McPhillamys Gold Project
Environmental Impact Statement

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Acknowledgment,
I have read the Expert Witness Code of Conduct in Schedule 7 of the UCPR and agree to be bound by it.

Documentation relating to the McPhillamys Gold Project Environmental Impact Statement for the proposed construction and operation of an open cut gold mine has been viewed and and evaluated with reference to the following sections: McPhillamys EIS Exec Summary, Appendix J- Surface water, Appendix O – Aquatic Ecology, Appendix R – Mine Preliminary Hazard Analysis, Appendix X – Pipeline Water.

The quality of the EIS documentation provided and experience of qualified personnel having conducted the work are both appropriate and at the level required for an EIS.

Critical comment can be made on EIS sections relating specifically to the following:
- Water quantity of existing surface water in the project area
- Baseline water quality guidelines
- Potential risk from additional input to existing disturbed aquatic environments at risk

Surface water quality

The EIS adoption of the ANZECC (2000) guideline values for 80% level species protection in south-eastern Australian upland rivers, and for Primary Industries water supplies is valid, particularly based on the documented evidence of existing ecological disturbance in the river catchment. However, in comparison to aquatic invertebrates, freshwater finfish are more sensitive to poor water conditions. If there is likelihood of native fish species presence, as indicated in Appendix O, the higher protection level of 90% should then necessarily be considered.

Recommendation in the EIS relating to the derivation of site specific Water Quality Objectives (**WQO**) (Appendix J Section 2.8.2, p.29) states that WQO should be generated from the monitored site data rather than the current ANZECC-derived NSW WQO. If a site specific WQO based on current water quality measures was used to set future WQO, the current values would be implicitly accepted as representing the 'normal' condition. The primary concern is that values from the site survey for specific variables (Attachment A), exceed the ANZECC trigger values indicating poor water quality relevant to a South-eastern Australian upriver freshwater system. The tenet that the ANZECC (2000) guidelines values are not representative of the site specific baseline values and therefore should not be used but altered to accept the poorer site specific condition values presents inherent risk. The ecological area is degraded to some extent, but not unusual or a unique environment that would require derivation of site-specific guidelines. Additionally, the statement that surface water baseline conditions are not available for comparative evaluation of impact related to the pipeline construction (Appendix X, Section 5.3.5, p.47), also requires clarification as the existing *in situ* water quality conditions of water bodies in proximity to the pipeline are quantifiable, providing the necessary 'before' baseline, against which 'during' and 'after' comparisons can be made.

Using the current measured water quality values as a baseline reference condition for 'before and after' impact monitoring is acceptable. However, using the current values as a baseline for 'normal' and thus implied 'acceptable' condition underestimates the predicted risk from elevated nutrient loading already present, in particular Total Nitrogen (TN) and Total Phosphorus (TP), which indicates potential for algal blooms, eutrophication and accompanying deoxygenation of the water column. Nutrient enrichment can lead to blooms of algae and aquatic plants resulting in both deleterious ecological impacts and loss of amenity. Onset of blooms is generally associated with warmer seasonal conditions linked to longer photosynthesis hours, and / or sudden flushes of storm water resuspending N and P stored in sediments. Sediment nutrient load effectively acts as a storage sink until a rapid storm pulse or flush resuspends the load to the water column.

ANZECC (2000) trigger values indicate accepted levels above which an adverse outcome is likely to be triggered. The surface water nutrient data recorded in Appendix A is expressed as a 'total' measure, which includes particulate and dissolved forms of the elements present in organic detritus, dissolved organic compounds or single inorganic ions such as nitrate, ammonium and phosphate. It is this soluble or readily bioavailable fraction of the total load, that provides a greater specificity for evaluating potential risk, and as such the total measure is generally less accurate. However, total values presented in Figures A15 and A16 (p A9) can be useful to calculate the potential for nutrient pollution in a waterbody. The ratio of total nitrogen to total phosphorus can indicate whether algal growth is likely to be limited or enhanced, which is particularly relevant in relation to potential eutrophication (Dodds et al.(2010). A Redfield N:P ratio for example could be used for brackish waters for example to identify if the ratio exceeds N/P =7 there is potentially excess nitrogen available and supply of P is limiting growth. Figures A15 and A16 show that N levels generally exceed P levels. If the ratio dropped to less than 7, the water would then become nitrogen limited. However, if or nitrogen fixing microorganisms such a blue green algae (cyanobacteria) are present, then P again would necessarily be the limiting factor for onset of rapid microalgal growth. Consequently an elevation in P from either an additional storm water-derived or sedimentation-derived input to the water body could rapidly shift the N:P ratio to enable optimal conditions for a microalgal bloom to occur. Depending on the algal or blue-green cyanobacteria species, particularly if it were *Anabaena* or *Microsystis*, the resultant bloom could produce a highly toxic water body.

Potential for acidification of the water bodies is also evident with a number of recorded pH levels below 7. The risk with further drop in pH towards acidification can exacerbate movement of previously bound metals into solution which then become readily available to organisms. Aluminium for example is presently above the ANZECC guideline trigger value (Appendix J), indicating an existing potential for metals toxicity in finfish. Additional inputs from construction activity or process discharge that could contribute to either a further reduction in pH of the surrounding surface waters, or an elevation in salinity of existing brackish conditions in some sectors (Appendix J), needs to be addressed.

The statement in the Executive Summary (ES.8) that any seepage from the tailings storage facility (TSF) that might migrate through the hydrostratigraphic units [which indicates a degree of porosity or permeability of the rock structure], and which could potentially enter the Belubula River, will have concentrations below the baseline ANZECC surface water quality 80% protection level "for analytes with elevated concentrations in the tailings liquid fraction results". This statement is not clear and requires clarification as to the specific analytes ie. which specific chemicals or suite of chemicals from the tailings waste are being referred to, and the predicted concentrations that could contribute to the existing chemical loading in the river.

The water quality data provided in the EIS does not include measures of the oxygen status of surface or ground waters where present. Despite surface waters being described as relatively shallow and occasionally intermittent, shallow water streams and pools are important as reservoirs or refuges for connectivity when environmental flows are high enough for connectivity to occur. Anoxic pools can establish relatively rapidly during periods of low environmental flow (Coates et al, 2009), particularly when the biological oxygen demand (BOD) exceeds the available dissolved oxygen. Some images of streams and dams presented in Attachment B indicate a limited littoral buffer zone, evidence of grazing up to the water's edge, and proliferation of aquatic plant or algal growth. Whilst not intensive, farming activity including livestock –mediated erosion (Appendix O), and probable livestock-derived organic waste input into shallow, low volume water bodies is important to consider in terms of contribution to what appears to be an already enriched N and P sink (Appendix J), and potential deoxygenation condition. Nutrient enrichment of waters and sediments in temperate upland freshwater systems doesn't otherwise occur unless a significant external nutrient load is added. Waste organic material is subject to bacterial degradation, the efficiency of which is constrained by the organic material itself and oxygen availability at the sediment water interface and water column above the sediment. When biological oxygen demand from decomposition of deposited organic waste by oxygen utilising bacteria exceeds oxygen supply, anoxic conditions in sediments and overlying waters are established. Increased incidence of anoxic (zero dissolved oxygen, DO) and hypoxic (less than 2.0 mg/L DO) events indicates the nutrient input is exceeding the carrying capacity of the surface waters.

Extended anoxic conditions, particularly during low flow, warm water conditions facilitate anaerobic bacterial respiration production of hydrogen sulphide. Nitrification, which is the process in which bacteria oxidise ammonium, from breakdown of proteins, to nitrite and nitrate, is inhibited under anoxia or exposure to hydrogen sulphide (Joye et al, 1995), causing a lowering of denitrification efficiency. As a result, nitrogen is recycled to the water column as ammonium. Both ammonium and hydrogen sulphide are toxic to oxygen requiring organisms, thereby adding to the potential toxicity load in the water column. Anoxia, ammonium and hydrogen sulphide generation indicates a significant decrease in river and dam sediment and water quality (ANZECC 2000), habitat modification, and loss of ecosystem integrity (National Land and Resources Audit 2008), supporting neither long term water quality nor ecosystem sustainability.

Sedimentation and burial of substrate and benthos, ie. plant and animal communities normally inhabiting the substrate, occurs when sediment or particulate matter is deposited more rapidly than tolerated by the benthic communities present. Elevated sedimentation equates to habitat loss for these community organisms. Increased sedimentation rates facilitate greater opportunity for anoxic degradation of organic matter present due to the decreased exposure to dissolved oxygen in the water column. Sediment –bound nutrients and toxicants also tend to increase in association with increased rates of sedimentation (Chenall et al, 1995) as a function of sediment adsorbed transport. It is likely that seasonal cycles of brackish salinity (based on the EIS electrical conductivity (EC) values documented), low oxygenated, warmer waters, alternate with fresher, cooler more oxygenated waters (Coates et al, 2009). Therefore, consideration of increased sedimentation loading during construction phases requires acknowledgement of probable effect both on environmental flows, and on the potential for significant seasonal alteration in oxic condition of refuge surface water habitats.

ANZECC/ARMCANZ (October 2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality. (www.ea.gov.au/water/quality/nwqms/#quality)

Chenhall BE et al (1995) Anthropogenic markers evidence for accelerated sedimentation in Lake Illawarra, New South Wales, Australia. Environmental Geology 26, 124-135.

Coates MJ and Mondon JA (2009) Effect of environmental flows on deep. Anoxic pools. Ecological Monitoring 230, 1643-1651.

Dodds WK and Whiles MR (2010) Freshwater Ecology Concepts and Environmental Applications of Limnology, Academic Press pp.437-467.

Joye SB and Hollibaugh JT (1995) Influence of sulphide inhibition of nitrification on nitrogen regeneration in sediments. Science 270, 623-625.

National Land and Water Resources Audit (2008).