Lue Action Group
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ATTACHMENT 2

Independent Review of the Bowdens Silver Pty Limited Surface Water Assessment – Updated

(Shireen Baguley, March 2022)

Updated May 2022

Independent Review of the

Bowdens Silver Pty Limited

Surface Water Assessment – Updated

(WRM Water + Environment Pty Ltd

February 2022)

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Introduction

This analysis considers the data used in the Bowdens surface water assessment (WRM Water & Environment Pty Ltd) to do the modelling showing the viability of water use and reuse at the proposed mine site.

It considers the rainfall data used and compares it with the known local conditions.

Comparative rainfall data has been drawn from the BOM data from the two closest towns, Mudgee and Rylstone. Local Lue landholders also provided rainfall data to inform this review, which gave rainfall data for:

- Lue Village,
- a property 2.2 km from the eastern edge of the proposed pit,
- a property approximately 1.0 km from southern edge of pit, and
- Lue Station.

Lue Station has recorded monthly rainfall totals since 1887 while the other properties in the local area have records dating back to the 1980s.

It also discusses the interaction of surface water with groundwater and considers the reliability of predictions using of groundwater models in this location.

Monthly rainfall

Data

From Bowdens surface water assessment:

Figure 3.2 Average monthly rainfall and pan evaporation at the Mine Site - 1889 to 2018 (source: SILO point dataset - Qld Department of Environment and Science)

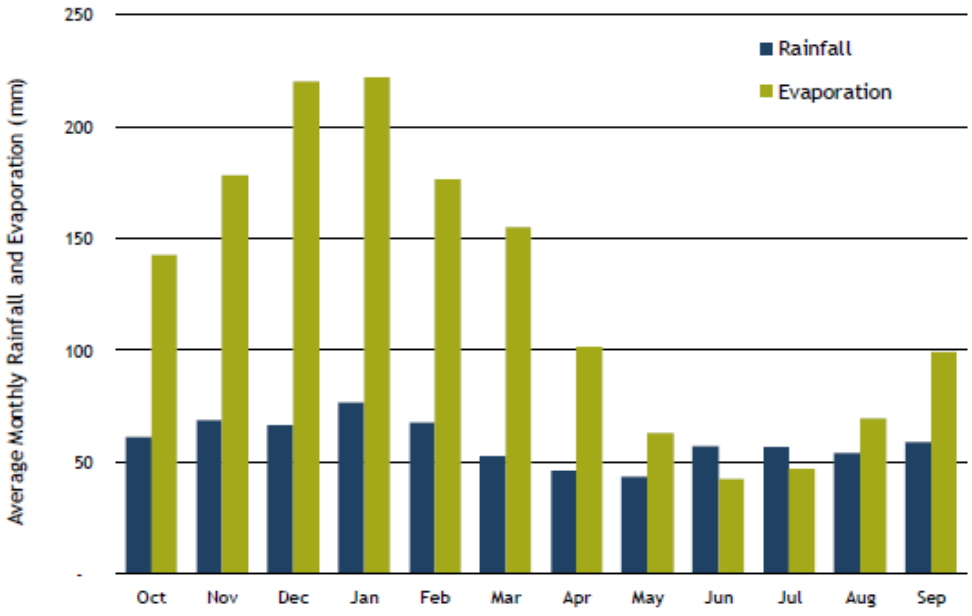

Figure 1 Average monthly rainfall data presented in Bowdens surface water assessment

From BOM site, for Mudgee Airport[1]

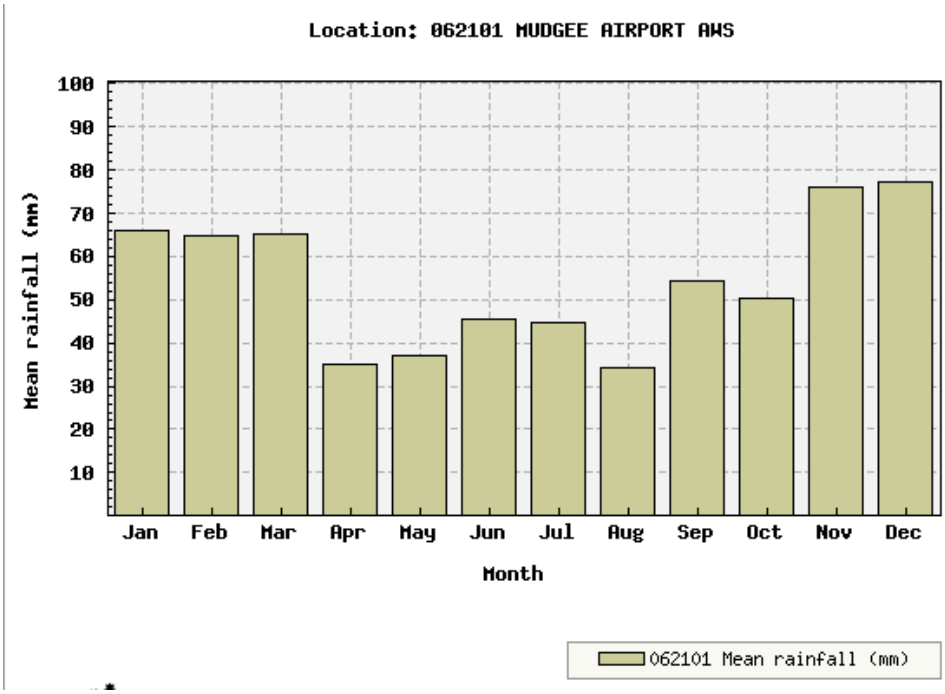

Figure 2 Average monthly rainfall data for Mudgee

1 http://www.bom.gov.au/jsp/ncc/cdio/cvg/av?p_stn_num=062101&p_prim_element_index=18&p_display_type=statGraph&period_of_avg=ALL&normals_years=allYearOfData&staticPage=

From BOM site, for Rylstone (062026[2]):

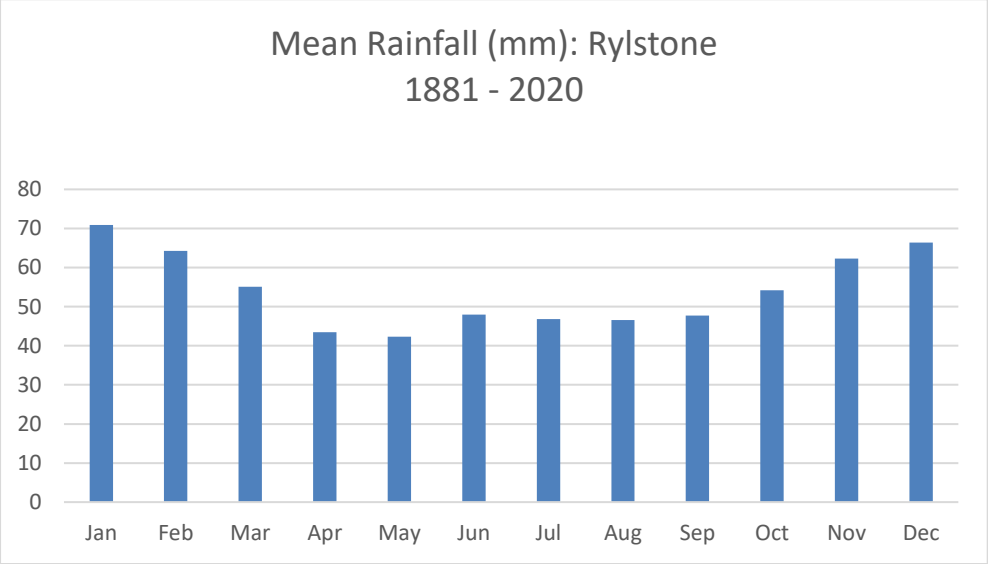

Figure 3 Average monthly rainfall data for Rylstone

From the Lue Station records:

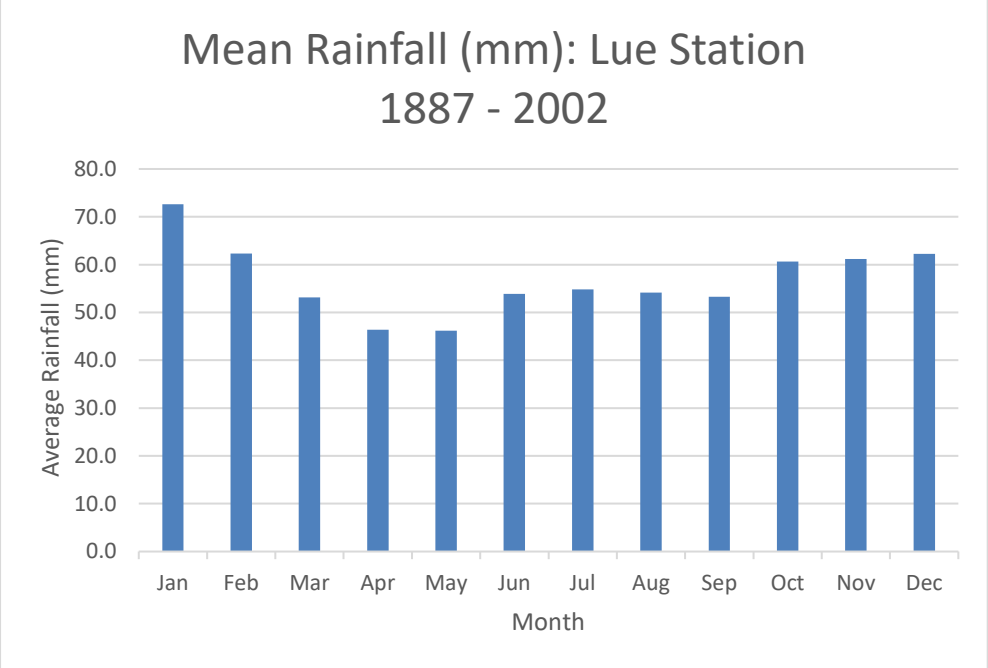

Figure 4 Average monthly rainfall data for Lue Station

Conclusion

The Bowdens surface water assessment data appears to show a monthly average that exceeds 75mm over summer. This is incorrect, as evidenced by the rainfall data from Mudgee (26km west of the mine site), Rylstone (22km south of the mine site) and Lue Station.

Many of the other months are also too high when compared to Mudgee, Rylstone and Lue rainfall statistics. The data should be reviewed and revised down so as to not incorrectly inflate the amount

[2] http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=062026

of rainfall which the region actually receives. The data for the Bowdens site needs to be presented numerically, so they can be clearly understood.

Annual rainfall

From Bowdens surface water assessment:

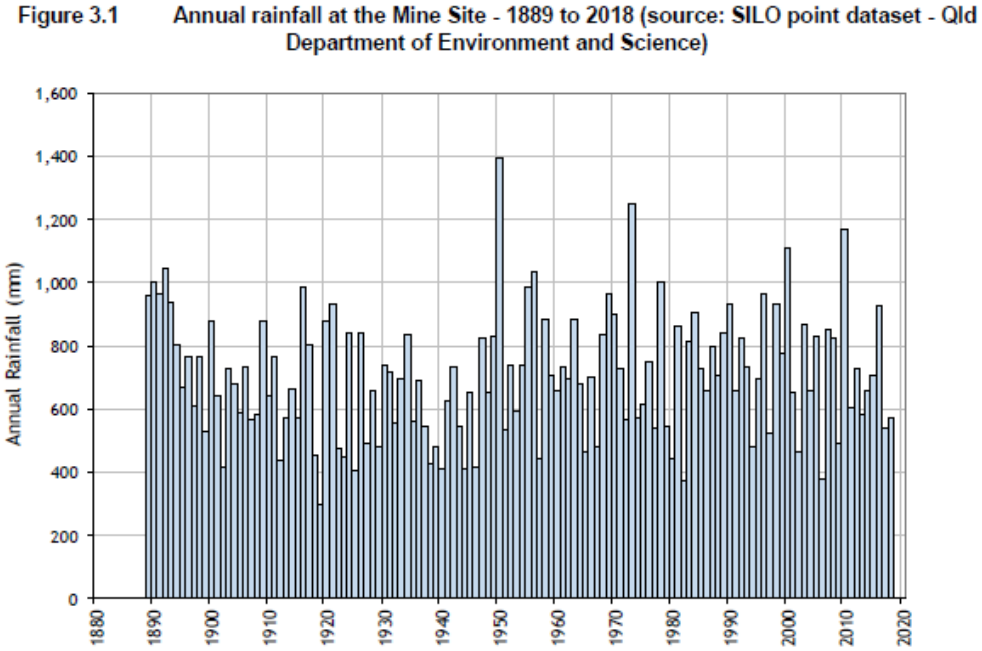

Figure 5 Annual monthly rainfall data presented in Bowdens surface water assessment

Average annual rainfall reported as 673 mm/a.

From BOM site, for Rylstone (062026[3]):

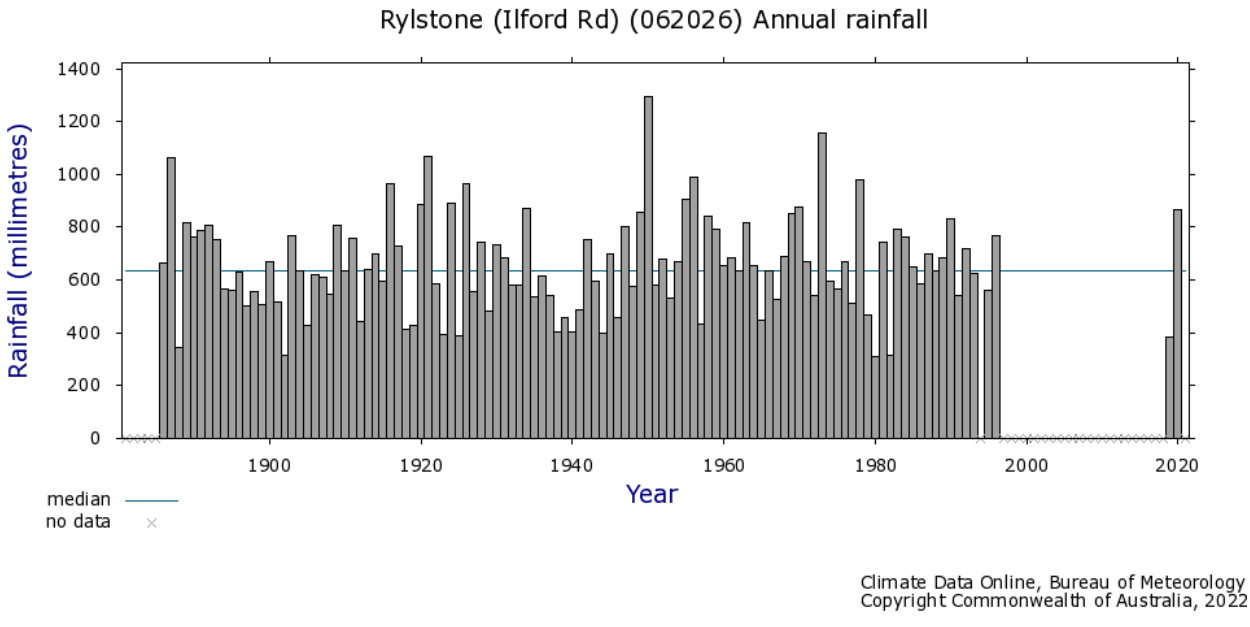

Figure 6 Annual monthly rainfall data for Rylstone

[3] http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=062026

Table 1 Rylstone Rainfall Statistics

Station 062026 Rainfall Statistic	Annual
Mean	654
Lowest	309.4
5th %ile	390.4
10th %ile	426.5
Median	635.4

From BOM site, for Mudgee (062021[4]):

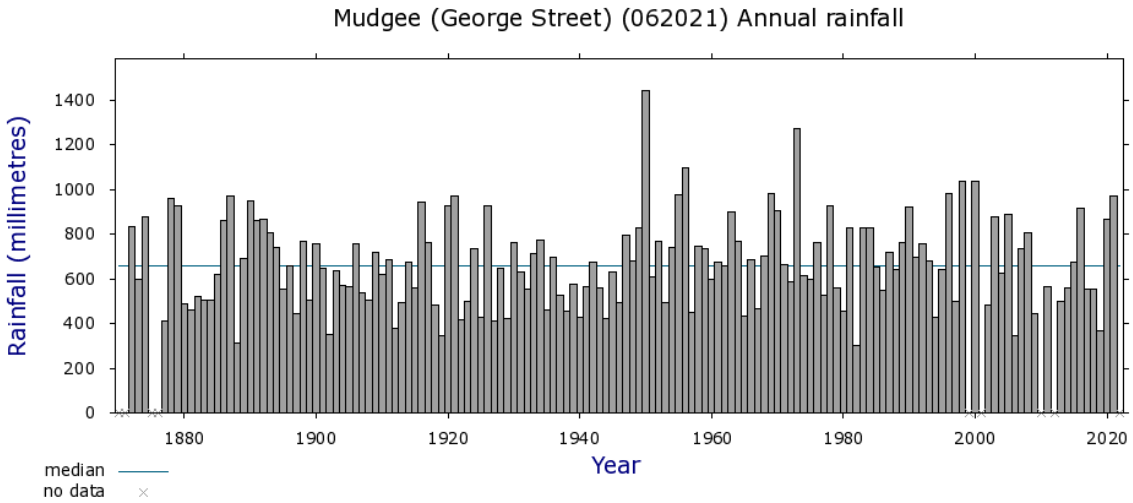

Figure 7 Annual monthly rainfall data for Mudgee

Table 2 Mudgee Rainfall Statistics

Station 062021 Rainfall Statistic	Annual
Mean	671.6
Lowest	302.4
5th %ile	411.4
10th %ile	431.4
Median	656.9

The following graph shows the recorded rainfall comparison with other properties within the Lue area. Good consistency can be seen, indicating that the records for Lue Station are indicative for other properties in the local area, and including for the Bowdens' site.

[4] http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_display_type=dataGraph&p_stn_num=062021&p_nccObsCode=139&p_month=13

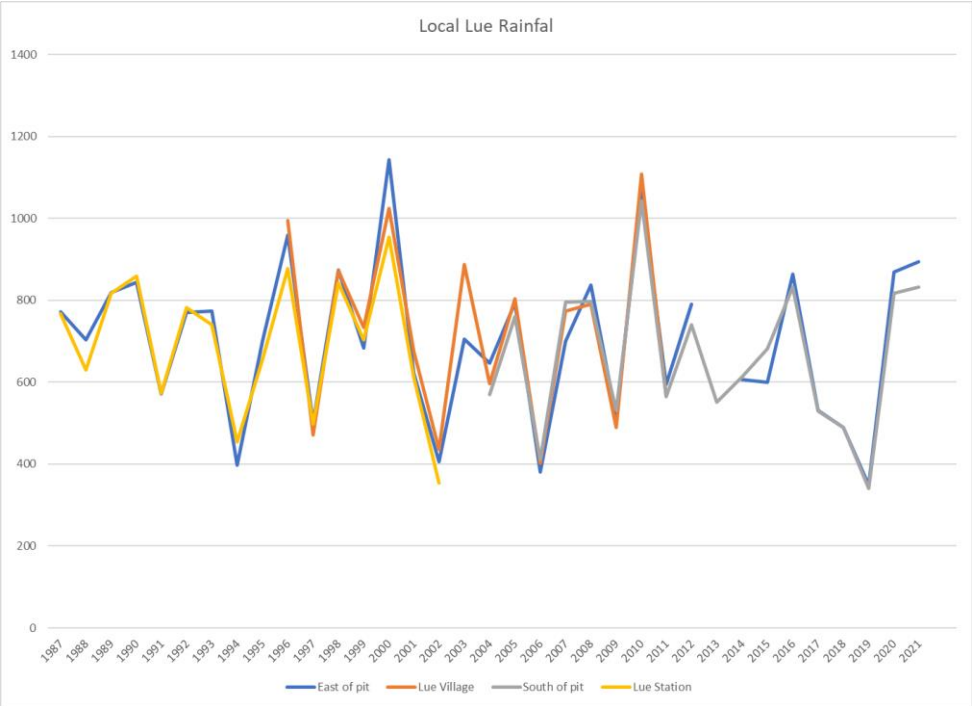

Figure 8 Comparison of rainfall recorded at properties adjacent to the Bowdens' proposed mine pit

The rainfall from Lue Station (1887-2002) and rainfall recorded at properties adjacent to the Bowdens' proposed mine pit (2003-2021) was combined to give a data set of precipitation for Lue for comparative purposes. . This is shown graphed in Figure 9. Statistics are in Table 3.

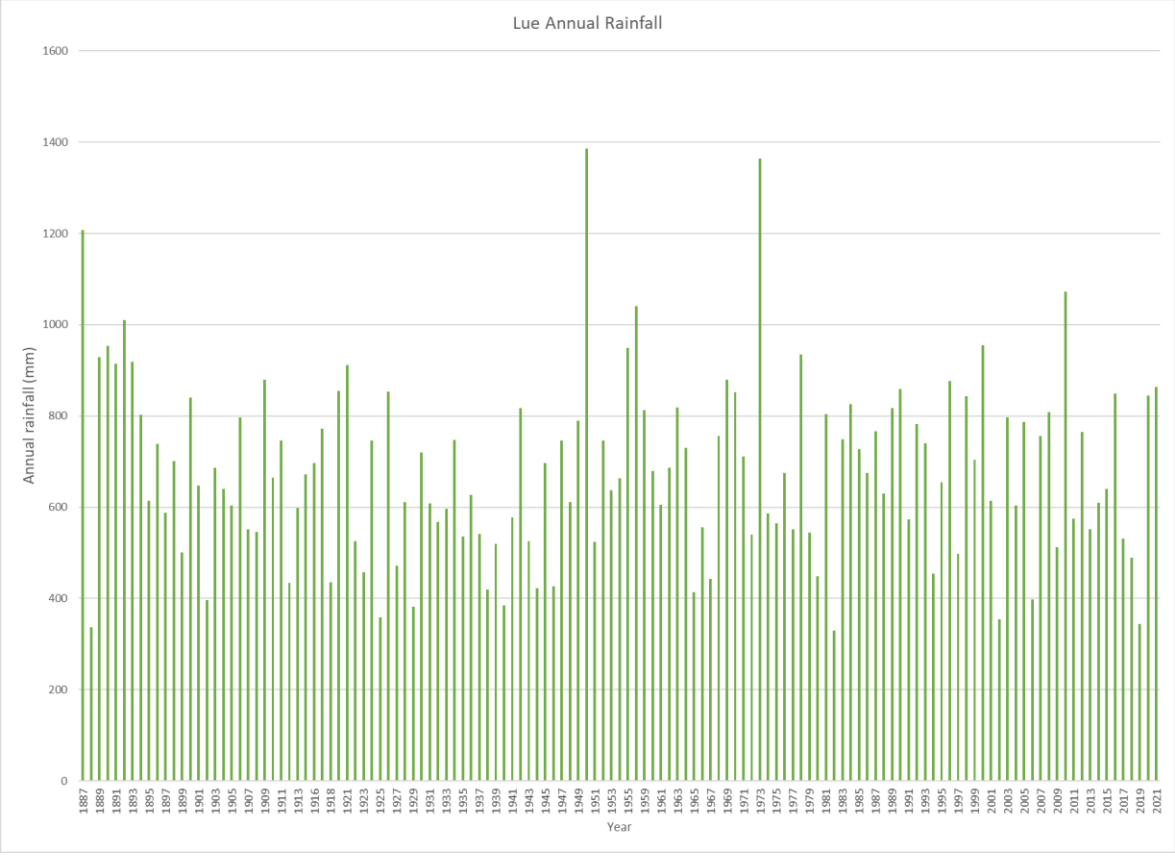

Figure 9 Annual monthly rainfall data for Lue Station (1887-2002) and sites surrounding Bowdens (2002-2021)

Table 3 Lue Rainfall Statistics

Statistic	Annual (mm)
Mean	671
Lowest	329
5th %ile	383
10th %ile	433
Median	672.8

The extract of years in which 500mm of rainfall or less than was received in Rylstone[5] and Mudgee[6] and Lue region is shown in Table 4. This region is a dry region.

[5] http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=062026

[6] http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_display_type=dataGraph&p_stn_num=062021&p_nccObsCode=139&p_month=13

Table 4 Lue, Rylstone and Mudgee Dry Years (annual rainfall, mm)

Lue Region		**Rylstone**		**Mudgee**	
Year	Annual	Year	Annual	Year	Annual
1982	329	1980	309.4	1982	302.4
1888	337	1902	314.9	1888	313.1
2019	345	1982	315.9	1919	345.9
2002	354	1888	346.2	2006	347
1925	359	2019	381.6	1902	349.1
1929	381	1925	388.1	2019	367.1
1940	385	1923	391.9	1912	377.2
1902	396	1944	397.7	1927	411
2006	398	1940	401.3	1877	413.6
1965	414	1938	402.6	1922	416.2
1938	419	1918	414.7	1929	421.6
1944	422	1919	426.1	1944	422.8
1946	426	1905	428.2	1994	426.9
1912	434	1957	435.3	1940	429.3
1918	436	1912	441.6	1925	430
1967	442	1965	449.2	1965	434.6
1980	449	1946	456.8	1897	445.1
1994	454	1939	458	2009	445.6
1923	457	1979	465.5	1957	451.7
1927	472	1929	482.3	1980	457.8
2018	490	1941	485.2	1938	457.9
1997	498			1881	463.6
1899	501			1935	463.9
				1967	468.8
				2002	482.6
				1918	484.7
				1880	487.2
				1913	492.8
				1953	494.6
				1946	494.7

The percentiles for Mudgee, Rylstone and Lue region have been calculated and are shown in Table5 and Figure 10. Based on the data from these three areas, in one in every five years the climatic conditions are akin to a semi-arid environment, receiving little more than 500mm per annum.

Table 5 Rylstone and Mudgee Average annual rainfall percentiles

	Rylstone	Mudgee	Lue region
Percentile	Average annual rainfall (mm)		
0	309	302	329
0.1	427	431	434
0.2	509	494	525
0.3	559	544	567
0.4	593	596	611
0.5	635	651	671
0.6	679	695	729
0.7	745	761	772
0.8	800	828	825
0.9	875	929	912
1	1293	1443	1385

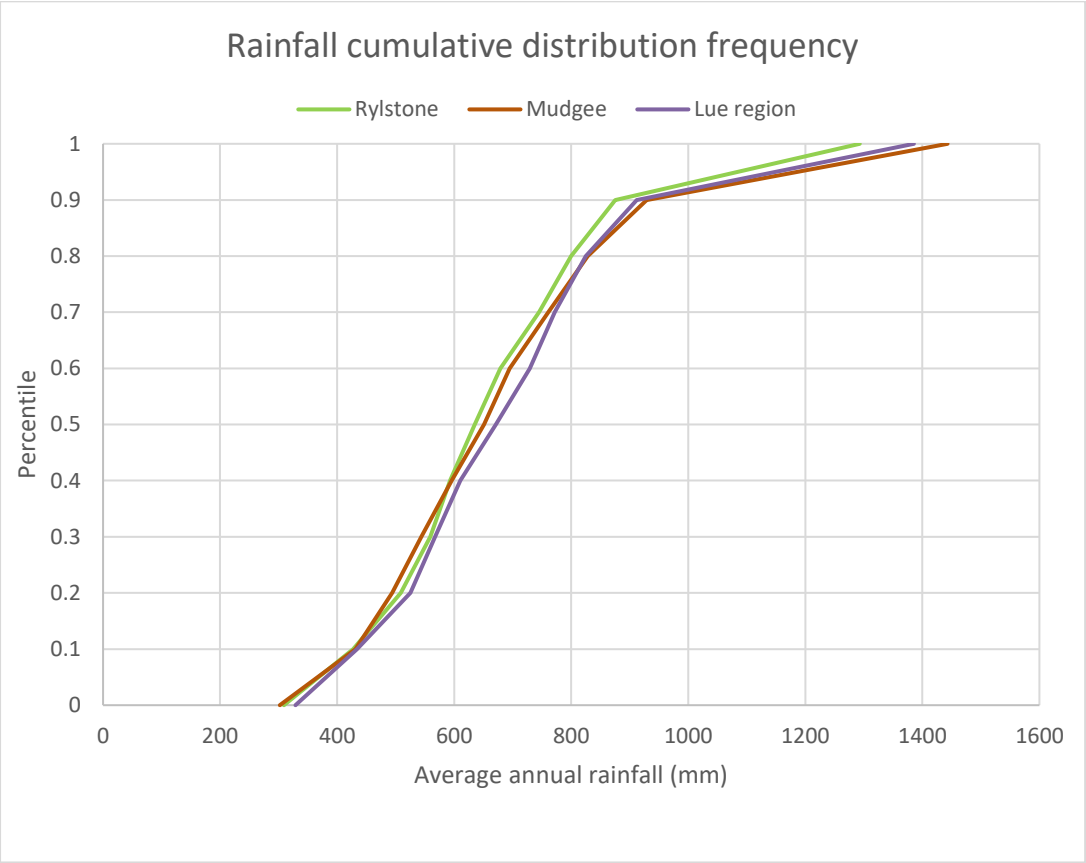

Figure 10 Rainfall cumulative distribution frequency

Conclusion

Exclusion of relevant data

The number of very low rainfall years is clearly not reflected in the Bowdens' surface water assessment annual rainfall data, which has only three years of less than 400mm. This in part seems to be a deliberate attempt to distort the data, as it has excluded 1888 and 2019, both of which are very dry years. Actual long term rainfall data recorded by landholders in the region show there has

been nine (9) years where rainfall of less than 400mm has been recorded between 1887 and 2021; and 23 years where rainfall of less than 500mm has been recorded in this period.

Given that the community that will be affected by this mine have recently lived through the crippling drought which culminated in the 2019/2020 Black Summer fires, this is viewed very poorly.

Impacts on water availability

It is also noteworthy that the 10th percentile is 427mm/a and 431mm/a respectively for Rylstone and Mudgee and 20th percentile is 509mm/a and 494 mm/a respectively. For the for Lue region the 10th percentile is 434mm/a and the 20th percentile is 525mm/a. In this area, one in every 10 years receives little over 400mm of rainfall and is very dry and one in every 20 years receives in the order of 500mm. The point of this is that in Australia, a semi-arid climate is one where average rainfall is between 250mm and 500mm per year[7]. **The analysis here shows that one in every five years, the climatic conditions for Rylstone, Mudgee and Lue are semi-arid.** This means that any loss of available water in these years severely impacts the land, and the people, plants and animals trying to survive on it.

The landholders who live in this area have adapted to these conditions, they store feed, destock, diversify, take off farm jobs or make other provisions to carry their properties through the dry times. In 2019, the groundwater resources were only just sufficient to supply the stock and domestic needs of the properties adjacent to the mine. This leaves two questions hanging:

- How does a mine 'get through the dry times'? Mothballing for years until the rains return? Diversification?
- **Where is the social licence if operating this mine makes all surrounding landholdings and business unviable because its left them with no water?**

Figure 11 Lawson Creek, 2019
(Credit T. Combes)

[7] https://www.environment.nsw.gov.au/threatenedspeciesapp/VegFormation.aspx?formationName=Semi-arid+woodlands+(shrubby+sub-formation)

Climate change impacts will increase the number and severity of the dry years experienced in this region. The surface water assessment acknowledges that there will be an impact on availability of water to downstream surface water users, and says:

> *The Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources states that water must not be taken under an access licence when there is no visible flow or where an access licence permits take from an in river pool, when the volume in that pool is less than its full capacity.*
>
> *The principal mechanism by which the Project would affect the quantity of water supplies available to other surface water users in the Lawsons Creek Water Source of the Macquarie Bogan Unregulated and Alluvial Water Sources is by reducing flows such that the frequency and duration of cease-to-flow periods is increased.*

The surface water assessment concludes:

> *The impact of the Project on the frequency of flows greater than 1 ML/d (approximately 12 L/s), which occur about 81.0% of the time downstream of the Walkers Creek confluence, is expected to be negligible. Therefore, the impact of the loss on the availability of water to downstream water users would be negligible.*

The conclusion drawn by WRM is incorrect. As is shown in the analysis in this paper, it is the other 19 percent of the time when extremely dry semi-arid conditions, are experienced in the affected catchment areas, when water is in desperately short supply. **Therefore, the impact of any loss of water is critical. It is also expected that in these conditions, one in every five years, that the conditions of the Macquarie Bogan Unregulated and Alluvial Water Sources Water Sharing Plan would be unable to be met.**

Further, the methodology used to calculate the loss of water downstream and the cease-to-flow predictions appears to be flawed. The assessment reports that:

> *The estimated impact of the Project on the frequency of flows at location C in Lawsons Creek that was conducted by comparing the outputs of the AWBM model of the premining catchment areas (described in Section 3.5.3) with the corresponding results of a model with the reduced catchment area* (pg 6 – 128)

This seems to indicate that the catchment area of the mine was subtracted from the AWBM model. However, what is not clear is what area was used. As noted elsewhere in the assessment, the catchment area of the containment system is expected to peak at 550 ha. This equates to an average annual loss of flow of 177 ML/a. From Table 8.1 of the assessment (Figure 12), it appears this is what is used, given the reduction in flows is 175.2 ML/a. **However, in actual fact, the reduction of flow must consider all water that is being extracted from the site – including the contiguous area of 2850ha** – and used in the proposed mining operations as this is what the downstream flows will be reduced by. As shown in Figure 5.3 of the surface water assessment, at peak requirement, the mean annual flow is 1,955 ML/a (p 6-86).

Table 8.1
Impact of Project on Mean Annual Streamflow in Downstream Waters

Reach Number	Unit	Operations			Post closure		
		1	2	3	1	2	3
Watercourse and reach		Hawkins Creek	Lawsons Creek	Lawsons Creek	Hawkins Creek	Lawsons Creek	Lawsons Creek
		P - A	B - C	C - D	P - A	B - C	C - D
Pre-mining catchment area	km²	61.0	222.3	272.1	61.0	222.3	272.1
Catchment area contained in WMS	km²	2.50	2.50	5.50	0.53	0.53	0.53
Mean annual flow							
Pre-mining	ML/a	1 958	7 136	8 735	1 958	7 136	8 735
Loss due to Mine Site WMS Capture*	ML/a	80.3	80.3	176.6	17.0	17.0	17.0
Potential baseflow reduction*	ML/a	9.5	5.1	14.0	11.2	8.0	19.3
Total change due to the Project	ML/a	-88.9	-84.9	-189.3	-27.2	-24.3	-34.6
Percent change due to the Project		-4.5%	-1.2%	-2.2%	-1.4%	-0.3%	-0.4%
Note that in low flow the reduction reduces to zero on zero flow days The baseflow losses from each creek would not coincide							

Figure 12 Impact of proposed mine on downstream catchments presented in the surface water assessment.

Even before there was a scheme to use all water from the Bowdens' lands for the proposed mine operations, there was a predicted increase in the cease-to-flow frequency during low flows, but this prediction is buried in the Environmental Impact Statement. It is also unclear where the 'Location C' is as presented in Figure 8.3 of the surface water assessment, which gives the effect of loss on Lawsons Creek streamflow frequency. This is important, as the impact appears to be greatest at Location D, as shown in Figure 12.

A review of the previous surface water assessment[8] found that the numbers in the table above are unchanged. **It is extraordinary, and simply unbelievable, that this has not changed under the revised proposal when such an increase in water use from the site it proposed.**

Groundwater

The Bowdens surface water assessment makes the following statements:

- *This advanced dewatering would occur via production bores that would provide up to 10L/s and supply between 376 ML/a to 408 ML/a. During mining operations, (after allowance for pit face evaporation) residual groundwater inflows to the main open cut pit are expected to range between approximately 174 ML/a and 662 ML/a.* (p6-13)
- *Due to the impact of drawdown on the local groundwater profile by the open cut pit. The groundwater assessment (Jacobs, 2022) predicts the reduction in baseflow would increase during operations such that at the conclusion of mining operations, the baseflow loss would be up to approximately 14.0 ML/a, increasing to up to 19.3 ML/a post mining. Bowdens Silver has obtained water access licencing to account for this loss*

These statements would seem to indicate:

[8] https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=SSD-5765%2120200514T074713.082%20GMT

- Much greater than 376 ML/a to 408 ML/a will be dewatered from the groundwater system, as this is exclusive of what is lost via evaporation once the water is in the pit
- Bowdens appears to be seeking a licence only for a small portion (14.0 ML/a) of the water proposed to be taken from the groundwater system, not the full amount of up to 662 ML/a.

Groundwater is a valuable resource for lands within the Lawson Creek catchment. The statements above relating to the value of surface water hold true for groundwater and its value in this region. It is not acceptable that such a significant loss will be experienced due to the proposed mine.

Groundwater modelling

Imrie[9] in her PhD investigated the use of numerical models in the prediction of surface and groundwater interactions as well as mining impacts on groundwater. Numerical models are used to 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. Imrie makes that point those 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:

> 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 13 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

[9] Imrie, J, 2019. Changing land use in an uncertain climate: impacts on surface water and groundwater in the Goulburn River, NSW PhD thesis ANU https://openresearch-repository.anu.edu.au/handle/1885/172041

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).

Numerical groundwater modelling has been undertaken for the proposed Bowdens' mining operations, however, as illustrated in the above discussion, to be of any value, the outputs of modelling methods are dependent on the availability of accurate and long term input. There is a paucity of data available in this instance, being limited to one off water levels and an average of measured groundwater levels measured for just over six years at the Bowdens' site[10]. Given the paucity of data, exacerbated by a high level of uncertainty, there cannot be any confidence in the predictions derived from the modelling which has been presented nor the impacts to springs and waterways assessed using the modelling.

[10] Jacob 2020 Groundwater Assessment Bowdens Silver Project Report No. 429/25

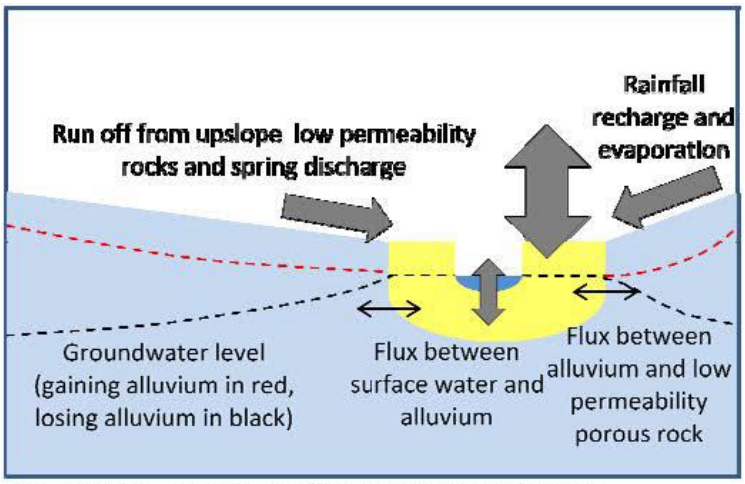

Figure 13 Potential groundwater induced leakage and interception due to mining[11]

[11] Imrie, J, 2019. Changing land use in an uncertain climate: impacts on surface water and groundwater in the Goulburn River, NSW PhD thesis ANU https://openresearch-repository.anu.edu.au/handle/1885/172041

Water Balance Modelling

The surface water assessment is based on a daily timestep water balance model which is used to assess the site water balance over the proposed mine site under "the range of historical rainfall and evaporation conditions" (p6-86). Figure 5.3 from the assessment presents the average annual main water source inflows. The most significant inflow is the runoff and rainfall. There is no information provided on how this inflow was derived. A sensitivity analysis has been presented, with 'low' and 'high' runoff scenarios. From Table 5.5 in the surface water assessment, average rainfall and runoff is 856ML/a; from Table 5.11, low rainfall and runoff is 740ML/a, and from Table 5.12, high rainfall and runoff is 1109ML/a. These values are summarised in Table 6 below. There is no information provided on what criteria is applied to determine the 'low' and 'high' conditions.

The high value is 30% greater than the average value, while the low value is only 14% lower than the average. **It would seem reasonable that a decrease of 30% from the average should also be considered to derive the low value for rainfall and runoff, but there are grounds for this to be greater than 30% given the implications of dry conditions on both the viability of the proposed mine operations as well as on downstream lands**.

Table 6 Rainfall and runoff

Scenario	ML/a	%
Low	740	14%
Average	856	-
High	1109	30%

A significant deficiency in the water balance is that it has not tested the proposed water strategy under climate change scenarios. The water assessment report does recognise that there will be greater variation in rainfall, and this will in fact impact the modelling it presents in its report - it considers climate change impacts in its modelling of the final void pit lake behaviour. It recognises that there could be decreases of nearly 50% in the rainfall (Table 7.2). However, **there is no sensitivity analysis of climate change impacts – which are already being felt in this region – in the site water balance model used to assess the feasibility of the mine being able to rely on water supplied by the surface and groundwater resources of the site. One could surmise that this is because it would show that the proposal is simply not viable.**

Conclusion

It is probable that the SILO data presented for historical rainfall data has been used in the water balance model. This will overestimate the water available for use across the site, in dust management and processing. It is highly questionable that 740 ML/a of rainfall and runoff would be available as an 'inflow' in a low rainfall scenario.

Given this question mark, there are concerns regarding the validity of the conclusions of the modelling and the assertions that water requirements for the site can be met.

Further, the sensitivity analysis appears to be fundamentally flawed, in that it considers only a 14% reduction in 'rainfall and runoff' to derive the low 'rainfall and runoff' value. There is also no sensitivity analysis of climate change impacts. It is considered that the reasons for this are that a true assessment of the low rainfall and runoff' would show there is insufficient water to meet the proposed mine's water demands for an unacceptable duration.

Harvestable Rights and Water Access Exemptions

The surface water assessment makes the following statements in regards to sediment dams:

- *Water captured in sediment dams would be released in accordance with best practice, and would therefore be exempt from licensing….In the event that (even after the addition of a flocculant) the quality of water captured in the Containment Zone was such that it could not be released it would be contained on site. No sediment dams would be constructed on a major stream. Therefore, these dams would be used "solely for the capture, containment and recirculation of drainage and/or effluent, consistent with best management practice or required by a public authority to prevent the contamination of a water source", and the captured runoff would be exempt from licensing*.(p6 – 123)

- *However, Bowdens Silver may choose to also utilise the water stored in one or more of the sediment dams. This water, and that collected for dust suppression, would be stored under the maximum harvestable rights provisions of the NSW Water Management Act, 2000*. (p 6-14)

Conclusion

The second statement appears to contradict the first one, indicating that the basins will form part of the water sources for the proposed mine site. Given this, **it appears unlikely that it is correct to assert that the water access licence exemptions will not apply.**

Water Access Licences, Transfers and Potential Impacts

Corkery (2022) reports that *Bowdens Silver holds the following volumetric entitlements to account for the predicted groundwater take from the relevant water sources.*

- *Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources Order 2020 - Lachlan Fold Belt Groundwater Source (Other) Management Zone – 1 480ML.*
- *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources Order 2020 - Sydney Basin Groundwater Source – 194ML.*
- *Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources 2012 - Lawsons Creek Water Source – 139ML.*

Bowdens Silver has also been notified of the successful purchase of an additional 200ML groundwater use entitlements within the Sydney Basin Groundwater Source of the Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources Order 2020.

The entitlement within the Lawsons Creek Water Source of the Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Sources 2012 accounts for runoff interception by the TSF which is required as its embankment is situated on a third order watercourse.

What is notable in this list of Water Access Licences is the for each of the water sources, Bowdens' is seeking to transfer the licence from either the Sydney Basin catchment or further downstream within in Murray Darling catchment.

In relation to the transfer within an unregulated water source, there are clear environmental constraints, as the instream impacts can be significant in the upstream locations when this occurs. This is because, to state the obvious, the purchase of Water Access Licences from elsewhere is not the purchase of water from those areas. It is merely the right to take water and with all due respect, there is no endless supply of water suddenly available at the upstream location. The water must be found locally, and as discussed elsewhere, the rainfall – and consequential runoff – within the Lue area is highly variable. Further, in dry periods, Lue's rainfall is on par with that experienced in semi-

arid environments and the premise of extracting the quantity of water required by the mine out of the upper catchment of the Lawson Creek, is not feasible and certainly unsustainable. Given this impact on transfers from downstream to upstream locations, **the NSW government has historically shown a preference not to move licenses upstream as the water is less likely to be available there and will consequently disadvantage all reliant on that water. Climate change will only exacerbate this variability and is predicted to reduce rainfall.**

This applies regardless of if the water source is from a surface or groundwater source. With the latter, it is clear from the analysis presented by Imrie[12] that the ground and surface water systems are highly connected and impacted by mining operations. Cardno[13] presented mapping of springs within the Bowden's study area stated there were 29 springs present within an approximately 320ha area – just under one per every 10ha. These springs are the lifeblood for many (humans, plants, animals) in the area.

Additionally, the groundwater also provides the baseflows further downstream. The mining operations and groundwater interference will irrevocably alter this natural resource. Extracting high volumes of groundwater and surface water will only further stress the waterways and disadvantage all who rely on that water.

Presence of springs and peatland swamps EECs

As noted above, there is a high number of springs in the Bowden's study area. A preliminary examination of these springs has indicated these are likely to be part of a widespread system of upland swamps, bogs and montane mires in Upper Lawson Creek catchment.

The presence of springs, swamps, bogs and mires was also an issue highlighted in the RRCFC's aquatic ecology report submitted to the recent Preliminary Regional Issues Assessment for Hawkins Rumker[14] This analysis established that there are upland swamps presenting throughout the Upper Cudgegong and Upper Lawson Creek catchments. These are all an important part of the complex of endangered montane mire communities distributed across the tablelands and adjacent ranges of NSW 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 EEC Commonwealth Environment Protection and Biodiversity Conservation Act 1999 listing. Information provided by landholders adjacent to the Bowdens site indicates that these areas are present within and adjacent to the Bowdens site (Figure 14) as well in adjacent valleys. Under the current mine proposal, these EECs are at risk of impact from the drawdown of groundwater and reduction in surface water from the proposed mine.

The environmental impact assessment for the Bowdens' project does not acknowledge the presence of these upland swamps within their own site nor in the adjacent areas. This is likely to be due to the fact that the peatland swamps within these areas are not well documented; nevertheless, the role of these wetlands is critically important in that they act as sponges in the landscape, supporting the surrounding and downstream areas in dry times. This is evidenced in (Figure 14), which shows the very parched areas in the background contrasted with the vibrant and verdant areas around the wetland area.

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[12] Imrie, J, 2019. Changing land use in an uncertain climate: impacts on surface water and groundwater in the Goulburn River, NSW PhD thesis ANU https://openresearch-repository.anu.edu.au/handle/1885/172041

13 Cardno (NSW/ACT) Pty Ltd (2020) Bowdens Silver Aquatic Ecology Assessment

[14] https://rylstonecfc.com/wp-content/uploads/2021/08/3.-RRCFC-submission-aquatic-ecology-FINAL-v3.pdf

Figure 14 Windmill Paddock Wetland January 2014
(Credit M. Boller)

The extent and the hydrology of these wetlands is not yet well understood. There is currently work underway to better document and understand these wetlands, but knowledge to date is preliminary.

What is well understood is that mining has a severe detrimental impact on these areas. In this case, this impact could reasonably be expected to encompass both the springs within the Bowdens' site as well as those in the adjacent areas will be affected by groundwater drawdown.

Any disturbance from mining activity would reduce the quantity and quality of water within the waterways and groundwater system supporting these wetlands. A mine would both damage any existing water resources within the affected footprint, as well as requiring a significant amount of water to operate. There will be severe and irreversible impacts on surface water including springs, creeks and rivers. These swamps are scarce and already face a rapidly changing climate; the dead swamps of the Newnes Plateau provide clear evidence of the impacts of mining[15]. Any mining will lead to the permanent loss of the meadows, sphagnum bogs, wetlands and associated ecosystems which includes a wide range of dependent threatened species, populations and communities. The meadows, sphagnum bogs, wetlands and associated ecosystems of the Upper Lawson 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 communities are not found anywhere else so cannot be offset

[15] . https://www.abc.net.au/news/2021-04-30/gardens-of-stone-conservation-proposal/100103246.

The impacts to the springs, creeks and rivers 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 mine project.

Loss of Water from The Landscape

The surface water assessment makes the following statements in regard to sediment dams:

> *The catchment area of this containment system would vary over the Project life, and is expected to peak at 550 ha (comprising 300 ha in the TSF catchment and 250 ha in the remainder of the water management system) or 2.0% of the Lawsons Creek catchment (of 272 km^2 downstream of the Walkers Creek confluence) would be removed over the Project life. Based on the estimated average undisturbed area runoff in the local catchment, this equates to an average annual loss of flow of 177 ML/a.* (p 6-14)

Conclusion

This assertion overlooks the fact that the water requirements for the whole project is being drawn from within Bowdens' land, both that within the 'containment system' as well as the Bowdens' contiguous land holdings. As shown in Figure 5.3 of the surface water assessment, at peak requirement, the mean annual flow is 1,955 ML/a (p 6-86), comprised of:

- Clean water harvesting: 48 ML/a
- Runoff and rainfall: 917 ML/a
- Additional groundwater extraction from the pit: 612 ML/a
- Advanced dewatering (bore water extraction): 378 ML/a

Putting aside the fact that a portion of the groundwater becomes baseflow for the creek downstream, and taking just the surface water flows, the surface water extraction by the proposed mine will be 965 ML/a. **This would equate to a loss of flow from 10.9% of the Lawsons Creek catchment.** It is an enormous and unsustainable impact on the water resources within this catchment and a significant impact on all land downstream of the proposed mine site. **The loss of baseflows must be considered in addition to this.**

Further, **it is not clear where the 917ML/a is going to come from, given the catchment area of this containment system is only going to yield 177 ML/a.** This is well short of the required water and its source has not been explained.

The Bowdens' site is 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 influence weather patterns. In the past decade the region has seen both the wettest and driest periods in recorded history.

Lawson Creek is identified in the NSW Stressed Rivers Assessment to be in the most seriously stressed category – with the highest level of environmental stress as well as a high extraction rate[16]. As there has been no interventions to improve the water stress Lawson Creek was subject to in 1998, it is expected that the situation will have only deteriorated since this time.

Mines demonstrably use and destroy the existing water resources. In this upper catchment areas, there is no alternative water sources. There are rural properties, farms and small businesses throughout this area, as well as downstream through to the town of Mudgee. All of these residents and businesses are at risk from either a total loss of water or will suffer a marked reduction in the available water if mining operations are permitted.

A report by Hydrocology Consulting analysing the use of Water Access Licences and other water entitlements by mining companies and the risk this may present for sustainable water supply[17] stated:

> *Crucially, NSW planning processes do not require mining companies to demonstrate that there will be water available for their production needs, and our findings demonstrate that this is a major flaw in the assessment process.*

This is an unacceptable negative externality and to the author's knowledge has not been addressed.

Impact on Biophysical Strategic Agricultural Land (BSAL)

Downstream of the proposed mine site, there is BSAL present (Figure 15). The surface water assessment has not considered the impacts of using water from within Bowdens' holdings on this land.

DPIE's provided the following information on BSAL[18] (DPIE 2014):

> This land has the best quality soil and water resources and plays a sustaining role in the State's $12billion agricultural industry.
>
> Agricultural land across the state was assessed against specific scientific criteria-levels of soil fertility, land and soil capability classes and access to reliable water and rainfall levels.
>
> It is the inherent values of the land itself, rather than the agricultural activity it supports, which determine the BSAL classification.

Given the climate variability experienced in this country, the water resources are a critical part of this equation. As DPIE itself says (above), BSAL is that land which has the best quality soil and water resources and plays a sustaining role in the State's $12billion agricultural industry.

As has been demonstrated in the analysis in this paper, the catchment in which the mine site is proposed has a high variability in rainfall and frequently experiences dry years. The water that supports the BSAL land moves through the upstream catchment and then is available to support agriculture in the mapped areas. Any mining within the supporting catchments threatens the water resource in the BSAL areas. The proposed mine will interrupt both groundwater and surface water flows, and as such, the BSAL area is at risk of losing the critical water which underpins its inherent value.

[16] NSW Department of Land and Water Conservation, 1998. Stressed Rivers Assessment Report, NSW State Summary 1998

[17] Hydrocology Consulting July 2014 Unfair Shares: How Coal Mines Bought the Hunter River

[18] Department of Planning Industry and Environment 2014. Strategic Regional Land Use Policy. Frequently Asked Questions Biophysical strategic agricultural land mapping across NSW https://www.planning.nsw.gov.au/-/media/Files/DPE/Factsheets-and-faqs/faqs-biophysical-strategic-agricultural-land-mapping-across-nsw-2014-01.pdf?la=en

Figure 15 Regional Biophysical Strategic Agricultural Land (BSAL)

Summary

The Bowdens surface water assessment data appears to show a monthly average that exceeds 75mm over summer. This is incorrect, as evidenced by the rainfall data from Mudgee (26km west of the mine site) and Rylstone (22km south of the mine site).

Many of the other months are also too high when compared to Mudgee and Rylstone rainfall statistics from BOM.

The number of very low rainfall years that has been experienced in this region is not reflected in the Bowdens surface water assessment annual rainfall data, which has only three years of less than 400mm. This in part seems to be a deliberate attempt to distort the data, as it has excluded 1888 and 2019, both of which are very dry years. Given that the community that will be affected by this mine have recently lived through the crippling drought which culminated in the 2019/2020 black summer fires, this is viewed very poorly.

It is also noteworthy that in the Lue region the 10th percentile is 434mm/a and the 20th percentile is 525mm/a. In this area, one in every 10 years receives little over 400mm of rainfall and is very dry and one in every 20 years receives in the order of 500mm. The analysis here shows that one in every five years, the climatic conditions for Rylstone, Mudgee and Lue are semi-arid. Any loss of available water in these years severely impacts the land, and the people, plants and animals trying to survive on it.

A major flaw in the water assessment is that it has not tested the proposed water strategy under climate change scenarios. The report does consider climate change impacts in its modelling of the final void pit lake behaviour, where it recognises that there could be decreases of nearly 50% in the rainfall. However, sensitivity testing of the site water balance model used to assess the feasibility of the mine being able to rely on water supplied by the surface and groundwater resources of the site

has not been presented. One could surmise that this is because it would show that the proposal is simply not viable.

It is probable that the SILO data presented for historical rainfall data has been used in the water balance model. This will overestimate the water available for use across the site, in dust management and processing. It is highly questionable that 740 ML/a of rainfall and runoff would be available as an 'inflow' in a low rainfall scenario.

Given this, there are concerns regarding the validity of the conclusions of the modelling and the assertions that water requirements for the site can be met.

Further, the sensitivity analysis appears to be fundamentally flawed, in that it considers only a 14% reduction in 'rainfall and runoff' to derive the low 'rainfall and runoff' value. It is considered that the reasons for this are that a true assessment of the low rainfall and runoff' would show that there is insufficient water to meet the proposed mine's water demands for an unacceptable duration.

Climate change impacts will increase the number and severity of the dry years experienced in this region.

At one point, the assessment attempts to quantify the loss of water to the downstream catchment, stating there would be an average annual loss of flow of 177 ML/a. This assertion is misleading as it relates only to the estimated flow from within the 'containment system' and overlooks the fact that the water requirements for the whole project are being drawn from within Bowdens land, both that within the 'containment system' as well as the Bowdens' contiguous land holdings. The mean annual flow is 1,955 ML/a comprised of 965 ML/a surface water and 990 ML/a ground water.

Putting aside the fact that a portion of the groundwater becomes base flow for the creek downstream, and considering only the surface water flows, this would equate to a loss of flow from **10.9% of the Lawsons Creek catchment**. It is an enormous and unsustainable impact on the water resources within this catchment and a significant impact on all land downstream of the proposed mine site.

This flawed presentation of the data also means that the cease-to-flow estimates are also incorrect. These appear to be based on a reduction in flow of 175.2 ML/a, rather than up to 1,955 ML/a. Even before there was a scheme to use all water from the Bowdens' lands for the proposed mine operations, there was a predicted increase in the cease-to-flow frequency during low flows, but this fact is buried in the Environmental Impact Statement. A review of the previous surface water assessment has found that the numbers in the table above are unchanged. It is extraordinary, and simply unbelievable that this has not changed under the revised proposal when such an increase in water use from the site it proposed.

Further, it is not clear where the 'rainfall and runoff' component of the surface water inputs – a significant 917ML/a – is going to come from, given the catchment area of this 'containment system' is only estimated to yield 177 ML/a. This is well short of the required water and its source has not been explained.

Previous studies on the aquatic ecology of the Upper Lawson Creek have established the presence of springs, swamps, bogs and mires throughout the Upper Lawson Creek catchments and that these are an important part of the complex of endangered montane mire communities distributed across the tablelands and adjacent ranges of NSW. They 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. Information provided by landholders adjacent to the Bowdens site indicates that these areas are present within and adjacent to the Bowdens site as well in adjacent valleys. Under the current mine proposal, these EECs are at risk of impact from the drawdown of groundwater and reduction in surface water from the proposed mine.

Bowdens' is seeking to transfer the licence from either the Sydney Basin catchment or further downstream within in Murray Darling catchment. In relation to the transfer within an unregulated water source, there are clear environmental constraints as the instream impacts can be significant in the upstream locations when this occurs. This is because the purchase of Water Access Licences from elsewhere is not the purchase of water from those areas. With all due respect, there is no endless supply of water suddenly available at the upstream location - the water must be found locally, and the rainfall and runoff within the Lue area is highly variable. Given this impact on transfers from downstream to upstream locations, the NSW government has historically shown a preference not to move licenses upstream as the water is less likely to be available there and will consequently disadvantage all reliant on that water. Climate change will only exacerbate this variability and is predicted to reduce rainfall.

It cannot be concluded that the impact of the loss on the availability of water to downstream water users would be negligible. The impact of **any** loss of water in the frequently experienced dry times is critical. Further, it is also expected that in these conditions, one in every five years, that the conditions of the Macquarie Bogan Unregulated and Alluvial Water Sources Water Sharing Plan would be unable to be met.

Numerical groundwater modelling has been undertaken for the proposed Bowdens' mining operations, however, the outputs of modelling methods are dependent on the availability of accurate and long term input and there is a paucity of data available to be used here. Given the paucity of data, exacerbated by a high level of uncertainty, there cannot be any confidence in the predictions derived from the modelling which has been presented nor the impacts to springs and waterways assessed using the modelling.

Groundwater is a valuable resource for lands within the Lawson Creek catchment. The statements above relating to the value of surface water hold true for groundwater and its value in this region. It is not acceptable that such a significant loss will be experienced due to the proposed mine.

In conclusion:

- there is limited data on which to base groundwater predictions on and a high risk that springs and waterways which are the lifeblood in this area will be permanently impacted.
- the surface water assessment has some serious shortcomings, as it does not rely on valid data, has not presented appropriate modelling, has not considered climate change impacts and contains a number of misleading statements
- the proposal to use water sources from within the Bowdens' land holdings to supply the water for the proposed mine is fundamentally flawed. Not only does the analysis within this document demonstrate this finding, but a cursory review of the extreme dry periods experienced by the landholders within the Lue region would show that the water is simply not available. To use what little there is, is not a viable option and, while the surface water

assessment has failed to properly consider a dry year scenario, the fact is mine will not be able to operate in dry periods.

- the proposal to transfer water licences for use in this location is unsustainable for Lawson Creek, an already highly stressed waterway. It will have a severe detrimental effect on the water resources in this area and all those who currently rely on it.
- there are a number of the statements made in the 'Summary of Assessment Outcomes - EIS and Amended Project' in relation to water impacts which are quite simply incorrect.

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