Government of Western Australia
Department of Environment Regulation

Works Approval

Environmental Protection Act 1986, Part V

Works Approval Holder: Western Areas Limited

Works Approval Number: W5839/2015/1

Registered office: Level 2, 2 Kings Road
WEST PERTH WA 6005

ACN: 091 049 357

Premises address: Cosmic Boy Nickel Concentrator
Forrestania Southern Cross Road
FORRESTANIA WA 6359
Being mining tenement M77/399, as depicted in Schedule 1.

Issue date: Thursday, 20 August 2015

Commencement date: Monday, 24 August 2015

Expiry date: Thursday, 23 August 2018

The following category/s from the *Environmental Protection Regulations 1987* cause this Premises to be a prescribed premises for the purposes of the *Environmental Protection Act 1986*:

Category number	Category description	Category production or design capacity	Approved premises production or design capacity
5	Processing or beneficiation of metallic or non-metallic ore: premises on which – (a) metallic or non-metallic ore is crushed, ground, milled or otherwise processed; or (b) tailings from metallic or non-metallic ore are reprocessed; or (c) tailings or residue from metallic or non-metallic ore are discharged into a containment cell or dam.	50,000 tonnes or more per year	600,000 tonnes per annual period

Conditions
This Works Approval is subject to the conditions set out in the attached pages.

.....
Danielle Eyre
Officer delegated under section 20
of the *Environmental Protection Act 1986*

Works Approval Conditions

1 General

1.1 Interpretation

1.1.1 In the Works Approval, definitions from the *Environmental Protection Act 1986* apply unless the contrary intention appears.

1.1.2 In the Works Approval, unless the contrary intention appears:

'Act' means the *Environmental Protection Act 1986;*

'CEO' means Chief Executive Officer of the Department of Environment Regulation;

'CEO' for the purpose of correspondence means;
Senior Manager – Industry Regulation (Resource Industries)

At the following address:
Department of Environment Regulation
Locked Bag 33
CLOISTERS SQUARE WA 6850
Telephone: (08) 9333 7510
Facsimile: (08) 9333 7550
Email: industry.regulation@der.wa.gov.au;

'Commissioning' means the process of operation and testing that verifies the works and all relevant systems, plant, machinery and equipment have been installed and are performing in accordance with the design specification set out in the works approval application;

'NATA' means the National Association of Testing Authorities, Australia;

'NATA accredited' means in relation to the analysis of a sample that the laboratory is NATA accredited for the specified analysis at the time of the analysis;

'Premises' means the area defined in the Premises Map in Schedule 1 and listed as the Premises address on page 1 of the Works Approval;

'Schedule 1' means Schedule 1 of this Works Approval unless otherwise stated;

"USEPA Method 15" means the USEPA Method 15 *Determination of Hydrogen Sulfide, Carbonyl Sulfide, and Carbon Disulfide Emissions from Stationary Sources*;

'Works Approval' means this Works Approval numbered W5839/2015/1 and issued under the Act; and

'Works Approval Holder' means the person or organisation named as the Works Approval Holder on page 1 of the Works Approval.

1.1.3 Any reference to an Australian or other standard in the Works Approval means the relevant parts of the standard in force from time to time during the term of this Works Approval.

1.1.4 Any reference to a guideline or code of practice in the Works Approval means the current version of the guideline or code of practice in force from time to time, and shall include any amendments or replacements to that guidelines or code of practice made during the term of this Works Approval.

1.2 General conditions

1.2.1 The Works Approval Holder shall construct the works in accordance with the documentation detailed in Table 1.2.1:

Table 1.2.1: Construction Requirements[1]

Document	Parts	Date of Document
Works Approval Application Form	All	14 April 2015
Cosmic Boy Concentrator Bioleach Plant Works Approval Supporting Document, Licence No.: L8041/1990/5, Forrestania Nickel Project, Cosmic Boy Concentrator Site – Revision 2, prepared by Western Areas Ltd and dated May 2015	All, including diagrams and attachments	May 2015

Note 1: Where the details and commitments of the documents listed in condition 1.2.1 are inconsistent with any other condition of this works approval, the conditions of this works approval shall prevail.

2 Emissions

2.1 Point source emissions to air

2.1.1 The Works Approval Holder shall ensure that where waste is emitted to air from the emission points in Table 2.2.1 it is done so in accordance with the conditions of this works approval.

Table 2.2.1: Emission points to air

Emission point reference	Emission Point and source	Emission point height (m)	Source, including any abatement
A1	Sulfide precipitation tank	Minimum 3.0	Sulfide precipitation tank vent(s)

3 Monitoring

3.1 General monitoring

3.1.1 The Works Approval Holder shall ensure that all non-continuous sampling and analysis is undertaken by a holder of NATA accreditation for the relevant methods of sampling and analysis.

3.2 Monitoring of point source emissions to air

3.2.1 The Works Approval Holder shall undertake the monitoring specified in Table 3.2.1 during the Commissioning period.

Table 3.2.1: Monitoring of point source emissions to air

Emission point reference	Parameter	Units	Frequency	Method
A1	Hydrogen sulfide	mg/m^3	Minimum required to demonstrate venting performance under all likely operating conditions	USEPA Method 15

4 Improvements

4.1 Improvement program

4.1.1 The Works Approval Holder shall complete the improvements in Table 4.1.1 by the date of completion in Table 4.1.1.

Table 4.1.1: Improvement program

Improvement reference	Improvement	Date of completion
IR1	The Works Approval Holder shall submit to the CEO an updated water balance assessment and seepage determination for the TSF that considers the following additional factors: (a) the amount and intensity of rain that falls on the TSF over time; (b) the amount of water lost from evaporation from wet areas on the TSF (i.e. decant pond and saturarted beach areas) and how this varies in time due to changes in pond geometry and seasonal factors; and (c) the rate and extent to which water entrained in tailings at depth in the TSF is lost due to consolidation of these materials.	30 October 2015
IR2	The Works Approval Holder shall submit to the CEO an updated groundwater recovery model, with simulations based on the updated seepage estimates obtained from IR1. The updated model shall include updates to the predicted pumping rates to reduce the magnitude of groundwater mounding near the TSF.	
IR3	The Works Approval Holder shall submit to the CEO an updated review of impacts of seepage from the TSF on groundwater quality, based on the updated predicted seepage estimates, magnitude of groundwater mounding near the TSF and groundwater recovery program, obtained from IR2.	

5 Information

5.1 Reporting

5.1.1 The Works Approval Holder shall submit a compliance document to the CEO, following the construction of the works and prior to commissioning of the same.

5.1.2 The compliance document shall:
(a) certify that the works were constructed in accordance with the conditions of the works approval;
(b) be signed by a person authorised to represent the Works Approval Holder and contain the printed name and position of that person within the company.

5.1.3 The Works Approval Holder shall submit a commissioning report for the sulfide precipitation tank to the CEO within 3 months of the completion of commissioning.

5.1.4 The Works Approval Holder shall ensure the report includes:
(a) a summary of the environmental performance of the sulfide precipitation tank as installed, against the design specification set out in the works approval application;
(b) a copy of the monitoring results required by condition 3.2.1;
(c) a review of performance against the design specification; and
(d) where they have not been met, measures proposed to meet the design specification, together with timescales for implementing the proposed measures.

Schedule 1: Maps

Premises map

The Premises is shown in the map below. The red line depicts the Premises boundary of this works approval (M77/399), being one of several tenements that constitute the greater Forrestania Nickel Operations.

Government of Western Australia
Department of Environment Regulation

Decision Document

Environmental Protection Act 1986, Part V

Proponent: Western Areas Limited

Works Approval: W5839/2015/1

Registered office:	Level 2, 2 Kings Road WEST PERTH WA 6005
ACN:	091 049 357
Premises address:	Cosmic Boy Nickel Concentrator Forrestania Southern Cross Road FORRESTANIA WA 6359 Being mining tenement M77/399
Issue date:	Thursday, 20 August 2015
Commencement date:	Monday, 24 August 2015
Expiry date:	Thursday, 23 August 2018

Decision

Based on the assessment detailed in this document the Department of Environment Regulation (DER), has decided to issue a works approval. DER considers that in reaching this decision, it has taken into account all relevant considerations and that the Works Approval and its conditions will ensure that an appropriate level of environmental protection is provided.

Decision Document prepared by:	Daniel Hartnup Licensing Officer
Decision Document authorised by:	Danielle Eyre Delegated Officer

Contents

1 Purpose of this Document

This decision document explains how DER has assessed and determined the application and provides a record of DER's decision-making process and how relevant factors have been taken into account. Stakeholders should note that this document is limited to DER's assessment and decision making under Part V of the *Environmental Protection Act 1986.* Other approvals may be required for the proposal, and it is the proponent's responsibility to ensure they have all relevant approvals for their Premises.

2 Administrative summary

Administrative details		
Application type	Works Approval ☒ New Licence ☐ Licence amendment ☐ Works Approval amendment ☐	
Activities that cause the premises to become prescribed premises	**Category number(s)**	**Assessed design capacity**
	5: Processing or beneficiation of metallic or non-metallic ore	600,000 tonnes per annual period
Application verified Application fee paid	Date: 12/05/2015 Date: 29/05/2015	
Works Approval has been complied with Compliance Certificate received	Yes☐ No☐ N/A☒ Yes☐ No☐ N/A☒	
Commercial-in-confidence claim	Yes☒ No☐	
Commercial-in-confidence claim outcome	Information relating to the bioleach process (proprietary bacterial leach technology owned by the applicant) has been deemed commercially sensitive and will be withheld.	
Is the proposal a Major Resource Project?	Yes☒ No☐	
Was the proposal referred to the Environmental Protection Authority (EPA) under Part IV of the *Environmental Protection Act 1986*?	Yes☐ No☒	Referral decision No: Managed under Part V ☐ Assessed under Part IV ☐
Is the proposal subject to Ministerial Conditions?	Yes☐ No☒	Ministerial statement No: EPA Report No:
Does the proposal involve a discharge of waste into a designated area (as defined in section 57 of the *Environmental Protection Act 1986*)?	Yes☐ No☒ Department of Water consulted Yes ☐ No ☒	
Is the Premises within an Environmental Protection Policy (EPP) Area Yes☐ No☒		
Is the Premises subject to any EPP requirements? Yes☐ No☒		

3 Executive summary of proposal and assessment

Western Areas Limited operates the Cosmic Boy Nickel Concentrator under Licence L8041/1990/5 as part of its Forrestania Nickel Operations. The concentrator treats ore mined from the Flying Fox and Spotted Quoll ore bodies, producing a ~14% nickel concentrate product. This proposal relates to the addition of a bioleach plant to improve nickel recovery during the ore processing phase.

The proposal targets the Spotted Quoll ore reject cleaner flotation cell tailings stream (~2.5%), which is currently disposed as tailings due to the high concentration of nickel arsenide (NiAs). This portion will be further concentrated by bioleaching the solids and precipitating the iron and arsenic as a stable ferric arsenate complex; the remaining nickel-rich liquor will be treated to precipitate out the nickel sulfide product.

There will be no change in the overall volume of tailings disposed. The ferric arsenate residue will make up approximately 5% of the total combined tailings stream.

Addition of the bioleach circuit will result in the following changes to the existing concentrator:

- Modification of the existing cleaner flotation cells and clarifier thickener;
- New bioleach feed buffer tank;
- New cyanide detoxification tank – to remove thiocyanates and weak acid dissociable cyanide complexes from the concentrate (may hinder the bacteria used to leach the nickel);
- 3 new primary and 3 new secondary leach tanks and one new polishing tank;
- New ferric arsenate filtration press;
- 4 new sulfide precipitation tanks;
- New bacteria farm – 6 enclosed leach tanks to produce the bacteria to be used in the bioleach plant;
- New cooling water system – to remove heat from the bioleach process; and
- New 60 tonne lime silo.

Additional reagents are also required for the process, including sulfuric acid, sodium sulfide, hydrogen peroxide and lime slurry, which will be stored in purpose-built concrete bunded areas in accordance with the code of practice for the storage and handling of dangerous goods.

Although considered much cleaner than the traditional heap leaching using cyanide, the bioleaching process is much slower than smelting and can produce toxic chemicals that can leak into the ground and surface water. As such, the primary environmental consideration associated with this proposal relates to the production of arsenic and arsenic leaching. A metals analysis and leach testing of a typical residue sample (bioleach and current tailings) indicates there will be no significant alteration to the chemical makeup of the current tailings, or impact significantly on the rate of leaching from the TSF tailings bed. Water quality monitoring will continue around the TSF to monitor for seepage and mounding, in addition to an existing groundwater recovery system that will continue to operate for the life of the operation.

4 Decision table

All applications are assessed in line with the *Environmental Protection Act 1986*, the *Environmental Protection Regulations 1987* and DER's Operational Procedure on Assessing Emissions and Discharges from Prescribed Premises. Where other references have been used in making the decision they are detailed in the decision document.

DECISION TABLE			
Works Approval / Licence section	**Condition number W = Works Approval L= Licence**	**Justification (including risk description & decision methodology where relevant)**	**Reference documents**
General conditions	W1	**Construction** There are no specified conditions required relating to general requirements during construction works.	Application supporting documentation
	L1.2.5	**Operation** **Normal operation** There are no specified conditions relating to general requirements for normal operating conditions. **Abnormal operation** <u>Emission Description</u> *Emission:* Contamination of stormwater with nickel-contaminated sediment at unknown concentration. *Impact:* In large doses nickel can be toxic to many organisms and may result in a reduction of fresh groundwater and surface water quality. Nickel concentrations in plants above 50 µg/g are toxic and can cause growth restraints. *Controls:* Rainfall runoff generated by the bioleach plant area will be directed to the existing plant footprint sedimentation pond, which will allow any sediment to settle out. The water in the sump will be periodically pumped to the TSF. <u>Risk Assessment</u> *Consequence*: Moderate. *Likelihood:* Possible. *Risk Rating:* Moderate. <u>Regulatory Controls</u> L1.2.5 is an existing condition on the licence that requires the operator to prevent stormwater	

DECISION TABLE			
Works Approval / Licence section	**Condition number W = Works Approval L= Licence**	**Justification (including risk description & decision methodology where relevant)**	**Reference documents**
		contamination in the first instance, and to treat contaminated stormwater prior to any discharge if required. This condition is considered adequate for managing the risk of impacts from nickel-contaminated stormwater; therefore no additional or changes to existing conditions are required on the licence. Residual Risk *Consequence*: Moderate. *Likelihood:* Unlikely. *Risk Rating:* Moderate.	
Premises operation	W1.3	**Construction** There are no specified conditions relating to premises operational requirements in this section.	Guidelines on the Safe Design and Operating Standards for Tailings Storage (DME, 1999) (TSF Guideline) Application supporting documentation
	L1.3.3, L3.8.1	**Operation** DER's assessment and decision making are detailed in Appendix A.	
Emissions general	W2	No emissions of significance are expected during construction of the bioleach plant requiring descriptive limits or targets to be set through the works approval.	
	L2.2.1	Descriptive limits have been set through conditions of the licence and therefore conditions regarding recording and investigation of exceedances of limits has been included.	
Point source emissions to air including monitoring	W2 and W3	**Construction** There are no point source emissions to air proposed in the application during construction works.	
	L2.2.1	**Operation** DER's assessment and decision making are detailed in Appendix A.	Application supporting documentation
Point source emissions to surface water	W2 and W3 L2.2 and L3.2	**Construction & Operation** There are no point source emissions to surface water proposed in the application.	

DECISION TABLE			
Works Approval / Licence section	**Condition number W = Works Approval L= Licence**	**Justification (including risk description & decision methodology where relevant)**	**Reference documents**
including monitoring			
Point source emissions to groundwater including monitoring	W2 and W3 L2.4 and L3.4	**Construction & Operation** There are no point source emissions to groundwater proposed in the application.	
Emissions to land including monitoring	W2 and W3 L2.5 and L3.5	**Construction & Operation** There are no emissions to land proposed in the application.	
Fugitive emissions	W2	**Construction** <u>Emission Description</u> *Emission:* Fugitive dust at unknown concentration, generated during ground disturbance activities. Dust, or total suspended particulate matter (TSP) is comprised of coarse particulate matter (CPM), which is generally comprised of particles greater than 10 µm in diameter, and the respirable fraction comprised of particles less than 10 µm in diameter (PM_{10}). *Impact:* Dust emissions can be harmful to human health and the environment. Elevated TSP levels can impact ambient environmental quality resulting in amenity impacts and can smother vegetation. PM_{10} or $PM_{2.5}$ can be drawn deep into the lungs causing human health impacts. The chemical and physical properties of the particles, the size of the particles and the duration of exposure are all factors which may affect human health impacts. *Controls:* A water cart with dribble bars will be used to control dust during construction activities, and during operations when required. <u>Risk Assessment</u> *Consequence*: Minor. *Likelihood:* Rare. *Risk Rating:* Low. <u>Regulatory Controls</u> The risk of fugitive dust emissions from ground disturbance activities during construction works causing amenity impacts and smothing vegetation is deemed to be low (given the distance to	

DECISION TABLE			
Works Approval / Licence section	**Condition number W = Works Approval L= Licence**	**Justification (including risk description & decision methodology where relevant)**	**Reference documents**
		the nearest sensitive receptor ~19 km and nearby vegetation to the processing plant area) and is not considered significant enough to warrant site specific conditions on the works approval. Residual Risk *Consequence*: Minor. *Likelihood:* Rare. *Risk Rating:* Low.	
	L2.6.1	**Operation** Emission Description *Emission:* Fugitive dust at unknown concentration, generated during ground disturbance activities and dried tailings liftoff from the TSF. *Impact:* Dust emissions can be harmful to human health and the environment. Elevated TSP levels can impact ambient environmental quality resulting in amenity impacts and can smother vegetation. Arsenic may be present at elevated concentrations in dust derived from dried tailings, which can impact flora and fauna values within proximity to the TSF. *Controls:* A water cart with dribble bars will be used to control dust during operations when required. Deposition of tailings into the TSF is rotated regularly with the entire surface renewed every 4 – 6 weeks, thereby maintaining a saturation layer on the surface of the TSF and minimising dust liftoff. Risk Assessment *Consequence*: Minor for general dust emissions; Moderate for dust emissions of arsenic tailings. *Likelihood:* Unlikely. *Risk Rating:* Moderate. Regulatory Controls The risk of fugitive dust emissions from ground disturbance activities causing amenity impacts and smothing vegetation is deemed to be low (given the distance to the nearest sensitive receptor ~19 km and nearby vegetation to the processing plant area). The risk of fugitive dust emissions from arsenic tailings impacting on flora and fauna values within proximity of the TSF is considered to be moderate. As such, conditions will be added to the licence to require dust	

DECISION TABLE			
Works Approval / Licence section	**Condition number W = Works Approval L= Licence**	**Justification (including risk description & decision methodology where relevant)**	**Reference documents**
		control of dried tailings within the TSF. Residual Risk *Consequence*: Moderate. *Likelihood:* Unlikely. *Risk Rating:* Moderate.	
Odour	W2	**Construction** Odour is not expected from construction of the bioleach plant. No specified conditions relating to odour emissions or the monitoring of these emissions are required to be added to the works approval.	
	L2.7.1	**Operation** Emissions of H_2S are expected from the sulfide precipitation process, which may be odourous. As this refers to a point source emission to air, the risk assessment of odour has been addressed in this section (refer section 2.2).	
Noise	W2 L2.8	**Construction & Operation** Emission Description *Emission:* Noise and vibration generated during construction/commissioning and subsequent operation of the bioleach plant (e.g. pumps and agitators). *Impact:* Annoyance, nuisance of nearby receptors ~19 km away. *Controls:* Installing modern equipment with low sound power rating. Risk Assessment *Consequence*: Minor. *Likelihood:* Rare. *Risk Rating:* Low. Regulatory Controls The risk of noise emissions impacting on nearby receptors is deemed to be low (given the distance to the nearest sensitive receptor ~19 km) and is not considered significant enough to warrant site specific conditions on the works approval or licence. Noise emissions can be adequately regulated through the provisions of the Noise Regulations. Residual Risk	*Environmental Protection (Noise) Regulations 1997* (Noise Regulations)

DECISION TABLE			
Works Approval / Licence section	**Condition number W = Works Approval L= Licence**	**Justification (including risk description & decision methodology where relevant)**	**Reference documents**
		Consequence: Minor. *Likelihood:* Rare. *Risk Rating:* Low.	
Monitoring general	W3	**Construction** Monitoring is not required during construction of the bioleach plant. No specified conditions relating to monitoring are required to be added to the works approval.	
	L3.1.1 – L3.1.5	**Operation** The existing licence includes OSCs regarding the requirements of sampling location, monitoring equipment and calibration. No additional conditions or changes to existing conditions relating to general monitoring requirements are required to be added to the existing licence.	
Monitoring of inputs and outputs	W3 L3.6	**Construction & Operation** Monitoring of inputs and outputs is not required to adequately manage emissions during construction or operation of the bioleach plant. No specified conditions relating to process monitoring are required to be added to the works approval or licence.	
Process monitoring	W3 L3.7	**Construction & Operation** Process monitoring is not required to adequately manage emissions during construction or operation of the bioleach plant. No specified conditions relating to process monitoring are required to be added to the works approval or licence.	
Ambient quality monitoring	W3	**Construction** Ambient quality monitoring is not required during construction of the bioleach plant. No specified conditions relating to ambient quality monitoring are required to be added to the works approval.	
	L3.8.1	**Operation** Monitoring of ambient groundwater quality around the TSF (i.e. seepage) is an existing requirement of the licence (L3.8.1). Monitoring for arsenic is an existing requirement; however the licence will require amending to impose a requirement a for management response (i.e. groundwater recovery) to be implemented if groundwater monitoring results indicate arsenic concentrations above a threshold of 25 µg/L.	
Meteorological monitoring	W3 L3.9	**Construction & Operation** Monitoring of meteorological conditions is not required.	

DECISION TABLE			
Works Approval / Licence section	**Condition number W = Works Approval L= Licence**	**Justification (including risk description & decision methodology where relevant)**	**Reference documents**
Improvements	W4 L4	**Construction & Operation** No improvements are required.	
Information	W5 L5	**Construction & Operation** No additional reporting conditions are required to be added to the works approval or licence.	
Works Approval Duration	N/A	The works approval will be issued for the standard 3 year duration.	

5 Advertisement and consultation table

Date	Event	Comments received/Notes	How comments were taken into consideration
08/06/2015	Application advertised in West Australian newspaper	Nil.	N/A.
17/07/2015 10/08/2015	Proponent sent a copy of draft instrument	No issues raised; query regarding suitable alternatives to USEPA Method	N/A.

6 Risk Assessment

Note: This matrix is taken from the DER Corporate Policy Statement No. 07 - Operational Risk Management

Table 1: Emissions Risk Matrix

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Severe
Almost Certain	Moderate	High	High	Extreme	Extreme
Likely	Moderate	Moderate	High	High	Extreme
Possible	Low	Moderate	Moderate	High	Extreme
Unlikely	Low	Moderate	Moderate	Moderate	High
Rare	Low	Low	Moderate	Moderate	High

Appendix A

A1 Premises operation – disposal of bioleach plant tailings to existing TSF

The bioleach plant will produce a ferric arsenate residue that will be recombined into the current tailings stream and disposed into the existing TSF. This residue will make up approximately 5% of the total combined tailings stream. A metals analysis of a typical residue sample (bioleach and current tailings) and subsequent leach testing for major metals indicates only a minor change to the tailings makeup from the addition of the bioleach tailings, as seen in the table below.

ALSP leach results for typical ferric arsenate and current tailings stream							
Parameter	**Units**	**Bioleach plant tailings Acetic Acid leachate**	**Cosmic Boy Current tailings Acetic Acid leachate**	**Combined result**	**Bioleach plant tailings DI water leachate**	**Cosmic Boy current tailings DI water leachate**	**Combined result**
Arsenic	mg/L	0.3	0.1	0.11	0.198	0.02	0.029
Cadmium	mg/L	0.05	0.05	0.05	0.0001	0.005	0.005
Chromium	mg/L	0.1	0.1	0.1	0.006	0.01	0.001
Cobalt	mg/L	3.0	0.1	0.245	3.13	0.01	0.17
Copper	mg/L	1.5	0.1	0.17	2.44	0.01	0.13
Lead	mg/L	0.1	0.1	0.1	0.001	0.01	0.001
Nickel	mg/L	151	17.6	24.27	163	0.04	8.2
Trivalent chromium	mg/L	0.01	0.01	0.01	0.01	0.01	0.01
Hexavalent chromium	mg/L	0.01	0.01	0.01	0.01	0.01	0.01

Under normal operating conditions, the TSF is expected to be operated in accordance with the TSF Guideline[1], i.e. a safe, stable, erosion-resistant and non-polluting structure that minimises environmental impacts. Abnormal operating conditions include excessive seepage of tailings liquor, overflow or leakage of tailings liquor, release of tailings material or liquor, and abrupt structural failures.

Emission Risk Assessment

Emission Description

Emission: Arsenic contamination of shallow groundwater from leaching of tailings. Ferric arsenate is a stable arsenic compound; it is soluble, but the solubility increases rapidly as the ratio of iron to arsenic decreases. Arsenic is very soluble at low acid concentrations and high temperatures.

Geochemical characterisation of the old tailings solids in 1998 (i.e. prior to closure and capping by Outokumpu Mining Australia), upon which the current TSF has been constructed upon, indicates the current TSF is sitting on mainly neutral-to-alkaline material, which would provide additional buffering capacity for any seepage.

Impact: Arsenic contamination of groundwater presents a serious threat to public health, particularly if the groundwater is used for drinking purposes. Arsenic is a documented human carcinogen with an acute toxicity at high concentrations, as well as harmful effects from low level, long-term exposure (e.g. arsenicosis). The concentration of mobile arsenic in liquid for the above bioleach plant tailings sample (0.3 mg/L) is nearly 16 times less than the leachable concentration criteria for a Class III landfill[2] of 5 mg/L. When

[1] *Guidelines on the Safe Design and Operating Standards for Tailings Storage (DME, 1999)*
[2] *Landfill Waste Classification and Waste Definitions 1996 (as amended)(DEC, 2009)*

combined with current tailings, the concentration of arsenic in leachate is below the leachable concentration criteria for a Class I inert landfill of 0.05 mg/L (this is also the criterion for As in drinking water[3]). All other metals tested appear to be relatively stable.

Controls: Tailings will be disposed in the existing TSF, and managed to ensure minimal seepage, overflow or leakage in accordance with the TSF Guideline.

A review of the TSF audit[4] clearly indicates that seepage from the TSF is discharging into groundwater; however the rate of seepage has been poorly defined due to the limited nature of the water balance that has been undertaken for the facility. As a consequence of this, groundwater modelling has been poorly constrained and there is a high degree of uncertainty in the rate of pumping required to reduce groundwater mounding near the TSF.

Risk Assessment – Normal operation

The consequence of arsenic contamination of shallow groundwater from leaching of tailings would be a localised alteration of the environment, with medium to long-term impacts and serious health effects (e,g, arsenicosis). Given the above, the likelihood of this consequence occurring under normal operating conditions is possible (could occur), with a combined risk rating of high.

Consequence: Major.
Likelihood: Possible.
Risk Rating: High.

Risk Assessment – Abnormal operation

The likelihood of this consequence occurring under abnormal operating conditions (examples of these conditions listed above), is likely (would probably occur in most circumstances), with a combined risk rating of high.

Consequence: Moderate.
Likelihood: Likely.
Risk Rating: High.

Regulatory Controls

L1.3.3 is an existing condition on the licence for activities that require the containment of material that would pose a threat to the environment, which specifies that tailings must be disposed and contained within the TSF that is constructed in accordance with the TSF Guideline and managed to maintain freeboard, integrity and a seepage recovery system.

L3.8.1 is an existing condition on the licence that requires groundwater quality monitoring around the TSF to determine the extent of seepage and mounding. A groundwater recovery system is also in place, predominantly to control groundwater mounding. This condition will require amending to include a threshold concentration for arsenic of 24 µg/L[5], which will trigger conditions 3.8.2 & 3.8.3 regarding management action and groundwater recovery to reduce arsenic contamination of groundwater.

An improvement condition will be added to the works approval to require a more comprehensive water balance to be undertaken, to enable the seepage component to be determined with a higher degree of certainty than currently exists. This will also require the groundwater recovery model to be updated (using a more reliable estimate of the seepage flux out of the TSF), to enable the predicted

[3] *Australian Drinking Water Guidelines (NHMRC, 2004)*
[4] *Forrestania Nickel Mine - Tailings Storage Audit and Management Review (Coffey Mining Pty Ltd, July 2014)*
[5] *ANZECC Guidelines (2000), trigger value for freshwater, 95% species level of protection*

pumping rates to reduce the magnitude of groundwater mounding near the TSF to be determined with a higher degree of certainty than currently exists.

Residual Risk

With the above regulatory controls imposed through the licence, the residual risk rating of arsenic contamination of shallow groundwater from leaching of tailings is moderate.

Consequence: Moderate.
Likelihood: Unlikely.
Risk Rating: Moderate.

Emissions & Monitoring

A2 Point source emissions to air and monitoring

There are two point source emissions to air identified for the proposed bioleach plant, being the venting of the sulfide precipitation tanks and venting from the additional lime silo.

Emission Risk Assessment – Sulfide precipitation tank venting

Emission Description

The sulfide precipitation process converts the soluble nickel compound into a relatively insoluble nickel sulfide compound through the addition of a precipitating agent (sodium sulfide, NaS). The dose rate of NaS is adjusted to just react with the levels of metals in solution. Excess sulfide ions in the supernatant are oxidised using the sulfur-reducing bacteria – this process must be carefully controlled (i.e. pH must be high enough) to minimise the release of toxic hydrogen sulfide (H_2S) gas.

Emission: Hydrogen sulfide (H_2S) gas, vented to the atmosphere.

Impact: H_2S emissions can be harmful to human health and the environment. H_2S is a highly toxic and flammable gas, and being heavier than air it tends to accumulate at the bottom of poorly ventilated spaces. It is both an irritant and a chemical asphyxiant with effects on both oxygen utilisation and the central nervous system. Its health effects vary depending on the level and duration of exposure – at low concentrations it can cause irritation; whilst high concentrations can cause shock, convulsions, unconsciousness, coma and death. In the environment, H_2S released as a gas remains in the atmosphere for an average of 18 hours, during which it can change into sulfur dioxide and sulfuric acid.

Controls: H_2S release from the tanks can be quickly controlled by stopping the dosing of NaS while continuing to feed the leach solution, which will quickly consume all the NaS and stop the evolution of H_2S. A vent will also be installed on the sulfide precipitation tanks at 3 m height to improve dispersion of H_2S under abnormal operating conditions. As a final safety measure, the monitoring and control system will be fitted with an alarm system to trip the system if H_2S presence is detected above a limit value (to be determined at detailed design stage, most likely consistent with Department of Health recommended H_2S exposure limits for the protection of occupational safety).

Under normal operating conditions only small volumes of H_2S are expected to accumulate in the head spaces of the sealed reaction tanks and storage tanks, with no expected (i.e. controlled) releases. The potential for H_2S release is increased if the circuit is acidifed, however the NaS is quickly consumed by the process liquors as part of the precipitation process.

Risk Assessment – Normal operation

The consequence of H_2S being released to the atmosphere would be a localised alteration of the environment, with moderate health effects (medical treatment) to workers in the vicinity. Given the above, the likelihood of this consequence occurring under normal operating conditions is unlikely (not expected to occur), with a combined risk rating of moderate.

Consequence: Moderate.
Likelihood: Unlikley.
Risk Rating: Moderate.

Risk Assessment – Abnormal operation

The likelihood of this consequence occurring under abnormal operating conditions (e.g. major mechanical failure of the tank or agitator seal), is possible (could occur), with a combined risk rating of moderate.

Consequence: Moderate.
Likelihood: Possible.
Risk Rating: Moderate.

Regulatory Controls

A condition will be added to the works approval to require validation monitoring of H_2S emissions from the venting for comparison to estimated/expected emissions under normal operating conditions (during commissioning) and to verify that occupational exposure controls are adequate to manage any public health risk. Ongoing monitoring is not expected to be required if validation monitoring during commissioning demonstrates that proponent controls are effective.

Residual Risk

With the above regulatory controls imposed through conditions, the residual risk rating of H_2S gas vented to the atmosphere is moderate.

Consequence: Moderate.
Likelihood: Unlikely.
Risk Rating: Moderate.

Emission Risk Assessment – Lime silo venting

Emission Description

Emission: Lime dust, discharged through a silo vent filter on the lime silos (during filling).

Impact: Lime is an alkaline material that is reactive in the presence of moisture; and therefore can cause irritation and burns to unprotective skin and if inhaled. In the environment its alkaline nature will cause an increase in pH if released into water or soil moisture.

Controls: A silo vent filter will be installed on the new lime silo, consistent with the existing lime silos at the Cosmic Boy site.

The lime silo filter to be installed is a reverse pulse air cleaning system, with a quoted filtration rating of ≤12 mg/m^3 particulate matter, which complies with the minimum standard required by the Concrete Batching Regulations (*Environmental Protection (Concrete Batching and Cement Product Manufacturing) Regulations 1998*) of 50 mg/m^3.

Risk Assessment – Normal operation

The consequence of lime dust discharge would be a localised alteration of the environment, with minor reversible impacts. Given the above, the likelihood of this consequence occurring under normal operating conditions is unlikely (not expected to occur), with a combined risk rating of moderate.

Consequence: Minor.
Likelihood: Possible.
Risk Rating: Moderate.

Risk Assessment – Abnormal operation

The likelihood of this consequence occurring under abnormal operating conditions (e.g. process upset or equipment failure), is possible (could occur), with a combined risk rating of moderate.

Consequence: Minor.
Likelihood: Possible.
Risk Rating: Moderate.

Regulatory Controls

L2.2.1 is an existing condition on the licence that lists all authorised point source emissions to air. This condition will require amending to include the additional lime silo requiring abatement via bag filter. L1.2.2 also applies with respect to maintaining pollution control equipment in accordance with the manufacturer's specifications.

Residual Risk

With the above regulatory controls imposed through the licence, the residual risk rating of lime dust discharge is moderate.

Consequence: Minor.
Likelihood: Unlikely.
Risk Rating: Moderate.