8 June 2018

Attn: Dr Paul Vogel
Chairman
Northern Territory Environment Protection Authority
PO Box 3675
DARWIN NT 0801

Primary Gold Limited – Environment Impact Statement (EIS), 14A Amendment to the Toms Gully Underground Project Site - Modifications Reflective of the Environmental Studies Associated with the EIS Supplement Preparation (June 2018).

Dear Dr Vogel,

Firstly, I would like to thank Lisa Bradley and the other NT Environmental Protection Authority (NT EPA) staff for their time to discuss the Toms Gully Underground Project EIS supplement on the 3 May 2018. Following their advice, this submission has been prepared to provide a notification of alterations to the Toms Gully Underground Project, for consideration by the NT EPA under clause 14A of the Environmental Assessment Administrative Procedures.

This document precedes the lodgement of the EIS supplement detailing changes made to the original proposal. These changes include infrastructure and activities in response to the matters raised by government agencies and stakeholders during the Draft EIS public exhibition period in October 2015. It is anticipated that during operations and closure the changes will better;

- meet stakeholder expectations,
- produce better environmental outcomes, and
- align to the Environmental Factors and Objectives developed by the NT EPA,

The project alteration is the result of further environmental work undertaken by Primary Gold Limited (Primary) since late 2015 in response to the matters raised during the EIS exhibition period and to close identified knowledge gaps. The basis of the project alterations are due to the findings from the following surveys and studies:

- Two Flora and Fauna surveys;
- Additional aquatic surveys;
- Assessment and revision of water quality site specific trigger values;
- LiDAR survey and associated updated flood assessment;
- Site baseline geochemistry survey (including drilling of waste rock dumps and pitting of tailings) leading to the conceptual site model upgrade;
- Assessment of five water treatment options leading to the selection of a preferred site specific water treatment option;
- Groundwater sampling and additional groundwater modelling;
- Ongoing surface water monitoring;
- Desktop tailings assessment;
- Updated water balance;
- Observed seasonal site conditions since 2015; and

- Further closure planning.

Further details of the studies and surveys will be provided in the EIS supplement. In response to the questions posed by the NT EPA during the meeting on the 3 May 2018, Primary has included details on the level of current confidence and certainty of the environmental outcomes, contingency options where appropriate and assessment against the NT EPA's defined Environmental Factors and Objectives (NT EPA 2018).

1. *The Environmental Advantages of the Changes Compared to the Previous Site Plans*

The advantages of the proposed changes can be summarised as follows:
The work completed in the list above has led to the amendments discussed within this letter. These amendments have the potential to improve the environment factors of terrestrial flora and fauna, terrestrial environmental quality, aquatic ecosystems, inland water environmental quality, hydrological processes and, social, economic and cultural surroundings while addressing the cumulative risks associated with the original project. Whereby:

- Potential reprocessing of tailings to decrease the acid forming nature of the tailings thus reducing potential acid mine drainage sources;
- Improved storage of tailings via consolidation of tailings into an upgraded TSF1 and TSF2 (preferred: designated as Option 1) or new tailings storage facilities (contingency: designated as Option 2) that are fit for purpose and are in accordance with ANCOLD 2012 guidelines.
- Replacement of the valley water dam with the construction of a purpose built and compacted base water storage dam for improved management of the water balance across site.
- Improvement in the proposed water quality (selection of water treatment option and refinement of SSTV) allowing extended discharge and improved water surface quality to Mount Bundey Creek
- Improvement in the proposed water treatment quality for potential transfer of water usage to third party for productive agriculture and horticulture adjacent to the site. Thus providing economic benefit while further improving the site water balance management.
- A reduction in the overall clearing footprint across the site of 10 hectares.

2. *The Alterations Between the Draft EIS and EIS Supplement for the Toms Gully Underground Project*

The proposed changes to the footprint of Toms Gully Underground Project are outlined in Figure 1 (original layout) and Figure 2 (revised layout).

The proposed alterations can be summarised as follows:

1. Selection of a preferred water treatment option provided by Global Aquatica known as the Bioaqua Process. This will result in a standalone water treatment plant.
2. Additional use of the Bioaqua Process to process both existing and future tailings to extract gold, mixed metal oxides, sulfur and silica. Thus reducing tailings volumes and creating more benign tailings. This will result in the same standalone water treatment plant being used for tailings processing.
3. Proposal to reprocess tailings from TSF1 and TSF2 with an upgrade of both facilities to ANCOLD 2012 guidelines and lined if the nature of the tailings requires it (Option 1: preferred option).

4. The proposed contingency if Option 1 does not work (i.e. if either TSF1 and TSF2 cannot be reused) is to construct a purpose built tailings storage facility in accordance to ANCOLD 2012 guideline. If required, lined to reflect the nature of the tailings material (Option 1: contingency option). Location presented in Figure 2.
5. Replacement of the originally proposed valley Water Storage Dam 2.1 GL with a 1 GL embankment enclosed Water Storage Dam. Location presented in Figure 2.
6. Inclusion of topsoil stockpiles
7. Potentially changing from grid power to diesel generators.

For completeness, both the proposed tailings management options (i.e. Option 1 and 2), will be discussed along with the water/tailings treatment and water storage dam changes. However, please note that if the Option 1 is pursued/attainable (i.e. upgrading and reusing TSF1 and TSF2) Primary still reserves the right to establish a purpose built tailings storage facility in the future as per Option 2. (if further drilling indicates that the Toms Gully orebody has a greater extent than is currently known and continues at depth). The Design of the new tailings facility will be in accordance to ANCOLD 2012 guidelines, the intended closure strategy will reflect tailings chemistry and full consultation with all relevant regulatory agencies will be undertaken.

Details of the location of the topsoil stockpiles will be within the green polygon contained in Figure 2. Locations for the topsoil stockpiles are selected to:

- minimise erosion by being positioned away from drainage lines and to avoid large upstream catchments and, to be outside of the inundation zone of 1 in 100yr 72 hour flood event, and
- located a short distance from where the material has been salvaged to reduce the breakdown of the soil's physical properties by mechanical handling.

Figure 1: Original Toms Gully Underground Project site layout (as submitted in the Draft EIS)

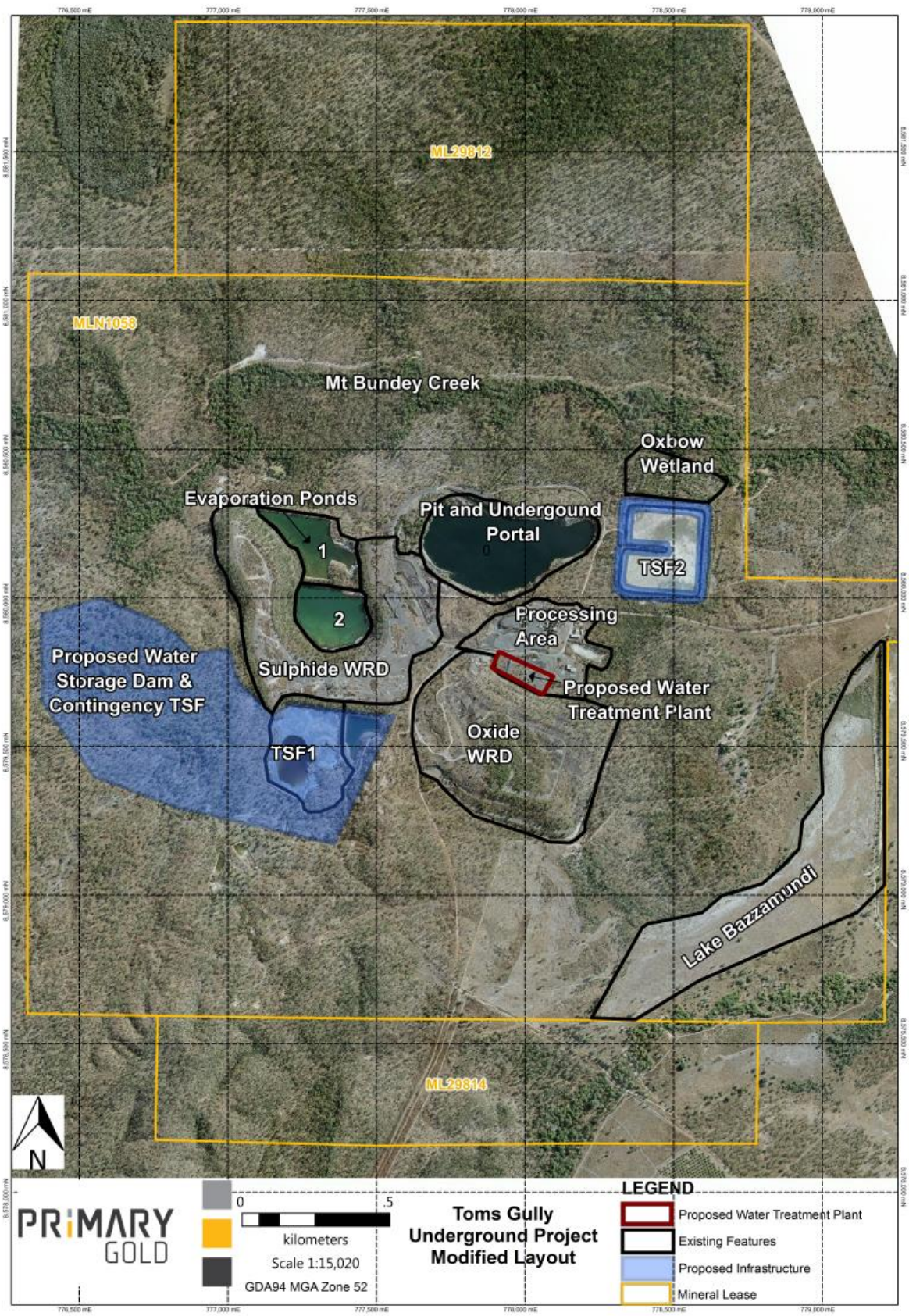

Figure 2: Modified Toms Gully Underground Project site layout (to be submitted as part of the EIS Supplement).

3. *Comparison Between the Draft EIS (dated 2015) and the Proposed Changes in the EIS Supplement for the Toms Gully Underground Project*

To better understand the changes between the Draft EIS and EIS Supplement Table 1 and 2 provide a comparison with information associated with activities and infrastructure presented on pages iv to x of the Executive Summary from the Draft EIS.

To illustrate alignment with ecological sustainable development and the NT EPA's environmental factors and objectives, each table provides details on these elements. Also where appropriate the currently known level of certainty for each of the changes is presented in Table 2.

Table 1: Comparison of Draft EIS (Column Generated from Draft EIS, Page vi) and EIS Supplement.

Item	Toms Gully Underground Project Draft EIS	Toms Gully Underground Project EIS Supplement	NT EPA Factors, Objectives (NT EPA 2018)
	Activities and Features		
1	Mining underground to the south of the existing underground workings;	No change	No alteration
2	Extraction of 0.9Mt of ore;	Extraction of 0.9Mt of ore with contingency to extract additional ore dependent on future resource drilling defining a continuation of the orebody.	No alteration unless orebody continues.
3	Mining of 1.7Mt of waste rock replaced underground or in the base of the existing pit (no external waste rock dumps);	No change	No alteration
4	Carbon In Leach (CIL) gold processing plant renovated and re-used;	No change	No alteration
5	Approximately 0.9Mt of tailings to be stored in raised Tailings Storage Facility 2 (TSF2); with a HDPE liner separating old and new tailings for the deposition of 0.9 Mt of tailings. At closure capping or placement in the pit.	Option 1: Reprocessing of tailings to upgrade existing Tailings Storage Facilities 1 and 2 to ANCOLD 2012 with lining and embankment lifts with capping at closure or, Option 2: building a new tailings storage facility. Tailings facilities capped at closure.	Improved tailings containment and control of seepage. • Reduction in effect to Land in particular to Terrestrial Flora and Fauna. • Reduced effect to Water in particular Inland Water Environmental Quality and Hydrological Processes.
6	New Water Storage Dam WSD; Valley fill water storage dam formed by building an embankment at valley opening.	New lined water storage dam of 1 gigalitre located away from creek lines.	Less catchment impedance/ flooding and control of seepage. • Reduction in effect to Land in particular to Terrestrial Flora and Fauna. • Reduced effect to Water in particular Inland Water Environmental Quality and Hydrological Processes.
7	Treatment of pit water and storage in WSD to facilitate mine dewatering. Options for water treatment being lime and caustic (Appendix L of Appendix 4) with limited detail on infrastructure.	A dedicated water treatment plant using technology to strip out metals and use bacteria to remove sulfates. Proposed location and details provided. Treatment will cover pit dewatering and site water during operations	Improved water discharge quality. • Reduction in effect to Land in particular to Terrestrial Flora and Fauna. • Reduced effect to Water in particular Aquatic Ecosystem and Inland Water Environmental Quality.

Item	Toms Gully Underground Project Draft EIS	Toms Gully Underground Project EIS Supplement	NT EPA Factors, Objectives (NT EPA 2018)
8	Removal or capping in-situ of tailings in TSF1 and TSF2.	Associated with Option 1: Proposal to retreat tailings reducing adverse chemistry capping of material in-situ once treated. Option 2: Capping of existing TSF 1 and 2 and new TSF.	Clear closure strategy with improved tailings containment. • Reduction in effect to Land in particular to Landforms. • Reduced effect to Water in particular Inland Water Environmental Quality.
9	Borrow pits to source clean construction materials	No change	No alteration
10	Clearing of 93 ha of generally disturbed vegetation for the WSD roads and borrow material.	Reduced to 83 ha. The 10 hectare reduction due to change to the WSD.	Less clearing and associated impacts. Reduction in effect to Land in particular to Terrestrial Flora and Fauna, Terrestrial Environmental Quality and Landforms.
11	**Not Present** in Draft EIS Tailings Treatment Plant.	Tailings treatment plant association with water treatment plant. Extracting mixed metal oxides, sulfur and silica from the tailings.	Less tailings and more benign in nature due to removal of deleterious elements. • Reduction in effect to Land in particular to Terrestrial Flora and Fauna. • Reduced effect to Water in particular to Aquatic Ecosystem and Inland Water Environmental Quality.

Table 2: Comparison of Draft EIS (Draft EIS Column Constructed from ES Table 1 page viii) and EIS Supplement.

Item	Toms Gully Underground Project Draft EIS	Toms Gully Underground Project EIS Supplement	Ecological Sustainable Development NT EPA Factors and Certainty (NT EPA 2018)
Project and Site Infrastructure			
Process plant;	Refurbish and re-use	No change	No alteration
Power Supply and reticulation;	Reuse	No change	No alteration
Offices and workshops;	Refurbish and re-use	No change	No alteration
Tailings Storage Facility 1; **(TSF1)**	Not used but potential to re-process. Cap and rehabilitate in situ or rehandle to base of the pit. Rehabilitate footprint.	• Preferred Option 1: Reprocess tailings and upgrade TSF1 to ANCOLD 2012 guidelines with lining for tailings containment and insitu rehabilitation • Contingency Option 2: if TSF1 cannot be upgraded to ANCOLD guidelines reprocess tailings and place in a new lined TSF and rehabilitate TSF1 footprint and new TSF insitu	Improve tailings containment improving environmental outcomes relating to waste minimisation and, the quality of discharge and/or seepage. Certainty of outcome high as a preferred and contingency option are both provided to improve tailings storage, management and closure implementation
Tailings Storage Facility 2; **(TSF2)**	Re-use and upgrade with a 7.8 m high downstream raise	• Preferred Option 1: Reprocess tailings and upgrade existing TSF2 to ANCOLD 2012 including a liner if required and an embankment lift to 6 m high. • Contingency Option 2: building a new tailings storage facility. TSF2 facilities capped insitu at closure.	Improve tailings containment improving environmental outcomes relating to waste minimisation and, the quality of discharge and/or seepage. Certainty of outcome high as a preferred and contingency option are both provided to improve tailings storage, management and closure implementation
Sulfide Waste Rock Dump (SWRD)	Not used. Investigate options for long term closure	No change	No alteration
Oxide Waste Rock Dump (OWRD)	Not used. Investigate options for long term closure	No change	No alteration
Evaporation Pond 1 (EP1)	Empty initially, treat water to livestock water quality. Then remains in use.	Empty initially, treat water to upgraded Site Specific Trigger Values (SSTV) for water quality. Then remains in use.	Improvement in water quality leading to an improved discharge quality providing protection to aquatic ecosystems and inland water environmental quality Certainty of water quality outcome high as discussed in the Section titled “Project Certainty and Confidence in the Delivery of Environmental Outcomes”.
Evaporation	Empty initially, treat water to livestock water	Empty initially, treat water to upgraded Site Specific	Improvement in water quality leading to an improved discharge

Item	Toms Gully Underground Project Draft EIS	Toms Gully Underground Project EIS Supplement	Ecological Sustainable Development NT EPA Factors and Certainty (NT EPA 2018)
Pond 2 (EP2)	quality. Then remains in use.	Trigger Values (SSTV) for water quality. Then remains in use.	quality providing protection to aquatic ecosystems and inland water environmental quality. Certainty of water quality outcome high as discussed in the Section titled "Project Certainty and Confidence in the Delivery of Environmental Outcomes".
Water Production bores	Refurbish and reuse	Where practicable refurbish and reuse. If unable to reuse redrill.	No alteration
Water Monitoring bores	Refurbish and reuse	Where practicable refurbish and reuse. If unable to reuse redrill. In addition add bores as recommended by GHD assessment thus expanding water monitoring network.	No alteration. Improved detection of water chemistry and hydrological change.
Oxbow wetlands	Continued use a passive treatment for runoff from OWRD	No change, except integrated with water treatment improving the quality of discharges.	No alteration. Improved through integrated water management strategy.
Site Drainage	Improve and reuse	Modified the size of bunds where required based on the additional completed baseline surveys/information.	No alteration
Water Storage Dam (WSD)	New Water Storage Dam WSD; Valley fill water storage dam formed by building an embankment at valley opening.	Lined water storage dam of 1 gigalitre located away from creek lines. Still access borrow pit area within original water dam footprint.	Improved water management, greatly reduced catchment disruption and potential seepage reduction. Remove damming of the catchment that would have an effect on the local hydrological processes. Certainty of outcome high
Lake Bazzamundi	Release fresh bore water into. Pastoralist to utilise for grazing	Release of bore water (and if required treated to be fit for agricultural or horticultural use). Third party to utilise for grazing and/or for use in producing mangoes.	Improve water quality for third party water usage provides economic benefits in the area adjacent to Toms Gully (i.e. social, economic and cultural surroundings). Pilot plant to confirm site specific requirements and process inputs leading to improved certainty of water treatment outcome.
Mine Pit	Treat water to livestock water quality. Remove water to enable access to underground portal. Use base of pit as long term storage location for acid producing materials and inert waste from plant demolition (at closure)	Treat water to SSTV water quality. Remove water to enable access to underground portal. Use base of pit as long term storage location for to be mined acid producing materials and inert waste from plant demolition (at closure)	Improvement in water quality leading to an improved discharge quality providing protection to aquatic ecosystems and inland water environmental quality. Pilot plant to confirm site specific requirements and process inputs leading to improved certainty of water treatment outcome. No alteration to the positioning of potential acid producing waste materials
Underground workings	Treat water to livestock water quality. Remove water to enable access to workings. Refurbish, re-use and extend to the south	Treat water to SSTV water quality. Remove water to enable access to workings. Refurbish, re-use and extend to the south	Improve water quality for either discharge or use by a third party for agricultural or horticultural use. Third party water usage provides economic benefits in the area adjacent to Toms Gully (i.e. social, economic and cultural surroundings). Pilot plant to confirm site specific requirements and process

Item	Toms Gully Underground Project Draft EIS	Toms Gully Underground Project EIS Supplement	Ecological Sustainable Development NT EPA Factors and Certainty (NT EPA 2018)
			inputs leading to improved certainty of water treatment outcome.
ROM Pad	Re-use	No change	No alteration
Haul roads and access roads	Re-use where relevant to the TGU Project.	No change	No alteration

4. Changes to the Potential Environmental Impacts as a Result of the Project Alterations

To understand the potential impacts associated with the proposed alterations, the changes need to be considered in the context of a source – pathway – receptor model for the site. Figure 3 summarises the changes in to the Preliminary Conceptual Site Model that was presented in the Draft EIS. Table 3 provides details on the changes to the environmental characteristics as a result of the proposed changes.

Adoption of the Bioaqua water treatment option is to improve the water quality prior to leaving site with the water quality above the level proposed in the Draft EIS. Improved water quality at the source allows the migration pathway of surface water and groundwater for acid mine drainage conditions to be targeted. The ongoing water treatment during operations also:

- removes the build up of water on site for controlled discharge or beneficial reuse,
- acid mine drainage loading is converted to mix metal oxides and sulfur for removal from site thus reducing the potential of source and sink formation in the immediate vicinity of the site.
- no build of spent acid mine drainage reagents (i.e. lime, caustic, activated red mud).

In culmination with the water treatment, the tailings treatment has the benefit of targeting the source of acid mine drainage within the tailings located in TSF1 and TSF2 and, any future tailings. The leaching of the tailings will remove mix metal oxides, sulfur and silica for onsale thereby reducing the volume and deleterious chemistry of site tailings. This process greatly reduces the extent of the likely impact of site tailings as the duration and magnitude of the acid mine drainage source is removed. Reducing this material results in a reduction in the required tailings storage capacity thus reducing the size of the tailings facilities. In conjunction the aligning of tailings storage on site to ANCOLD 2012 guidelines via upgrading TSF 1 and 2 (i.e. Option 1) or the construct of a new TSF (i.e. Option 2) reduces hydraulic water gradients and resultant seepage pathways to groundwater.

In the original EIS draft it was proposed a 2.1 GL would be constructed by damming a catchment to the west of the project area. The impact of this facility would result in catchment inundation, surface water disruption and possible habitat fragmentation across the catchment boundaries. Additionally, water before being discharged to the dam was proposed to be treated to meet livestock drinking guidelines. The impact of the amended 1 GL water dam and water treatment is to contain the excess site water in a discrete area of the catchment away from the main drainage line reducing catchment inundation, surface water disruption and possible habitat fragmentation. The amended water dam with a reduced footprint and improve water quality would better assist in managing water across the site. From a pathway perspective the impact of seepage is reduced since the valley fill water dam had a greater footprint and higher potential to connect through the geomorphology, fractures or faults in the underlying geology to groundwater pathways.

The use of diesel fuel for power generation is a result of the current conditions of power generation in the Northern Territory where the cost of grid power is uncompetitive. If a competitive pricing arrangement could be attained grid power would be used. The use of diesel for power generation compared to gas generated grid power will add more greenhouse gas to the environment than was anticipated under the Draft EIS.

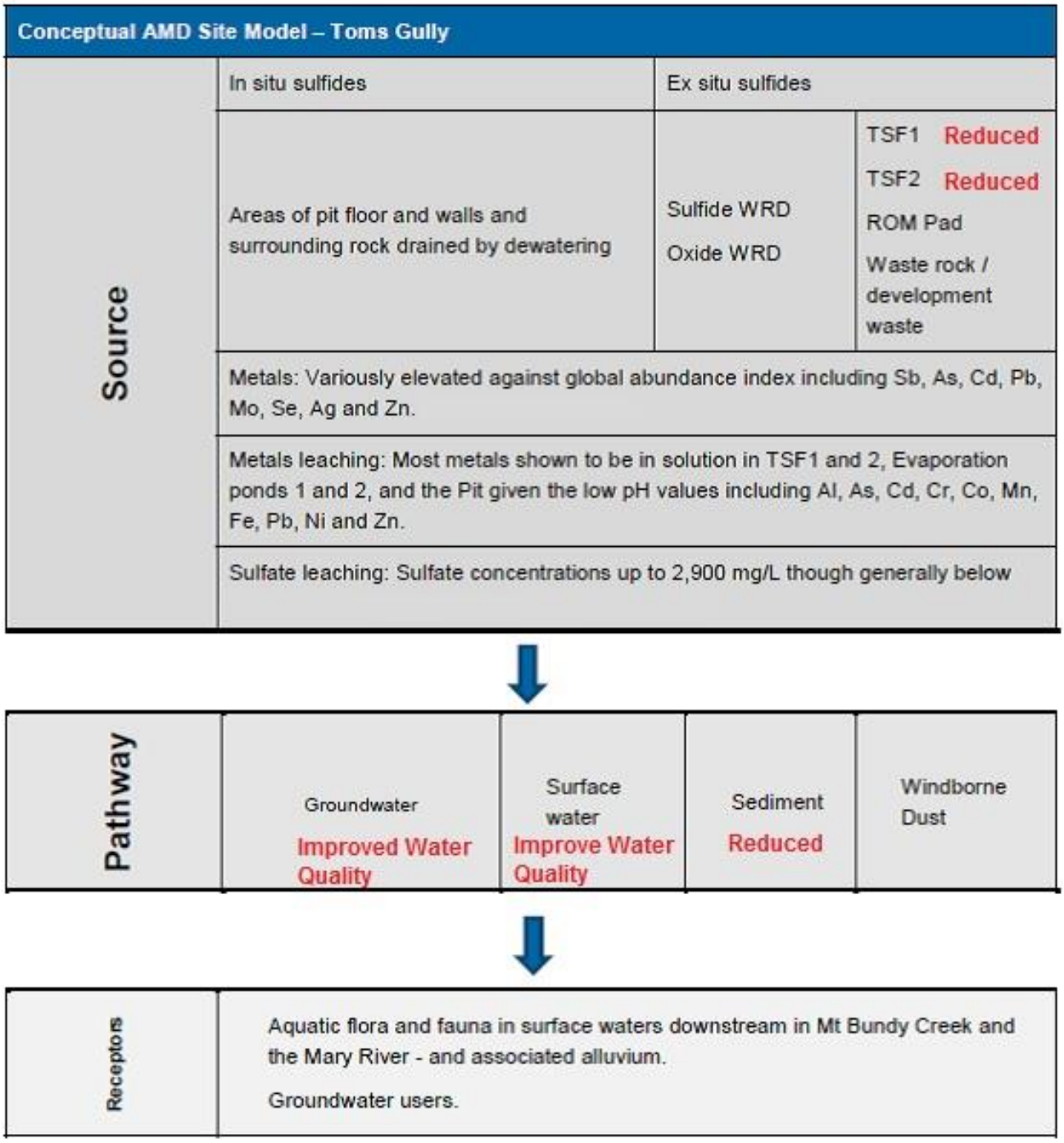

Figure 3: Preliminary Conceptual AMD Model with the effect of the Amendments (Reproduced from pg 43 Appendix A of Appendix 11 within the Draft EIS).

In respect to the project's specific cumulative impacts the proposed amendments in this letter provide a holistic approach to reducing the potential summation or multiplying effect of associated impact on receptors as:

- The proposed water treatment option has a dedicated water treatment plant to manage all water and related water quality encountered on site,
- Clear strategy for tailings management reducing tailings volume, adverse chemistry and potential footprints.
- Where possible addressing acid mine drainage at source or along pathways.

Table 3: Comparison of Draft EIS (Draft EIS Column Constructed from ES Table 2 page ix) and EIS Supplement.

Item	Toms Gully Underground Project Draft EIS	Toms Gully Underground Project EIS Supplement	Ecological Sustainable Development Incorporating NT EPA Factors and Certainty (NT EPA 2018)
		Environmental Characteristics	
Mining	Underground declining and stoping to the south of the existing underground workings, with access via the existing portals in the pit wall.	No change	No alteration
Mining Rate	Extraction of up to 0.35Mtpa of ore	No change	No alteration
Waste Rock	Removal of approximately 1.7Mtpa of waste rock, replaced underground or in the base of the existing pit (no external storage of waste rock).	No change	No alteration
	No disturbance of existing WRDs, review of closure options.	No change	No alteration
Processing	Conventional CIL gold processing plant and ancillaries renovated and re-used.	No change	No alteration
Tailings	Storage of approximately 0.9Mt of tailings in TSF2 which is to be raised with a downstream lift, then capped and rehabilitated or placed in base of pit at closure.	• Preferred Option 1: Upgrade existing Tailings Storage Facilities 1 and 2 to ANCOLD 2012 with liner if required and embankment lifts • Contingency Option 2: Building a new tailings storage facility. Tailings facilities to be capped at closure.	Certainty of outcome is high as two options presented a preferred (Option 1) and contingency (Option 2).
	Removal and placement in base of pit, or capping in-situ of tailings stored in TSF1	Preferred: Option 1 retreat tailings to remove gold, mix metal oxides, sulfur and silica thereby reducing adverse nature and volume of tailings to be placed in: • Upgrade existing Tailings Storage Facilities 1 and 2 to ANCOLD 2012 with lining and embankment lifts • or contingency building a new tailings storage facility. In-situ capping of tailings.	Certainty of outcome is high as two options presented a preferred (Option 1) and contingency (Option 2).
Water supply	New Water Storage Dam WSD; Valley fill water storage dam formed by building an embankment at valley opening.	New Water Storage Dam compacted base to contain 1 gigalitre. Located away from creek lines.	High certainty of less seepage, waterlogging and inundation.
	Treatment of approximately 2.6 GL of pit water, then storage in new dam to facilitate	Treatment of approximately 2.6 GL of pit water, then either release to Mt Bundey Creek, provide to third party and/or	Improved water quality. Pilot plant to confirm site specific requirements and process inputs leading to improved

Item	Toms Gully Underground Project Draft EIS	Toms Gully Underground Project EIS Supplement	Ecological Sustainable Development Incorporating NT EPA Factors and Certainty (NT EPA 2018)
	mine dewatering.	storage in new dam to facilitate mine dewatering.	certainty of water treatment outcome. Certainty of outcome regarding water treatment improvement from Draft EIS.
Water Management	Underground dewatering from bores released to lake Bazzamundi	Release of bore water (and if required treated to be fit for agricultural or horticultural use). Third party to utilise for grazing and/or for use in producing mangoes. A dedicated water treatment plant using technology to strip out metals and use bacteria to remove sulfates. Proposed location and details provided.	Improved water quality. Pilot plant to confirm site specific requirements and process inputs leading to improved certainty of water treatment outcome. Certainty of outcome regarding water treatment improvement from Draft EIS.
	Annual water release into Mount Bundey Creek in wet season via discharge licence.	No change	Improved water quality and aquatic ecosystem protection.
	Retention, renovation and use of existing evaporation ponds, oxbow wetlands, process water pond and other site drainage facilities.	No change	No alteration
	Not in original Draft EIS	Supply treated water to third party for agricultural and horticultural purposes.	Beneficial water usage for adjacent land uses and practices.
Disturbance	Clearing of approximately 93ha of native vegetation (54ha being for WSD, the remainder for borrow materials, new access and drainage)	Clearing of approximately 83ha of native vegetation (44ha being for WSD and new TSF if required, the remainder for borrow materials, new access and drainage)	Less habitat removal
	Borrow pits for clean construction material from the WSD area and area to the south and east of the WSD	No change	No alteration
Workforce	Approximately 104, sourced locally where possible, accommodated off-site	No change	No alteration
Waste	Construction, workshop and office waste only. Renovate existing sewage and landfill sites	No change	No alteration
Power	Use existing powerline from grid	Use existing powerline from grid if access can be gained at a competitive price or diesel generation dependent on costs.	No alteration if using grid power. Increase in emissions from diesel generation. Slight effect to air in particular to Air Quality and Greenhouse Gases.
Closure and Rehabilitation	Tailings to be capped and rehabilitated or placed in base of pit. Waste rock generated during the TGU Project to be retained underground or placed in base of pit. Pit allowed to re-fill with water on closure. Options for WRDs to be reviewed	Tailings to be capped and rehabilitated. Waste rock generated during the TGU Project to be retained underground or placed in base of pit. Pit allowed to re-fill with water on closure. Options for WRDs to be reviewed	No alteration, however elements within overall closure strategy for each mining feature amended. To improve closure outcomes.

5. *Modifications to Mitigation and Management Measures as Implemented by the Proposed Project Alterations*

The resultant changes in mitigation and management measures are discussed below

Water Treatment and Tailings Management

One of the more frequent comments in response to the Draft EIS were the concerns raised about the physical condition of the site (including but not limited to the source terms and locations of acid mine drainage) and interaction with the environmental conditions (including the defined four month wet season with intense rainfall events). The above interaction culminated in a major pathway for the transport of acid mine drainage products from the movement of water across the site which then entered water ways of the Mary River catchment. To improve water quality along this pathway, five water treatment options were assessed with the preferred option being the Bioaqua Process by Global Aquatica. Concurrent with the water treatment study, a review of the Site Specific Triggers Values (SSTV) was completed by the CSIRO to investigate water quality suitability for downstream declared beneficial usage and aquatic ecosystem protection. The outcome of this work is presented in Appendix A with Table 3 of the Appendix containing the revised SSTV. It is intended that water captured across the site including water from the pit, TSFs, evaporation ponds, waste rock dumps and infrastructure areas will be treated as required with the water recycled in the plant, reused for dust suppression and disposed via discharge to Mt Bundey Creek or passed to a third party.

The Bioaqua Process has been developed to both treat water and the source of acid mine drainage, in the case of Toms Gully this is the tailings in TSF1 and TSF2. A simple explanation of how the Bioaqua Process works (i.e. treats water) is:

- Firstly the process removes the metals and acidity whereby cavitators break down the water into oxygen, hydrogen and hydroxy group that via chemical reactions allow metals and elements to come out of the water column, and
- Secondly once this has occurred the water is then combined with nutrients and sulfide reducing bacteria that convert the sulfate to sulfur for removal.

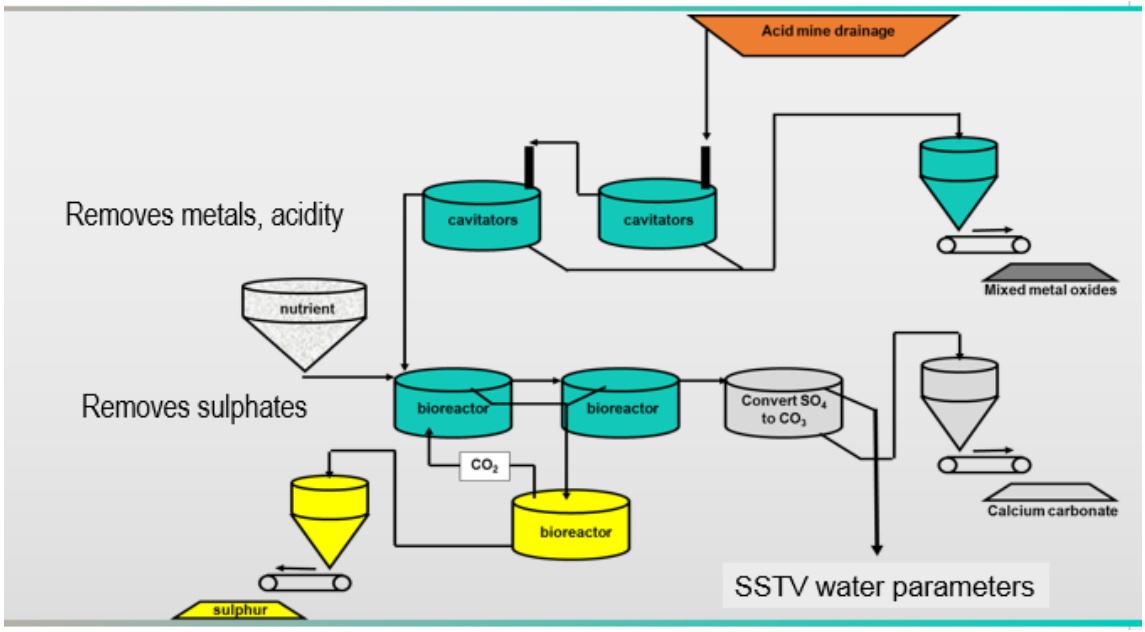

Figure 4: BioAqua Process Flow Chart

On completion of this process, water quality meeting the desired Toms Gully SSTV is produced, thus reducing the potential amount of acid mine drainage water at Toms Gully. For tailings treatment material will:

- Be removed from TSF1 and TSF2 by slurrying and pumping to the treatment plant,
- The water treatment process detailed above is used after the tailings is leached by the inherit acidity of the material. The leaching process occurs within a 2.5km section of pipe transporting the tailings from the tailing storage facility to the treatment plant.
- After the leaching process, silica is physically removed to produce a saleable product.

The extracted mixed metals oxides, sulfur and silica from both the water and tailings treatment have available markets whereby each concentrate is a saleable product thus removing the requirement for either on or off site disposal. The end tailings stream is greatly reduced leaving behind more benign minerals and clay. If practicable the current intent is to also utilise this technology in other areas of the site to reduce the acid mine drainage profile across the site.

During operations, minor amounts of sodium hydroxide, magnesium hydroxide, carbon and ethanol used in the process will be stored in bunded areas under relevant chemical storage codes. Recycled products including metal hydroxides, sulphur, calcium carbonate, magnesium hydroxide are contained in geobags next to the treatment plant for removal and on sale.

For the Toms Gully site this allows the existing tailings structures (TSF1 and TSF2) to be re-processed not just to extract the residual gold, but also to create greatly reduced tailings as part of this process. As tailings is removed from TSF1 and TSF2 each structure will be assessed against ANCOLD 2012 guidelines and upgraded to reflect the chemical and physical condition of the tailings (i.e. if required lining) and filled with the treated tailings (preferred tailings option (Option 1)).

As discussed and requested in the meeting on 3 May 2018, an approval is being sought from the Department of Primary Industry and Resources (DPIR) for the placement and operation of a pilot plant on site. Primary is to increase the level of certainty of the desired water quality and tailings treatment outcome Additionally, the onsite trial will allow the Bioaqua Process to be fine-tuned for specific conditions encountered at the Toms Gully site and for regulatory agencies to review the performance.

A question was posed at the meeting on 3 May 2018, regarding what contingency measures would be in place if this processing technology did not obtain the desired environmental outcomes in respect to water quality and tailings. In response to this question, this document outlines a secondary option (Option 2) as detailed above for tailings management whereby a new purpose built facility will be constructed within the previously proposed water storage dam footprint (Figure 2). This facility would contain future tailings produced by mining. For this option the existing TSFs would have:

- TSF1 being reprocessed to extract the residual gold within the tailings and then would be sent to the new tailings storage facility and the emptied structure rehabilitated insitu, and
- TSF2 capped insitu.

Water Management

In the Draft EIS it was proposed a 2.1 GL water storage dam (WSD) would be constructed by building an embankment across a small sub-catchment to the west of the Toms Gully site. It is proposed to reduce the water storage dam to 1 GL and rather than closing off the creek line and associated sub catchment position the facility within the same catchment however away from the creek line. The borrow areas within the original WSD for TSF and WSD construction would remain the same. For the new 1 GL WSD any underlying drill holes are to be grouted and the base compacted to reduce water infiltration. The reasons for reconfiguring the WSD are:

- Minimise the mixing of site water with "clean" water from the catchment area,
- Better control water infiltration and the site water balance,
- Reduce the disturbance footprint (i.e. not flooding a large part of the existing catchment), and
- Provides a clear closure strategy.

Based on an assessment of the previous environmental management and mitigation put forward in the Draft EIS and, the management and mitigation outlined in this letter it is considered that the amendment does not pose any additional factors/events that fall outside of the scope of the intended management. Additionally, the changes improve the intended environmental outcomes and do not create a situation whereby the desired environmental outcomes are not attainable due to cumulative risks or an inability to manage the risks via appropriate management measures.

6. *Summary of Changes in the Potential Impacts to Environmental Values and Factors Associated with the Toms Gully Underground Project*

Throughout the letter, details are presented on the proposed effects on environmental values and factors. Table 4 provides a summary of the environmental outcomes as a result of changes to infrastructure and onsite activities and, their relationship to the environmental factors, objectives and principles as defined by the NT EPA (NT EPA 2018)

Table 4: Summary of Changes to the Environmental Factors.

Environmental Theme	Environmental Factor	Environmental Outcomes from changes to Toms Gully Underground Project
Land	Terrestrial Flora and Fauna	• Reduce overall clearing by 10 hectares with a reduction in habitat fragmentation. • Removal of catchment inundation and reduction in the modification of surface water flows. • Improved water quality (i.e. water treatment) and reduction in the size of water sources (i.e. more regular discharges) • Option 1 reduce acid mine drainage profile by processing tailings. • Option 2 Improve tailings containment.
	Terrestrial Environmental Quality	• Reduced overall clearing of 10 hectares leading to less disturbed soils and erosion. • Removal of vegetation inundation. • Management and consolidation of tailings for improved post mining landuse and management • Minimise waste generation in respect to tailings via reprocessing.
	Landforms	Integration of future infrastructure into existing topography and geomorphology by placing within current disturbance or higher up away from drainage lines where possible.
Water	Aquatic	• Improved water quality (i.e. Option 1 water treatment, potential

	Ecosystems	reduction of acid rock source or Option 2 containment of acid rock source) along Mt Bundey Creek. • Reduce contamination loads. • Enhanced and controlled discharge/use of water excess water.
	Inland Water Environmental Quality	• Improvement in surface water quality. • Enhanced and controlled discharge/use of water excess water. • Option 1 less acid mine drainage source term with potential to be released into the water (i.e. down pathway) • Option 2 Tailings containment and reduction in potential seepage.
	Hydrological Processes	• Reduced surface water build up on site (i.e. reduction in water dam and water stored on site) and associated seepage. • Option 1 and 2 reduced seepage during operations and closure.
People and Communities	Social Economic and Cultural Surroundings	• Potential recycling of water for beneficial reuse and value adding to adjacent land users. • Less potential impact on recreational activities in the Mary River.

7. *Project Certainty and Confidence in the Delivery of Environmental Outcomes*

As discussed above the changes have occurred to improve environmental outcomes associated with the project and tighten the scope of the projects restart. The level of uncertainty with each change and resultant environmental outcome has been detailed in the sections above. It was requested at the 3 May meeting that if the proposed water quality was not achieved a contingency option was to be provided. As requested this option is provided below.

It is anticipated that water quality at the discharge point will attain the SSTV as detailed in Appendix A. However, if the SSTV values at the discharge point cannot be achieved then it is anticipated that the water quality target will be at the ANZECC and ARMCANZ (2000) 80% ecosystem protection guidelines level. By obtaining this value and discharging to the creek under suitable flow conditions will allow the water quality to reach a level better than the previous Draft EIS (whereby water quality of 80% ecosystem protection level after mixing was targeted) at the compliance point (i.e SWTG2). Water quality at the downstream monitoring compliance point SWTG2 would be approaching 90% after starting at 80% ecosystem protection guideline levels. In addition, by attaining the ANZECC and ARMCANZ (2000) 80% ecosystem protection guidelines level the water quality would be fit for purpose for agricultural and horticultural as it would not exceed the criteria for livestock drinking and irrigation water quality. As discussed through this document the planned water treatment pilot plant is intended to demonstrate the ability to produce water of an appropriate quality.

In selecting the proposed water treatment option a staged assessment (that included bench scale testing where required) of five alternative water treatments was used to de-risk the preferred option. For the proposed water and related tailings treatment (Bioaqua Process) option the technology's feasibility and viability has been demonstrated at a pilot scale level at the Angas Zinc mine in South Australia, at the Mt Chalmers site associated with the historic Mount Morgans mine in Queensland and the Brukunga legacy site in South Australia. In addition, Global Aquatica are currently in discussions with the Angas mine owners to advance the establishment of a fully scale water/tailings treatment plant.

To further improve the site specific certainty (i.e. continuing the staged de-risking process) for the treatment option at Toms Gully and to tailor the solution for site specific conditions, Primary has lodged an application for a pilot plant with the DPIR. The feedback from the field

trials will refine the process to meet the requirements for the Toms Gully site thus further enhancing the proposed outcome. At any stage during the trial, regulators are welcome to attend the site to observe the pilot plant in operation and collect samples for independent analysis.

In the case of the tailings treatment the above field trial will assess the suitability of the tailings to be reprocessed and refine the recovery of mix metal oxides, sulfur and silica. Based on preliminary assessments the tailings have the appropriate chemistry for the reprocessing and product extraction. As a contingency against the tailings treatment not being viable this letter has presented 2 options for the management and mitigation of the impact of tailings onsite during operations and closure.
It is considered that the proposed changes to the Toms Gully Underground Project provide:

- a clearer project scope,
- reduced environmental impact compared to the original submission,
- begins the process of life of mine closure planning and,
- delivers better outcomes in respect to the NT EPA environmental factors and objectives while aligning to the concept of “Ecologically Sustainable Development”.

If further information is required please contact Justin Robins on jrobins@primarygold.com.au

Yours Sincerely

Garry Mills
Managing Director
Primary Gold Limited

REFERENCES

NT EPA (Northern Territory Environment Protection Authority) (2018) *NT EPA Environmental Factors and Objectives.* February 2018 Version 1.0, As provided the NT EPA on the 8 May 2018

APPENDIX A: REVIEW OF SITE SPECIFIC TRIGGER VALUES FOR TOMS GULLY MINE, NT. CSIRO

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Review of Site-Specific Trigger Values for Toms Gully Mine, NT

Jenny L. Stauber and Graeme. E. Batley

January, 2018

Report prepared for Primary Gold Limited

Commercial-in-confidence

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Executive Summary

Primary Gold Limited is planning to reopen the Toms Gully mine which has been in care and maintenance since November 2010. The site is characterised by acid mine drainage produced through pyrite and chalcopyrite in the pit walls, waste rock and tailings. In addition, there are a number of water storages from previous operations that contain poor quality water, including two evaporation ponds and the larger water storage in the open pit. It is proposed to discharge treated water into Mount Bundey Creek during either the wet season (when there is sufficient dilution capacity) or the dry season and/or provide water to a third party for potential agricultural and horticultural uses, both of which will require water treatment prior to discharge to meet agreed beneficial uses and water quality guidelines.

Primary Gold requested that CSIRO assess the suitability of the site-specific trigger values (SSTVs) derived by GHD in 2015 and, if required, re-derive trigger values for physical and chemical indicators appropriate to the proposed range of beneficial uses of on-site water. The aim was to assist Primary Gold with their water management strategy, particularly to help maintain a neutral water balance and appropriately dispose of any legacy wastewaters.

For physico-chemical parameters, SSTVs for wet season use only were recalculated using the most recent wet season water quality monitoring data from 2015-2017. The revised SSTVs were similar to previous values, with marginally lower 50th and 80th percentile values for conductivity, and higher values (less conservative) for TSS, turbidity, dissolved iron and dissolved aluminium. No SSTVs could be derived for the dry season due to lack of flow, and hence a lack of monitoring data. If discharges are likely to occur in the dry season, then currently only wet season or default ANZECC/ARMCANZ (2000) Guideline Values (GVs) for physico-chemical parameters can be used.

For sulfate, for which no GV exists, chronic ecotoxicity data from the study by Elphick et al. (2011) in soft waters was used to re-derive an 80% species protection value for sulfate of 316 mg/L. This value was higher than the more conservative 95% species protection value of 129 mg/L from Elphick et al. (2011) that was used by GHD (2015).

For toxicants such as metals, default ANZECC/ARMCANZ (2000) GVs should be used. If an 80% species protection level is chosen at the discharge point, then there should be commitment for continuous improvement such that 90 or 95% species protection is achieved at the end of the 1-2 km mixing zone.

If an appropriate treatment before discharge will likely mean that 90 or 95% species protection values could be achieved in Mount Bundey Creek then discharges in both the wet and dry seasons can occur, without the need for a mixing zone, and assuming no additional contamination from seepage or groundwater infiltration. Minimal impacts could be confirmed using direct toxicity assessment with relevant tropical species and this would help to ensure that there is no chronic toxicity of the discharge beyond the compliance point.

For other beneficial uses, such as stock watering or irrigation, lower levels of treatment may be satisfactory, as defined in ANZECC/ARMCANZ (2000) as these GVs are less stringent than for aquatic ecosystem protection. Monitoring of sulfate and other ions in soils, as proposed by Primary Gold, will be required to ensure that there is no build-up of these ions in soils over the longer term.

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1 Introduction

Primary Gold Limited is planning to reopen the Toms Gully mine which has been in care and maintenance since November 2010. The Toms Gully Underground project will utilise the existing Toms Gully mine footprint, dewatering the existing pit to gain access to historic underground workings. The site is characterised by acid mine drainage produced through pyrite and chalcopyrite in the pit walls, waste rock and tailings. In addition, there are a number of water storages from previous operations that contain poor quality water, including two evaporation ponds and the larger water storage in the open pit. Release of untreated water would require dilutions of up to 250:1 to meet aquatic ecosystem water quality objectives for cobalt and zinc, based on the pit water quality in 2012 (EIS, 2015). Therefore, it was proposed to discharge **treated** water into Mount Bundey Creek during either the wet season (when there is sufficient dilution capacity) or the dry season, both of which will require water treatment prior to discharge to meet agreed beneficial uses and water quality guidelines.

The only discharges into Mount Bundey Creek since November 2010 have been:

1. passive discharges via surface water runoff in the wet season, and groundwater
2. licenced discharges from SWTG12 (concrete weir at wetland oxbow overflow point) from 1/2/13 to 31/8/14.

Primary Gold lodged a draft Environmental Impact Statement document (EIS) as required by the Northern Territory Environmental Protection Authority (NT EPA). Since the EIS, Primary Gold has been investigating a number of water treatment options including liming and Virtual Curtain technology to improve water quality prior to discharge. Rather than storing poor quality water in an evaporation dam on site, it was hoped to discharge the water offsite either by a stream discharge (into the ephemeral Mount Bundey Creek) or by supplying the water to local pastoralists to either flood irrigate pastures or to water a mango plantation. The purpose of disposing of water is to maintain a neutral water balance and reduce water management resourcing and the requirement for engineered water-holding structures.

The current compliance site is SWTG2, slightly upstream of the Arnhem Highway Crossing, although this may move slightly further upstream in future, to be further away from road runoff. For a short section downstream from the Arnhem Highway Crossing (approximately 3 km), the beneficial use of the water is for stock drinking. However, for all other parts of Mount Bundey Creek, upstream and downstream, including at the SWTG2 compliance point, the beneficial uses of Mount Bundey Creek are environmental, riparian and cultural, and this applies to all tributaries of the Mary River. Given that water quality guideline values (GVs) for aquatic ecosystem protection are more stringent than for other beneficial uses, these are the values that should apply to Toms Gully.

In previous waste discharge licences for Toms Gully, there had been agreement that the 80% species protection GV be applied as Mount Bundey Creek is considered to be a highly disturbed environment. For future discharges, this level of species protection has not yet been agreed to by the NT EPA, as the regulator is now requesting comparison of these GVs with those for higher levels of protection, i.e. 90% and 95% (See Table 1). As a general rule, continual improvement from such a highly disturbed state is recommended in the existing water quality management framework (ANZECC/ARMCANZ, 2000).

Table 1. ANZECC/ARMCANZ (2000) default guideline values for aquatic ecosystem protection

Toxicant	Guideline value for different % species protection, µg/L		
	95%	**90%**	**80%**
Al (pH>6.5)	55	80	150
As	13	42	140
Cd[a]	0.2	0.4	0.8
Cr	1	6	40
Cu	1.4	1.8	2.5
Fe (total)[b]	700	950	1400
Pb[a]	3.4	5.6	9.4
Mn	1900	2500	3600
Ni[a]	11	13	17
Zn	8	15	31
Total ammonia (pH 8)	900	1430	2300

[a]Low hardness value
[b] New guideline under review

Primary Gold requested that CSIRO assess the suitability of the site-specific trigger values derived by GHD in 2015 and, if required, re-derive trigger values for physical and chemical indicators appropriate to the proposed range of beneficial uses of on-site water. The aim was to assist Primary Gold with their water management strategy, particularly to help maintain a neutral water balance and appropriately dispose of any legacy wastewaters.

2 Review of Site-Specific Guideline Values (Trigger Values) Derived by GHD

The assessment of the acceptability of discharges associated with the Toms Gully project area has relied primarily on the development of site-specific trigger values (SSTVs) (now referred to as GVs (Warne et al., 2015)). The ANZECC/ARMCANZ (2000) water quality guidelines discusses the use of site-specific trigger values noting*: 'If background concentrations cannot be measured at a site, measurement at an equivalent high-quality reference site that is deemed to closely match the geology, natural water quality etc., of the site(s) of interest is suggested. If the background concentration has been clearly established and it exceeds the trigger value, the 80th percentile of the background concentration can be accepted as the site-specific trigger value for ensuing steps." Noting also that: 'Users may apply direct toxicity assessment to background or reference waters using locally adapted species, to confirm that there is no toxicity.'*

Another relevant statement from ANZECC/ARMCANZ (2000) is that: *'Toxicant concentrations may vary seasonally. Because of this and the need to be confident about the best estimate of background concentrations, it is recommended that background data be gathered on a monthly basis for at least two years. This applies to both physical-chemical stressors as well as toxicants. Until this minimum data requirement has been established, comparison of the test site median should be made with reference to the default ANZECC/ARMCANZ (2000) guidelines. For those months, seasons or flow periods that constitute logical time intervals or events to consider and derive background data, the 80th percentile of background data (from a minimum of 10 observations) should be compared with the default guideline value.'*

The derivation of SSTVs undertaken by GHD did not specifically follow all the above recommendations in ANZECC/ARMCANZ (2000) (see below). In selecting a relevant GV, a choice was made between the SSTV values and the 80% species protection default GVs from ANZECC/ARMCANZ (2000). The choice of 80% species protection (usually for highly disturbed systems) is yet to be agreed by the regulator, as at the edge of a mixing zone normally the 95% protection or at worst the 90% protection value would be expected to be used. However, there are precedents for selection of the 80% species protection level. We are aware that there is at least one other mine in the NT where the regulator has agreed to 80% species protection, with the aim to gradually improve towards higher levels of species protection.

2.1 Physico-chemical stressors

Toms Gully site is situated at approximately 40 m AHD so would be classed as a tropical lowland river ecosystem for determining default GVs for physico-chemical stressors. The climate is highly seasonal with a distinct wet season from December to April each year. Mount Bundey Creek is an ephemeral creek with limited flow and isolated pools during the dry season.

Site-specific trigger values for physico-chemical parameters (pH, DO, EC, turbidity, and TSS) were derived by GHD (April 2015). They obtained monitoring data (93 samples) for one upstream reference site (SWTG1A) collected between April, 2003 and February, 2015. It is more usual to derive SSTVs from a number of reference sites (not just one). However, Primary Gold has confirmed that no other reference sites were accessible or appropriate.

Background concentrations were derived by GHD for the Mount Bundey Creek reference site, SWTG1A, *'based on samples collected annually from 2003 to 2008 followed by intermittent sampling from 2010 to*

2015'. More frequent wet season data were collected from the 2010/11 wet season and onwards over 4 wet seasons. In the GHD report, plots are shown of sampling frequency for SWTG1A and the compliance point SWTG2, but different axis labels were used so the actual dates of sampling were not easily estimated. The actual raw data were not provided in the GHD report, with only a summary table of the minimum, median, maximum, 20th and 80th percentiles, together with plots of some data in Section 6. From these plots, it appears that both wet and dry season data were used to derive the SSTVs. Because the site is subject to wet and dry season flows, it is not appropriate to use data from both seasons in deriving SSTVs. It would be more relevant to derive separate SSTVs for each season, assuming sufficient dry season data are available.

Ideally SSTVs should be derived from the most recent data. Including data from 2003 to 2008 is not advisable unless trends in the data can be observed using control charting to show that values were not significantly changing. Ideally, a minimum requirement of 10 wet season data points should be used from the most recent monitoring data over several years.

GHD compared the 80th percentile of the monitoring data from the reference site to the ANZECC/ARMCANZ GVs for tropical lowland systems, and then usually took the least conservative of the two values as the SSTV.

- pH: The GV for pH was appropriate, with a SSTV of 5.8-8.0.
- Electrical conductivity: ANZECC/ARMCANZ recommends the lower values from the range 20-250 µS/cm for ephemeral rivers in NT, but recognises that values can be higher during the wet season first flush. GHD quoted this range as the SSTV, but we are unsure of whether the upper or lower limit will be used for compliance and whether this differs between seasons. The 80th percentile of the monitoring data was much lower, 57 µS/cm, and hence would be a more conservative value.
- Total suspended solids (TSS): There is no ANZECC/ARMCANZ GV for TSS (only a value for turbidity), so the 80th percentile of the combined monitoring data from both the wet and dry seasons was used (32 mg/L).
- Turbidity: GHD selected the upper ANZECC/ARMCANZ value of 15 NTU as the GV because there were too few data from the monitoring program to derive a SSTV. It is unclear if this would be applied to the wet season only.

2.2 Nutrients

No SSTVs were derived due to limited historical monitoring data, so default ANZECC/ARMCANZ GVs for tropical lowlands would apply. It is not known how agricultural land use in the area may contribute to nutrient levels in Mount Bundey Creek.

2.3 Toxicants

For toxicants, including metals, it is usual to apply the ANZECC/ARMCANZ (2000) GVs as these are based on a toxicological response of freshwater biota, rather than a statistical distribution of the background chemical monitoring data from a reference site. In this way, ecosystem protection is related to the chemical concentrations that would have no chronic toxicity to freshwater biota. Note that GVs for some toxicants are currently being revised and these new guidelines should be released in 2018. However, for the purposes of this report, we have used the current 2000 toxicant GVs (Table 1), except for iron, for which a new GV based on total iron, is under peer review.

For most toxicants, GHD have used the ANZECC/ARMCANZ (2000) GVs appropriately, where values exist. Exceptions include:

- Sulfate (for which no ANZECC/ARMCANZ GV exists): GHD used a GV of 129 mg/L based on a chronic ecotoxicity study with temperate organisms in soft water (temperatures ranged from 11 to 25°C) by Elphick et al. (2011). This value is for 95% species protection and is a reasonable conservative approach.
- Ammonia: GHD used a GV of 2.3 mg/L ammonia at pH 8.0 and 20°C for 80% species protection. The median pH of the monitoring data at the reference site was 6.5 (so ammonia toxicity is potentially less) but the 80th percentile of temperature is 31°C (so ammonia is potentially more toxic). Overall, GHD has taken a conservative value (at 31°C and pH 6.5, the GV could be up to 34.5 mg/L), but given that pH changes over a wide range, their approach is conservative and appropriate.
- Aluminium: GHD used the 80th percentile of the monitoring data (260 µg/L) rather than the more conservative and ecotoxicologically-based ANZECC/ARMCANZ (2000) value of 150 µg/L. They justified this by suggesting that there were catchment-specific characteristics that increased aluminium background concentrations, including the impacts of rainfall runoff. This approach is consistent with ANZECC/ARMCANZ (2000) which allows the use of background concentrations as GVs.
- Iron: There was no ANZECC/ARMCANZ GV for iron in freshwaters at the time, so the 80th percentile of reference site monitoring data (430 µg/L) was used. A new guideline for iron of 1400 µg/L for 80% species protection is now available (undergoing peer review) and this is based on toxicity of dissolved and particulate iron to freshwater biota, rather than a statistical distribution of iron monitoring data. However, if iron background concentrations are naturally higher, the 80th percentile of reference site monitoring data is acceptable as a GV.
- Mo, Co and U GVs were classified as low reliability by ANZECC/ARMCANZ (2000).

2.4 Historical water quality at the compliance point

2.4.1 Physico-chemical stressors

For physico-chemical stressors, the median of the monitoring data is compared to the GV (usually derived from the 80th percentile of the reference site monitoring data). A total of 215 samples were collected from the downstream compliance site SWTG2 (approximately 800 m downstream from the project area) from July, 2002 to February, 2015, with the majority collected in the wet season. Table 6-2 in the GHD report compares the median SWTG2 site data over this entire period, with their SSTVs. It is more usual to compare the annual site median with the SSTV, not a site median over 13 years, and in the case of a seasonal difference, to separate data for each season, to be consistent with the ANZECC/ARMCANZ (2000) approach. In addition, only the most recent data should have been used, as operations and discharges have changed since the site went into care and maintenance, and previous data may bear little resemblance to the proposed discharges of treated water outlined in the current EIS.

There were very wide ranges in concentrations of many parameters at SWTG1A, notably pH, hardness and alkalinity, with turbidity, and occasionally EC, elevated above SSTVs. This may have potential impacts on aquatic biota downstream. An aquatic macroinvertebrate, fish and habitat survey in April 2015 (during a lower than usual wet season) showed that the downstream site near SWTG2 had the lowest abundance of macroinvertebrates (Primary Gold, 2015). Water quality monitored at the time showed elevated EC and low pH downstream at the site on the edge of the lease boundary. A more recent survey in May, 2017, at

the end of a more typical wet season, showed similar results, with the macroinvertebrate community characterised by pollution-tolerant families. Limited fish data suggested poor fish condition, and low abundance and diversity immediately downstream of the new tailings dam discharge (Primary Gold Ltd, 2017).

2.4.2 Toxicants

For toxicants, action is triggered if the 95th percentile of the monitoring data exceeds the SSTV or default GV. The Guidelines note that this is equivalent to: *'no action is triggered if 95% of the values fall below the guideline value. The more stringent approach is recommended here because, unlike physical and chemical stressors, toxicant default values are based upon actual biological effects data and so by implication, exceedance of the value indicates the potential for ecological harm. Note that because the proportion of values required to be less than the default trigger value is very high (95%), a single observation greater than the trigger value would be legitimate grounds for action in most cases, even early in a sampling program.'*

In the GHD report, median values of the downstream monitoring site SWTG2, were compared to the SSTVs, rather than the 95th percentile. Their summary does include maximum values (from July, 2002 to February, 2015), and, if these were used, exceedances of SSTVs would occur for cyanide, sulfate, and most dissolved metals, including Al, Cd, Co, Cu, Fe, Mn, Mo, Ni, U and Zn. However, it should be noted that since August, 2014, there have been no direct discharges into Mount Bundey Creek and concentrations of metals have substantially decreased. For this reason, drawing conclusions from historical monitoring data is of limited use.

3 Derivation of Revised SSTVs for SWTG1A

3.1 Wet-season SSTVs

The SSTVs derived by GHD used combined wet and dry season historical monitoring data over 2003-2015, far longer than the two years of monitoring data recommended by ANZECC/ARMCANZ (2000). SSTVs for wet and dry seasons should be derived separately. From the more recent dataset provided by Primary Gold, SSTVs for pH, electrical conductivity (EC), total suspended solids (TSS), turbidity, sulfate, aluminium and iron were derived for reference site SWTG1a, for the wet season only and only for the period 2015 to 2017.

The revised SSTVs are shown in Table 2. The revised SSTVs were similar to previous values, with marginally lower 50th and 80th percentile values for conductivity, and higher values for TSS, turbidity, dissolved iron and dissolved aluminium. The revised SSTV for sulfate was 1.5 mg/L, similar to the previous value of 2 mg/L. In keeping with ANZECC/ARMCANZ (2000), the revised 80th percentile values should be used as SSTVs for the wet season only.

Table 2. Recalculated 50th and 80th percentile values using only wet season data for 2015-2017

	Revised 50th percentile	Revised 80th percentile	Old 50th percentile[a]	Old 80th percentile[a]
pH	6.7	6.9	6.5	7.0
EC, µS/cm	28	41	42	57
TSS, mg/L	40	54	17	32
Turbidity, NTU	51	87	22	60
Sulfate, mg/L	1.0	1.5	1	2
Al (total), µg/L	520	1680	-	-
Al (dissolved), µg/L	174	295	-	260
Fe (total), µg/L	1200	2700	-	-
Fe (dissolved), µg/L	256	492	-	430

[a] Old values derived by GHD based on combined wet and dry season data for 2003-2015

Recommended revised SSTVs for Toms Gully Mine are shown in Table 3. SSTVs for all physico-chemical parameters, as well as total iron and dissolved aluminium, were based on the 80th percentile of wet season monitoring data from the reference site SWTG1A, to take into account natural backgrounds. For all other toxicants, the default guidelines from ANZECC/ARMCANZ (2000) were used as these are based on actual ecotoxicological effects.

Sulfate: The exception was sulfate, for which no ANZECC/ARMCANZ guideline exists. Sulfate toxicity is known to decrease with increasing hardness and Dunlop et al. (2016) derived a site-specific GV of 936 mg SO_4/L for 80% species protection for hard waters (550 mg/L as $CaCO_3$). However, as Bundey Creek at site SWTG1A has a median hardness of 9 mg $CaCO_3$/L (i.e. very soft), this GV is not applicable. Instead, the 95% species protection GV for soft waters from Elphick et al. (2011) of 129 mg/L was recommended in the GHD report. A more recent study by Maeys and Nordin (2013) used the data from Elphick together with data from additional species, and derived a similar value for 95% species protection for soft waters (0-30 mg

$CaCO_3$/L) of 128 mg SO_4/L. Neither study derived a sulfate GV for lower levels of species protection. Using the 8 chronic data points (EC10s) from Elphick et al. (2011) at their lowest hardness values (15-40 mg $CaCO_3$/L), we re-derived a sulfate GV for 80% species protection of 316 mg/L, and 210 mg/L for 90% species protection. Although Bundey Creek has a lower hardness, these values are recommended, if 95% species protection is not required.

Table 3. Final recommended trigger values for discharges into Bundey Creek

Parameter	Trigger Value[a]	Trigger Value (90% species protection)	Final Proposed Trigger Values for the Discharge Point or Compliance Site SWTG2 after dilution
pH	6.9	-	5.8-8.0
EC, µS/cm	41	-	41
TSS, mg/L	54	-	54
Turbidity, NTU	87	-	87
Sulfate, mg/L	316[b]	210[b]	210
Al (pH>6.5), µg/L	295[c]	-	295[c]
As, µg/L	140	42	42
Cd, µg/L	0.8	0.4	0.4
Cr, µg/L	40	6	6
Cu, µg/L	2.5	1.8	1.8
Fe, µg/L	2700[d]	950[e]	2700[d]
Pb, µg/L	9.4	5.6	5.6
Mn, µg/L	3600	2500	2500
Ni, µg/L	17	13	13
Zn, µg/L	31	15	15
Total ammonia (pH 8), mg/L	2.3	1.4	1.4

[a] based on 80th percentile of reference site monitoring data for pH, EC, TSS and turbidity; based on 80% species protection for toxicants
[b] data for soft waters re-derived from Elphick et al. (2011) chronic toxicity study
[c] based on dissolved Al from background data
[d] based on total Fe from background data
[e] new ANZECC/ARMCANZ GV for total Fe (under review)

3.2 Dry season SSTVs

Given that Mount Bundey Creek only flows strongly for 3-4 weeks/year, Primary Gold proposes to also discharge treated water to Mount Bundey Creek in the dry season. Examination of the dry season data for SWTG1A showed that there were data for only 3 samples from 2015 to 2017, which did not meet the minimum sample requirements for derivation of SSTVs. Therefore no SSTVs could be calculated for

physicochemical parameters specifically for the dry season. If discharges are to occur in the dry season, then wet season SSTVs, together with toxicant TVs (ANZECC/ARMCANZ, 2000), could be used.

4 Future Compliance with Guideline Values for Stock Drinking Water and Irrigation

Previous monitoring at SWTG12 (wetland oxbow onsite near Mount Bundey Creek – the onsite discharge point) showed that discharge water had low pH, elevated EC, and elevated Co, Cu and Zn concentrations. Therefore, fortnightly monitoring at 13 surface water sites, including Coulter Creek upstream and downstream, for a large range of parameters, is proposed in the Water Management Plan.

The EIS proposed that pit water be treated to meet stock water GVs, to ensure that discharges to Mount Bundey Creek meet the aquatic ecosystem 80% species protection GVs at the compliance site downstream. This means that the section of Mount Bundey Creek that flows through the mining lease would be used as a mixing zone. In this mixing zone for several km (NT EPA says 7 km), the GV for 80% of species aquatic ecosystem protection would not be met. Our understanding is that previous water discharges (2005-2007) had required dilutions of 100:1 for untreated water discharge (from the evaporation pond) into the creek during high flow, but there were no agreed GVs for aquatic ecosystem protection at the time.

Although the EIS states that the compliance point for surface water discharge for the proposed project will be DP1 on Mount Bundey Creek **at the lease boundary**, Primary Gold has suggested that the compliance point will now be a few hundred metres further upstream than SWTG2 to avoid the influence of the road on water quality. A mixing zone of 1-2 km from the point of discharge was proposed.

Table 4 summarises the ANZECC/ARMCANZ (2000) guidelines for stock drinking water. Site water currently stored in pit and evaporation ponds would require treatment before discharge at DP1 to meet stock water GVs for sulfate and a range of metals including Al, Cd, Co, Cu, Ni and Zn. With appropriate treatment technologies, discharge from these storages could meet SSTVs for 80% protection (or better). Meeting sulfate SSTVs would be the biggest challenge, but should be possible using a combination of treatments. If only treated water was discharged, then there would be no need for a mixing zone in Mount Bundey Creek, assuming no seepage or groundwater infiltration of contaminated water. The treated discharge should comply with SSTVs (Table 3) and no dilution would be required. This would mean that discharges could occur in the dry season if necessary.

Lake Bazzamundi is an artificial wetland that was previously used to store mine water and bore water that was compliant with ANZECC/ARMCANZ stock water GVs. No water has been actively pumped into the lake since cessation of underground dewatering in 2010. The lake passively overflows from the south into Coulter Creek. The second proposed compliance site will be DP2 on Coulter Creek at the lease boundary, but there will be no surface water release at this location.

Groundwater, which is assumed to flow from Lake Bazzamundi to the northwest, is fresh and slightly acidic. Water from bores near the underground workings is expected to be of suitable quality for direct release into Lake Bazzamundi, providing the pastoralist with additional water in the dry season. Most bores have groundwater is bicarbonate dominated, but several bores along the edge of the sulfide and oxide waste dumps that is sulfate-dominated, probably due to acid leachate contamination. The Water Management Plan outlines the proposed groundwater concentrations with water quality monitoring upstream, within the site, and downstream on a quarterly basis. Water quality will be assessed against ANZECC/ARMCANZ (2000) stock water GVs and if met, should enable stock watering as a beneficial use.

Table 4. ANZECC/ARMCANZ (2000) guideline values for stock drinking water and irrigation

Analyte	Stock Drinking Water GV (ANZECC/ARMCANZ, 2000)	Irrigation GV (Short-term ANZECC/ARMCANZ 2000)
Sulfate, mg/L	1000	-
EC, µS/cm	~ 3000	-
Al, µg/L	5000	20000
As, µg/L	500	2000
Cd, µg/L	10	50
Co, µg/L	1000	100
Cr, µg/L	1000	1000
Cu, µg/L	1000	5000
Fe, µg/L	-	-
Pb, µg/L	100	5000
Mn, µg/L	-	10000
Ni, µg/L	1000	2000
U, µg/L	200	100
Zn, µg/L	20000	5000

Another possible beneficial water use is for irrigation of mango crops. The ANZECC/ARMCANZ (2000) GVs for short-term irrigation (up to 20 years) are shown in Table 4. There are no GVs for sulfate, chloride or sodium specifically for mango cultivation. Generally the irrigation GVs are less stringent than the stock watering GVs for metals, except for Co, Cr and U. There were very few monitoring data for water quality in Lake Bazzamundi. Site CCO2 (a reference site on Coulter Creek below Lake Bazzamundi) had elevated EC in the April, 2015 and May, 2017 aquatic biota surveys, but all downstream sites had no GV exceedances. There were no exceedances of dissolved metals compared to stock GVs at this site or downstream.

Given the lack of GVs, Primary Gold proposed to regularly survey soils to ensure that there is no long-term build-up of sulfate or other ions in soils over time.

5 Recommendations

For physico-chemical parameters, SSTVs for wet season use only were recalculated using the most recent wet season water quality monitoring data from 2015-2017 (Table 3). No SSTVs could be derived for the dry season due to lack of flow, and hence a lack of monitoring data. If discharges are likely to occur in the dry season, then wet season SSTVs for physico-chemical parameters would have to be used.

For sulfate, for which no GV exists, chronic ecotoxicity data from the study by Elphick et al. (2011) in soft waters was used to re-derive an 80% species protection value for sulfate of 316 mg/L. This value was higher than the more conservative 95% species protection value of 129 mg/L from Elphick et al. (2011) used by GHD (2015).

For toxicants such as metals, default ANZECC/ARMCANZ (2000) GVs should be used. If an 80% species protection level is chosen, then there should be commitment for continual improvement such that 90 or 95% species protection is achieved at the end of the 1-2 km mixing zone.

Liming, Virtual Curtain technology or some equivalent water treatment before discharge, will be required before discharges will meet the SSTVs for physico-chemical parameters and toxicants. Sulfate, aluminium and EC remain elevated after Virtual Curtain treatment (G. Douglas, pers. comm), but could be removed with additional post-treatment, e.g. reverse osmosis. Appropriate treatment before discharge will likely mean that 90 or 95% species protection GVs could be achieved in Mount Bundey Creek with discharges in both the wet and dry seasons, without the need for a mixing zone, and assuming no additional contamination from seepage or groundwater infiltration.

While Primary Gold proposed to undertake water and sediment quality monitoring, as well as biological monitoring downstream, direct toxicity assessment (DTA) of discharges using tropical freshwater species relevant to these soft waters should also be undertaken. This will ensure that there is no chronic toxicity of the discharge beyond the compliance point and will provide a further line of evidence in the weight of evidence approach now recommended in the revised guidelines. This knowledge gap has been identified in the Water Management Plan. DTA of the treated water discharge (with upstream water as the diluent) would provide a “safe” dilution and would be undertaken prior to each wet season, with results used by NT EPA for discharge approval. However, the WMP does not currently include DTA in its monitoring plan.

For other beneficial uses such as stock watering or irrigation, lower levels of treatment may be satisfactory, as GVs are less stringent than for aquatic ecosystem protection. Monitoring of sulfate and other ions in soils as proposed by Primary Gold, will be required to ensure that there is no build-up of these ions in soils over the longer term.

6 References

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