiversity Offsets Scheme – these are not found anywhere else so cannot be offset.**

The loss of groundwater springs and seepages which feed the creeks and rivers during non-rainfall periods in this area and meadows, sphagnum bogs, wetlands and associated ecosystems as well as the wide range of threatened species, populations and communities that are dependent on these features is an unacceptable impact for a short-term exploration and mine project in the Hawkins and Rumker areas.

All these long-term impacts were considered in the Upper Hunter Strategic Review undertaken by the Department of Infrastructure, Planning and Natural Resources (DIPNR, 2005; Smith, 2009).

5.1.1 Geomorphological impacts

Alterations to the physical character of landforms occur as a result of topographic impacts associated with subsidence following the progress of Longwall panels or longer term collapse of pillars following Bord and Pillar style coalmining. Changes in topography (especially gradient) have the potential to affect geomorphological processes. **The nature and scale of potential geomorphological impacts on a reach or broader catchment area are complex.** Possible geomorphological impacts associated with subsidence include:

- Cracking of rock bars or fracturing of alluvial strata altering the permeability of a stream bed. This can lead to reductions in stream flow, which in turn has potential to affect physical processes and instream habitat. Cracking in swamps has dewatered and dried out these swamps, changing the wetland vegetation communities to sclerophyllous types, increasing their flammability and in turn increasing the susceptibility of these areas to erosion during extreme rainfall events (Commonwealth of Australia, 2015). Such tragedies have been carefully recorded locally in the Ben Bullen State Forest (pers comm. Jonkers, C. and Favell, J. 2010, personal observations).
- Lowering of channel bed and changes to channel grade. This could potentially **alter channel hydraulics** and patterns of sediment erosion, transportation, and deposition within an affected reach, with **impacts on the character and distribution of pools and riffles and stability of channel banks** (NSW DoP 2008; Lucas et al. 2009 in Commonwealth of Australia, 2015).
- **Depending on location and extent of subsidence on a watercourse, geomorphological impacts may extend beyond the reach and impact on the condition of the broader catchment.** Upstream or downstream deepening of stream beds following subsidence may

lead to incision and destabilisation of incoming tributaries, resulting in increased sediment loads to waterways (Commonwealth of Australia, 2015).

- **Rock falls, slumping and erosion of channel banks. Fracturing of bedrock in cliff and gorge settings can lead to rock falls** (pers comm. Jonkers, C. and Favell, J. Lithgow Environment Group 2010; personal Ben Bullen SF observations; NSW DoP 2008; Commonwealth of Australia, 2015). Slumping and erosion of channel banks may arise from cracking alluvial banks. Lowering channel beds can also affect channel bank stability (Lucas et al. 2009).

5.1.2 Hydrological impacts

Changes in topography can result in changes in surface runoff following rainfall events, which in turn alter soil moisture across the landscape and create areas of ponding (Frazier et al. 2010). **Surface and subsurface cracking can alter or create new flow paths, thus altering surface and groundwater flow.** The magnitude of change in surface and groundwater flow is dependent on the extent to which subsidence changes the structure of the overlying strata (Frazier et al. 2010; MSEC 2006; Sidle et al. 2000). Subsidence related impacts on surface water primarily occur in the following ways:

- **diversion of surface flows into groundwater flows** via fractures and joints in the bedrock, with water travelling through near-surface strata and potentially resurfacing further downstream
- **leakage through rock bars**, where water held in ponds and pools may leak through fractures and joints in rock bars and potentially resurface further downstream
- **infiltration into the groundwater system**, particularly where the water table is lower than the surface water level of the river – (Thirlmere Lakes WHA drainage - Dr Philip Pells Independent Expert Report 2021).

Diversion of surface flows to become groundwater through subterranean flows and rock bar leakages are the main types of surface water impacts that are likely to occur as a result of subsidence induced cracking. Infiltration of surface water into deeper groundwater can occur if a conduit is established for flow through to a deeper permeable horizon. Experience shows that in cases of increased surface flow diversion into subterranean flows and rock bar leakage, impacts are most obvious at times of low flows. **Partial and complete loss of surface flows downstream is shown to coincide with periods of low flow** (Commonwealth of Australia, 2015).

These effects have long been recognised by the NSW Government. The NSW Department of Environment and Climate Change (DECC) (2007) noted that longwall mining subsidence is frequently associated with cracking of valley floors and creek lines with subsequent effects on surface and groundwater hydrology. Of particular concern is the potential for longwall mining to affect upland swamps. Upland swamps, particularly peat swamps, are important to catchment hydrology and ecology because they absorb water and allow runoff for long periods after rainfall has ceased. Surface cracking as a result of longwall mining subsidence can have a variety of impacts on riverine features or attributes. These include:

- Loss of surface flows or water levels.
- Loss of aquatic or instream habitats. Complete drying of river pools or wetlands has occurred. The loss of these surface features is potentially irreversible in some cases.
- Loss of connectivity between pools as surface water is lost to subsurface flows.
- Loss of water quality (Increased dissolved iron oxides, manganese, sulphides and salts - measured by electrical conductivity, and lower dissolved oxygen).

• Simplification of remaining instream habitat due to the growth of iron-oxidising bacteria which can also be seen as a rusty-coloured mass in the water.

The DECC considered that much of the **impact/damage to natural features from longwall mining is unacceptable as many are irreversible and contrary to the principles of ecologically sustainable development.** Of key concern to DECC was that subsidence due to longwall mining has had significant impacts on river health and water dependent ecosystems, including threatened species and endangered ecological communities.

Regardless of which approach to mining is taken in the Hawkins and Rumker areas, the risk of modification of the landform and detrimental water impacts is unacceptably high. There will be open cut pits creating scars across the valleys, and widespread topographic, geomorphologic and hydrologic changes across the sandstone plateaus, leading to changes in and loss of surface water flows.

This will be exacerbated by large-scale industrial complexes built to support any mine as well as the infrastructure to support such a complex, such as new roads and railway lines built across, through or under the existing creeks, streams and rivers, which would interrupt these waterways and change the flow of water across the catchments.

There would be irreversible changes to the landform and the natural hydrological cycle that has been set up over one hundred million years.

These changes cannot be rehabilitated or artificially reinstated by a mining company using earthmoving equipment.

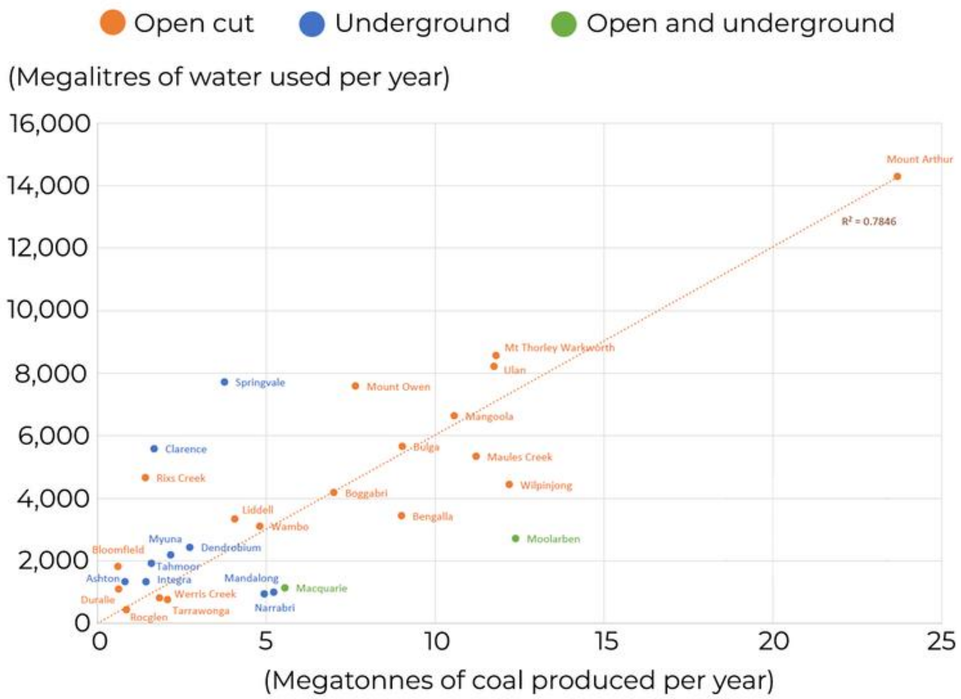

Figure 5 NSW Coal mine coal production vs water use
Source: Overton, I. 2020

About 80 percent of this water is freshwater from rainfall and runoff, extracted from rivers and water bodies, groundwater inflows or transferred from other mines. The other 20 percent comes from water already contained in tailings (mine residue), and recycled water or seepage from the mines. Almost all water used in coal mines is consumed and cannot be reused (Overton 2020).

The Hawkins and Rumker areas are in the upper part of the catchments. While mines use the term 'water make' to describe water that ends up in the mine, they do not in fact make water. Seepage into or from the mine is only water that would have become available at some other point in the catchment, either rising as a natural spring or as groundwater seeped into surface waterways further downstream in a catchment. It is not the mine's doing, but rather the mine is taking the water away from somewhere else it had naturally flowed.

The Australian climate is extreme, characterised by both short-term variability as well as medium to long-term wet/dry cycles. The extremity of these cycles will only be exacerbated as climate change continues to influence weather patterns. In the past decade the Hawkins and Rumker areas have seen both their wettest and driest periods in recorded history (Bureau of Meteorology, 2021a). Further, there is significant variation across the catchments being considered, with rainfall on, or at the foothills of the ranges being higher, approximately 940mm on average per annum (BOM, 2021a) due to the orographic effect, and rainfall in the valley being several hundred millimetres lower at approximately 535mm on average per annum (BOM, 2021b). Some of the northern areas through Hawkins lie in a rain shadow and become desperately dry in drought years. Variations of up to 63 percent on these have been recorded in extreme years.

Any mining operation will consume what little water there is naturally in the three affected catchment areas.

A report by Hydrocology Consulting (2014) found that **there was a major flaw with NSW planning processes in that they do not require mining companies to demonstrate that there will be water available for their production needs. This is an unacceptable negative externality and to RRCFC's knowledge has not been addressed.**

5.1.3 Lost economic production

There are rural properties, farms and small businesses throughout the Hawkins and Rumker areas. Land uses include grazing, cropping, orchards, vineyards, plantation forests and native forestry (Earthscapes, 2021). Businesses include tourism-based enterprises such as farm stays, B&Bs and retreats, an olive press which presses for many olive growers in NSW as well as cattle, sheep, horse and alpaca studs, poultry egg production, artisanal workshops, mineral water supplies, boutique brewers and more.

These land uses and business are all sustainable long-term business and rely on the water resources within these catchments.

If mining operations use or divert all water available in the upper catchments through either river extractions or seepage, all of these businesses are put at risk.

5.2 Contamination

The waterways in this area are in good condition and the water quality is good. The waterways run through highly sensitive environments and support life and livelihoods. This would be put at risk by mining in these catchments.

5.2.1 Increased salinity and other contaminants

Coal seams within the Permian Coal Measures in the Hawkins and Rumker area are overlain by younger Triassic sandstone. This porous sandstone acts as a giant sponge absorbing rainfall runoff.

Consequently the sandstone is a very large water reservoir, slowly releasing groundwater and providing via seepage and springs the water to maintain the ongoing flow of streams and rivers when rainfall runoff ceases. Underground coal mining below the Triassic sandstones, or open cut mining close to alluvial aquifers, will lead to fracturing of the hard rock layers that confined the groundwater. The result is very many additional pathways for increased movement of groundwater through the broken rock strata, giving the water much greater opportunity to dissolve salts and other contaminants, including sulphur and a variety of metals - iron, zinc, copper, manganese, uranium, strontium, barium, and others. This contaminated groundwater water may then seep into surface waterways directly or enter alluvial aquifers, and then on to surface water features (Commonwealth of Australia 2015).

The Hawkins and Rumker areas lie across the Hunter River and the Murray Darling River catchments. For many years the Hunter region has been coal mined. It provides clear examples of the risks to water quality and quantity by mining.

In the Sydney – Bowen Basin area, coal companies mine coal seams within Permian Coal Measures. These measures contain many strata of mudstones, tuffaceous claystones (volcanic ash beds), paleosols (fossil soil horizons), sandstones, conglomerates and a few coal seams. Some of these rocks contain saline rock strata deposited following occasional periods of marine transgression over river delta sediments.

A report by Hydrocology Consulting (2014) found the increasing connectivity between these formations and the productive freshwater alluvial aquifers of the river system. This followed the extensive fracturing caused by both underground and open cut coal mining which increased the salinity of groundwater. This report also highlighted the issue of mining contributing directly to salinity. Mine dewatering of contaminated groundwater is frequently discharged under government licence into waterways. Mine dewatering is increasingly found to be drawing water which originally entered the mine from alluvial and rock aquifers and surface water sources.

This unaccounted loss of surface and groundwater compounds the poor quality of these water sources as it reduces base flows, which would otherwise have diluted the Permian coal measures aquifers' saline discharge. Hydrocology Consulting (2014) found the reduction in available volume and quality of both groundwater and surface water in the Hunter region is having a significant impact on sustainable rural industries.

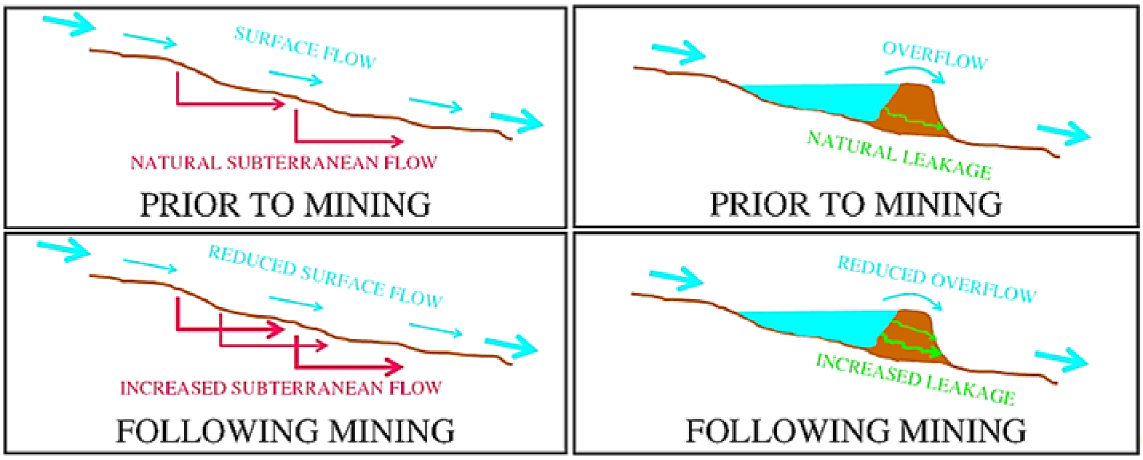

Figure 6 Mining leads to a reduction in available volume and quality of both groundwater and surface water

Figure 6 is a representation of surface water diversion into subterranean flow and rock bar leakage, and how rates of flows are potentially affected by subsidence induced fracturing (Commonwealth of Australia 2015)

Agricultural water users in the Hunter Valley have identified fracturing of sometimes saline rock during open cut mining as one of the main causes of rising background salinity in the waterways. Very extensive rock fracturing ("goaf") following longwall operations, or pillar collapse eventually following bord and pillar conventional mining, leads to vastly greater opportunity for groundwater to dissolve salts, metals, and sulphur in low salinity rock strata above the mined coal seam (Wright, I, 2012).

Groundwater mixing may result in changes in salinity and heavy metal concentrations. Other potential impacts include the introduction of surface water borne contaminants (e.g. sediment, pesticides and bacteria) to groundwater. Mixing waters of variable composition and physico-chemical properties (particularly pH and Electrical conductivity *Eh*) will result in changes in solute saturation leading to the dissolution of some species and precipitation of others. One of the most well documented examples of pH and *Eh* changes in some mines is the acidification of groundwater in the fractured rock ("goaf") as a result of the oxidation of pyritic (sulphurous) minerals (Commonwealth of Australia, 2015).

In surface waters overlying the Hawkesbury Sandstone aquifer, pH and bicarbonate increase due to chemical reactions involving carbonate minerals that form part of the sandstone (Jankowski et al. 2008). The presence of carbonates allows iron, manganese, zinc, strontium and barium to mobilise, significantly increasing the concentration of these elements downstream, where subsurface flow re-emerges at the ground surface. Discharge of iron and manganese-rich groundwater caused the development of thick mats of iron oxidising bacteria during low flow conditions, which have reduced habitat, clogged stream flow, reduced available food, and reduced the level of dissolved oxygen in the stream. Loss of native plants and animals may occur directly by iron and other metals toxicity, or indirectly by smothering (NSW DoP 2008; Jankowski et al. 2008). Loss of plants from swampland and waterways can increase erosion, resulting in high levels of sedimentation and further reductions in water quality (Total Environment Centre 2007; NSW DoP 2008). Gaseous emissions, such as methane and other natural gas components have been observed in areas affected by mining subsidence, which can also affect water quality (NSW DoP 2008).

Hydrocology Consulting (2014) also found there is a failure of the NSW Government regulators to prevent coal mines leaving final voids dotted throughout the Hunter Valley. This leaves a legacy of salinity and groundwater drawdown that continues for centuries after exploitation of the coal seams is finished. Final voids draw groundwater from surrounding aquifers and evaporation of this water renders it increasingly saline. It reported that research has already found that Hunter mine voids are reducing the base flow of the Hunter River. Water quality and its maintenance in post-mining voids have long-term implications for the entire community and ecosystem. Voids in the Hunter Valley coal measures, in particular, will continue to reduce base flow for centuries, placing even greater pressure on water storages to satisfy increasing water demands (Hancock et al, 2005 in Hydrocology Consulting, 2014).

The increase in salinity levels in any location is unacceptable; however, the contribution of mining to high salinity levels is of particular concern within both the Hunter and the Murray Darling River systems. The Hunter River has already developed a major salinity issue, due to the coal mining operations already underway. The addition of further saline waters only exacerbates this.

High salinity levels already plague the Murray Darling River system and are leading to degradation of waterways, reduction in agricultural production and damaged ecosystems. Any discharge of saline water into the surface water of the Cudgegong River system or the Lawsons Creek system would increase the background salinity levels in these waterways. This is considered an

unacceptable impact on downstream communities, industries that depend on that water and sensitive receiving environments.

Case Study 1: Mining Impacts on Groundwater - Thirlmere Lakes, NSW

Tahmoor Colliery is an underground coal mining operation situated in the Southern Highlands region of NSW, just south of the Tahmoor Township and approximately 75 km southwest of Sydney. It targets the Bulli coal seam - mining began in 1979. The primary method of coal extraction until 1987 was bord and pillar mining, after which longwall mining was introduced. The mine currently has development approvals to produce up to three million tonnes run of mine (ROM) coal per annum (Tahmoor Coal 2013).

The mine is located adjacent to Thirlmere Lakes, which are described as a unique wetland believed to be 15 million years old. The Lakes are within Thirlmere Lakes National Park, part of the Greater Blue Mountains World Heritage Area. Over the last 10 years, the water levels in Thirlmere Lakes have declined and members of the community have expressed concern. The NSW Government announced an independent inquiry in 2011 into the reductions in the level of Thirlmere Lakes, which delivered a final report in August 2012 (ITLIC 2012). The inquiry found that the lakes have fluctuated between dry and full conditions over history and that climate change is 'undoubtedly responsible' for the majority of the changes in lake level that have been experienced over the last 40 years. The inquiry found that there is no direct evidence that mining and associated subsidence has breached geological containment structures beneath the lakes. However, it concluded that there is substantive evidence of the steepening of the hydraulic groundwater gradients and lowering of the groundwater table towards the east of the lakes. The inquiry further concluded that there is some evidence to suggest that mining has contributed to changes in water table and groundwater gradients but it is not possible to distinguish changes due to mining from changes due to extraction of groundwater from bores and climate change (Riley et al. 2012).

Pells Consulting (2011) considered the available information on groundwater, geology and mining to provide three hypotheses to help explain lake level observations:

1. that the lakes have dried due to recent drought
2. that longwall mining at the neighbouring Tahmoor Colliery has resulted in increased downward seepage from the lakes
3. erosion of a palaeochannel beneath Lake Nerrigorang has allowed greater seepage and leakage to groundwater from the lake.

Pells Consulting (2012) considered more recent climate and lake level observations and concluded that recent water levels in Lake Nerrigorang are atypical of its historic behaviour, which points to factors **other** than climate for its current dry condition (Commonwealth of Australia 2015).

Case Study 2: Mining Impacts on Groundwater – Redbank Creek, Picton, NSW

Severe subsidence fracturing of Redbank Creek, near Picton. An isolated pool which was stagnant, with minimal flow due to extensive channel fracturing and loss of flow from upstream. The mixture of stream water with sections of fracturing rock mobilised minerals and metals and combined to create water quality that was hostile to stream biodiversity.

Figure 7 Upwelling groundwater flowing into Redbank Creek

Figure 7 was the site of a groundwater 'vent' where upwelling groundwater flowed into Redbank Creek, through a fresh subsidence fracture. Water quality very extremely poor for the aquatic ecosystem with very low dissolved oxygen, very high salinity, and hazardous concentrations of metals such as zinc and nickel (Wright, I, 2012; Morrison et al. 2018; Morrison et al. 2019).

The damage to Redbank Creek was covered by the ABC in September 2018 and Sydney Morning Herald in June 2020 (Hannam, 2020). *"I am yet to observe major subsidence damage to a creek or river channel effectively repaired. I have personally observed repairs to minor channel fracturing in the Georges River, but I am yet to see any evidence that repairs are able to fully repair the damage."* WaterNSW (2018)

6 | Conclusion

Whilst the PRIA process is regarding coal exploration, this must be seen as a precursor for coal mining. A mine in this area may initially be open cut in the major valley bottoms where the Permian Coal Measures outcrop, but because the majority of the coal measures here are overlain by Triassic sandstone plateau, most coal production is likely to come from underground operations via drives tunnelled under the sandstone plateau from the valley bottoms.

Subsidence resulting from longwall coal mining has a range of impacts on topography. These include cracking, the formation of steps and voids, undulation and buckling of the surface. Subsidence and changes in topography are not uniform but will vary depending on the compressive and tensile properties of the surrounding strata and depth of the coal seams from the surface above. Impacts from underground mining can include:

- Loss of ground and surface water flows and depressed water tables;
- Loss of aquatic or instream habitats. Complete drying of river pools or wetlands has occurred already elsewhere in this region and beyond. The loss of these surface features is probably irreversible in most cases;
- Loss of connectivity between pools as surface water is lost to subsurface flows;
- Loss of water quality; and
- Simplification of remaining instream habitat.

The impact and damage to natural features from longwall mining is unacceptable as many are irreversible and contrary to the principles of ecologically sustainable development. Of key concern is that subsidence due to longwall mining has had significant impacts on groundwater and consequent surface water river health and water dependent ecosystems, including threatened species and endangered ecological communities.

Regardless of which approach to mining is taken in the Hawkins and Rumker areas, the risk of modification of the landform and detrimental water impacts is unacceptably high. There may be open cut pits in the valley bottoms creating scars and impacting movements of both ground and surface waters. Across the sandstone plateau widespread topographic, geomorphologic and groundwater hydrologic changes will follow underground mining, leading to changes in and loss of ground and consequent surface water flows.

There would be irreversible changes to the landform and the natural hydrological cycle that has been set up over a hundred million years. These changes cannot be rehabilitated or artificially reinstated by a mining company.

Mining operations increase the salinity of the local groundwater and then flows to downstream surface water resources. The increase in salinity levels in any location is unacceptable; however, the contribution of mining to high salinity levels is of particular concern within both the Hunter and the Murray Darling River systems. Loss of groundwater quality also occurs due to increased iron oxides, manganese, other metals, sulphides, salts, and lower dissolved oxygen. Many of these contaminants are toxic and lead to elimination of water-dependent invertebrate populations.

Knowledge of the Hawkins – Rumker groundwater and almost all other environmental attributes is not available, as very little survey or other research has been conducted here (Imrie, J, 2019). The environment of this area replicates the "Special Areas" of the Sydney Drinking Water Catchment. As the following Open Letter to the NSW Premier prepared by accredited scientific experts indicates, new mine approvals here and indeed around NSW are granted without adequate knowledge of current environmental conditions and longer-term consequences, or truly effective government regulatory management. **On that basis, no approvals for coal mine exploration, and potential mining licences following, should be granted in Hawkins and Rumker areas.**

> "**Open Letter to the Premier of NSW Regarding Coal Mining in the Schedule 1 Special Areas of the Sydney Drinking Water Catchment.**
>
> "Krogh review and the 2007 McNally and Evans Southern Coalfield impacts report prepared for the then NSW Department of the Environment and Climate Change.
>
> "These reports and references therein document the nature and possible extent of the damage caused by mining beneath the Special Areas and, **repeatedly, point to the data, modelling, transparency, balance, knowledge and understanding inadequacies and uncertainties under which mining has been approved and allowed to proceed. The inadequacies and uncertainties are such that it is still not possible to reliably gauge the magnitude, extent and significance of the impact and consequences of mining in the Schedule 1 Special Areas. There continues to be no timetable nor direction to funding to address these longstanding problems.**
>
> "The ongoing level of ignorance with which mining is approved and undertaken, highlighted by unexpected impacts and consequences at the Dendrobium and Metropolitan mines, urges the suspension of the approvals process for coal mining in the Schedule 1 Special Areas. The suspension should remain in place until deficiencies in data gathering and reporting, data and information access, modelling, knowledge and understanding are comprehensively addressed, such that cumulative impacts to date can be reliably and openly assessed, and quantitative predictions of the compounding effects of new mining proposals can be made with a high degree of scientific confidence. Assessments and predictions should be capable of reliably determining whether or not proposed mining will have a neutral or an adverse effect on the Special Areas, from commencement and into the intergenerational future. As the 2008 report of the Southern Coalfield Inquiry points out, "*The single most important land use in the Southern Coalfield is as water catchment*."

Cover letter from the authors of the above extract:

> **Open Letter to the Premier of NSW Regarding Coal Mining in the Schedule 1 Special Areas of the Sydney Drinking Water Catchment**
> 18/5/20
>
> "Dear Premier,
> We the undersigned write as concerned academic researchers and scientists to urge an ongoing suspension of the approval processes for any further planning applications or post-approval plans (Subsidence Management Plans and Extraction Plans) for mining in the Schedule 1 Special Areas of the Sydney Drinking Water Catchment. A summary of our reasons for seeking a suspension of mining approvals is attached.
> The suspension of approvals should include new projects, the next stage of existing projects and project modifications, and should include proposals and plans currently under consideration. The suspension should remain in place until the now long recognised deficiencies and inadequacies in data gathering and reporting, alert triggers, data and information access, modelling, knowledge and understanding are comprehensively addressed. The suspension should remain in place until the cumulative impacts and consequences of mining to date can be reliably assessed and quantified, with a suitably high degree of scientific confidence. The suspension should remain in place until

predictive estimates of the compounding effects of new mining proposals can be made with a suitably high degree of scientific confidence.
In part our letter is compelled by the reports of the Independent Expert Panel for Mining in the Catchment (IEPMC). Adding to those provided to the government since at least 2007, the IEPMC reports reaffirm that the long known and ongoing inadequacies are such that it is not possible to reliably estimate the extent and, accordingly, significance of water losses and water contamination caused by mining in and around the Metropolitan and Woronora Special Areas.

"The 2008 Southern Coalfield Inquiry report points out that "*The single most important land use in the Southern Coalfield is as water catchment.*" The importance of accordingly protecting the Special Areas, which lie within the Southern Coalfield, has been emphasised by the recent drought, with low reservoir levels and revelations of high metal contamination levels in the deeper waters of the reservoirs. Among other impact and consequence concerns, the attached summary points to a drinking water loss rate of between 8 and 25 million litres a day as a consequence of mining the Special Areas. Unlikely to be lower, the loss rate could be greater than the range suggested by the available information.

"We further encourage the Government to undertake planning for the phase-out of mining in the Metropolitan and Woronora Special Areas. We note that while these areas have been degraded by mining, they still contain some of the few areas of pristine bushland left in NSW. With just two mines currently active, phase out with no further approvals would seem timely. www.special-areas-concerns.org

"Please note that this letter, its concerns and recommendation, reflect our personal views as scientists with expertise in hydrology, chemistry, geology and Earth science, environmental and ecosystem science, and public health. The letter is not intended to reflect or represent the institutions and organisations for which we work or are otherwise associated. Sincerely, Sincerely,

Prof. Simon Chapman
Assoc. Prof. Timothy Cohen

"Prof. Allan Chivas
Assoc. Prof. Matthew Currell
Assoc. Prof. Mark Diesendorf
Mr. Pete Dupen
Assoc. Prof. Jason Evans
Dr. Nicolas Flament
Prof. Melissa Haswell
Prof. Grant Hose
Prof. Lesley Hughes
Prof. Stuart Khan
Dr. Tanya Mason
Prof. Graciela Metternicht
Assoc. Prof. Scott Mooney
Assoc. Prof. Gavin Mudd
Assoc. Prof. Patrice Rey
Dr. Peter Turner
Dr. Floris Vanogtrop
Prof. David Waite
Dr. Ian Wright "

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RYLSTONE REGION
COAL FREE
COMMUNITY

Appendix A| MWRC Advice on Bowdens Silver Project

RYLSTONE REGION COAL FREE COMMUNITY

MID-WESTERN REGIONAL COUNCIL
PO Box 156, MUDGEE NSW 2850
86 Market Street, Mudgee | 109 Herbert Street, Gulgong | 77 Louee Street, Rylstone
T 1300 765 002 or 02 6378 2850 | F 02 6378 2815
E council@midwestern.nsw.gov.au

JR:CA:SSD5765

27 July 2020

Attention: Rose-Anne Hawkeswood
NSW Department of Planning & Environment
GPO Box 39
SYDNEY NSW 2001

Dear Rose,

RE: SSD 5765 ENVIRONMENTAL IMPACT STATEMENT

Thank you for providing Mid-Western Regional Council (Council) with the opportunity to provide input into the proposed Bowdens Silver Project. Council has reviewed the Environmental Impact Assessment (EIS) and wishes to provide the following comments for consideration.

WATER SUPPLY

The significant and long-term water usage for the project remains a serious ongoing concern for Council, particularly in light of the recent drought conditions and rural hardship experienced across the Region. The recent drought has demonstrated water is a highly valuable resource and Council does not support any potential threat to the existing town water supplies or the amount of water available for rural property owners for domestic and agricultural purposes.

Whilst the EIS identifies a range of potential water sources for the project, it does not consider the contingencies available for the project during prolonged periods of drought. If water is not available in the volumes required, the EIS does not consider the implications this will have on the project and the associated environmental impacts.

The proponent has also recognised that water security continues to be a critical issue for this project and the broader community, and has proposed to obtain excess water from either the Ulan or Moolarben Coal mines via a 59km water pipeline.

The EIS states that up to 5ML of water per day may be transferred via the water pipeline but formal agreements have not been established with either Ulan or Moolarben Coal mines in relation to water access and sharing. Given the significant amount of water required for the viability of this project, details of a guaranteed water supply and evidence of formal agreements should be provided before the project can be determined.