Technical Memorandum

10/07/2019

Dear Charles,

The following document contains an assessment of impacts to aquatic ecosystems as a result of Primary Gold's proposed mining operations and site water management.

Background

Aquatic ecology monitoring has been undertaken at Toms Gully Mine in 2015, 2017 and 2018. The surveys to date have gathered data on fish, and macroinvertebrate communities as well as habitat information and water quality for Mount Bundey and Coulter Creeks. In 2017 and 2018, remote camera trapping was included to understand the spatial distribution of Mitchell's and Mertens Water Monitors along Mount Bundey Creek. This work has resulted in a body of data that can be used for the assessment of the impact of the proposed release regime. A summary of the results of aquatic ecology monitoring are as follows:

- Coulter Creek is a low order stream, and a tributary of Mount Bundey Creek. The confluence of the two creeks is located approximately 4 km downstream of the Arnhem Highway. The Creek originates upstream on the Old Mount Bundy Station, and previous studies have observed impacts at sites on Coulter Creek as a result of cattle access. The riparian zone along Coulter Creek is not continuous, and the greater catchment area has also been cleared for grazing. Although to date there has not been remote camera monitoring on Coulter Creek, freshwater crocodiles and turtles have been observed at sites along the creek during aquatic ecology monitoring. Anecdotally, a large saltwater crocodile was previously removed from Coulter Creek close to the cattle yards at Old Mount Bundy Station.
- Mount Bundey Creek is a higher order stream, draining north to Hardies Creek and on to the Mary River. The Riparian zone of Mount Bundey Creek is more intact than Coulter Creek, and clearing of land beyond the riparian zone is more intensive surrounding Toms Gully Mine and downstream than in the upstream area that has been monitored. Although during sampling events there were observable breaks in surface water, where dry sand was present in the creek bed, surface water flow was recorded at most sites. Alluvial groundwater and surface water interact along Mount Bundey Creek, and there is likely an extended period of sub-surface flow in the dry season through the sandy substrates found there. The presence of reptiles such as turtles and monitors in Mount Bundey Creek indicate that refugial pools are likely to occur along the watercourse. Although not observed in camera trapping or during monitoring, large saltwater crocodiles have been seen from helicopters in Mount Bundey Creek between the Arnhem Highway and Hardys Creek.
- Water quality has been poorest in Mount Bundey Creek adjacent to Toms Gully Mine. This is likely caused by connectivity between stored tailings, groundwater and surface water in Mount

Bundey Creek. Elevated conductivity and concentrations of some metals have been recorded over the previous two monitoring events compared with background water quality. This was particularly evident in 2017, coinciding with substantial rainfall being recorded over the wet season. Elevated conductivity has also been observed at sites along Coulter Creek, which are more likely associated with agricultural land use at Old Mount Bundy Station.

- The macroinvertebrate community of Mount Bundey Creek and Coulter Creek is made up of pollution/disturbance tolerant families. The macroinvertebrate community of Coulter Creek showed very little variability in composition across all sites, owing to similarities in habitat availability and water quality at all sites. Mount Bundey Creek on the other hand, showed more variation. Sites adjacent to and directly downstream of Toms Gully Mine showed variation in the community and health metrics between samples at the same site, denoting an uneven distribution of macroinvertebrate families. Surrounding land use (mining and grazing) also varied along the watercourse, and where these disturbances were greatest, the macroinvertebrate community showed the greatest amount of variability. This coincided with changes in water chemistry noted above. Any impact associated with water quality and habitat availability were confined to sites adjacent and directly downstream of Toms Gully Mine. Sites further downstream did not show the same type of variability in the community and were considered similar to those upstream of the mine.
- The fish communities of Mount Bundey Creek and Coulter Creek are indicative of moderately disturbed ephemeral streams in the area. Although no barramundi were caught during sampling, anecdotally they are caught from the bridge passing over Mount Bundey Creek directly downstream of Toms Gully Mine in the wet season.
- Mertens water monitors have been recorded upstream and adjacent to Toms Gully Mine, along with a number of birds and mammals. The population of Mertens water monitors in the vicinity of the mine site is thought to be sparse, with only a single individual captured from a combined 540 days of camera deployment in a given year. There have been no Mitchell's water monitors observed during sampling or recorded on remote cameras to date. Introduced species such as cane toads, pigs and wild dogs were recorded at all sites where remote cameras were deployed.
- There have not been any observations of submerged aquatic plants growing at any site, which is expected in intermittent stream environments. However there has been some emergent fringing aquatic vegetation observed at some sites on Mount Bundey Creek, but growth is sparse.
- Additional observed aquatic fauna recorded during surveys included northern snapping turtles and freshwater crocodiles.

Proposed Site Water Management

The proposed mining activity is set out in the Section 14A Amendment dated 14 December 2018. Primary Gold seeks to undertake mining by accessing ore outside of the current open cut pit via a box cut on the southern side of the mine site. Rather than requiring tailings to be stored above ground and capped, it is proposed that tailings will be deposited at the base of the existing pit with a depth of cover of water being maintained to prevent the oxidisation of tailings. Tailings currently stored above ground will be reprocessed, and any residual tailings also placed within the pit. During tailings deposition, water displaced from the pit will be treated and discharged to Mount Bundey Creek and Lake Bazzamundi. Water pumped to Lake Bazzamundi will overflow, at capacity, to Coulter Creek and flow downstream to Mount Bundey Creek. Dewatering of the box cut is also required to allow for mining and will take place throughout the year. Where pumped groundwater quality does not meet site-specific trigger values (SSTVs), it will be treated and then pumped to a New Water Storage Dam (WSD).

Proposed changes to the tailings deposition, water treatment and construction of the new WSD are projected to result in a reduction of water discharged from the site by 3 gigalitres over the life of the project, i.e. compared with the proposed activity set out in the EIS. Based on the updated water balance model (GHD 2019), the discharge of treated water to Lake Bazzamundi and Mount Bundey Creek is expected to take place in from the Northern Rainfall Onset (when 50 mm of rainfall or greater is recorded at site) and continue through the wet season. Discharges to both creeks will be relative to flow, and reduce in proportion to reductions in flow recorded in Mount Bundey and Coulter Creeks towards the end of the wet season. The intention of discharges is to empty the new WSD in order to allow for storage of water through the dry season.

Environmental Objectives

The following section considers the objectives of environmental factors identified by NT EPA for water (NT EPA 2018). Where appropriate, suggested mitigation measures and recommendations for future monitoring have been included.

Protect aquatic ecosystems to maintain the biological diversity of flora and fauna and ecological functions they perform

The aquatic ecosystems of Mount Bundey Creek and Coulter Creek are characterised by flora and fauna commonly found in highly disturbed intermittent streams. Very low coverage of aquatic plants has been recorded due to the seasonal drying of the majority of the system. Although Mount Bundey Creek maintains sub-surface flow through sandy substrates, this would occur for a much shorter period of time in Coulter Creek due to the comparative smaller size of the catchment. Under the proposal specified in the EIS, complete dewatering of the pit would have been required, resulting in continuous discharge of water into Mount Bundey Creek (and likely Coulter Creek) through the entire dry season. The revised plan, including increased water storage on-site has reduced the volume requirement to dewater the pit by 3 gigalitres, thus allowing for discharges to cease during the dry season. The drying

of intermittent streams is a natural and important component in the ecology of these environments (Steward *et al.* 2012), and the proposed discharge strategy allows for this to occur. This presents a better outcome for the aquatic ecosystems of both creeks, as natural intermittent flow patterns can be maintained (although modified), compared with a previous proposal to continue discharges for at least one entire dry season.

Inter-annual rainfall variability has been a climatic feature of the Project Area during baseline aquatic ecology monitoring, which has in turn varied flow magnitude and duration in Mount Bundey and Coulter Creeks. As the Northern Rainfall Onset varies with prevailing climate each year, the discharge regime will allow for natural variability in length of the wet season. The slowing and ceasing of flows result in ecological processes (including laying of eggs, aestivation and downstream migration) that are extremely important to the aquatic communities of intermittent streams (Boulton and Suter 1986). Abruptly ceasing discharges are not likely to allow this process to occur, and this may negatively impact fauna of all trophic levels, further exacerbating any impacts associated with rapid drying. As above, if this process is repeated over several years, localised alterations to population structure may occur, with the likelihood increasing closer to the discharge, where drying is likely to occur fastest. Water balance modelling by GHD (GHD 2019) has stipulated that flow will decrease in volume at the end of the wet season in line with flow conditions upstream of Toms Gully Mine. This will allow natural ecological processes related to intermittent streams to occur in the early dry season, and assist in the maintenance of flow-related cues.

While discharges will be proportional to flow, the volume of water in the receiving environment will be greater than in upstream areas of both creeks. Surface water connection between Mount Bundey Creek and Coulter Creek will be present for a longer period than would be expected under natural conditions, and there is also the likelihood of isolated pools on Mount Bundey Creek persisting into the early dry season. As previously mentioned, discharges will be reduced and ceased according to flow conditions upstream of Toms Gully Mine. This is likely to delay some natural ecological processes associated with the early dry season, but will not impede them.

Baseline monitoring has confirmed the presence of Mertens water monitors in Mount Bundey Creek upstream and adjacent to Toms Gully Mine, suggesting that refugial pools are likely to persist along the watercourse well into the dry season. The proposed water management and discharge regime is not likely to have an impact on populations of Mertens water monitors, as wet and dry season water availability will remain similar to baseline conditions.

Mount Bundey Creek flows via Hardies Creek to the Mary River Floodplain, a Site of Conservation Significance (SOCS) (DNREAS 2017). The proposed discharge regime will result in a greater volume of water reaching The Floodplain via Mount Bundey Creek. Given the volume of water received by the Mary River Floodplain during the wet season, the additional water discharged to Mount Bundey Creek

is not likely to be consequential. Connectivity associated with increased water volume is not likely to be extensive enough to result in any changes to the upstream fish or reptile communities as a result of migration.

Mitigation

The abrupt cessation of flows as a result of concluded pumping to Lake Bazzamundi and Mount Bundey Creek is likely to cause changes to aquatic assemblages over time, should measures not be taken to allow for natural flow-related cues to take place. A stepped approach to decrease mine water discharges towards the end of wet season e.g. reducing discharge slowly over time is proposed in the current water balance model (GHD 2019). This process will assist with maintaining natural cues and thus reduce the mortality of fish in Mount Bundey and Coulter Creek. The drying of isolated pools is a natural process that occurs annually in both Mount Bundey and Coulter Creeks. It is expected that there will be some morbidity and deaths as a result of this, but should stepped releases be undertaken at the end of wet season releases, it is not likely to result in higher than normal rates of mortality or impact on the aquatic ecosystem of the catchment.

Pulsed discharges of higher than average volumes should also be avoided after a stepped decrease in wet season flows have been instigated. Pulsed water flows derived from the mine water can result in ecological cues such as upstream migration and spawning, which may result in negative impacts on species assemblages when higher flows do not continue.

Monitoring recommendations

Continued aquatic ecology monitoring should be undertaken to maintain an unbroken record of aquatic ecosystem health surrounding Toms Gully Mine. Continued remote camera monitoring for water monitors will have the indirect outcome of also monitoring any introduced species and their presence downstream of the Project Area. Currently remote camera monitoring does not extend to the section of Mount Bundey Creek to be affected by discharges, including the site furthest downstream on Mount Bundey Creek (SWTG3). This site was added to remote camera monitoring in 2019, and should be considered for ongoing monitoring to assist with an understanding of these potential impacts.

Currently remnant pools that naturally occur in Mount Bundey Creek through to the end of the dry season (if any) are not mapped. Understanding the location of these pools, if they are present will assist in placement of fauna cameras in these locations to monitor terrestrial and aquatic fauna densities in these locations.

Maintain the quality of groundwater and surface water so that environmental values including ecological health, land uses, and welfare and amenity of people are protected.

During baseline surveys, interaction between stored tailings, groundwater and surface water were detected after an above average wet season in 2017. Poor water quality in the area adjacent to tailing storages resulted in declines in ecological health of the aquatic community adjacent to the tailing storage area. The emplacement of tailings below water (including reprocessing and emplacement of tailings currently stored above-ground) within the pit reduces the opportunity for oxidisation of tailings material and also removes the risk of above-ground storages becoming compromised due to above average rainfall. The planned storage of tailings within the pit therefore represents a lower risk of impacts to environmental values. Further, in-pit treatment of water will allow for the precipitation of metals out of solution, resulting in lower dissolved metal concentrations that may interact with groundwater or surface water.

Water discharged to Lake Bazzamundi and Mount Bundey Creek will be treated to meet the SSTVs set out by Stauber and Batley (2018). The SSTVs generated for the Toms Gully Project are based on water quality upstream in Mount Bundey Creek and have been designed to protect the receiving environment from changes to water quality associated with mine water discharge. Although Coulter Creek is a much smaller and lower order stream, the SSTVs calculated for Mount Bundey Creek are considered sufficient to protect aquatic ecological health. Monitoring data collected during baseline surveys have shown poor water quality results for a number of parameters at sites on Mount Bundey Creek and Coulter Creek adjacent to Toms Gully Mine. The introduction of treated water to both watercourses is likely to counteract some of the influences of agriculture and mining on water quality through dilution, lowering conductivity and dissolved metals.

Coulter Creek has been previously impacted by cattle access, road building and irrigation, resulting in erosion. High turbidity water has been observed previously within Coulter Creek downstream of the Arnhem Highway, and been attributed to livestock access. Although fish species found in Coulter and Mount Bundey Creek are tolerant of very turbid conditions (Pusey *et al.* 2004), increased flows may further erode Coulter Creek and result in further degradation of remaining habitat within the Coulter Creek for aquatic fauna.

Mount Bundey Creek has a much more intact riparian zone, and very little erosion beyond what would be expected to occur naturally. The Creek is not likely to be impacted by any increase in flow, as it is resilient to high flows experienced through the wet season annually.

Mitigation

Erosion and sediment control within Coulter Creek is problematic, given the external influence of grazing on the catchment. Under the proposed water balance model (GHD 2019), discharges will be

lower in Coulter Creek compared with Mount Bundey Creek relative to the size of the watercourse. This will not decrease susceptibility to erosion but will assist with limiting erosion within the creek.

Monitoring recommendations

The release of treated water to Coulter Creek via Lake Bazzamundi is likely to result in the requirement for a new Licence Discharge Point (LDP). In addition, a compliance monitoring point should be established on Coulter Creek to capture data during periods of flow (both natural and during discharges). This will assist in understanding changes (if any) to water chemistry and aquatic ecosystem health as a result of water management at Toms Gully Mine. The monitoring point should be located on Coulter Creek in the mine lease between the discharge point at the spillway from Lake Bazzamundi and the Mount Bundey Creek confluence.

The revised SSTV document suggests the use of ecotoxicity testing to establish an additional line of evidence that current SSTVs are sufficient to protect the aquatic fauna of soft waters. It is recommended that ecotoxicity testing take place during the wet season, and at the ceasing of wet season flows, when water discharged to Mount Bundey and Coulter Creek will make up 50% of flow being received by the catchment. This will assist in assessing the effectiveness of water treatment and the discharge regime to protect aquatic ecological values.

Maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.

The influences of higher flows in Coulter Creek coupled with its already modified channel are likely to result in exacerbated geomorphological processes, such as erosion, transport and deposition of sediments downstream. As mentioned above, this has the capacity to alter habitat for fish and macroinvertebrates, as well as affecting water quality, increasing turbidity and dissolved solids.

Mitigation

An erosion and sediment control plan should be put in place during mining activities that includes measures to reduce erosion processes in Coulter Creek. Current areas susceptible to erosion should be identified, and control measures taken to decrease erodibility.

Monitoring recommendations

Monitoring at erosion-susceptible locations on Coulter Creek should be undertaken during discharges to measure effectiveness of erosion control measures and impacts of increased flows.

Conclusion

Short-term changes to habitat availability, water availability and connectivity within Coulter and Mount Bundey Creeks are expected as a result of increased water volume in received during discharges. These short-term modifications to the ecosystem are considered a better outcome for the aquatic ecology of

both creeks, compared with previously proposed strategies that would have likely required a permanent discharge over several years.

Although the wet season flows in both creeks will be altered, provided a decrease in discharges is undertaken during the conclusion of wet season dewatering each year, it is unlikely that long-term impacts on the aquatic ecology of the receiving environment will occur. Coulter Creek is susceptible to erosion given that the catchment is highly disturbed. Where appropriate erosion and sediment control is in place and regular monitoring is undertaken, modifications to the channel of Coulter Creek are less likely to be such that habitat availability or water quality are negatively impacted.

Ongoing monitoring of the receiving environment will be the most effective tool in adaptive management of the discharge strategy, should negative impacts be observed.

Warm Regards,

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