MEMORANDUM - REVIEW OF MCPHILLAMYS GOLD PROJECT (SSD 9505) EIS AND APPENDICES: INDEPENDENT PLANNING COMMISSION (IPC) PUBLIC HEARING.

PREPARED FOR | Environmental Defenders Office

PREPARED BY | Hydro Geo Enviro Pty Ltd, Dr Ryan Vogwill, Director

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I acknowledge that I have read and prepared the following report in accordance with the adhere to Division 2 of Part 31 of the Uniform Civil Procedure Rules 2005 (UCPR), and the Expert Witness Code of Conduct (Code of Conduct) contained in Schedule 7 of the UCPR, both of which govern the use of expert evidence in NSW Courts and the Expert Witness Code of Conduct.

Expert Opinion

This review is of the Environmental Impact Statement (EIS) McPhillamys Gold Project (SSD 9505) in the context of an Independent Planning Commission (IPC) public hearing. This is in response to the document 221128 Letter to Ryan Vogwill - expert brief.pdf (Annexure A). In this matter I adhere to Division 2 of Part 31 of the Uniform Civil Procedure Rules 2005 (UCPR), and the Expert Witness Code of Conduct (Code of Conduct) contained in Schedule 7 of the UCPR, both of which govern the use of expert evidence in NSW Courts. Although the IPC public hearing is not a Court proceeding, the EDO office has the view that the Code of Conduct should be adhered to in this instance.

As a first point when my review refers to page numbers these are the PDF file page numbers and not the page numbers in individual documents contained within the PDF files. As part of this review I've reviewed the following documents:

- McPhillamys EIS Exec Summary.pdf
- McPhillamys EIS Main Report.pdf
- 2nd Amendment - Amendment Report - Main Report (Jun 2022).pdf
- 3rd Amendment - Amendment Report - Main Report (Oct 2022).pdf
- Appendix J - Surface water.pdf
- 1st Amendment - Appendix G - Surface Water (Sep 2020).pdf
- Appendix K - Groundwater.pdf
- 1st Amendment - Appendix H - Groundwater (Sep 2020).pdf
- Appendix C - SW and GW Interaction.pdf
- Groundwater Expert Review & Regis Responses.pdf
- Assessment Report.pdf

This review was focussed on surface water, groundwater and environmental impacts. It should also be noted that the time available for this review did not permit an exhaustive review of all other sources of publicly available information that may be relevant.

Part A of the expert review will consist of my general comments. Part B contains answers to specific questions posed by the EDO in their expert brief (Annexure A) followed by Part C contains specific comments in response to issues I have identified in the individual documents that I have reviewed.

Part A: General Comments

The Proponent seems generally considerate of environmental issues in their project design and has adequately collated and documented the environmental receptors/biodiversity assets. Relevant guidelines and policies are followed in the areas I've reviewed.

Flood risk is low to negligible. In fact, the project will reduce flooding risk (which is low regardless) for the immediately downstream areas.

Environmental impact of water at the water supply pipeline source (pre-existing mine discharge water) seems likely to be of low impact potential but it is unclear if any impact assessment for this is to be undertaken by the proponent. Regardless none has been provided but it is important to note that the imported water may introduce additional contaminants to those generated in-situ at the mine site.

Pipeline construction and operation (both water supply off site and water conveyance on site) are of low risk in terms of hydrological and hydrogeological impact if procedures and guidelines cited are followed. Any impacts from water supply pipeline will be of limited duration and can be managed with environmental protection measures (including underground drilling in defined stream sections) as proposed.

Surface water, monitoring network looks suitable. The groundwater monitoring network could use some bolstering which will be expanded upon below.

Most of the current impact assessment shortcomings relate to groundwater conceptual uncertainty with respect to the fractured rock nature of the aquifer not being explicitly assessed or included in the numerical modelling. There is also a lack of uncertainty analysis covering key predictions such as travel time for mine site contaminants (50m in 100 years) and the nature of the pit void as a potential flow through system verses a groundwater sink in perpetuity. These predictions are key elements of the EIS but we don't know what the range is in these potential impacts.

In terms of additional work required I would recommend:

- an expanded geochemistry/isotope study - the latter technique has had some preliminary application;
- tracer experiments;
- expanded aquifer testing regime and geophysics to better identify faults/fractures and their hydraulic status; and
- Assessment of the implications of the findings of these studies in the numerical modelling with detailed predictive uncertainty analysis.

Groundwater Modelling

I have reviewed the JBS&G review of the groundwater model and believe they have raised many valid points, the EMM Aegis response does not fully address the issues raised. One issue JBS&G raise, that has also been highlighted in my review, relates to the hydrogeological effect of geological structures (faults and fractures). Model sensitivity and parameter uncertainty for the groundwater model have been undertaken but the fractured rock nature of the aquifer hasn't been addressed in terms of conceptual uncertainty. This could be done for example by incorporation of the mapped faults as areas of high hydraulic conductivity, explicit conduits or through the use of horizontal anisotropy (higher hydraulic conductivity values in one horizontal direction than another). This means that a key groundwater transport mechanism (groundwater flow in fractures) has not been incorporated in the impact assessment, leading to an under prediction of the scale and magnitude of water quality impacts. As noted in the General Comments heading above, additional investigations and assessment are recommended to be undertaken to better identify areas of active fracture flow to more holistically quantify risk of impact.

The model also does not include local groundwater user's abstraction. While these local abstractions are not high volume, understanding the impact of the mine site on top of these abstractions is important to understand the cumulative impact on the surface water features and the surface water groundwater interaction.

Model recharge (downward flow of rainfall and surface water to groundwater) seems low and along with hydraulic conductivity forms a non-unique solution. If recharge was higher in the model then hydraulic conductivity would need to be higher (for the model to calibrate) and flow volumes (hence down gradient contaminant risk) would be higher. Storage properties have been estimated and effectively remain untested by a lack of transient model calibration or robust aquifer testing (i.e. using time or distance drawdown methods). The pit lake will act as a flowthrough lake after "400 years" (which is uncertain in terms of timing) the effect of which hasn't been modelled in terms of downstream discharge/contamination. Therefore, it would be preferable, from an off-site impact (risk of contamination) perspective, that the final void remains a groundwater sink in perpetuity.

A class 1 groundwater model has significant uncertainty in it that has not been holistically explored, as identified in their peer review (7_Appendix K - Groundwater.pdf pages 515 and 517-518) and the JBS&G review (10_Groundwater Expert Review & Regis Responses.pdf page 8). High uncertainty leads to increased likelihood of impacts manifesting differently to those precited both in terms of extent and magnitude of contamination.

Groundwater Impact Likelihood

The model currently does not definitively prove that contamination cannot move to the north east, although I agree with the proponent that this is unlikely (7_Appendix K - Groundwater.pdf page 190).

Impacts to the south of the mine site are likely and will be of the greatest severity. In the context of Section 9.3 of the EIS groundwater impacts are focussed on declines, it is important to note that increased groundwater levels can also cause impacts particularly if waterlogging/salinity/acidic drainage occurs. Otherwise, the impact risks have been highlighted. However, in my opinion these impact risks have not been comprehensively explored by the proponent's current analysis.

The waste rock dumps and pit void will interact with and contaminate the aquifer, but we only have one prediction of the extent of contamination with no assessment of uncertainty. Also, all TSF liners (clay or geo-membrane) do leak even if only via diffusion. Given the community concerns some tracer tests pre development would be helpful to better understand the hydrogeology and reduce community concerns. Also note that a lined TSF will reduce natural groundwater recharge so may impact springs etc in that context by reducing their flow/discharge if their recharge areas are covered by a lined TSF. Impacts will occur the only question is their extent and magnitude.

Acid Rock Drainage and Metal Contamination

Contamination risk is inferred by the proponent (7_Appendix K - Groundwater.pdf page 229) to be low due to mixing during down gradient flow. But this has only been assessed using analytical models, simple dilution calculations and predictions from a porous media only flow model. The 50m in 100 years prediction of the extent of downstream contamination output needs to have a greater exploration of sensitivity and uncertainty (including conceptual uncertainty) associated with this key prediction.

Numerous fault springs and faults/fractures have been identified in the area but porous media alone is assumed in GW models. This will affect contaminant travel time predictions as the fractured rock portions of the aquifer are dominated by conduits, these areas will flow faster than a porous media equivalent. I raise this in reference to the 50m in 100 years prediction of extent of contamination, which could be an underestimate. The structural geology shown on the Geology Map (Figure 7.1

_2_McPhillamys EIS Main Report.pdf page 270) shows the extent of fractures and faults. The highly variable water quality (salinity) in the springs and dams further reinforces the likelihood that fault/fracture conduits are active. I also note the dominance of sulphate in some of the water quality samples indicating ARD is already active, a component of which could be natural but this is unlikely as the area has already been disturbed and mined.

Also, what will happen after "400 years" if the pit lake becomes a flow through system? The timing of the pit lake potentially becoming a flow through system is also highly uncertain and this should be explored with the model sensitivity and uncertainty (see also Part B – Groundwater quality). This is important in the context of intergenerational equity and impact on cultural values. Also note that fracture/conduit hosted groundwater flow could migrate downstream much further and much quicker than in porous media (as modelled) but this has not been assessed.

Surface Water Impacts and Modelling

Sensitivity and uncertainty analysis of surface water models is lacking, in my opinion. In the 1st Amendment for Appendix G - Surface Water they have varied the volumes of surface water storages by +/- 20%, but the sensitivity of other model inputs (such as the balance of groundwater inflow verses outflow or rainfall) have not been tested.

They have used the range of observed rainfall data and a range of rainfall realisations of past data but climate change necessitates looking outside the observed range, in my opinion. I would like to see storages like the open cut pit have their predicted volumes (such as Figure 27 in Appendix J of the EIS) shown as well as the total storage capacity. This is particularly important in the early phases on mining when the pit will be shallow, and overflow is possible. However, the small upgradient catchment, proposed water diversions and storages suggest this a low risk of occurring.

With regard to sensitivity of other surface water modelling model parameters/inputs, more sensitivity testing is possible and would be helpful. For example, the uncertainty scenarios in the groundwater model used to generate a best, worst and expected case for GW inflow to the pit could be used in the sensitivity analysis for the void water balance modelling. A more detailed sensitivity analysis for the flow volume impact to downstream flow to Lake Carcoar would also be prudent but the impact near the mine is proposed to be larger (22% at the proposed Belubula Downstream gauging station) and may have some concerns for any local surface water users, particularly during drought conditions outside of the observed range of climate data. Surface water quantitative impacts are often quoted as percentage of average flows but the focus should be more on the impact on low flows and the impact on the duration of river flow.

Water courses in the mine project area are likely to be substantially degraded by the operations. How far this will extend outside the site is unclear but I would suggest it is possible that 1-2 kilometres downstream of the mine site will be impacted by altered water flow, and possible ARD. Rehabilitation of these areas will be unlikely to return the area to pre development condition. The TSF and pit lake will alter the hydrology/hydrogeology and some erosion (on site) and deposition in drainages is inevitable but the proponent is taking industry standard surface water management measures to minimise this. It is likely that drainages are already impacted by sedimentation due to land clearing. Metals and acidiferous drainage will cause impacts but the current modelling cannot robustly determine the extent of said impacts.

It also appears as though the version of the Australian Rainfall and Runoff (ARR) from 1998 was used, why have the updated ARR guidelines (2016 to 2019) not been used? Given that our climate is changing, and the new version of ARR has additional data incorporated, I would recommend that the new-revised version is used.

GoldSIM (the surface water modelling package used) cannot predict flow velocities (the speed at which surface water moves over the landscape), some assessment of this will be required to determine if rock armouring will be required on surface water storages and conveyances (except buried areas of pipelines). This is an issue that can be rectified in the next iteration of the surface water modelling and is more of an operational/maintenance issue regardless.

Climate Change

Climate change has the potential to impact rainfall/flooding/GW recharge. Annual rainfall predicted changes are small but are more extreme events (both rainfall and drought) predicted in this area? These events could be outside the range of observed natural variability and may affect some of the surface water and groundwater modelling predictions. Although the surface water and groundwater impacts assessments have considered the range of observed climate data, the only climate change implication the impact assessments have considered is that of reduced mean annual rainfall and increased evaporation. Also note the comments above under the Surface Water Impacts and Modelling heading.

Biodiversity Impacts

Although not core to my field of expertise, I have worked on impacts to biodiversity in many contexts both aquatic and terrestrial. A key impact is that on the biodiversity of high value (macroinvertebrate rich) springs in the area that the proponent plans to construct the proposed project infrastructure on. If these are culturally significant sites then this alone may be considered unacceptable to traditional owners. Currently these sites are inferred by the proponent (7_Appendix K - Groundwater.pdf page 8) to be associated with the shallow local flow system but this should be confirmed with an investigation if these sites have significant biodiversity or cultural values. The most biologically important waterways in the site (Type 1 and Class 2&3) will be covered by the TSF. Also, although dams weren't included in the waterways survey, due to a lack of fish passage in dams, they could have other aquatic biodiversity values of local importance and conducting surveys would have been prudent to address stakeholder concerns and obtain baseline data.

It is likely, based on my experience working in heavily cleared areas converted to agriculture, that many of these biodiversity assets have been degraded but that does not mean they have no value. These systems could be rehabilitated but not if they are covered by a TSF. Given its position in the landscape (high in the catchment) it is likely that riparian areas in the proposed mine site have not been as degraded as the system further down the catchment.

The fact that water quality breaches (according to ANZEEC) already exist shows that the existing mining (small scale hand dug workings) has already had an impact. This suggests large scale mining will have additional water quality impacts. Care needs to be taken in interpreting these water quality data for determining action criteria/triggers for McPhillamys. The existing water quality breaches are not a true "background" as it appears the area is already impacted (2_McPhillamys EIS Main Report.pdf page 512 and 514). Some of the ANZEEC guidelines are based on the inherent toxicity of metals and need to be used unchanged in that context.

Part B: Specific Questions Posed in the Brief

a. Please summarise any surface water and ground water impacts to arise as a consequence of the Project.

Answer

Groundwater - Quantity

Drawdown from the mine is not expected to significantly impact any nearby water users but will reduce surface water flow and may impact some small areas of groundwater dependant ecosystem in the project area. I agree with many of the concerns in the JBS&G review (10_Groundwater Expert Review & Regis Responses.pdf) of the groundwater modelling and don't believe some of these have been sufficiently resolved in the proponent's response. Hence impacts may be greater than predicted in the proponent's worst-case scenarios in the model.

The JBS&G review (pages 7-8) summary concerns relate to:

- requirement for a Class 2 groundwater model;
- presence of geological structures and effect on hydraulic conductivity values;
- regional boundary conditions and aquifer hydraulic properties; and
- if a subjective probability approach it to be used for model uncertainty then multiple parameters should be changed forming scenarios such as 'significant fracturing' scenario or a 'limited influence of Godophlin Fault'.

Groundwater - Quality

Groundwater quality in the mine area will degrade because of the project, with the main potential issues being ARD, with lower pH, increased acidity and metal contamination. The pit, TSF and waste rock dump all have potential to contribute to this. The current prediction of 50m in 100 years maximum extent of groundwater movement is not robust and has no estimate of uncertainty in this key prediction. The presence of fractures and other matters of conceptual hydrogeological uncertainty could end up with contamination moving much further than 50m and will eventually migrate offsite, particularly if the final void lake ends up as a flow through system as the proponent has indicated is possible (see also above at Part A – ARD and Metal Contamination).

Surface Water - Quantity

Predicted impacts are reasonable (22% near the mine and 5% flow reduction at Carcoar Dam) but the sensitivity of the relevant model has not been widely tested so these figures still have uncertainty. How much uncertainty there is in these predictions is unclear as the sensitivity/uncertainty analysis has not been done. With the current data/analysis risks appear low as the area where surface water flow has been disturbed (i.e. the mine site) represents only a small part of the catchment for Carcoar Dam so impact to the dam should be relatively small. Local (immediately downstream) impacts could however be more severe. Sensitivity to the observed climate has been tested in the surface water models but see comments on climate change below.

Surface Water - Quality

There will be an increase in metal contamination, acidity and reduced pH. There is ample evidence that existing-historical mining has caused impacts already. The magnitude of impacts to surface

water quality will depend on the magnitude and extent of groundwater quality impacts (as groundwater discharges to surface water systems including springs and seepages) which have significant uncertainty as described above. The mine is proposing to put in best practise surface water management by, for example, separating clean and mine-affected runoff and restricting off site discharge of mine affected water while diverting clean water around the mine. Also, the catchment area upgradient of the mine is small so the risk of off-site contamination from mine affected surface water discharge appears low based on their assessment.

b. Please summarise any impacts on groundwater dependant ecosystems.

Answer

A number of groundwater dependant ecosystems will be destroyed in the project area. Those not buried or excavated (particular springs and seeps) may also experience altered flow and reduced water quality. Environmental values at an EPBC/national significance level should not be impacted but areas of local (and cultural) biodiversity significance will be impacted. Important to note the area has already been impacted by historical mining and agriculture, so the current environment is not pristine.

c. Have the impacts of climate change on groundwater and surface water been adequately and accurately considered?

Answer

Although the surface water and groundwater impacts assessments have considered the range of observed climate data, the only climate change implication the impact assessments have considered is that of reduced mean annual rainfall and increased evaporation. This is a good start but the nature of climate change is such that the range in the observed record does not capture what potential impacts may occur from extreme events outside this range. The existing models should be used to look at the impact of the project during a prolonged drought or rainfall period.

d. In your opinion, does the Department's Assessment Report and Recommended Conditions of Consent accurately and adequately consider, and respond to, the impacts you have identified?

Answer

Partially. Although the conditions will allow impacts to be detected, the various management plans won't be fully developed until after the approval is given. I would prefer to see the management plans more fully developed and the impact assessment improved prior to approval. The lack of transient groundwater model calibration could have been addressed if a transient dataset was collected over the last 5 to 10 years and this project has been active for some time. If impacts manifest in excess of those predicted in the EIS it will be very difficult to "turn off the tap" in terms of environmental impacts. Impact to other water users in the area can be managed regardless, it's just a question of cost for importing or treating water.

e. What, if any concerns do you have about the impacts you have identified, bearing in mind the mitigation measures proposed?

Answer

My opinion is that the fracture-based groundwater discharge of contaminants will lead to impacts in excess of those predicted in the EIS, but how much worse is unclear with the existing data and analysis. Given the area's geology and the number of springs present is it clear that the groundwater is moving via porous media and fracture flow however, the groundwater modelling does not incorporate fracture flow. Other techniques such as:

- an expanded geochemistry/isotope study - the latter technique has had some preliminary application;
- tracer experiments; and

- expanded aquifer testing regime and geophysics to better identify faults/fractures and their hydraulic status

could have been applied to improve the impact assessment.

f. Provide any further observations or opinions which you consider to be relevant.

Answer

The pipeline construction is of low risk of hydrological and hydrogeological impact in my opinion.

The importation of water from offsite may have impacts at the source not addressed in the EIS. The use of this water may also introduce other potential contaminants to the mine site and surrounding areas.

Based on the level of assessment undertaken so far, in my opinion the proponent is seeking approval for a major project prior to undertaking transient calibration of impact assessment models, incorporating conceptual uncertainty due to fracture flow and robust aquifer testing. In my professional opinion, this is poor practise and the proponent should be required to have robust aquifer testing, transient calibration and incorporate the effect of fracture flow in all relevant impact assessment models prior to approval. Otherwise, the level of uncertainty in impact assessment is unacceptably high for a number of reasons in my opinion.

Data for a transient calibration could have been obtained (the project has been active for some time) and the scientific techniques mentioned in my response to question e above could have been applied to better understand the role of groundwater flow via fractures in their impact assessment. This would have reduced the uncertainty considerably.

Better predictions of the possible range of impacts would help regulators better balance the needs of development verses environmental protection (including protecting traditional owner cultural values) alleviating some stakeholder's concerns. With a more thorough analysis, based on more data, all important predictions could be framed in terms of their uncertainty. For example, currently the EIS states that contaminants can only migrate 50m in 100 years. With a better impact assessment this could theoretically be revised to between 20m and 1,500m (best estimate 50m) in 100 years.

The nature of the potential pit lake as a throughflow system also needs more exploration in terms of timing, uncertainty and the consequences of this for environmental impact. This is key issue that has not been addressed adequately in my professional opinion

It's a question of what the various stakeholder's appetites for risk are, typically local landholders and traditional owners understandably have a lower appetite for risk than proponents.

Part C: Specific comments with respect to individual documents (page references relate to the various file's PDF file page numbers)

This section presents specific points that have come up during the review with my comments. These specific points underpin my conclusions in the Expert Opinion Section above although given time constraints not all of the documents could be exhaustively commented upon but have been reviewed.

McPhillamys EIS Main Report.pdf (note I cannot extract text or images due to the security settings of the pdf)

Page 14 - Last Paragraph (50m of seepage in 100 years).

Comment - Uncertainty and sensitivity?

Page 115 - Paragraph 5 (pit refilling prohibitively expensive)

Comment - Some detail on why refilling the pit is prohibitively expensive is warranted, it's a bit vague.

Page 125 - TSF optimal geology

Comment - Although the low permeability of the site has been tested this has only occurred via slug tests and other single bore hole tests that are highly uncertain and cannot measure storage properties. This can only be improved using multiple bore hole aquifer testing (time drawdown or distance drawdown methods). The fractured rock nature of the aquifer has been noted but porous media equivalent has been assumed and only the latter incorporated in the modelling. Numerous faults and fractures have been mapped as propagating to the near surface with a N-S orientation could provide extensive and permeable conduits.

Page 128 - First Paragraph (alternative liner thickness)

Comment - Although a less permeable material at a lesser thickness can give an equivalently low permeability the thinner liner will be more prone to issues (resulting in leaks) during construction. Is any post liner testing proposed to ensure the liner is sound prior to filling the TSF? Geomembrane liners are good but are prone to leaks and tears during installation.

Page 128 - Groundwater Occurrence

Comment - Unsure that this is truly perched groundwater, which requires a permanently saturated portion of the aquifer to be underlain by a permanently unsaturated portion. In my experience it is more likely recharge migrating to the water table, which can move laterally seasonally in what is sometimes termed soil interflow. The fractured nature of the aquifer is just as likely to be causing this as opposed to truly perched groundwater. The presence of groundwater in test pits and bore holes will be controlled by the number of fractures intersected. Dry pits/holes can therefore occur in close proximity to those with groundwater inflow but do not represent "perched aquifers".

Page 130 - TSF design features (monitoring bores and backup capture bores)

Comment - If fractured rock-conduit type aquifers are hosting contaminated groundwater flow these will be hard to place such that they will detect and capture all flow due to the conduit nature of the aquifer. It is appropriate that downstream surface water is monitored but some tracer tests could be

undertaken (florescent dye etc) pre development to help understand the hydrogeology and contamination risk areas better.

Page 131 - Paragraph 4 (further geophysical investigations)

Comment - Increased drilling depth is a good safeguard but some more detail on the geophysical methods to be employed would be helpful to assess their feasibility.

Page 148 - Last paragraph (pipeline source water approvals)

Comment - Unusual for another proponent (Centennial Coal) to be managing the water source approvals however this agreement may have done a robust impact assessment. Water trades typically require a dedicated impact assessment, it is not clear how this is being managed.

Page 255 - iii Climate

Comment - no discussion of climate change which seems short sighted given the impact flooding or drought may have on the project's impacts.

Page 261 - Bathurst WWTP

Comment - Water supply from the Bathurst WWTP seems like it could have been a good option as it may have decreased downstream impacts at the Bathurst discharge site and won't be affected by water quality issues inherent in a coal mining area.

Page 262 - Upper Lachlan Alluvium Zone 2

Comment - This contingency will need environmental impact assessment. None is provided or references cited.

Page 304 - Second paragraph (ephemeral fluvial system with stagnant pools)

Comment - As described many have been converted to dams (but not all) and these may have some biodiversity value as they are. Agreed they are heavily impacted by previous land use/activities. They will certainly be important local drought refugia for fauna at least.

Page 316 - v Groundwater Monitoring Network and Figure 9.6.

Comment - Network is sparse on the south side (pit impacts) and very sparse (inadequate) on the north side (TSF impacts). Are the other land holder bores proposed to be monitored also? This is important to help ensure GW quality doesn't degrade, current impact assessment very focussed on drawdown.

Page 316 - Last Paragraph (low yielding aquifers and inability to undertake time-drawdown or distance-drawdown aquifer testing).

Comment - I disagree, this can be done with the right (closely spaced) infrastructure and low yielding pumping. It would be helpful to identify not only hydraulic properties but barrier and recharge boundary which would help understand the impact of fractures and faults.

Page 321 - Last paragraph (dissolved metal concentrations)

Comment - Although dissolved metals in some sites are currently high, this does not represent a true (no impact) baseline as the area has be mined historically so it is likely that workings, waste rock etc

have already contaminated the area to some level. This shows the capacity for the disturbance of the area's geological material to manifest as ARD and not be completely buffered by Non-Acid Forming (NAF) rock types present on site. ANZEEC guidelines can be used to develop local WQO's and triggers but caution needs to be taken with parameters such as toxic metals that have intrinsic limits on some organisms.

Page 325 - Second Paragraph (Fault Springs)

Comment - It is an important finding that there are fault springs present in the area which confirms faults (and fractures) as important mechanisms for groundwater transport. During low flow periods these conduits will be important as groundwater discharge will be an increased component of the surface water so any contaminants (primarily metals) will have increased impact potential. Currently spring sites only have an inferred level of hydrological understanding, this needs confirmation with further investigation as these are important and sensitive receptors.

Page 332 - 9.3 Assessment Approach (Groundwater Criteria)

Comment - Increased groundwater levels can also cause impacts, currently focussed on groundwater level declines. Water quality guidelines need to be developed (and Regis propose to do this).

Page 335 - Flooding

Comment - They have interpreted the impact of a 10% AEP flood to be sufficient, but I would have thought that 1% would be more appropriate (and what I would have done). For closure 0.1% AEP (1:1000) is typically required in WA if pits are proposed to be permanent (unfilled). Not a high-risk issue given the position of the project high in the local landscape, hence the upgradient surface water catchment is small so runoff volumes will be small compared to those further down the catchment.

Page 336 - i Site water balance and page 337 b Climate Change effects

Comment - This modelling is only based on historical climate and in the context of climate change the past cannot be considered as a comprehensive range for what the future holds. I do not consider assessment of a 1:20 (5%) AEP sufficient in this context.

Page 336 - ii Final void water balance

Comment - Goldsim isn't a particularly robust model in the context of predicting impacts as it is a lumped parameter model (not a physically based and distributed parameter model). It is fine for mine water balance but will not be able to sufficiently predict impacts in my experience. The limited size of the catchments upstream/upgradient of the mine site limit the impact this has but it is still not a robust tool. A rain on grid modelling solution would have been a more robust tool in the context of flooding and mine void SW inflows. Also, again note the comments above about the data used and climate change.

Page 358 - Last paragraph (TSF verses springs)

Comment - I generally agree with this statement, springs will be destroyed (buried) and others will form but water quality will be worse.

Page 362 - Only paragraph (summary statement on SW flow impacts).

Comment - Agreed the predicted reductions are small compared to current allocations but an extended drought may increase the flow reductions caused by the mine relative to downstream flow/allocation. This section is also missing an assessment of how utilised the Carcoar dam itself is, if the dam is heavily utilised by other water users the mine reductions could be more significant.

Page 365 - 5th paragraph (seepage velocity 50m in 100y)

Comment - Note previous comments about potential for this to be quicker in a fractured rock environment. It is "predicted" to stay in the saprock zone but it is unlikely with the Class 1 groundwater model that this has a high degree of certainty. Next paragraph talks about dilution and makes some simplistic calculations on dilution, but the mixing will be less in a fractured rock aquifer relative to the modelled porous media flow. This is relevant for flow from the TSF, stockpiles and water storages.

Page 366 - iv External water supply via the pipeline

Comment - given the source is a coal mining area there is potential for there to be low pH and metals. Are elevated nutrients or other potential contaminants present? A more holistic assessment of this water source than just EC is required.

Page 375 - 9.7.1 Water management plan

Comment - The WMP is an important consideration, currently these are not prepared and will only be prepared post approval. An indicative or preliminary WMP could have been prepared at least and some criteria proposed. This may help reduce community concerns.

Page 376 - Monitoring

Comment - Some of the monitoring proposed therein would have been useful for the EIS, particularly the comprehensive spring monitoring program.

Page 490 - Groundwater dependant ecosystems

Comment - Although I generally agree with these comments, they don't have a great dataset to inform the model with respect to depth to groundwater across the whole area (not a synaptic snapshot and not lots of transient data/groundwater levels through time). The depth to groundwater is mostly predicted via an uncertain Class 1 groundwater modelling. Consequentially some additional areas may be groundwater dependant, particularly in drainages.

Page 509 - Section 14.4.2 Survey Results (Aquatic biodiversity)

Comment - Most biologically important waterways in the area (Type 1 and Class 2&3) will be covered by the TSF. Also, although dams weren't included in the waterways survey, due to a lack of fish passage in damns, they could have other aquatic biodiversity values of some local importance. Agreed that all these ecosystems have been degraded but that does not mean they have no value and cannot be rehabilitated. Given its position in the landscape (high in the catchment) it is likely that riparian areas in the mine site have not been as degraded as the system further down the catchment (nutrients and sedimentation).

Page 513 - Section 14.5.5 ii

Comment - Given the model is class 1 and some conceptual uncertainty issues exist (presence of fracture conduits not accounted for in the modelling) these predictions of impact level need to be taken with the uncertainty with which they were generated.

2nd Amendment - Amendment Report - Main Report (Jun 2022).pdf and 3rd Amendment - Amendment Report - Main Report (Oct 2022).pdf

Comment - No material changes relevant to this review.

Appendix J - Surface water.pdf

Page 25 - First paragraph (Copperhania Fault Zone)

Comment - As stated the faults are defined by strong shearing and faulting which continues to the south for over 6km, this reinforces the risks posed by fracture conduits for contaminated groundwater movement.

Page 33 - Table 9 (Summary of Surface water Quality Data) and Table 10 (Summary of Regional Surface Water Quality Data)

Comment - The monitoring presents a suitable water quality baseline but the area has been impacted so not indicative of “pristine” conditions.

Page 39 - 2.8.3 Surface Water Groundwater Interactions

Comment - Paragraph 2 and 3 contradict each other. The stream can’t all be a losing type” (i.e. discharge only occurs from the stream to the aquifer) when 5% of the surface water comes from groundwater. During low flow periods this percentage may be higher but the existing analysis hasn’t focussed on this.

Page 72 - End of paragraph from previous page (contaminant recovery).

Comment - where fractured rock conduits are active these bores may have limited ability to recover seepage and will also increase drawdown impacts.

Page 79 - 3.1.3 Development/Construction Water System

Comment - The proponent's proposed sediment trap installation and maintenance is in line best practice.

Page 96 - first paragraph (post mining rehab)

Comment - It is proposed that the final void catchment will not be rehabilitated and the rationale for this is unclear. To increase runoff into the void is the main reason that comes to my mind but some more explanation of this is required to understand their rationale.

Page 96 - Key Data and Assumptions (pit void model) 3rd dot point

Comment - If a pan correction factor (a scaling factor for pan evaporation data to evaporation flux) of 0.7 is used for dams and streams why would the shading effects in the pit result in the same correction factor and then when the pit is near full (10m below spill way) full pan evaporation is used. These choices of scaling factors for evaporation seem contradictory and illogical. For example,

dams and streams are more likely to evaporate at a higher rate than a deep mine void that is shaded and has restricted wind effects on evaporation. They are saying the evaporation rate for these features is the same. Then once the mine void has got within 10m of being full this water body will evaporate more than dams and streams.

1st Amendment - Appendix G - Surface Water (Sep 2020).pdf

Page 7 - 1.2 Project Amendment Overview

Comment - Looking at what has been revised none of these changes are material to the content of my review in the context of surface water with the following exceptions.

Page 95 - 4.1.1.2 Belubula River Flow Modelling

Comment - The model refinement is good and has improved calibration but this refinement shows how sensitive the surface water model is to changes. The incorporation of one set of sensitivity scenarios (surface water storages +/- 20%) is a good step forward but sensitivity scenarios across a greater range of surface water modelling parameters and inputs are required.

Appendix K - Groundwater.pdf

Page 7 - 2nd Paragraph in ES2 Water Resources (fractures generally being clay filled in the saprock)

Comment - Some are still potentially active according to this statement and no mention is made of the fault/fracture conduit status in the unweathered material. Would be helpful to have a map of thickness of weathered material and faults. Aquifer testing could help understand the hydraulic status of fractures/faults.

Page 7 - Last Paragraph in ES2 Water Resources (groundwater quality)

Comment - pH of 2.2 is definitely indicative of ARD, what was the SO4/Cl ratio at this site? High dissolved metals may not be 100% “naturally high” as the area has had mine workings previously. The existing metal data may act as a baseline pre project but it is unclear what the true background is for metal concentrations due to the disturbed nature of the site.

Page 8 - 2nd Paragraph (hydraulic testing)

Comment - A more robust aquifer test could have been undertaken in the low hydraulic conductivity aquifer, it just needs purpose designed infrastructure that is much more closely spaced (between pumping and observation bores) than is typical.

Page 9 - 1st Paragraph (changes to springs)

Comment - I agree that the springs aren’t EPBC level biodiversity assets however they may have local significance particularly to traditional owners.

Page 9 - 2nd Paragraph (Seepage from TSF)

Comment - Note previous comments on the effect of the fractures and the fact the model is modelling the whole area as porous media flow. I think this is an area where more impact potential than stated exists. How much is unclear with the existing data and assessment. The waste rock dump (minor) and pit (more significant particularly in the early mining phases before the pit has become a

groundwater sink and later if it becomes a flow through system) also have potential to discharge contaminants to the river.

Page 49 - 3.4.3 Surface water quality.

Comment - The highly variable water quality (salinity) in the Anson Formation (referring forward to Figure 4.19) springs and dams further reinforces the likelihood that fault/fracture conduits are active. Also note the dominance of sulphate in some of the water quality samples (including Anson Formation referring forward to figures 4.9 and 4.10) indicating ARD is already active, a component of which could be natural but this area has already been disturbed and mined so not this is not all natural.

Page 49 - 3.6.4 Groundwater level and flow direction

Comment - Is the timing of the WaterNSW data collection consistent with the Regis data? if not this may introduce some inaccuracy as the data are not from the same time period so may be +/- a few meters. May not change the flow pattern significantly but worth noting if this is the case.

Page 80 - Groundwater monitoring network

Comment - Network is sparse on the south side (pit impacts) and very sparse (inadequate) on the north side (TSF impacts). Are the other land holder bores south of the project and other bores external to the site (north side) proposed to be monitored also? There is also a bias towards deep monitoring bores, given the risk of contamination from the TSF and Waste Rock Dump (WRD) will start in the shallow aquifer (saprock and top of fractured rock) more shallow bores would help identify contamination before it migrates deeper or off site. The proposed monitoring network needs expansion in my opinion.

Page 86 - Table 4.4

Comment - Note that the range is very similar and the maximum hydraulic conductivity is slightly higher in the Anson Fm saprock (max 1.3) than in the Anson Fm (max 0.5) which contradicts statements that the hydraulic conductivity is lowest in the weathered zone. It appears as though this aquifer is highly heterogeneous.

Page 88 - 3rd Paragraph (Faults)

Comment - I agree that faults can be barriers or conduits and I think the nature of faults should be tested with a purpose designed aquifer testing program, as per previous comments this can be done.

Page 115 - iii Dissolved metals nutrients and hydrocarbons

Comment - Note the metal concentration and water quality guideline exceedances in some analytes for the Anson Formation saprock verses the fresh rock indicating oxidation is occurring in situ.

Page 137 - 4.7 Surface water - groundwater interactions

Comment - the baseflow (Section 4.7.1) versus the springs (Section 4.7.2) sections contradict each other with respect to groundwater inflow to the river tributaries. Are not all of the seeps and springs connected to the river system some of the time?

Page 143 - Table 4.23 Inferred spring type

Comment - 18 of the 35 springs are identified as fault type or possibly fault type springs. Important context for the activity of faults as groundwater conduits. Also note that the locations of faults as mapped on figures 4.28, 4.29 and 4.31) don't always line up with the locations of interpreted faults so other features (joints/fractures or smaller associated fault splays) may also be active as groundwater conduits.

Page 157 - 5.2.1 Groundwater quantity and 5.2.2 Groundwater quality

Comment - If the pit lake is connected to faults/fractures that are conduits this could allow some outflow from the pit that would be on top of the porous media flow. This may alter the void water balance and could also provide a source of low pH, higher salinity and metalliferous discharge down gradient.

Page 158 - c Water affecting activity - Dust suppression

Comment - This higher salinity water will mostly evaporate and will produce elevated soil salinity and the salts will be flushed to the aquifer during winter rainfall. This may increase aquifer salinity but is not noted in their text. There may be other contaminants in the water proposed to be used for dust suppression that could impact water quality.

Page 160 - c Water affecting activity - Rehabilitation

Comment - If the pit ends up as a flowthrough system there will be a significantly elevated risk of down gradient contamination.

Page 161 - Table 5.3

Comment - Cultural values can also be associated with the terrestrial vegetation.

Page 173 - Open cut mine post mining (boundary conditions)

Comment - In the post mining phase this could be represented by a third type boundary condition to help better predict pit lake level, inflows and outflows. I think this would be more robust than the GoldSIM modelling.

Page 175 - 5.4.3 Model design and limitations

Comments - Faults are not simulated, this affects the robustness of downstream impacts. Storage parameters are estimates as no aquifer testing (distance or time drawdown) have been completed.

Page 176 - Calibration

Comments - No transient calibration so storage is effectively uncalibrated. The groundwater model has high residuals (the difference between observed and predicted data) with many of the bores used for model calibration having residuals greater than 2m and as much as 40m. Transient hydrographs predicted by the model show no variation, hence the model is not simulating recharge/discharge dynamics with any degree of robustness.

Page 228 - First paragraph (after table)

Comment - yes seepage water will mix with groundwater and be diluted but this dilution process will be more relevant in the porous media flow than in conduits, with the effect of the latter has not been modelled. The calculated concentrations (Table 6.10) are high speculative.

Page 515 - Appendix H Model Peer Review

Comment - The reviewer states that uncertainty analysis categorised as basic and is considered arguably adequate. The use of "arguably adequate" still does not mean definitely adequate. I would consider this model suitable at a pre-feasibility level but not for project approval impact assessment level particularly due to the lack of inclusion of fracture based groundwater movement. It comes down to what an individual's appetite for risk is and my appetite for risk is clearly lower than the reviewer.

Page 517 - 5 Sensitivity and Uncertainty in Model Peer Review

Comment - I agree that the sensitivity and uncertainty analyses need to be extended to other parameters. The use of PEST (Parameter estimation software) is also supported for a more robust uncertainty analysis.

1st Amendment - Appendix H - Groundwater (Sep 2020).pdf

Comment - No comments as there appear to be no matters of significance in the amendment from my perspective.

Appendix C - SW and GW Interaction.

Comment - reviewed but no addition comments on top of those for other reports. Most of this information has been included in the groundwater, surface water and EIS documents.

Groundwater Expert Review & Regis Responses.pdf

Comment - Reviewed but not directly commented due to a lack of time. JBS&G raise many relevant issues but only some of these have been satisfactorily addressed by EMM. I would note that current data for the site is not sufficient to address all concerns.

Assessment Report.pdf pages 47-64.

Overall - this document is an effective summary of the Aegis and EMM EIS and appendices.

Page 69 (58) - Final void would continue to function as a groundwater sink.

Comment - EMM has indicated that the pit lake could end up functioning as a throughflow system in about 400 years but the model's uncertainty indicates it would be worth assessing if this could occur in a more rapid time frame. Another case of a critical prediction being presented with no measure of uncertainty.

Environmental Defenders Office

28 November 2022

Ryan Vogwill
Director and Principal Hydrologist
Hydro Geo Enviro

By email only: [redacted]

CONFIDENTIAL AND PRIVILEGED

Dear Mr Vogwill

Brief to expert – McPhillamys Gold Project (SSD 9505): Independent Planning Commission (IPC) public hearing

1. We act for the Belubula Headwater Protection Group (**BHPG**) in relation to the McPhillamys Gold Project (**Project**). The BHPG is a large community organisation, representing members who reside in the area of the proposed Project, including local farmers and Aboriginal people. Our client and its constituent members strongly oppose the Project due to the impacts on the environment, Aboriginal cultural heritage and the broader social and economic fabric of the local community.

2. The Project has previously been on public exhibition through an Environmental Impact Statement Review process between 12 September 2019 and 24 October 2019. As a consequence of the assessment undertaken to date, the proponent has amended the Project three times. On 17 November 2022 the Department of Planning and Environment (**Department**) published its assessment of the Project and recommended that the Project be approved. The Project has now been referred to the Independent Planning Commission (**IPC**) for determination.

3. Our client wishes to engage you to review the surface water, groundwater and groundwater dependant ecosystems assessment conducted by the proponent Regis Resources Limited (**Regis**) and prepare an expert opinion on the appropriateness and adequacy of the assessment.

Duty to act as an impartial expert

4. We note as a preliminary matter that our primary purpose in briefing you to prepare your report is to provide independent expert advice in your area of expertise. We do not ask you to be an advocate for our client. You are requested to prepare an independent report that is clear and well-written.

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5. In this respect, we draw your attention to Division 2 of Part 31 of the *Uniform Civil Procedure Rules 2005* (**UCPR**), and the Expert Witness Code of Conduct (**Code of Conduct**) contained in Schedule 7 of the UCPR, both of which govern the use of expert evidence in NSW Courts. We understand that the IPC public hearing is not a Court proceeding, however, we are of the view that the Code of Conduct should be adhered to in this instance.

6. In particular, we note that clause 2 of the Code of Conduct states that:

> *An expert witness is not an advocate for a party and has a paramount duty, overriding any duty to the party to the proceedings or other person retaining the expert witness, to assist the Court impartially on matters relevant to the area of expertise of the witness.*

7. Please read these documents carefully before you commence the work requested. Please include in your expert report an acknowledgment that you have read the Code of Conduct and that you agree to be bound by it.

Scope of your expert report

8. We request that you undertake the following work:

   a. review the documents listed below at [13]-[15];
   b. prepare a written expert report that addresses the issues identified below ('Expert Opinion Sought' at [16]-[17]) and ensure that the work is prepared in accordance with Division 2 of Part 31 of the UCPR and the Expert Evidence Practice Note; and
   c. appear as an expert witness at the IPC public hearing for the purpose of giving evidence. Appearing at the IPC public hearing may be done via video link.

9. You will be required to register to speak at the IPC hearing, for a 15-minute timeslot by **5pm AEDT on Friday, 2 December 2022**. The online speaker registration form can be accessed here - IPC Hearing Registration to Speak. Please let us know once you have registered.

10. Our client intends to attach a copy of your expert advice to their own submission to the IPC.

11. Your expert report will be used as evidence in chief of your professional opinion. In providing your opinion you must set out all the assumptions upon which the opinion is based.

12. Your expert report must also set out the process of reasoning which you have undertaken in order to arrive at your conclusions. It is insufficient for an expert report to simply state an opinion or conclusion reached without an explanation as to how this was arrived at. The purpose of providing such assumptions and reasoning is to enable decision makers to make an assessment as to the soundness of your opinion.

Documents

13. Division 2 of Part 31 of the UCPR is available via the following link: https://legislation.nsw.gov.au/view/html/inforce/current/sl-2005-0418#pt.31-div.2. The Expert Code of Conduct contained at schedule 7 of the UCPR is available via the following link: https://legislation.nsw.gov.au/view/html/inforce/current/sl-2005-0418#sch.7.

14. Full Project documentation is available at the following website: NSW Government Planning Portal: https://pp.planningportal.nsw.gov.au/major-projects/projects/mcphillamys-gold-project

15. The following documents relating to the Project are provided for your consideration. We have highlighted key pages for your particular attention:

Environmental Impact Statement

a. Executive Summary
b. McPhillamys EIS Main Report (pp, 228-307; 408-411)
c. Appendix J - Surface water
d. Appendix K - Groundwater

Response to Submissions

e. Response to Submissions Report (pp, 34-73; 238-262)
f. Appendix C - SW and GW Interaction

Project Amendments

g. Amendment Report (1st Amendment) (pp, ES.2-ES.3; 53-54; 111-148)
h. 1st Amendment – Appendix G Surface Water
i. 1st Amendment - Appendix H - Groundwater (Sep 2020)
j. Amendment Report (2nd Amendment) (3, 19-20)
k. Appendix D - Updated mitigation measures (D.2-D.3)
l. Amendment Report (3rd Amendment) (3; 11-12)
m. Appendix D Project Mitigation Measures (pp, D.2-D.3)

Agency Advice

n. DPE & NRAR advice on EIS
o. DPE Water Advice on 1st Amendment (10 February 2021)
p. DPE Water Advice on 1st Amendment (22 June 2021)
q. DPE Water Advice on 1st Amendment (19 August 2021)
r. DPE Water advice on 2nd Amendment
s. DPE Water advice on SPAL Package
t. DPE Water - Reduced Inflow to Carcoar Dam Memorandum
u. DPE Water - Reduced Inflow to Carcoar Dam Clarification
v. DPE Water final advice and Recommendations (p, 3 of the PDF format)

Additional Information from proponent

w. Groundwater Expert Review & Regis Responses
x. Regis Response - Mine Site Land Contamination Assessment (p, 41)
y. Regis Response - Agency Advice on RTS & 1st Amendment Report (20-27)
z. RTS & 1st Amendment Report
aa. DPE Water & NRAR Advice & Regis Responses

Department's Assessment

bb. Assessment Report (pp, iii-ix; 47-64)
cc. Recommended Conditions of Consent (pp, 15-19)

Expert opinion sought

16. Within the constraints of the time available, please prepare an expert report that addresses the following:

    a. Please summarise any surface water and ground water impacts to arise as a consequence of the Project.
    b. Please summarise any impacts on groundwater dependant ecosystems.
    c. Have the impacts of climate change on groundwater and surface water been adequately and accurately considered?
    d. In your opinion, does the Department's Assessment Report and Recommended Conditions of Consent accurately and adequately consider, and respond to, the impacts you have identified?
    e. What, if any concerns do you have about the impacts you have identified, bearing in mind the mitigation measures proposed?
    f. Provide any further observations or opinions which you consider to be relevant.

17. We request that you provide us with a draft of your report for review before finalising it. The purpose of this is not to influence the conclusions or recommendations you make but to ensure that the report is clear and addresses the issues adequately to inform the IPC.

Key dates

18. The IPC hearing for the Project will be held on **Thursday 8 and Friday 9 December 2022**. The deadline for registering to speak at the IPC hearing is **5pm AEDT on 2 December 2022**.

19. The deadline for making a written submission to the IPC is **5pm AEDT on 21 December 2022**. To allow our client sufficient time to complete their own submission, we would appreciate receiving your advice by **19 December 2022**.

Duty of confidentiality

20. Please treat your work as strictly confidential until your expert report is provided to the IPC, unless authorised by us.

Fees and terms

21. Thank you for agreeing to provide your advice on a capped fee basis of $4,400 (incl. GST). As a not-for-profit environmental legal centre, EDO relies on the support of experts such as yourself in ensuring that the community is able to obtain independent scientific advice on environmental issues.

22. Please note the following terms:

    a. Your work will only be used by EDO in relation to the above matter, unless your consent is obtained first;

    b. Our client may choose to make your expert report publicly available. Your report will also be publicly released by the IPC on the IPC's website;

    c. EDO will take all reasonable steps to prevent your work from being used for purposes other than that mentioned above, but we accept no responsibility for the actions of third parties and note that your report may be disclosed by the *Government Information (Public Access) Act 2009* (NSW) (akin to a "freedom of information" request);

    d. Regardless of the above points, EDO may choose not to use your work; and

    e. You will not be covered by the EDO's insurance while undertaking the above tasks.

23. If you require any further assistance, please call or email either myself [redacted], or Sharyn Goldstien, Scientific Director via email at [redacted]

24. We are grateful for your assistance in this matter.

Yours sincerely
Environmental Defenders Office

[redacted]

Nadja Zimmerman
Solicitor
Our ref: S493

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