

## APPENDIX J2

### PEER REVIEW OF WATER TREATMENT OPTIONS STUDY

# BIRD IN HAND GOLD PROJECT

## MINING LEASE PROPOSAL MC 4473



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**TO** Jason van den Akker, Senior Hydrogeologist  
Golder Associates Pty Ltd.

**FROM** Martin Vogel and Dave Featherstonhaugh

**EMAIL** Martin\_Vogel@golder.com;  
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**RE: PEER REVIEW OF WATER TREATMENT OPTIONS STUDY, BIRD IN HAND (BIH) GOLD MINE  
PREPARED FOR TERRAMIN AUSTRALIA LTD. BY GPA ENGINEERING 27 OCTOBER 2017**

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## 1.0 INTRODUCTION

Golder Associates Ltd. (Golder) was retained by Golder Associates Pty Ltd. to perform a Peer Review of the Water Treatment Options Study for the Bird In Hand (BIH) Gold Mine that was prepared by GPA Engineering (GPA) for Terramin Australia Ltd. (Terramin). This peer review is to support the Mine Lease Proposal and is a requirement of the Ministerial Determination for a Mining Proposal for Bird In-Hand Gold Project.

This Peer Review deals solely with the water treatment options and does not include review of the underground portion of the water balance, surface water management systems or processes related to managing water introduced into the underground environment.

The Peer Review reviews the Risk Matrix, provides technical comments on each of the sections of the Report and provides general comments on the overall structure of the Report.

## 2.0 DRAFT PEER REVIEW REPORT

Following the review of Revision 1 of the GPA report, Golder submitted a Draft Peer Review Report on 28 November 2017 for discussion with Golder Associates Pty Ltd. The Draft Report was circulated to their client, Terramin, who shared the document with GPA to allow for dialogue and feedback.

Subsequently, GPA revised their Report (Revision 2) and submitted it to Terramin. Golder was then asked to review the revised report and provide an updated Peer Review.

This Peer Review is the updated Peer Review of Revision 2 of the GPA Report. In general, Revision 2 incorporated and addressed the majority of Golder's comments. There are several outstanding comments that Golder feels require additional detail in the GPA report.



## **3.0 REPORT REVIEW**

### **3.1 Section 1: Introduction**

GPA has incorporated all of Golder's comments from the Draft Peer Review on this Section into Revision 2 of their Report. We have no further comments on this Section.

### **3.2 Section 2: Basis of Design**

GPA has incorporated all of Golder's comments from the Draft Peer Review on this Section into Revision 2 of their Report. We have no further comments on this Section.

### **3.3 Section 3: WTP Process Concept**

GPA has incorporated the majority of Golder's comments from the Draft Peer Review on this Section into Revision 2 of their Report. There are still several areas that Golder recommends be addressed in more detail.

The Report identifies the need for three treatment stages in series to achieve nitrate reduction to the MAR target level. Treatment for other parameters will be achieved in one or more of these stages.

Each treatment stage had options that were discussed and a selected treatment process. These were reviewed and the selected treatment process for each stage was found to be generally appropriate and capable of achieving the Managed Aquifer Recharge or ReInjection (MAR) targets when combined in series. However, shortcomings that would be expected to cause or potentially cause the treated water NOT to meet the MAR targets, have been identified by Golder.

The individual components of the recommended treatment stages were reviewed and those that should be addressed in more detail are discussed below and potential risks are identified.

#### **3.3.1 Section 3.3.3 Tertiary Treatment**

##### **3.3.1.1 Cation Exchange Unit**

The cation exchange unit utilizes a strong acid cation exchange resin that will be regenerated with sulphuric acid. The purpose of the process is to remove cations (positively charged ions such as calcium, magnesium, and sodium) and replace these cations with hydrogen ion. The exchange for hydrogen ions results in a lowering of the total dissolved solids (TDS) concentration as hydrogen ions do not contribute to TDS but also causes the pH of the water to decrease. The following risk has been identified for this process: The pH of the treated water may be lower than the minimum pH of 7.1 identified for MAR water. Means for raising the treated water pH following cation exchange should be investigated.

##### **3.3.1.2 Anion Exchange Unit**

The purpose of the anion exchange unit is to lower nitrate nitrogen from a maximum influent concentration of 3.0 mg/L to 0.3 mg/L. This is to be accomplished with nitrate selective anion exchange resins. The exchangers would be operated in a lead-lag scenario. The resin will be regenerated with a sodium chloride solution. The following risk has been identified for this process:

The anion exchange unit will also have to provide removal of sulphate as this anion would be added to the water due to the proposed use of the ferric sulphate as coagulant and sulphuric acid to lower the pH downstream of the clarifier. Any removal of sulphate, as well as removal of nitrate, by an anion exchanger that is regenerated with sodium chloride would result in an equivalent increase in the chloride concentration. The proposed process has no identified treatment step for the removal of chloride. Consequently, the chloride treated water objective would not be met.

### **3.4 Section 4: Treatment Technology Selection**

GPA has incorporated the majority of Golder's comments from the Draft Peer Review on this Section into Revision 2 of their Report. Remaining concerns relate to treated water pH and chloride concentrations as described above.

### **3.5 Section 5: Next Phase of Design**

Section 5 was updated by GPA to reflect items identified in Golder's Draft Peer Review that require further investigation. We are in agreement with the contents of this Section but point out that it does not include all items that required further investigation as described in this Peer Review.

### **3.6 Appendix 1 Conceptual Process Flow Diagram (PFD) - Stream Table**

The stream table in Appendix 1 identifies parameter concentration estimates for various streams. Comments are as follows:

- 1) The Clarifier Recycle Water (Stream 9) should have the same sodium concentration as the Return from Storage Dam stream (Stream 3) but is shown with a lower concentration for Stream 9.
- 2) There would be an increase in the chloride concentration between Stream 5 (Filtered Water) and Stream 6 (Treated Water) as a result of sulphate removal by anion exchange (may require re-design of anion exchange) and nitrate removal (minor effect).
- 3) It is expected that the decrease in treated water pH between Stream 5 (Filtered Water) and Stream 6 (Treated Water) as a result of exchange of cations for hydrogen ion would be greater than shown.

The risk associated with the presumed errors in concentration estimates is that treated water objectives may not be achieved.

### **3.7 Appendix 2 Conceptual Plant Layout**

The Conceptual Plant Layout was reviewed and Golder finds it to be a reasonable layout, with sufficient space for operations and maintenance of the facility. We have no further comments on Appendix 2.

### 3.8 Appendix 3 Preliminary Risk Matrix Review

The Preliminary Risk Matrix in Appendix 3 of the Report was updated to reflect the majority of comments in the Draft Peer Review. Risks that still need to be identified include the following as described above:

- Potential for treated water pH to be lower than required
- Potential for treated water chloride concentration to be higher than required

### 3.9 Appendix 4 Analysis of Bores Surrounding BIH

Golder reviewed Appendix 4 as it relates to the water quality of the surrounding aquifer. We have no comments on this Appendix.

### 4.0 CLOSURE

The reader is referred to the Study Limitations, which follows the text and forms an integral part of this memorandum.

We trust the above review meets your needs. If you have any questions or require additional information, please do not hesitate to contact the undersigned.

Yours very truly,

**GOLDER ASSOCIATES LTD.**



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Attachment: Study Limitations

[https://golderassociates.sharepoint.com/sites/20601g/deliverables/3.issued/1790559-002-tm-rev0-1000/1790559-002-tm-rev0-1000-peerreview wtr treatment opt study bih gold mine 15dec\\_17.docx](https://golderassociates.sharepoint.com/sites/20601g/deliverables/3.issued/1790559-002-tm-rev0-1000/1790559-002-tm-rev0-1000-peerreview%20wtr%20treatment%20opt%20study%20bih%20gold%20mine%2015dec_17.docx)

## STUDY LIMITATIONS

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