



# Attachment 3

## Environmental Management Plan

## DISCLAIMER

**This disclaimer applies to and governs the disclosure and use of this Environmental Impact Statement (“EIS”), and by reading, using or relying on any part(s) of the EIS you accept this disclaimer in full.**

This Environmental Impact Statement, including the Executive Summary, and all chapters of and attachments and appendices to it and all drawings, plans, models, designs, specifications, reports, photographs, surveys, calculations and other data and information in any format contained and/or referenced in it, is together with this disclaimer referred to as the “EIS”.

### Purpose of EIS

The EIS has been prepared by, for and on behalf of Wafi Mining Limited and Newcrest PNG 2 Limited (together the “**WGJV Participants**”), being the participants in the Wafi-Golpu Joint Venture (“**WGJV**”) and the registered holders of exploration licences EL 440 and EL1105, for the sole purpose of an application (the “**Permit Application**”) by them for environmental approval under the Environment Act 2000 (the “**Act**”) for the proposed construction, operation and (ultimately) closure of an underground copper-gold mine and associated ore processing, concentrate transport and handling, power generation, water and tailings management, and related support facilities and services (the “**Project**”) in Morobe Province, Independent State of Papua New Guinea. The EIS was prepared with input from consultants engaged by the WGJV Participants and/or their related bodies corporate (“**Consultants**”).

The Permit Application is to be lodged with the Conservation and Environment Protection Authority (“**CEPA**”), Independent State of Papua New Guinea.

### Ownership and Copyright

The EIS is the sole property of the WGJV Participants, who reserve and assert all proprietary and copyright ©2018 interests.

### Reliance and Use

The EIS is intended and will be made available to CEPA, for review by CEPA and other applicable agencies of the Government of the Independent State of Papua New Guinea (“**Authorised Agencies**”), for the purpose of considering and assessing the Permit Application in accordance with the Act (“**Authorised Purpose**”), and for no other purpose whatsoever.

The EIS shall not be used or relied upon for any purpose other than the Authorised Purpose, unless express written approval is given in advance by the WGJV Participants.

Except for the Authorised Purpose, the EIS, in whole or in part, must not be reproduced, unless express written approval is given in advance by the WGJV Participants.

This disclaimer must accompany every copy of the EIS.

The EIS is meant to be read as a whole, and any part of it should not be read or relied upon out of context.

### Limits on investigation and information

The EIS is based in part on information not within the control of either the WGJV Participants or the Consultants. While the WGJV Participants and Consultants believe that the information contained in the EIS should be reliable under the conditions and subject to the limitations set forth in the EIS, they do not guarantee the accuracy of that information.

### No Representations or Warranties

While the WGJV Participants, their Related Bodies Corporate and Consultants believe that the information (including any opinions, forecasts or projections) contained in the EIS should be reliable under the conditions and subject to the limitations set out therein, and provide such information in good faith, they make no warranty, guarantee or promise, express or implied, that any of the information will be correct, accurate, complete or up to date, nor that such information will remain unchanged after the date of issue of the EIS to CEPA, nor that any forecasts or projections will be realised. Actual outcomes may vary materially and adversely from projected outcomes.

The use of the EIS shall be at the user’s sole risk absolutely and in all respects. Without limitation to the foregoing, and to the maximum extent permitted by applicable law, the WGJV Participants, their Related Bodies Corporate and Consultants:

- do not accept any responsibility, and disclaim all liability whatsoever, for any loss, cost, expense or damage (howsoever arising, including in contract, tort (including negligence) and for breach of statutory duty) that any person or entity may suffer or incur caused by or resulting from any use of or reliance on the EIS or the information contained therein, or any inaccuracies, misstatements, misrepresentations, errors or omissions in its content, or on any other document or information supplied by the WGJV Participants to any Authorised Agency at any time in connection with the Authorised Agency’s review of the EIS; and
- expressly disclaim any liability for any consequential, special, contingent or penal damages whatsoever.

The basis of the Consultants’ engagement is that the Consultants’ liability, whether under the law of contract, tort, statute, equity or otherwise, is limited as set out in the terms of their engagement with the WGJV Participants and/or their related bodies corporate.

### Disclosure for Authorised Purpose

The WGJV Participants acknowledge and agree that, for the Authorised Purpose, the EIS may be:

- copied, reproduced and reprinted;
- published or disclosed in whole or in part, including being made available to the general public in accordance with section 55 of the Act. All publications and disclosures are subject to this disclaimer.

### Development of Project subject to Approvals, Further Studies and Market and Operating Conditions

Any future development of the Project is subject to further studies, completion of statutory processes, receipt of all necessary or desirable Papua New Guinea Government and WGJV Participant approvals, and market and operating conditions.

Engineering design and other studies are continuing and aspects of the proposed Project design and timetable may change.

### NEWCREST MINING LIMITED DISCLAIMER

Newcrest Mining Limited (“**Newcrest**”) is the ultimate holding company of Newcrest PNG 2 Limited and any reference below to “Newcrest” or the “Company” includes both Newcrest Mining Limited and Newcrest PNG 2 Limited.

### Forward Looking Statements

The EIS includes forward looking statements. Forward looking statements can generally be identified by the use of words such as “may”, “will”, “expect”, “intend”, “plan”, “estimate”, “anticipate”, “continue”, “outlook” and “guidance”, or other similar words and may include, without limitation, statements regarding plans, strategies and objectives of management, anticipated production or construction commencement dates and expected costs or production outputs. The Company continues to distinguish between outlook and guidance. Guidance statements relate to the current financial year. Outlook statements relate to years subsequent to the current financial year.

Forward looking statements inherently involve known and unknown risks, uncertainties and other factors that may cause the Company’s actual results, performance and achievements to differ materially from statements in this EIS. Relevant factors may include, but are not limited to, changes in commodity prices, foreign exchange fluctuations and general economic conditions, increased costs and demand for production inputs, the speculative nature of exploration and project development, including the risks of obtaining necessary licences and permits and diminishing quantities or grades of reserves, political and social risks, changes to the regulatory framework within which the Company operates or may in the future operate, environmental conditions including extreme weather conditions, recruitment and retention of personnel, industrial relations issues and litigation.

Forward looking statements are based on the Company’s good faith assumptions as to the financial, market, regulatory and other relevant environments that will exist and affect the Company’s business and operations in the future.

The Company does not give any assurance that the assumptions will prove to be correct. There may be other factors that could cause actual results or events not to be as anticipated, and many events are beyond the reasonable control of the Company. Readers are cautioned not to place undue reliance on forward looking statements. Forward looking statements in the EIS speak only at the date of issue. Except as required by applicable laws or regulations, the Company does not undertake any obligation to publicly update or revise any of the forward looking statements or to advise of any change in assumptions on which any such statement is based.

### Non-IFRS Financial Information

Newcrest results are reported under International Financial Reporting Standards (IFRS) including EBIT and EBITDA. The EIS also includes non-IFRS information including Underlying profit (profit after tax before significant items attributable to owners of the parent company), All-In Sustaining Cost (determined in accordance with the World Gold Council Guidance Note on Non-GAAP Metrics released June 2013), AISC Margin (realised gold price less AISC per ounce sold (where expressed as USD), or realised gold price less AISC per ounce sold divided by realised gold price (where expressed as a %), Interest Coverage Ratio (EBITDA/Interest payable for the relevant period), Free cash flow (cash flow from operating activities less cash flow related to investing activities), EBITDA margin (EBITDA expressed as a percentage of revenue) and EBIT margin (EBIT expressed as a percentage of revenue). These measures are used internally by Management to assess the performance of the business and make decisions on the allocation of resources and are included in the EIS to provide greater understanding of the underlying performance of Newcrest's operations. The non-IFRS information has not been subject to audit or review by Newcrest's external auditor and should be used in addition to IFRS information.

### Ore Reserves and Mineral Resources Reporting Requirements

As an Australian Company with securities listed on the Australian Securities Exchange (ASX), Newcrest is subject to Australian disclosure requirements and standards, including the requirements of the Corporations Act 2001 and the ASX. Investors should note that it is a requirement of the ASX listing rules that the reporting of Ore Reserves and Mineral Resources in Australia comply with the 2012 Edition of the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (the JORC Code) and that Newcrest's Ore Reserve and Mineral Resource estimates comply with the JORC Code.

### Competent Person's Statement

The information in the EIS that relates to Golpu Ore Reserves is based on information compiled by the Competent Person, Mr Pasqualino Manca, who is a member of The Australasian Institute of Mining and Metallurgy. Mr Pasqualino Manca, is a full-time employee of Newcrest Mining Limited or its relevant subsidiaries, holds options and/or shares in Newcrest Mining Limited and is entitled to participate in Newcrest's executive equity long term incentive plan, details of which are included in Newcrest's 2017 Remuneration Report. Ore Reserve growth is one of the performance measures under recent long term incentive plans. Mr Pasqualino Manca has sufficient experience which is relevant to the styles of mineralisation and type of deposit under consideration and to the activity which he is undertaking to qualify as a Competent Person as defined in the JORC Code 2012. Mr Pasqualino Manca consents to the inclusion of material of the matters based on his information in the form and context in which it appears.

### HARMONY GOLD MINING COMPANY LIMITED DISCLAIMER

Harmony Gold Mining Company Limited ("Harmony") is the ultimate holding company of Wafi Mining Limited and any reference below to "Harmony" or the "Company" includes both Harmony Gold Mining Company Limited and Wafi Mining Limited.

### Forward Looking Statements

These materials contain forward-looking statements within the meaning of the safe harbor provided by Section 21E of the Securities Exchange Act of 1934, as amended, and Section 27A of the Securities Act of 1933, as amended, with respect to our financial condition, results of operations, business strategies, operating efficiencies, competitive positions, growth opportunities for existing services, plans and objectives of

management, markets for stock and other matters. These include all statements other than statements of historical fact, including, without limitation, any statements preceded by, followed by, or that include the words "targets", "believes", "expects", "aims", "intends", "will", "may", "anticipates", "would", "should", "could", "estimates", "forecast", "predict", "continue" or similar expressions or the negative thereof.

These forward-looking statements, including, among others, those relating to our future business prospects, revenues and income, wherever they may occur in this EIS and the exhibits to this EIS, are essentially estimates reflecting the best judgment of our senior management and involve a number of risks and uncertainties that could cause actual results to differ materially from those suggested by the forward-looking statements. As a consequence, these forward-looking statements should be considered in light of various important factors, including those set forth in these materials. Important factors that could cause actual results to differ materially from estimates or projections contained in the forward-looking statements include, without limitation: overall economic and business conditions in South Africa, Papua New Guinea, Australia and elsewhere, estimates of future earnings, and the sensitivity of earnings to the gold and other metals prices, estimates of future gold and other metals production and sales, estimates of future cash costs, estimates of future cash flows, and the sensitivity of cash flows to the gold and other metals prices, statements regarding future debt repayments, estimates of future capital expenditures, the success of our business strategy, development activities and other initiatives, estimates of reserves statements regarding future exploration results and the replacement of reserves, the ability to achieve anticipated efficiencies and other cost savings in connection with past and future acquisitions, fluctuations in the market price of gold, the occurrence of hazards associated with underground and surface gold mining, the occurrence of labour disruptions, power cost increases as well as power stoppages, fluctuations and usage constraints, supply chain shortages and increases in the prices of production imports, availability, terms and deployment of capital, changes in government regulation, particularly mining rights and environmental regulation, fluctuations in exchange rates, the adequacy of the Group's insurance coverage and socio-economic or political instability in South Africa and Papua New Guinea and other countries in which we operate.

For a more detailed discussion of such risks and other factors (such as availability of credit or other sources of financing), see the Company's latest Integrated Annual Report and Form 20-F which is on file with the Securities and Exchange Commission, as well as the Company's other Securities and Exchange Commission filings. The Company undertakes no obligation to update publicly or release any revisions to these forward-looking statements to reflect events or circumstances after the date of this EIS or to reflect the occurrence of unanticipated events, except as required by law.

### Competent Person's Statement

The Wafi-Golpu Joint Venture is an unincorporated joint venture between a wholly-owned subsidiary of Harmony Gold Mining Company Limited and a wholly-owned subsidiary of Newcrest Mining Limited.

The information in the EIS that relates to Golpu Ore Reserves is based on information compiled by the Competent Person, Mr Pasqualino Manca, who is a member of The Australasian Institute of Mining and Metallurgy. Mr Pasqualino Manca, is a full-time employee of Newcrest Mining Limited or its relevant subsidiaries, holds options and/or shares in Newcrest Mining Limited and is entitled to participate in Newcrest's executive equity long term incentive plan, details of which are included in Newcrest's 2017 Remuneration Report. Ore Reserve growth is one of the performance measures under recent long term incentive plans. Mr Pasqualino Manca has sufficient experience which is relevant to the styles of mineralisation and type of deposit under consideration and to the activity which he is undertaking to qualify as a Competent Person as defined in the JORC Code 2012. Mr Pasqualino Manca consents to the inclusion of material of the matters based on his information in the form and context in which it appears.



# Environmental Management Plan

## **Module 1: Introduction and Overview**

## TABLE OF CONTENTS

1	MODULE 1 – INTRODUCTION AND OVERVIEW .....	1
1.1	Introduction.....	1
1.1.1	Objectives of the Project Environmental Management Plan .....	1
1.1.2	Structure of the Environmental Management Plan .....	4
1.2	Environmental Setting .....	5
1.2.1	Existing Environment .....	5
1.2.2	Key Areas of Environmental Management .....	17
1.3	Regulatory Framework.....	18
1.3.1	PNG Regulatory Requirements .....	18
1.3.2	Project-specific Environment Permit Conditions.....	19
1.3.3	International Guidelines and Standards.....	19
1.4	Environmental Management Framework.....	20
1.4.1	Sustainable Business Management System .....	20
1.4.2	Environmental Management System .....	21
1.4.3	Environment Policy .....	21
1.4.4	Planning .....	21
1.4.5	Implementation and Operation.....	23
1.4.6	Checking and Corrective Action.....	29
1.4.7	Management Review .....	33
1.5	References .....	34

## LIST OF FIGURES

Figure 1.1: General arrangement of proposed Project.....	2
Figure 1.2: General arrangement of proposed Mine Area.....	3
Figure 1.3: Sub-catchments in the Lower Watut River catchment .....	12
Figure 1.4: WGJV Environment Policy .....	22

## LIST OF TABLES

Table 1.1: Legend – unique identifier numbering system.....	5
Table 1.2: Approximate volume of waste rock to be extracted.....	8
Table 1.3: Summary applicable legislation .....	18
Table 1.4: Proposed WGJV roles and responsibilities Note: titles, roles and responsibilities may change subject to the allocation of activities by the Project General Manager. ....	25

Abbreviation/Acronym	Description
%	percent
AMD	acid and metalliferous drainage
CEPA	Conservation and Environment Protection Authority (previously Department of Environment and Conservation)
EIS	environmental impact statement
EMS	Environmental Management System
FIMS	Forest Inventory Mapping System
IFC	International Finance Corporation
IUCN	International Union for the Conservation of Nature
km	kilometres
km <sup>2</sup>	square kilometres
KPI	Key Performance Indicator
LLG	Local Level Government
m	metres
mASL	metres above sea level
mbgl	metres below ground level
Mt	million tonnes
Mtpa	million tonnes per annum
NAF	non-acid forming
OH&S	occupational health and safety
PAF	potentially acid forming
PM <sub>10</sub>	respirable particulates less than 10µm
PNG	Independent State of Papua New Guinea
SOP	standard operating procedure
WGJV	Wafi-Golpu Joint Venture
WHO	World Health Organization

Glossary	Description
alluvium	Loose, un-consolidated soil or sediments, which have been eroded, re-shaped by water in some form, and re-deposited in a non-marine setting. Alluvium usually consists of a variety of materials such as fine particles of silt and clay, and larger particles of sand and gravel.
aquifer	A layer of water-bearing permeable rock, rock fractures or unconsolidated materials (gravel, sand, or silt) which may store or transmit groundwater.
block caving	An underground hard rock mining method that involves undermining an ore body, allowing it to progressively collapse under its own weight as a means of breaking and extracting the ore.
Coastal Area	The Coastal Area includes the proposed Port Facilities Area and the proposed Outfall Area.
colluvium	Loose and fragmented deposits, usually at the foot of a slope or cliff line and brought down by gravity.

Glossary	Description
cultural heritage	Intangible and tangible heritage that includes: <ul style="list-style-type: none"> <li>• Oral tradition sites, which include spiritual and oral history sites of importance to landowners</li> <li>• Historic sites specific to World War II or associated with the early period of the Independent State of Papua New Guinea’s colonial history or associated with the early history of mining in PNG</li> <li>• Archaeological sites, which often reveal information about past human activity in the area</li> </ul>
decline	A sloping underground tunnel excavated for mobile equipment access from surface or from level to level.
environmental impact statement (EIS)	A document that provides a comprehensive assessment of potential environmental, social and cultural heritage impacts (or benefits) associated with a project, in accordance with Section 53 of the PNG <i>Environment Act 2000</i> .
Environmental Management System (EMS)	A tool for managing the impacts of an organisation's activities on the environment, by providing a structured approach to planning and implementing environment protection measures, and monitoring environmental performance.
Equator Principles	A risk management framework, voluntarily adopted by financial institutions, for determining, assessing and managing environmental and social risk in projects and is primarily intended to provide a minimum standard for due diligence to support responsible risk decision-making.
erosion	The process by which material, such as rock or soil, is worn away or removed by wind or water.
greenhouse gas	A gas that contributes to the greenhouse effect by absorbing infrared radiation. Carbon dioxide and methane are examples of greenhouse gases.
hydrogeology	Area of study concerning the distribution and movement of groundwater in the soil and rocks of the Earth’s crust (commonly in aquifers).
Infrastructure Corridor	The area encompassing the proposed Project infrastructure linking the Mine Area and the Coastal Area, being corridors for pipelines and roads and associated laydown areas. The proposed concentrate pipeline, terrestrial tailings pipeline and fuel pipeline will connect the Mine Area to the Coastal Area. A proposed Mine Access Road and Northern Access Road will connect the Mine Area to the Highlands Highway. New single-lane bridges are proposed over the Markham, Watut and Bavaga rivers. Laydown areas will be located at key staging areas.
Mine Area	The area encompassing the proposed block cave mine, underground access declines and nearby infrastructure, including a portal terrace and waste rock dump supporting each of the Watut and Nambonga declines, the Watut Process Plant, power generation facilities, laydown areas, water treatment facilities, quarries, wastewater discharge and raw water make-up pipelines, raw water dam, sediment control structures, roads and accommodation facilities for the construction and operations workforces.
non-acid forming	Chemically-stable materials that will not generate any by-products which are likely to adversely affect the environment. A sample is usually defined as non-acid forming when it has a negative NAPP and the final NAG pH is greater than or equal to 5.
Outfall Area	The area encompassing the Outfall System, pipeline laydown area, choke station, access track and parking and turnaround area.
Outfall System	Includes mix/de-aeration tank, seawater intake pipelines and DSTP outfall pipelines. Located in the Outfall Area.
Port Area	Port of Lae including Lae Tidal Basin and surrounds

Glossary	Description
Port Facilities Area	Located at, or in proximity to, the Port of Lae, with a site adjacent to Berth 6 (also known as Tanker Berth) nominated as the preferred option. The proposed facilities will include the concentrate filtration plant and materials handling, storage, ship loading facilities and filtrate discharge pipeline. This area may in the future need to include fuel oil handling and storage facilities.
potentially acid forming	Material that contains sulphidic compounds with the potential to generate sulphuric acid under oxidising conditions.
Project Area	The land that is the subject of the proposed Project activities and Project facilities, being: <ul style="list-style-type: none"> <li>• The Mine Area</li> <li>• The Infrastructure Corridor</li> <li>• The Coastal Area</li> </ul>
standard operating procedures (SOPs)	A set of step-by-step instructions compiled by an organisation to help workers carry out complex routine operations
Sustainable Business Management System	A set of corporate policies and standards which guide WGJV's approach to sustainability.
tailings	The fine-grained rock particles remaining after the recoverable metals and minerals have been extracted from mined ore, and any remaining process water.
ventilation shaft	A vertical or sub-vertical passage used in an underground mine to allow the flow of air either into, or out of the mine.



## 1 MODULE 1 – INTRODUCTION AND OVERVIEW

### 1.1 Introduction

Wafi Mining Limited and Newcrest PNG 2 Limited (hereafter WGJV Participants) are equal participants in the Wafi-Golpu Joint Venture (hereafter WGJV) and propose to construct, operate and (ultimately) close an underground copper-gold mine and associated ore processing, concentrate transport and handling, power generation, water and tailings management and related support facilities and services (hereafter the “Wafi-Golpu Project” or the “Project”) in the Morobe Province of Papua New Guinea (PNG).

The Project is located approximately 65km southwest of Lae. The focus of the Project is the proposed development of:

- An underground mine, with a design production rate of 16.84 million tonnes per annum (Mtpa) over an anticipated mine life of 28 years
- Ore processing, and concentrate transport/handling facilities
- Deep sea tailings placement (DSTP) for tailings management
- Related ancillary infrastructure

The location of the main Project infrastructure is shown in Figure 1.1 and Figure 1.2.

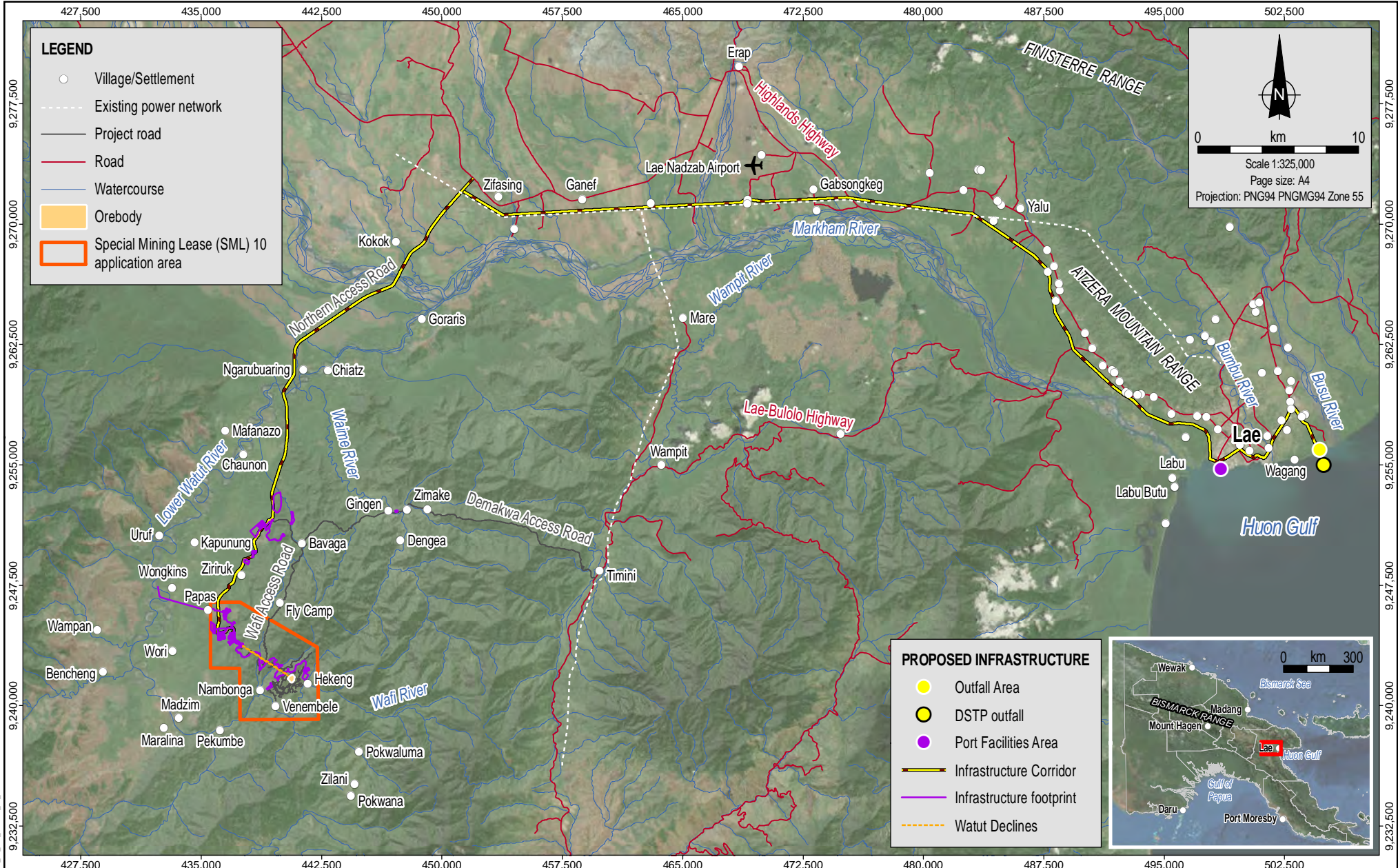
This whole-of-Project Environmental Management Plan (EMP) addresses the construction and operations phases of the Project. A separate Conceptual Closure and Rehabilitation Plan has been developed that includes strategies for mine decommissioning and closure, including closure objectives.

#### 1.1.1 Objectives of the Project Environmental Management Plan

The objectives of the Project Environmental Management Plan (EMP) are to:

- Communicate to Project personnel and contractors the environmental legal obligations and minimum environmental standards required during construction, and operation.
- Define accountabilities for implementation of the measures contained herein during construction and operation activities.
- Provide environmental objectives for the Project.
- Detail the proposed monitoring, reporting and auditing programs to be put in place to monitor the Project’s environmental performance and verify the effectiveness of management and mitigation measures.
- Provide guidance on completing any corrective action(s) in a timely manner and advise on the appropriate documentation of any action(s) taken.
- Provide procedures to be followed by Project personnel and contractors in response to environmental incidents that may occur during the life of the Project.
- Detail the ways in which WGJV management will be kept regularly informed on the performance of monitoring programs.
- Provide the basis for further guidelines, procedures and plans to be developed by WGJV for the Project.

The Project EMP has been prepared in accordance with the WGJV Environment Policy set out in Section 1.4.3, applicable WGJV standards, PNG regulatory requirements and international standards voluntarily adopted by WGJV (refer to Section 1.3).



**LEGEND**

- Village/Settlement
- - - Existing power network
- Project road
- Road
- Watercourse
- Orebody
- Special Mining Lease (SML) 10 application area

0 km 10

Scale 1:325,000  
Page size: A4  
Projection: PNG94 PNGMG94 Zone 55

**PROPOSED INFRASTRUCTURE**

- Outfall Area
- DSTP outfall
- Port Facilities Area
- Infrastructure Corridor
- Infrastructure footprint
- - - Watut Declines



MXD Reference: 0520DD\_10\_BM\_GIS001\_v0\_10

Source:  
Power network, SML and orebody from WGJV.  
Villages, infrastructure and project roads from WGJV and Coffey.  
Roads and watercourses from NSO.  
Imagery from ArcGIS Online (capture date unknown).

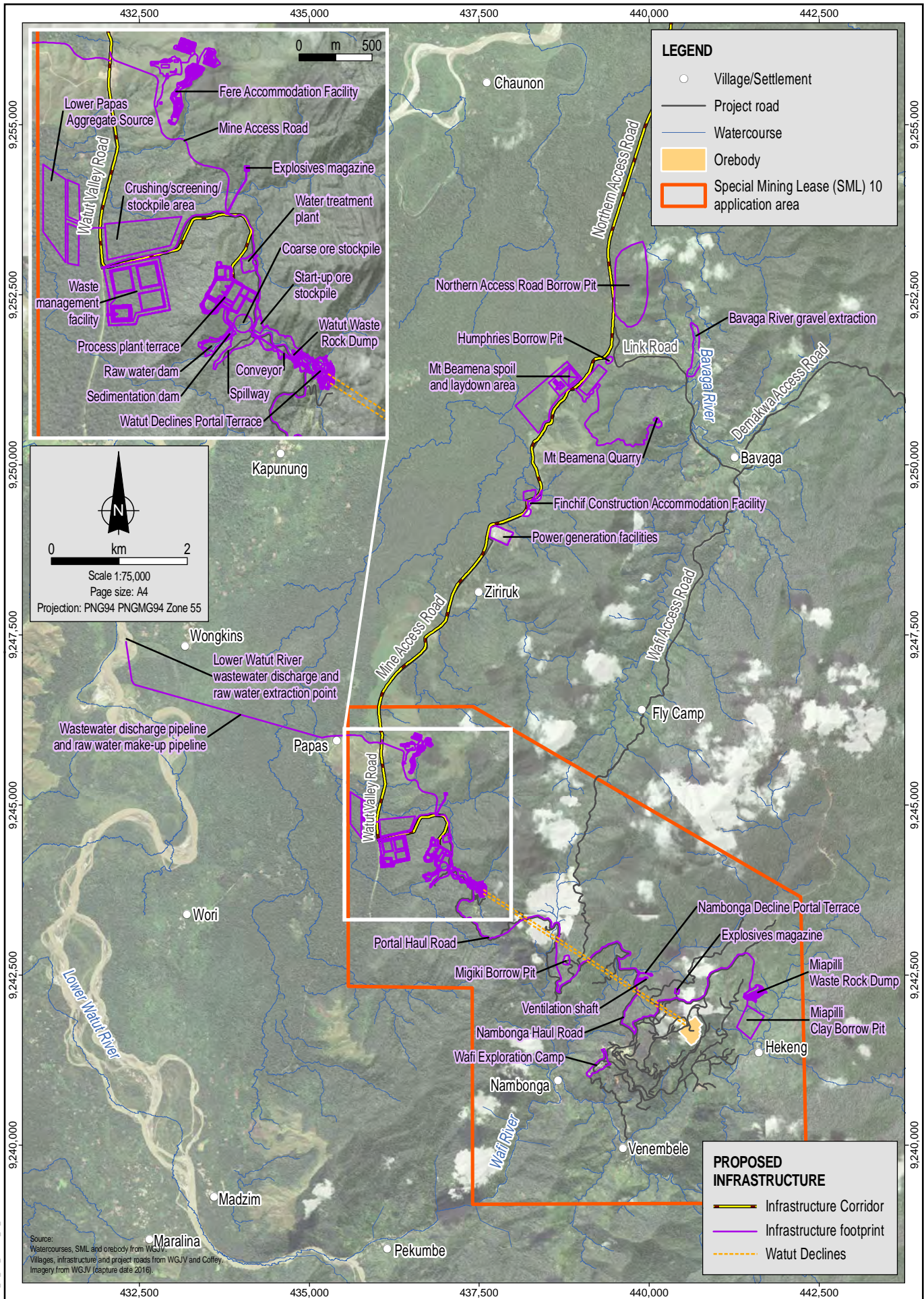


Date: 22.03.2018  
Project: 754-ENAUABTF100520DD  
File Name: 0520DD\_10\_F01.01\_GIS



General arrangement of proposed Project

Figure No: 1.1



Source:  
 Watercourses, SML and orebody from WGJV.  
 Villages, infrastructure and project roads from WGJV and Coffey.  
 Imagery from WGJV (capture date 2016).

MAD Reference: 0520DD\_10\_EM\_GIS002\_v01.14

### 1.1.2 Structure of the Environmental Management Plan

The Project EMP comprises three modules:

- Module 1 – Introduction and Overview
- Module 2 – Construction
- Module 3 – Operations

Module 1 (this module) comprises the following key sections:

- Introduction
- Environmental setting
- Regulatory framework
- Environmental management framework

Modules 2 and 3 include detailed discussion of the key areas of environmental management relevant to the scope of the particular module, including management plans that comprise:

- Introduction (incorporating potential significant impacts and Project activities that may cause those impacts)
- Objectives
- Proposed Management measures
- Proposed Monitoring and reporting

This structure will enable Project personnel and contractors for each phase of the Project to reference applicable sections of the Project EMP as necessary. For example, during the operations phase, Project personnel will predominantly utilise Modules 1 and 3, and may make reference to management measures in Module 2 if further construction works are required during the operations phase of the Project.

Each management measure specified in the Project EMP has a unique identifier to facilitate internal auditing and reporting of performance against the management measures in Project EMP. The unique identifier for each management measure is structured as follows:

XX-YY

Where:

- XX indicates the primary area of environmental management to which the management measure relates.
- YY indicates the number of the management measure within that environmental aspect.

A legend for the management measure identifiers is provided in Table 1.1.

Table 1.1: Legend – unique identifier numbering system

Code	Abbreviation	Environmental Aspects
Aspect code (XX)	GE	General
	AQ	Air quality and greenhouse gas
	NV	Noise and vibration
	TE	Terrestrial flora and fauna
	WA	Freshwater and aquatic flora and fauna
	SE	Soils, sediment and erosion
	WR	Waste rock, tailings and AMD
	ME	Marine ecology
	HZ	Hazardous materials
	NZ	Non-hazardous materials
	WP	Weed and pest
	RH	Rehabilitation
IR	Environmental incident response	
Identification number (YY)	01-99	Unique identification number

## 1.2 Environmental Setting

### 1.2.1 Existing Environment

This section provides an overview of the physical and biophysical environments in which the Project is being developed.

Consideration of the Project's social and cultural setting and management is outside the scope of this document and is addressed in the Project Social Management Plan and Cultural Heritage Management Plan.

#### 1.2.1.1 Geographic Setting

The Mine Area is located on the northern side of the Owen Stanley Ranges of PNG, approximately 65km west southwest from the Port of Lae, within the Watut River catchment. The elevation of the Mine Area ranges from approximately 100 metres above sea level (mASL) in the Lower Watut River floodplain to 380mASL where the proposed ventilation shaft is located. The Mine Area includes land which is steep, mountainous and covered by dense tropical rainforest (to the east), and the floodplain of the Lower Watut River (to the west).

The Infrastructure Corridor originates at the Watut Process Plant and traverses northwards along the Lower Watut River valley (Figure 1.2) following the proposed Mine Access Road and Northern Access Road. It crosses both the Lower Watut and Markham rivers, to a point just south of the Highlands Highway, where the corridor intersects the PNG Power high-voltage transmission line (Figure 1.1). At this point, the proposed pipelines diverge from the Northern Access Road to travel east following the PNG Power transmission line to approximately 3km west of the settlement of Yalu on the Highlands Highway. There, the Infrastructure Corridor deviates from the PNG Power transmission line, heading southeast through partially-cleared forest and gardens, and along the upper terrace of the Markham River floodplain, to a point just north of the Port of Lae.

While the proposed concentrate and fuel pipelines terminate at the Port Facilities Area at the Port of Lae, the Infrastructure Corridor continues through Lae to the Outfall Area, located between the Wagang settlement and the mouth of the Busu River. Collectively, the Port Facilities Area and the Outfall Area are referred to as the Coastal Area.

Further information on the geographic setting for the Project is provided in Chapter 6, Project Description, of the Project EIS (WGJV, 2018).

### 1.2.1.2 Climate

Papua New Guinea's climate is dominated by two main seasons: the northwest monsoon (wet) season which occurs annually between November and April, and the southeast monsoon (dry) season, occurring annually between May and October.

Historical meteorological data has been collected intermittently from the automatic weather station located on Mt Golpu and from a manual rainfall gauge at Wafi camp since 1990.

The data obtained indicates that the highest rainfall occurs in the wet season between December and April. Annual recorded rainfall was highest in 1995 (3,440mm) and the average annual rainfall was 2,836mm.

Regional evaporation is generally constant throughout the year, ranging from 1,320mm/year to 2,040mm/year at Bulolo and 2,100mm/year at Lae airport. The average annual evaporation rate for the Project site is approximately 2,000mm.

Based on the mean annual rainfall total recorded at Wafi Camp, and the estimated annual evaporation, the Mine Area experiences a water surplus where rainfall exceeds evaporation by approximately 800mm/year.

Further information on the climatic setting for the Project is provided in Chapter 8, Physical and Biological Environment Characterisation, of the Project EIS (WGJV, 2018).

### 1.2.1.3 Air Quality

Due to the remote location of the Mine Area, high rainfall, low wind speeds and dense vegetation of the area, background concentrations of gaseous pollutants and particulate matter are negligible. Exceptions include areas affected by road dust, burning of the kunai grassland by landowners or regionally significant events such as a volcanic eruption.

A monitoring program to characterise existing air quality for the Mine Area was conducted in May 2011 (Coffey, 2011a). This data remains relevant due to the absence of development since that time. Four villages in proximity to the Mine Area (Wongkins, Wori, Bavaga, Madzim) were selected for the characterisation survey of dust deposition rates and PM<sub>10</sub> concentrations. A dust deposition monitoring program at the same locations has been ongoing since June 2011, as well as at Hekeng village since May 2015.

The data shows that ambient PM<sub>10</sub> concentrations are highest at Wongkins and Bavaga villages and very low at Wori and Madzim villages. These concentrations vary seasonally and are also dependent on the activities occurring in and around the villages (e.g., construction of new dwellings, burning of vegetation, land clearance). The results demonstrate compliance with the WHO 24-hour average guideline of 50µg/m<sup>3</sup> for PM<sub>10</sub>, and while it is not possible to draw firm conclusions as to the typical concentrations in these locations, due to the limited temporal extent of the measurements, the findings are consistent with experience at similar locations elsewhere in PNG.

Dust deposition rates from ongoing monitoring at Wongkins, Bavaga and Hekeng villages are consistently low and below the maximum cumulative nuisance-based criterion of 4g/m<sup>2</sup>/month<sup>1</sup> used in Australia (NSW OEH, 2005).

---

<sup>1</sup> The New South Wales, Australia dust deposition guideline for cumulative nuisance-based criteria states that deposition should not exceed 4g/m<sup>2</sup>/month, or no more than 2g/m<sup>2</sup>/month incremental change above background (NSW OEH, 2005).

Further information on the air quality setting for the Project is provided in Chapter 8, Physical and Biological Environment Characterisation, of the Project EIS (WGJV, 2018).

#### 1.2.1.4 Noise and Vibration

Noise monitoring was undertaken in May 2011 (Coffey, 2011b) for villages in proximity to the Mine Area (Wongkins, Wori, Bavaga, Madzim). This data remains relevant due to the absence of development since that time.

These measurements show that background noise in the villages generally falls within the range typical of a rural setting within PNG. The exception was Bavaga village where high noise levels were measured during the evening and night periods, which is thought to be due to insects.

Further information on the noise setting for the Project is provided in Chapter 8, Physical and Biological Environment Characterisation, of the Project EIS (WGJV, 2018).

#### 1.2.1.5 Geology

The Project lies in a block of deformed Upper Mesozoic to Middle Miocene period metasedimentary to sedimentary rocks, cut by Miocene-Pliocene calc-alkaline dioritic intrusives.

The Golpu Porphyry copper-gold orebody consists of multiple, diorite porphyries (i.e., volcanic rocks with coarse crystals within a finer grained matrix) bearing hornblende (an amphibolite mineral), intruded into host sediments of the Owen Stanley Metamorphics (SRK, 2018). The shape of the Golpu orebody is near vertical and extends from 200 metres below ground level (mbgl) to a depth of more than 2,000mbgl. Within the Golpu deposit are a porphyry core, a high sulphidation hydrothermal system surrounding the core and a mixed zone where these two systems combine. The porphyry system is mineralised with gold, copper, silver and molybdenum. In the outer hydrothermal zone of the orebody, gold is associated with pyrite and chalcopyrite.

Further information on the geological setting for the Project is provided in Chapter 8, Physical and Biological Environment Characterisation, of the Project EIS (WGJV, 2018).

#### 1.2.1.6 Seismicity

Papua New Guinea is bounded by several major tectonic plates and is one of the most seismically active regions in the world (World Bank, 2008). To the north of the Owen Stanley Ranges, tectonic plate movements thrust the leading edge of PNG over the Pacific Plate, leading to rotation and compression in the Project Area. There are two main sources of earthquakes that could occur in the vicinity of the Project Area:

- Crustal events that occur in areas away from plate contacts and have produced earthquakes up to magnitude 7.7 (SRK, 2007)
- Subduction events that occur due to the subduction of the Pacific Plate at the interface between the Pacific Plate and the overriding Indo-Australian Plate, or in the intra-slab zones within the subducting Pacific Plate. These events have produced earthquakes up to magnitude 8.4 (SRK, 2007)

Further information on the seismic setting for the Project is provided in Chapter 8, Physical and Biological Environment Characterisation, of the Project EIS (WGJV, 2018).

### 1.2.1.7 Mine Materials Geochemistry

Geochemical characterisation of mine materials has revealed that almost all of the ore and much of the waste rock is predicted to be potentially acid forming (PAF). As a result, waste rock will require appropriate management and, as mining progresses and the zone of subsidence increases, mine water quality is expected to deteriorate and become acidic with elevated concentrations of dissolved metals, particularly zinc, copper, iron and manganese.

The shape of the Golpu orebody is near vertical and extends from 200mbgl to a depth of more than 2,000mbgl. Underground mining by block caving is proposed to extract the ore. Access to the mine workings is proposed via declines (both Watut and Nambonga) and a ventilation shaft and these will generate waste rock that will be segregated into non-acid forming (NAF) and PAF components and both will be managed separately. Block cave mining will not result in the production of waste rock per se, but will cause a subsidence zone of fractured rock to develop that will propagate to surface, and will allow the ingress of water and, to a lesser extent, oxygen.

Mined ore will be stockpiled temporarily on surface before being processed.

The declines, ventilation shaft, block caves, rock subsidence zone and ore stockpile will increase the exposure of PAF rock to both water and oxygen, and that could lead to acidification of contact water and dissolution of metals.

#### 1.2.1.7.1 Waste Rock Characterisation

A total of approximately 2.40Mt of waste rock is expected to be excavated from the declines and the ventilation shaft during construction. This will be produced from the Babuaf Conglomerate, Babuaf Volcanics, Langimar Beds and Owen Stanley Metamorphics.

Based on geochemical analysis, it is expected that waste rock excavated from the Watut and Nambonga declines will comprise approximately 1.87Mt (78%) of material classified as PAF and approximately 0.53Mt (22%) of waste rock classified as non-acid-forming (NAF). Geochemical characterisation of waste rock from the lithologies to be intersected by the declines indicates that, in general, acidification of PAF waste rock (either in waste rock or the subsidence zone) is expected to lead to acidic drainage with elevated metal concentrations, in particular zinc, copper, iron, manganese and other metals.

No geochemical characterisation of the rock to be extracted from the ventilation shaft has been specifically undertaken; however, characterisation of samples taken nearby, from the same rock types as those intersected by the shaft, indicates that the waste from the ventilation shaft is likely to be predominantly PAF. As a precautionary measure, waste rock will be geochemically characterised ahead of abstraction by means of 'cover' drilling along the decline and ventilation shaft alignment.

Table 1.2 outlines the approximate waste rock generated from the declines and ventilation shaft and the estimated volumes and tonnages of NAF and PAF material produced.

Table 1.2: Approximate volume of waste rock to be extracted

Rock Type	Location	Classification	Volume (m <sup>3</sup> )	Tonnage (t)
Portal Conglomerate	Watut	NAF	17,539	48,232
Babuaf Volcanics	Watut	NAF	59,051	162,391
Babuaf Conglomerate	Watut	NAF	46,737	128,526
Langimar Beds	Watut	NAF	57,917	159,271
Weathered Material	Nambonga	NAF	11,650	32,036



Rock Type	Location	Classification	Volume (m <sup>3</sup> )	Tonnage (t)
<b>NAF Total</b>			<b>192,893</b>	<b>530,456</b>
Owen Stanley Metamorphics	Watut	PAF	406,280	1,117,269
	Nambonga	PAF	200,082	550,227
Nambonga Porphyry	Nambonga	PAF	74,202	204,055
<b>PAF Total</b>			<b>680,564</b>	<b>1,871,550</b>
<b>Grand Total</b>			<b>873,457</b>	<b>2,402,006</b>

Competent non-acid forming material will be used during construction of the Project (e.g., for portal terraces) and as lining and capping for the PAF waste rock cells in the waste rock dumps. The PAF material will be stored in engineered waste rock dumps adjacent or nearby to the Watut and Nambonga declines as described below.

Further information on the characterisation of waste rock for the Project is provided in Chapter 6, Project Description, of the Project EIS (WGJV, 2018).

#### 1.2.1.7.2 Rock Subsidence Zone

Block caving will affect the local topography at the surface above the orebody. The depth of the resultant subsidence zone generally relates to the mass of rock removed by mining while its lateral extent reflects a complex relationship between the surface topography, structural controls below surface (faults and boundaries between rock types) and the width of the orebody below. A subsidence crater is expected to start to form on the ground surface above the orebody approximately 38 months after the start of block caving, and is predicted to be approximately 975m in diameter with a depth of approximately 400m from the natural ground surface at the conclusion of mining (Itasca, 2018).

Most of the rock within the subsidence zone is expected to be argillic and advanced argillic rock types which are known to be predominantly PAF. Oxidation of the reactive sulphides within these rock types is predicted to occur in the presence of air and water and acid rock drainage is expected to occur. During operations, this acidic water will drain into the mine workings and surplus mine water will be treated if required to meet regulatory permit conditions before reuse or disposal.

At closure, the PAF material in the subsidence zone will remain in place and, in the long term, is expected to continue to oxidise until all the sulphide minerals have been oxidised or until oxidation is precluded i.e. the PAF material is permanently submerged underwater.

Further information on the Project subsidence zone is provided in Chapter 6, Project Description, of the Project EIS (WGJV, 2018).

#### 1.2.1.7.3 Tailings Characterisation

CSIRO conducted geochemical and ecotoxicological characterisation of two tailings samples produced from a pilot flotation testwork program in October 2017 (CSIRO, 2018). The two samples comprised approximate porphyry and metasediment compositions of 90:10 and 25:75, representing the likely outlying ratios of the two principal rock types extracted during the Life of Mine.

The tailings samples were both pH neutral.

The concentrations of total recoverable metals in the tailings samples exceeded the Sediment Quality Guideline Value (SQGV) for chromium, copper, nickel and zinc. Similarly, the concentrations of potentially bioavailable metals in the tailing samples exceeded the SQGV for copper, nickel and zinc.

Further information on the characterisation of tailings for the Project is provided in Chapter 6, Project Description, of the Project EIS (WGJV, 2018).

#### **1.2.1.8 Soil Resources**

Information describing the soils across the Project Area is derived from the Papua New Guinea Resource Information System dataset. Soils across the Project Area comprise five main geological units. Visual inspection and physical/chemical analysis of soils in the Mine Area (KCB, 2013) provides further detail of the soil classifications used in Papua New Guinea Resource Information System. The geological units and their particular properties based on investigations in the Mine Area are alluvium, colluvium, residual, slopewash and topsoils. Soil conditions throughout the site are fairly homogenous; while the test results indicated the soils are non-dispersive, erosion is still a risk due to the high rainfall.

Soils within the Mine Area sampled during baseline testing already have elevated levels of some elements prior to mining – including antimony, arsenic, lead, selenium and zinc – which is typical of a highly-mineralised zone. The results of testing indicate that soils from around the ventilation shaft would have a low pH (2.7), and leachate and water-soluble concentrations of arsenic, lead, selenium and zinc would be above detection limits, whereas soils around the portal terrace, process plant terrace and Fere Accommodation Facility would have an alkaline pH (8.7) leachate and water-soluble concentrations of arsenic and zinc above detection limits (KCB, 2013).

Further information on soils in the Project Area is provided in Chapter 8, Physical and Biological Environment Characterisation, of the Project EIS (WGJV, 2018).

#### **1.2.1.9 Groundwater**

Groundwater systems in the Project Area comprise alluvial aquifers associated with the expansive floodplains of the Lower Watut River and Markham River, and shallow and deep aquifers associated with faults and fracture zones in the weathered and partially weathered bedrock of the Mine Area. Both systems are recharged through ground infiltration following rainfall, with the rivers hydraulically connected to the alluvial aquifers. The water table in the alluvial plains is between 0.28mbgl and 2.54mbgl.

Faults through Mt Golpu provide preferential pathways for groundwater flow through the strata including the orebody. Groundwater flow through the strata decreases with depth. These aquifers discharge through springs and into watercourses, as baseflow, with artesian conditions on the eastern flanks of Mt Golpu. Groundwater quality is reflective of the low residence time and mineralisation of the host rock. Groundwater-fed springs supply drinking water to a number of villages in proximity to the Mine Area, with watercourses providing a secondary supply.

Further information on groundwater in the Project Area and its existing use is provided in Chapter 8, Physical and Biological Environment Characterisation, and Chapter 12, Socioeconomic Environment Characterisation, of the Project EIS respectively (WGJV, 2018).

### 1.2.1.10 Surface Water

The main watercourses within the Project Area include (Figure 1.3):

- Lower Watut River
- Markham River
- Wafi River
- Bavaga River
- Busu River

The Lower Watut River is a large, turbid river that bisects a broad floodplain. It drains an area of approximately 4,860km<sup>2</sup>, including approximately 4,161km<sup>2</sup> upstream of the confluence with the Wafi River.

The Markham River, a large, fast flowing and turbid river, is the fourth largest river in PNG, with a total catchment area of approximately 13,000km<sup>2</sup> (including the Lower Watut River catchment).

The Wafi River catchment is located in the middle section of the Lower Watut River basin and has a catchment area of 120km<sup>2</sup>. The catchment has a mountainous terrain with an elevation of 760m at Mt Golpu, with deeply incised valleys and steep valley walls of up to 45 degrees that are largely forested.

The Lower Watut River floodplain area has numerous small streams draining the steep catchments to the west and east. Some sub-catchments to the east of the floodplain fall within the Mine Area and Infrastructure Corridor, and these include the Bavaga River and Bobul, Kufikasep, Finchif, Ziriruk, Fetaf, Womul, Boganchong, Wassing and Wadgink creeks. The eastern floodplain catchments are small in area (1 to 5km<sup>2</sup>) and prone to flash flooding, but individually contribute a small proportion to the total Lower Watut River flow.

The Bavaga River is the one of the largest sub-catchments in the eastern Watut River floodplain, with a total area of 28km<sup>2</sup>. The Bavaga River flows into wetlands within the Lower Watut River floodplain, which then flows into the main Lower Watut River channel.

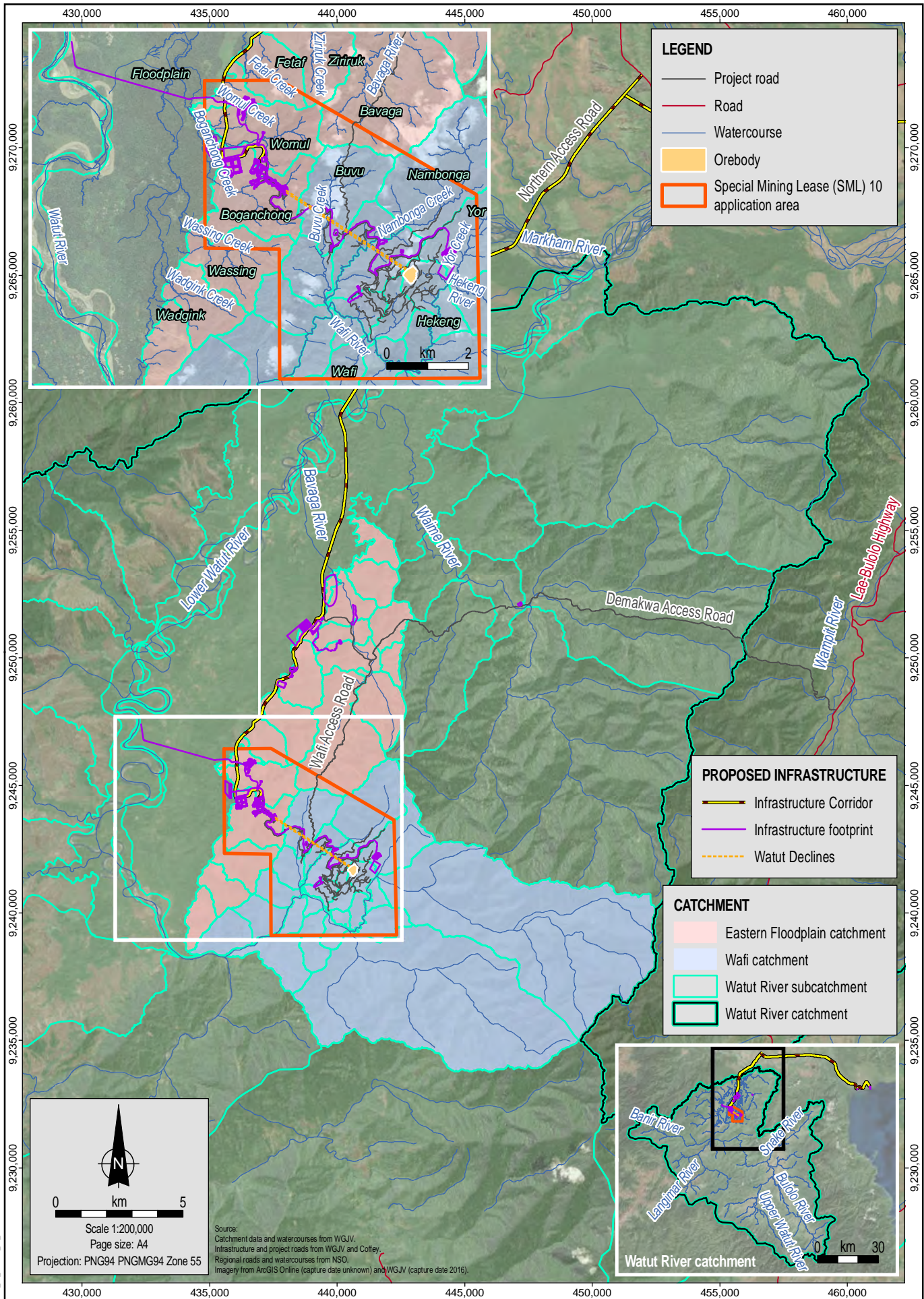
Further information on surface water in the Project Area and its existing use is provided in Chapter 9, Freshwater Environment Characterisation, and Chapter 12, Socioeconomic Environment Characterisation, of the Project EIS respectively (WGJV, 2018).

### 1.2.1.11 Aquatic Flora and Fauna

#### 1.2.1.11.1 Freshwater Ecosystems

Four broad aquatic ecosystem types are present within the Project Area:

- High to moderate-gradient tributary watercourses
- Low-gradient floodplain tributary watercourses and wetlands
- Unconfined, turbid major river systems (Lower Watut River and Markham River)
- Oxbow lakes



MAD Reference: 0520DD\_10\_GIS016\_v0.8



Date: 13.06.2018  
 Project: 754-ENAUABTF100520DD  
 File Name: 0520DD\_10\_Att3\_F01.03\_GIS

**WAFI-GOLPU**  
 JOINT VENTURE  
**Wafi-Golpu Project**

**Sub-catchments in the Lower Watut River catchment**

Figure No: **1.3**

High and moderate-gradient tributary watercourses occur within steep valleys, and have confined (high gradient headwaters) and partially confined (moderate gradient downstream reaches) channels. Watercourse flows vary substantially over time in response to rainfall and surface water runoff. Micro-habitat complexity is high in these watercourses. Rock crevices, woody debris and/or trailing vegetation are common physical instream habitat characteristics, often occurring with various combinations of root mats, undercut banks and/or overhanging vegetation. Instream vegetation, in the form of aquatic macrophytes, was absent in these high and moderate-gradient tributary watercourses.

A number of watercourses with small catchments eventually drain onto the Lower Watut River floodplain to form floodplain watercourses and flood-out swamps. Parts of the Lower Watut River floodplain within the Project Area have a water table that is at or near the surface, forming a water source (i.e., springs) and sink for floodplain tributary watercourses. The hydrological regime of floodplain wetlands and watercourses in the Project Area is complex; however, it is considered that they are at least partially dependent on groundwater. Snags, other woody debris, leaf litter, trailing vegetation and trailing roots are abundant, providing important micro-habitats for aquatic macroinvertebrates and fish. With the exception of one site in the Bavaga River, aquatic macrophytes are not abundant in floodplain watercourses, most likely due to high flows (such as occur during flood events), high canopy cover and, in places, high turbidity.

The Lower Watut River is located in a broad floodplain and has unconfined channels. In places the river consists of multiple braided channels that are highly unstable and subject to shifts in position of the deepest channel. The river also forms a continuous meandering channel that is highly unstable, migrating across the width of the floodplain over time. Aquatic macrophytes are not well represented in the Lower Watut River, most likely due to a combination of high turbidity, unstable substrates, and deep and fast-flowing water.

Oxbow lakes form where meander bends have been cut-off from the main channel and several large oxbow lakes occur on the Lower Watut River floodplain. While the ecological character can vary markedly, they commonly have high proportion of aquatic macrophytes and high groundcover along the fringes of the oxbow lakes.

#### 1.2.1.11.2 Fish Assemblages

Analysis of recent fish sampling results indicates that there are no consistent differences in species richness among ecosystem types; however, the proportion of introduced fish species is generally lower in tributary and floodplain watercourses compared to oxbow lakes and Lower Watut River sites. There appears to have been a fundamental change in fish community structure in the Lower Watut River catchment over time, with introduced fish now the dominant taxa in many watercourses and off-river waterbodies. Further, it is possible that the changes in abundance of some native species, including tapiroid grunter (*Mesopristes cancellatus*) and Idenburg's tandan (*Neosilurus idenburgi*) may be related to the dominance of introduced species.

Previous surveys in the Watut River catchment have recorded only one threatened species listed on the IUCN Red List, i.e., the Critically Endangered freshwater sawfish (*Pristis pristis*, formerly *Pristis microdon*). The recorded sample was collected in the Lower Watut River below the Wafi River junction in 1988 but has not been recorded in subsequent surveys between 2007 and 2015. The Lower Water River catchment is not considered likely to support a significant proportion of the population of any endemic fish species.

### 1.2.1.11.3 Semi-Aquatic Reptiles

The northern PNG turtle fauna is depauperate, and comprises two species: Schultze's snapping turtle (*Eseya schultzei*) which was captured in the Mine Area during field survey at Uruf Oxbow and the New Guinea giant softshell turtle (*Pelochelys signifera*), which may occur in the Lower Watut River. Crocodiles have been recorded as incidental sightings during transit of the Lower Watut River during surveys but are unlikely to occur in any high velocity (high gradient) tributary watercourses in the Lower Watut River catchment.

Further information on aquatic ecology in the Project Area is provided in Chapter 8, Physical and Biological Environment Characterisation, of the Project EIS (WGJV, 2018).

### 1.2.1.12 Terrestrial Flora and Fauna

The Project is located on the northern slopes of the main dividing range of PNG between the Lower Watut and Wampit rivers. The region includes two distinctive landforms, which in turn influence vegetation types. These are the:

- Northern hills of the main dividing range of PNG, characterised by steep terrain intersected with steep valleys and waterways
- Alluvial plains and foothill terraces of the Lower Watut River valley, and further downstream the lower Markham River valley to the Huon Gulf

Vegetation occurring on upland areas (i.e., mountains or hills) comprises Medium Crowned Forest/Small Crowned Forest (FIMS Hm/Hs). Vegetation occurring on the Lower Watut River floodplain comprises Large to Medium Crowned Forest (FIMS Pl). Vegetation occurring in the adjacent back plains (i.e., low-lying, permanently swampy areas) adjacent to the major watercourses consists of Mixed Swamp Forest (FIMS Fsw/FswC) and Swamp Woodland (FIMS Wsw). Grasslands (FIMS G) are also present in the foothills south of the Lower Watut River floodplain and in the Markham River valley to the north (Hammermaster and Saunders, 1995).

The majority of the broad alluvial floodplain of the Lower Watut River is vegetated with large tracts of intact and relatively unmodified primary lowland forest. In contrast, the vegetation along the Infrastructure Corridor between the Markham River crossing and the Coastal Area, is mostly cleared and anthropogenically modified falling under the 'Other non-vegetation and areas dominated by land use' FIMS category.

Factors influencing vegetation condition are distance from human occupation (Lae and villages) and access (proximity to and condition of roads). The Mine Area was assessed as supporting largely intact vegetation, a likely reflection of its relative remoteness, and steep, mountainous terrain. Areas along the Infrastructure Corridor east of the Markham River crossing and the Coastal Area, which are proximate to the Highlands Highway, numerous villages and the city of Lae, the second largest city in PNG, are highly modified.

Five main terrestrial fauna habitat types were characterised within the terrestrial ecology study area, these being alluvial forest, hill forest, grassland, watercourses and wetlands, and highly disturbed anthropogenic habitats. The height, floristic and structural complexity of both alluvial and hill forest provides for a wide variety of ecological niches for fauna. As such, both lowland forest types support an equally rich diversity of terrestrial fauna species across the Project Area. By comparison with the surrounding forests and wetland habitats, grassland habitats support fewer species. The fringes of rivers, oxbow lakes and swamp grassland provide foraging habitat for waterbirds such as egrets and cormorants that occur in small numbers. The clear, fast-flowing waters of mountain creeks provide breeding habitat for a variety of frogs.

The following thirteen flora species of conservation significance (based on IUCN status) have been recorded within the Project Area:

- *Aglaiia brownii* (Vulnerable)
- *Aglaiia sexipetala* (Near Threatened)
- *Cycas apoa* (Near Threatened)
- *Cycas schumanniana* (Near Threatened)
- *Flindersia amboinensis* (Near Threatened)
- *Diospyros insularis* (Endangered)
- *Diospyros lolinopsis* (Critically Endangered)
- *Flindersia pimenteliana* (Endangered)
- *Halfordia papuana* (Critically Endangered)
- *Intsia bijuga* – kwila (Vulnerable)
- *Myristica buchneriana* (Vulnerable)
- *Myristica globosa* (Near Threatened)
- *Pterocarpus indicus* – New Guinea rosewood (Vulnerable)

Several conservation significant species were recorded as present, yet their occurrence within the Study Area would appear contrary to previously known distributions, and their identification has not been verified; this includes *H. papuana* and *D. insularis*. Based on recent records, *D. lolinopsis* is unlikely to meet the Critically Endangered criteria and BAAM (2018) speculate that it should be revised to Vulnerable.

Five fauna species of conservation significance (based on IUCN status) have been confirmed as occurring within the Project Area. These are:

- Goodfellow's tree kangaroo (*Dendrolagus goodfellowi*; Critically Endangered), recorded as a pet at Madzim
- New Guinea pademelon (*Thylogale browni*; Vulnerable), recorded as a captive individual in Pekumbe
- Papuan eagle (*Harpyopsis novaeguineae*; Vulnerable)
- Pesquet's parrot (*Psitttrichas fulgidus*; Vulnerable)
- Gurney's eagle (*Aquila gurneyi*; Near Threatened)

A total of 87 introduced plant species were recorded in the Project Area, 23 of which are considered to pose a risk to biodiversity values as invasive weed species, particularly in areas of disturbance. Twelve of these are listed on the Global Invasive Species Database (2015), with five identified as being among the 'world's 100 worst invasive alien species'. Additionally, 19 of the 87 species were assessed as high risk in the Pacific Island Ecosystems at Risk Database (PIER, 2013).

Introduced species are a common part of the regional landscape and are associated with an ongoing disturbance regime for agriculture. The majority of these weeds are widespread herbaceous species and, although capable of rapid invasion to disturbed areas, are not considered highly invasive or a threat to native vegetation.

At least six different introduced fauna species have been recorded, including water buffalo (*Bubalus bubalis*), feral pig (*Sus scrofa*), feral cat (*Felis catus*), Polynesian rat (*Rattus exulans*), common house gecko (*Hemidactylus frenatus*) and cane toad (*Bufo marinus*).

Further information on terrestrial ecology in the Project Area is provided in Chapter 8, Physical and Biological Environment Characterisation, of the Project EIS (WGJV, 2018).

#### 1.2.1.13 Nearshore Marine Ecology

The nearshore marine environment includes shallow benthic and pelagic habitats to a water depth of approximately 20m (corresponding to a maximum distance from shore of approximately 100m), and the littoral zone and foreshore. Various aspects of the Outfall Area (including the Outfall System) and Port Facilities Area are located within or near the nearshore marine environment, and include the mix/de-aeration tank, seawater intake pipelines and DSTP outfall pipelines, the concentrate filtration plant, materials handling, storage, and ship loading facilities and the filtrate discharge pipeline.

Large volumes of fluvial sediment are transported by the Markham River and the 20 or so other rivers that drain into the Huon Gulf to the east of Lae, while smaller quantities of sediment are discharged from rivers on the south coast of the Huon Gulf. Of the rivers discharging along the northern shoreline of the Huon Gulf coast in the Coastal Area, the Markham and Busu rivers generate the dominant turbid plumes in the region. The combined terrestrial sediment load from the Markham River and catchments discharging into the northern shoreline of the Huon Gulf is presently estimated to be about 60Mtpa (IHAConsult, 2018).

High terrestrial sediment input, low light penetration and high freshwater inflow – combined with a steeply sloping seafloor – largely preclude the development of complex benthic communities and present unfavourable conditions for the establishment and growth of invertebrates, including reef-building corals in most of the Huon Gulf.

The nearshore marine area is considered to be natural habitat, with the exception of the modified habitat present along the portion of the coastline in the immediate vicinity of Lae (including around the Lae Tidal Basin, the Port of Lae and other nearby coastal areas affected by development activities). While the degree of modification of nearshore habitats and the effects this will have on individual species varies, the primary ecological functions and species composition of these locations has been substantially modified. Areas of natural habitat include around the proposed Outfall Area and further east, and all nearshore marine habitat south of the Markham River.

The only habitat capable of supporting regular occurrences of any species of conservation significance is the nesting habitat along the western coast of the Huon Gulf (from around Labu Tale and further south) for the west Pacific leatherback turtle (*Dermochelys coriacea*; Critically Endangered). No species that occur within the area, or the Huon Gulf more broadly, are known to be endemic.

Further information on nearshore marine ecology relevant to the Project is provided in Chapter 10, Nearshore Marine Environment Characterisation, of the Project EIS (WGJV, 2018).

#### 1.2.1.14 Offshore Marine Ecology

The offshore marine environment is the region seaward of the nearshore zone, encompassing the ocean water column from the surface to and including the sea floor. That is, the zone beyond the foreshore, littoral zone and shallow-water benthic and pelagic habitats and in waters deeper than 20m and more than 100m from the shore.

The Markham River discharges into the Huon Gulf west of Lae and directly south of the Atzera Mountain Range and southern slopes of the Finisterre Range. Below sea level, seafloor slopes plunge steeply to a submarine canyon known as the Markham Canyon. The



canyon floor is the main pathway for the transport of terrestrially-derived sediment through the Huon Gulf towards the New Britain Trench. Where the Markham Canyon emerges from the mouth of the Markham River, the floor of the canyon has a slope of approximately 6° for the initial 2km of the canyon, reducing to an approximately 3° slope until a depth of about 1,700m some 35km from the Markham River mouth.

The natural distribution, transport, settling and redistribution of suspended sediment through the Markham Canyon is characterised by an almost continual occurrence of bottom-attached plumes of suspended sediment of variable thickness near the canyon floor.

The overall diversity of deep slope and pelagic fish species in the upper Huon Gulf off Lae was low for both cartilaginous fish such as sharks (elasmobranchs) and bony fishes. Diversity was also much lower than recorded from similar baseline surveys at other DSTP sites elsewhere in PNG.

Benthic habitats displayed a high degree of surface uniformity and were characterised by fine, largely homogenous sediments. Evidence of presence of benthic macrofauna includes mounds, burrows, and faecal casts. Shrimp, sea whips and other fauna were observed in very low numbers (typically solitary). While no benthic fish were observed, demersal fish including a grenadier or rattail fish of the family Macrouridae, and solitary dwarf gulper sharks were encountered swimming just above the seafloor.

Further information on offshore marine ecology relevant to the Project is provided in Chapter 11, Offshore Marine Environment Characterisation, of the Project EIS (WGJV, 2018).

### 1.2.2 Key Areas of Environmental Management

The key areas of environmental management are:

- Air quality and greenhouse gas
- Noise and vibration
- Terrestrial flora and fauna
- Freshwater and aquatic flora and fauna
- Soils, sediment and erosion control
- Waste rock and acid and metalliferous drainage
- Marine ecology
- Hazardous materials
- Non-hazardous materials
- Weeds and pests
- Rehabilitation
- Environmental incident response

These aspects are addressed as they apply to construction and operations in Modules 2 and 3, respectively.

### 1.3 Regulatory Framework

The regulatory and policy framework applicable to the Project includes:

- The legislation and regulations of the Independent State of Papua New Guinea (PNG).
- Conditions of the Level 3 Environment Permit for the Project, once issued.
- International guidelines and standards that have informed the development of the Project.

#### 1.3.1 PNG Regulatory Requirements

The key piece of legislation applicable to the environmental management of the Project is the *Environment Act 2000*. The *Environment Act 2000* sets out the requirement for proponents to obtain an environment permit for activities prescribed in the Environment (Prescribed Activities) Regulations 2002 that have the potential to cause environmental harm.

Under the *Environment Act 2000*, activities are classified as Level 1, Level 2 or Level 3 based on their risk of causing environmental harm and each requires a different level of environmental and social assessment. Level 3 activities, which include mining developments of the scale of the Project, are considered to have the highest risk of causing environmental harm. The grant of a Level 3 environment permit is subject to a comprehensive environmental impact assessment, presented in an EIS and reviewed by the CEPA in consultation with the public.

In addition to the *Environment Act 2000*, other relevant PNG acts and regulations associated with the key areas of environmental management for the Project are listed in Table 1.3 below.

Table 1.3: Summary applicable legislation

Acts and Regulations	Description
<i>Environment Act 2000</i>	<p>The <i>Environment Act 2000</i> regulates the impact of industry on the environment and defines the 'environment' as:</p> <ul style="list-style-type: none"> <li>• ecosystems and their constituent parts including people and communities and including human-made or modified structures and areas; and</li> <li>• all natural and physical resources; and</li> <li>• amenity values; and</li> <li>• the qualities and characteristics of locations, places and areas, however large or small, that contribute to their biological diversity and integrity, intrinsic or attributed scientific value or interest, amenity, harmony and sense of community; and</li> <li>• the social, economic, aesthetic and cultural conditions which affect the matters stated in Paragraphs (a) to (d) of this definition or which are affected by those matters.</li> </ul> <p>The <i>Environment Act 2000</i> sets out the requirement for proponents to obtain an environment permit for activities prescribed in the Environment (Prescribed Activities) Regulations 2002 that have the potential to cause environmental harm.</p>
<i>Mining Act 1992</i>	<p>The <i>Mining Act 1992</i> is the principal regulatory document governing minerals exploration and mining in PNG.</p> <p>The <i>Mining Act 1992</i> vests ownership of all minerals with the State of PNG and governs the exploration, development, processing and transport of minerals.</p>
<i>Mining (Safety) Act 1977</i>	<p>Provides for the regulation and inspection of mines and works to manage safety. The act outlines various permits and approvals required for mines that WGJV will obtain, and is to be read in conjunction with the <i>Mining Act 1992</i>.</p>

Acts and Regulations	Description
<i>National Water Supply &amp; Sewerage Act (1986)</i>	Provides for the licencing of water supply and sewerage services.

In addition to the legislation described above the Project EMP for the Project has been developed with regard to the Environmental Code of Practice for the Mining Industry (OEC, 2000). The Environmental Code of Practice for the Mining Industry provides guidance for environmental management such as (but not limited) to the management of mineral wastes, risk management, rehabilitation, monitoring and community relations.

### 1.3.2 Project-specific Environment Permit Conditions

The Project has been designated by CEPA as a Level 3 activity under the Environment Protection (Prescribed Activities) Regulations 2002. An EIS (which the Project EMP supports) will be submitted to CEPA to support the application for a Level 3 Environment Permit.

The Project EMP is designed to satisfy the requirements of the environment permit conditions that will apply to the Project, and will be reviewed upon issue of a Level 3 Environment Permit to ensure any new requirements are captured once known.

### 1.3.3 International Guidelines and Standards

A number of international standards have informed the development of WGJV's environmental and social policy and standards and, in turn, have influenced Project design and the preparation of this EIS, including environmental, social and cultural heritage studies. These standards include:

- International Council on Mining and Metals (ICMM) Sustainable Development Framework (ICMM, 2015) comprising ten sustainable development principles and six position statements which encompass ethical business practices, partnering for development, human rights and the rights of Indigenous People. Newcrest Mining Limited (Newcrest), the parent company of one of the WGJV Participants, is a member of ICMM, and is a signatory to 'Enduring Value – the Australian Mining Industry Framework for Sustainable Development', which adopts the ICMM Framework for Sustainable Development. The ten sustainable development principles are (ICMM, 2015):
  - Apply ethical business practices and sound systems of corporate governance and transparency to support sustainable development
  - Integrate sustainable development in corporate strategy and decision-making processes
  - Respect human rights and the interests, cultures, customs and values of employees and communities affected by our activities
  - Implement effective risk-management strategies and systems based on sound science and which account for stakeholder perceptions of risks
  - Pursue continual improvement in health and safety performance with the ultimate goal of zero harm
  - Pursue continual improvement in environmental performance issues, such as water stewardship, energy use and climate change
  - Contribute to the conservation of biodiversity and integrated approaches to land use planning

- Facilitate and support the knowledge-base and systems for responsible design, use, re-use, recycling and disposal of products containing metals and minerals
- Pursue continual improvement in social performance and contribute to the social, economic and institutional development of host countries and communities
- Proactively engage key stakeholders on sustainable development challenges and opportunities in an open and transparent manner. Effectively report and independently verify progress and performance
- Voluntary Principles on Security and Human Rights (Voluntary Principles) (Voluntary Principles, 2015). The Voluntary Principles are a multi-stakeholder initiative involving governments, companies and non-government organisations that promote the implementation of a set of principles that guide oil, gas and mining companies on providing security for their operations in a manner that respects human rights. Newcrest is a participant in the Voluntary Principles Initiative and the WGJV conducts business in a manner that considers the human rights of people associated with the Project.
- Equator Principles III (Equator Principles, 2013). The Equator Principles are ten principles adopted by signatory financial institutions to ensure large infrastructure and resource projects are executed in a manner that is both environmentally and socially responsible. The Equator Principles require the application of appropriate environmental and social standards, which for non-designated countries are deemed to be the International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability (IFC, 2012). The Equator Principles provide a risk management framework for determining, assessing and managing environmental and social risk in projects and are primarily intended to provide a minimum standard for due diligence to support responsible risk-based decision-making.

## 1.4 Environmental Management Framework

The WGJV proposes to implement an integrated management system to manage the predicted environmental, socioeconomic and cultural heritage impacts, and other risks, of the Project.

### 1.4.1 Sustainable Business Management System

The WGJV Sustainable Business Management System (SBMS) provides policies and standards to guide the WGJV's long-term approach to sustainability. The policies and standards that currently comprise the SBMS include:

- Governance, leadership and culture
- Enterprise risk management
- Health and safety
- People
- Environment
- Social responsibility
- Operational management, improvement and innovation
- Sustainable business growth

#### 1.4.2 Environmental Management System

The WGJV Environmental and Social Management Framework has been developed to guide the implementation of the environmental and social components of the SBMS. The Environmental and Social Management Framework comprises a number of management plans which relate to the management of predicted environmental and social impacts.

Potential environmental, socioeconomic and cultural heritage impacts will be addressed by implementing the management measures presented in one or more of the plans shown in the Environmental and Social Management Framework; principally:

- The Project EMP (i.e., this document) – Addresses construction and operations activities that directly affect an environmental aspect.
- Attachment 4, the Project Social Management Plan – Addresses matters that pertain to community health, safety and security, in-migration and resettlement.
- Attachment 5, the Project Cultural Heritage Management Plan – Addresses matters that relate to an archaeological or historic site, or an oral tradition site that holds importance to a community.

Management plans that constitute the Environmental and Social Management Framework will identify environmental, socioeconomic and cultural heritage opportunities and potential impacts and risks and the measures proposed to be implemented to manage them. Plans will be implemented, where appropriate, through a series of standard operating procedures as well as agreed requirements arising from the State of PNG's assessment of this EIS, and any conditions of approval for the Project.

Further details of the integrated management system and the Environmental and Social Management Framework is provided in Chapter 23, Integrated Management System, in the EIS (WGJV, 2018).

#### 1.4.3 Environment Policy

The WGJV Environment Policy is provided in Figure 1.4. The WGJV operational standards associated with the Environment Policy most relevant to environmental management are:

- ENV01 Environmental Impact Assessment and Management
- ENV02 Waste Rock Management
- ENV03 Tailings Management
- ENV04 Greenhouse Gas and Carbon Management
- ENV05 Rehabilitation and Closure

#### 1.4.4 Planning

The planning element of an environmental management system consists of identifying the following in relation to the Project managed under the Project EMP:

- Key areas of environmental management
- Legal and other requirements related to environmental management
- Objectives, targets, key performance indicators and programs for environmental management
- Roles and responsibilities for the implementation of management measures
- Audit and checking processes



# Environment Policy

The Wafi-Golpu Joint Venture (WGJV) is committed to achieving an excellent standard of environmental performance in our exploration and mining activities in Papua New Guinea

We will achieve this outcome by:

- Establishing and implementing effective environmental management systems
- Integrating sustainable development considerations within the corporate decision-making process and when setting and reviewing our objectives and targets
- Identifying, mitigating and acting upon environmental risks to achieve planned environmental outcomes, continually improve our performance and prevent pollution
- Engaging and involving our employees and contractors to promote environmental awareness and responsibilities
- Complying with applicable environmental statutory and regulatory obligations and other requirements to which WGJV subscribe, and encouraging compliance from those with whom we do business
- Rehabilitating sites or areas disturbed by our activities to comply with environmental management plans and contributing to conservation of biodiversity and integrated approaches to land use planning
- Supporting research to reduce our environmental impacts and improve long term environmental outcomes within the realms of economically and ecologically sustainable development
- Informing stakeholders of our activities and consulting with the community in relation to our projects

**At WGJV we believe it is every employee's responsibility to protect the environment**

**None of us alone can achieve more than what we can achieve together**

  
Craig Jones

Operating Committee Representative

  
Johannes van Heerden

Operating Committee Representative



Revision: 04  
Issue Date: 23/06/2016

The Project EMP has been developed to address these topics and incorporates them into the Project EMP structure for use by Project personnel and contractors.

#### **1.4.4.1 Key Areas of Environmental Management**

Key areas of environmental management are identified in Section 1.2.2 and addressed in the individual management plans in Modules 2 and 3. Management measures have been prepared for construction and operations, with measures for unplanned events outlined in the both the WGJV Incident Management, Reporting and Notification procedure and the WGJV Crisis, Emergency and Incident Management Plan (Part 2A Wafi-Golpu Incident Response Plan).

A register of the risks identified and the management measures proposed will be maintained and informed by the environmental impact assessment undertaken as part of the EIS. This register will be used to track ongoing changes that occur and allow changes to be incorporated into the Project EMP, ensuring it retains relevance to ongoing construction and operation activities.

#### **1.4.4.2 Legal and Other Requirements**

Environmental management is subject to legislation and associated regulations for the environment. Statutory control is evidenced within the various approvals, licenses and permits that may be necessary for the commencement and control of certain facets of work.

Identifying and understanding the relevant environmental, legal and other requirements that govern the WGJV's activities is as important as evaluating the aspects and impacts of these activities, as this forms the foundation for an environmental management system. Legal and other requirements are detailed in Section 1.3 of the Project EMP. A legal register has been developed and will be maintained for the life of the Project to track legal obligations for the Project, including those arising from the environmental assessment process and enacted through the Project EMP, but also those arising from all relevant legislation, regulation and standards taken on by the Wafi-Golpu Joint Venture Participants and relating to all Project activities.

#### **1.4.5 Implementation and Operation**

##### **1.4.5.1 Responsibility**

The Project EMP outlines procedures to be followed during construction and operation of the Project. The Project General Manager will oversee all activities associated with the Project and assume ultimate responsibility for the implementation of, and compliance with, the Project EMP. Consequently, the General Manager is responsible for the provision of sufficient resources to implement the Project EMP.

The General Manager has the right, at any point, to issue an order to suspend works if the environmental requirements are deemed to be at risk.

Management or designated personnel will be responsible for ensuring that their work complies with the conditions of relevant legislation, environmental permits and the environmental management measures outlined in the Project EMP. Individual accountability will be defined through position descriptions and conditions of employment contracts. Additionally, all personnel are responsible for complying with the 'general environmental duty' outlined in Section 7 of the *Environment Act 2000* (as described in Section 1.3.1). The WGJV will provide governance, procedures and training on requirements as needed.

An organisational structure will be implemented to ensure effective environmental management of the Project. The organisational structure and roles will differ between the construction and operations phases of the Project to reflect the different skill sets required to execute the works.

Under the current proposed organisational structure, the General Manager is supported by a General Manager for Social Performance and External Affairs and a senior management team covering the following functions: construction, operations services, community affairs and lands, environment, mining, processing, human resources and training, safety, engineering and maintenance, local economic development, power station, commerce, marketing, public relations and technical services.

The roles and responsibilities associated with this organisational structure, as they apply to this plan, are shown in Table 1.4. This organisational structure may be expanded or altered at any time during the Project.

#### **1.4.5.2 Competence, Training and Awareness**

The WGJV is committed to increasing and enhancing the awareness of site environmental issues with key stakeholders. The Wafi-Golpu Joint Venture Participants will induct and train Project personnel and contractors, so that they have an appropriate knowledge and skills to meet WGJV's policies and the objectives of the Project EMP. Environmental inductions will be conducted for Project personnel and contractors to inform them of environmental issues and responsibilities including:

- Obligations under the WGJV Environmental Policy, conditions of approval and any other Project commitments
- Site layout and areas of particular environmental significance
- Relevant standard operating procedures and other Environmental Management Plan and site documentation outlining key environmental and social management procedures
- Environmental incidents and reporting procedures
- Key Project and environmental contacts onsite

Project personnel and contractors will be required to attend the environmental induction prior to beginning work on the Project. Records of all Project personnel receiving inductions will be kept in the business management system database.

Existing Project personnel and contractors will be made aware of any new information pertaining to their environmental management obligations through toolbox meetings, notice boards and the issue of E-flash (information note), encouraging regular feedback and participation.

Contractors are responsible for ensuring their personnel are competent in the requirements of their roles on the basis of education, training and experience.



Table 1.4: Proposed WGJV roles and responsibilities Note: titles, roles and responsibilities may change subject to the allocation of activities by the Project General Manager.

	General Manager	General Manager Social Performance and External Affairs	Surface Construction Manager	Mining Manager	Process Manager	Operations Service Manager	Community Affairs and Lands Manager	Environment Manager	OH&S Manager	Human Resources and Training Manager	Engineering and Maintenance Manager	Environment Personnel	OH&S Superintendent	Emergency Response Superintendent	Work Area Superintendents	Logistics Superintendent	Maintenance Superintendents	WGJV Staff and Contractors
Project phase (C = construction, O = operation, LOM = Life of Mine)	LOM	LOM	C	LOM	O	LOM	LOM	LOM	LOM	LOM	O	LOM	LOM	LOM	LOM	LOM	LOM	LOM
Ultimate responsibility for the Project compliance with the Project EMP	✓																	
Ensure activities are undertaken in accordance with the Project EMP and as per detailed design plans and specifications	✓		✓	✓	✓													
Ensure environmental issues and impacts are considered for all activities and are included in work procedure documentation	✓		✓	✓	✓			✓						✓				
Ensure personnel are aware of the Project EMP and their obligations within it			✓	✓	✓	✓	✓	✓	✓	✓	✓							
Ensure an appropriate environmental induction process is in place whereby all new employees and contractors are made aware of their obligations and major site environmental considerations								✓		✓								
Identify training requirements, changes in work practices, new procedures and other actions required to achieve the Project EMP compliance								✓		✓								

	General Manager	General Manager Social Performance and External Affairs	Surface Construction Manager	Mining Manager	Process Manager	Operations Service Manager	Community Affairs and Lands Manager	Environment Manager	OH&S Manager	Human Resources and Training Manager	Engineering and Maintenance Manager	Environment Personnel	OH&S Superintendent	Emergency Response Superintendent	Work Area Superintendents	Logistics Superintendent	Maintenance Superintendents	WGJV Staff and Contractors
Conduct environmental inductions and training/toolbox workshops to ensure employees and contractors are aware of their obligations under the Project EMP												✓						
Ensure all equipment within the work area is appropriately serviced and mechanically sound															✓		✓	
Ensure all vegetation clearing activities are undertaken in accordance with the Project EMP and as per detailed design plans and specifications			✓															
Monitor contractor compliance and performance (including in relation to the Project EMP)			✓	✓	✓										✓			
Ensure audits and inspections within the Project EMP are completed as specified			✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	
Notify the onsite Environment Manager and the relevant department manager in the event of an environmental incident or instance where the environment is deemed to be at risk so that a stop work order can be issued	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Issue an order to suspend works in the event of an incident causing, or with the potential to cause, serious environmental harm or in instances where the environment is deemed to be at risk	✓		✓	✓	✓			✓	✓									
Ensure any assigned corrective action requests or incident response actions are completed in the specified timeframe			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓ (issue actions)	✓	✓	✓	✓	✓	✓
Manage community related complaints lodged during the Project as per the WGJV Grievance Procedure		✓					✓											

	General Manager	General Manager Social Performance and External Affairs	Surface Construction Manager	Mining Manager	Process Manager	Operations Service Manager	Community Affairs and Lands Manager	Environment Manager	OH&S Manager	Human Resources and Training Manager	Engineering and Maintenance Manager	Environment Personnel	OH&S Superintendent	Emergency Response Superintendent	Work Area Superintendents	Logistics Superintendent	Maintenance Superintendents	WGJV Staff and Contractors
Complete quality reviews of the Project and verify compliance with the Project's design criteria, drawings, and specifications			✓	✓	✓				✓		✓				✓		✓	
Participate in the annual review process for the Project EMP			✓	✓	✓			✓	✓		✓				✓		✓	
Prepare annual reports on compliance with the Project EMP (and other statutory requirements) for submission to CEPA								✓				✓					✓	

### 1.4.5.3 Communication and Consultation

Communication and consultation with stakeholders, both internal and external, is integral to the ongoing success of environmental management of the Project, and will continue throughout the Project.

The key external Project stakeholders with which the WGJV will consult include the local community, the local, provincial and national governments, and other stakeholders as appropriate.

Wherever appropriate feedback arising from stakeholder consultation will be used to enhance the Project EMP during the management review process.

Community engagement will be managed by the WGJV Community Affairs Department. The Community Affairs and Lands Manager will ensure the Project activities are effectively and continuously communicated to the local community.

Consultation with relevant levels of government will continue for the life of the Project. As required, WGJV environmental representative(s) will arrange regular meetings with CEPA, local level government (LLG) and provincial government (and national government) to provide Project updates and discuss any issues.

The WGJV's internal communications will also be crucial to ensure environmental standards and compliance requirements for the Project are understood by Project personnel. The Project EMP will provide a key tool for transferring knowledge about the key areas of environmental management for the Project to Project personnel and contractors who work on the Project. Briefings and training will also be provided on an as needs basis.

### 1.4.5.4 Documentation

The storage and retrieval of information is an important part of environmental management, helping to resolve issues and achieve continuous improvement. The WGJV will maintain a database for the storage and retrieval of environmental data, records and other relevant information for the Project, including:

- Regulatory documents (e.g., legislation, government policies, compliance register, permits and licences)
- Environmental management plans and standard operating procedures
- Induction and training records
- Environmental audit schedules and reports
- Environmental monitoring programs, schedules and data
- Incident register
- Complaints received and actions taken (i.e., complaints reporting system)
- Consultation records, including meeting notes

Electronic and hard copies of the Project EMP documentation will be maintained by the WGJV Environment Department.

The WGJV will maintain environmental management databases for the Project. These will be used to:

- Manage all spatial data
- Manage environmental monitoring programs, schedules and data
- Interrogate and manage hydrological monitoring data and real time water quality data

- Use a business management system, such as the current integrated business information system (IBIS) to manage all documentation (including policies, procedures, meeting minutes and communication records), and incident records (i.e., incident response and reporting). Induction records and inspection and audit records will also be managed using this module.

#### **1.4.5.5 Document Control**

The primary purpose of WGJV's document control system is to ensure only current and approved documents are referenced. The WGJV's document control procedures include:

- Authorised review and approval for each EMS document including a document number, revision and issue date
- Maintenance of a document revision tracking process
- Ensuring correct revisions are available and out-of-date documents are archived and removed from circulation

#### **1.4.6 Checking and Corrective Action**

##### **1.4.6.1 Monitoring**

An environmental monitoring program will be implemented to monitor and measure, on a regular basis, the environmental performance of Project activities. The program will be based on a conventional three-phase surveillance system incorporating monitoring of:

- Operations (through inspections and audit)
- Discharges (i.e., emissions monitoring)
- Environmental and social impacts

Environmental monitoring results will be maintained in a dedicated database. Data collected will be checked by WGJV Environment Manager or delegate against relevant criteria. In the event of an exceedance, additional follow-up monitoring may be required. If WGJV environment personnel believe the exceedance is due to Project activities, then an incident report must be raised and the procedure detailed in the Project's Incident Notification and Investigation Procedure (APR009) followed.

Monitoring requirements during construction are listed in each individual management plan section in Modules 2 and Module 3 of the Project EMP.

##### **1.4.6.2 Inspections and Audit**

In addition to environmental monitoring, a range of inspections and audits are proposed to be undertaken during construction and operation. The inspection and audit regime will be quite different during the construction and operational phases as described below.

###### **1.4.6.2.1 Construction**

The proposed inspection and audit regime during construction will entail:

- Daily inspections of construction sites by the relevant contractor and WGJV area lead.
- Regular inspections of construction sites and installed management devices (such as sediment traps) completed by the relevant contractor and a WGJV environmental representative.

- Regular audits of hazardous materials storage facilities for compliance with the requirements of the Project EMP (and other relevant hazardous materials management procedures).
- Regular audits by the Environment Department to assess Project works against the Project EMP.
- Regular inspections of spill response kits to ensure they remain maintained and well stocked.
- Routine monitoring of waste management practices and facilities to ensure compliance with the requirements of the Project EMP.
- Ad-hoc audits following a significant event including:
  - An environmental incident such as an uncontrolled release occurs
  - After heavy rainfall or a major storm event
  - Following an environment-related community complaint
- Ad-hoc audits in work areas of particular environmental sensitivity
- A full audit upon completion of surface construction works for the Project. This audit will include a review of all relevant environmental requirements, records and incidents during construction.

Inspections and audits to be conducted during construction are listed in Module 2 for surface construction and underground developments.

#### 1.4.6.2.2 Operations

Once the Project enters its operational phase, a structured risk-based inspection and audit schedule will be developed for key operational infrastructure.

Regular inspection of operational facilities will be conducted by the responsible Department Manager (or delegate) and Environment Department personnel. It will be the responsibility of the responsible Department Manager (or delegate) to ensure issues identified during the inspections are rectified in a timely manner.

Both external and internal environmental audits will be performed periodically in accordance with the EMS procedures to identify opportunities for improvement to both the system and performance. A compliance auditing system will be established as part of the business management system for periodic compliance evaluation by relevant personnel onsite. The compliance auditing process will cover the requirements of the environment permits, the *Environment Act 2000* and the Project EMP.

#### 1.4.6.2.3 General Compliance

Compliance with the Project's environmental management framework will be assessed using the following processes:

- Collected monitoring data will be reviewed and interpreted when received and during collation of periodic environmental reports to be submitted to CEPA
- Regular workplace inspections will be undertaken according to the Environment Department audit and inspection schedule
- Regular internal audits will be undertaken according to the Environment Department audit and inspection schedule

Performance indicators are provided in the management plan chapters. Environmental performance will be assessed against these indicators.

A copy of each environmental inspection and audit will be retained on file by the Environment Department and a copy provided to the relevant area/Project supervisor and/or contractor. Electronic records of inspections and audits will be kept in the business management system.

Where non-conformance or suggested improvement is discovered through an inspection or audit, the auditor will inform the appropriate Department Manager (or delegate), detailing the issue(s). If possible, appropriate corrective and/or preventive action will be agreed with the manager at the time of audit/inspection. Where follow-up actions need approval or agreement from senior management, this will be achieved as soon as practicable. Any findings that are deemed as an opportunity for improvement, but not necessarily a discrepancy against the requirements of the Project EMP, will be reported as observations. Observations can also be used to describe examples of best practice. Non-compliances with the Project EMP or permit conditions will be reported as an incident.

Corrective actions required to address observations and non-compliances should be completed within the timeframe nominated in the approved incident report. Where actions are not completed within this timeframe, the General Manager has the right to issue a stop work order for those works associated with the corrective action request based on the level of risk and potential environmental impacts. Works may not resume until the appropriate action has been completed and is approved by the General Manager and an environmental representative.

#### **1.4.6.3 Reporting and Notification**

The WGJV will employ the following reporting systems for the Project:

- All significant incidents and non-compliances with legal requirements will be reported in accordance with statutory requirements
- Significant aspects and impacts will be communicated through the Project's annual environment reports, which are submitted to CEPA

#### **1.4.6.4 Incidents and Emergency Response**

For the purposes of the Project EMP, an environmental incident is defined as any unplanned or unintentional event that may lead to material or serious environmental harm, as defined under the *Environment Act 2000*, or any activity resulting in regulatory non-compliance or the breach of company policies, standards or commitments. Environmental incidents may occur as a result of day-to-day operations or may be the result of major incidents and natural hazards such as an earthquake.

All environmental incidents will be documented, notified and reported in accordance with established procedures (refer to Module 2 and Module 3 of the Project EMP for details). Environmental incidents include but are not limited to:

- Spills (e.g., hydrocarbons, process solutions, reagents and untreated waste water)
- Non-compliances with environment permit and regulatory requirements

Environmental incidents occurring as a result of emergency, accident, equipment malfunction, extreme weather conditions or other factors that have the potential to cause serious or material environmental harm will be reported internally to the Work Area Superintendent who must inform the Environment Department within 24 hours of the event.

Incident reports must contain the date, time, location and description of events, volumes (for spills and releases), analysis of the cause, remedial actions and corrective actions required to prevent future occurrences.

The incident will be registered in the business management system. The incident report will detail a prescribed time-frame for the completion of corrective actions.

Records of any incidents and non-compliances must be kept in the business management system, documenting the corrective measures completed and the timeframe within which these were actioned.

The WGJV Incident Management, Reporting and Notification document governs the incidence response workflow to be followed in the event of an incident or unplanned event.

#### **1.4.6.5 Incident Investigation**

All incidents will be investigated as per the WGJV's Incident Management, Reporting and Notification procedure. The General Manager is accountable for completing an investigation after any emergency response in order to assess:

- The work practices that caused the incident
- Whether the cause can be eliminated or designed out
- Whether improved work practices will prevent recurrence
- The need for improved preparation

#### **1.4.6.6 Corrective Action**

Environmental non-compliances can arise from incidents/accidents, monitoring, technical audits, and deviations from policies, objectives and targets. Corrective action to re-establish compliance should be taken as soon as possible (i.e., before the next management review). The steps to corrective action will usually involve:

- Review of the technical and system audit reports by the appropriate manager in consultation with the Environment Department
- An investigation to identify and analyse the root cause of the non-compliance
- Development of objectives, targets and resource plans to correct or prevent further non-compliance

The solution may involve remedial actions and:

- Changes to the Project EMP, SOPs, emergency response plan and other environmental management documentation
- Identification and implementation of specific training

The WGJV Environment Department is responsible for reviewing incident reports, audit reports and other documents on non-compliances related to an environmental incident, and for ensuring that required actions are identified and effectively implemented.

Relevant department managers are responsible for preparing objectives, targets and plans to address non-compliances related to their department.

#### **1.4.6.7 Annual Environmental Reports**

The WGJV Environment Department will prepare an annual environment performance report that:

- Provides, in accordance with the requirements of the environment permit, a summary of compliance with the permit conditions for the reporting period
- Reviews the performance of Project works against the Project EMP
- Summarises monitoring results



- Provides an overview of any major environmental actions over the previous 12 month (calendar) reporting period

A copy of the annual environmental report will be submitted to CEPA.

#### 1.4.6.8 Complaints

The WGJV has implemented a formal grievance procedure for the Project, which also addresses complaints. Where the WGJV becomes aware of any complaint relating to Project activities, the relevant manager would be informed in a timely manner e.g. within 24 hours.

In the event a Project-related complaint is received, the procedure outlined in the Grievance Procedure must be followed.

#### 1.4.7 Management Review

Management reviews will be undertaken to ensure that environmental management systems remain effective, widely used and appropriately communicated. Management reviews will be held to determine:

- Any system deficiencies or changes required to ensure ongoing suitability, adequacy and effectiveness of the system
- Whether objectives and targets are still appropriate
- The environmental impacts of Project activities

The WGJV will review the environmental management system outlined in the Project EMP annually and ensure its continuing suitability, adequacy and effectiveness. Reviews will include assessing opportunities for improvement and the need for changes, including review of environmental objectives, targets and Project personnel. Records of management reviews will be retained in the business management system.

A review of the Project EMP may also be conducted following request by CEPA.

The management reviews will typically include consideration of the:

- Progress of the implementation of the Project EMP
- Effectiveness of management
- Adequacy of resources
- Results of inspections and audits
- Summary of complaints and incidents
- Environmental incidents or non-compliances
- Actions taken to correct or remedy non-compliances and their status
- Performance against environment permit conditions, objectives, targets and performance indicators
- Follow-up actions from previous management reviews
- Changing circumstances, including organisation changes and legislative changes
- Recommendations for continual improvement

Any modifications to the Project EMP resulting from the review process will be conveyed to personnel and contractors by relevant managers and/or environmental representatives where required.

## 1.5 References

- BAAM. 2018. Terrestrial Ecology Characterisation - Mine Area to Markham River. Appendix C of the Wafi-Golpu Project Environmental Impact Statement. Report prepared by BAAM Ecological Consultants.
- CSIRO. 2018. Geochemical and Ecotoxicological Characterisation of Tailings.
- Coffey. 2011a. Air Quality Characterisation - Wafi-Golpu Project. Prepared for Wafi-Golpu Joint Venture by Coffey Environments Australia Pty Ltd.
- Coffey. 2011b. Noise Characterisation - Wafi-Golpu Project. Prepared for Wafi-Golpu Joint Venture by Coffey Environments Australia Pty Ltd.
- Equator Principles. 2013. The Equator Principles. A financial industry benchmark for determining, assessing and managing social and environmental risk in project financing: [www.equator-principles.com](http://www.equator-principles.com).
- Global Invasive Species Database. 2015. Available at: <[www.issg.org](http://www.issg.org)>. Accessed on 26 May September 2015.
- Hammermaster, E. T., and Saunders, J. C. 1995. Forest Resources and Vegetation Mapping of Papua New Guinea. PINGRIS Publication 4. CSIRO and AIDAB, Canberra, Australia.
- ICMM. 2015. Sustainable development framework, s.l.: International Council on Mining and metals, accessed from <https://www.icmm.com/en-gb/about-us/member-commitments/icmm-10-principles>.
- IFC. 2012. IFC Performance Standards on Environmental and Social Sustainability., Washington: International Finance Corporation, World Bank Group.
- IHAConsult. 2018. Physical, Chemical and Biological Sedimentology of the Huon Gulf. Appendix M of the Wafi-Golpu Project Environmental Impact Statement.
- Itasca. 2018. Numerical Assessment of Caveability and Subsidence for BC44, BC42 and BC40. DRAFT. Prepared for Wafi-Golpu Joint Venture (WGJV). Victoria. Australia.
- KCB. 2013. Wafi-Golpu Soils Assessment Surface Soils Assessment Final. Report prepared by Klohn Crippen Berger for the Morobe Mining Joint Venture.
- NSW OEH. 2005. Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales. Prepared by the NSW EPA of NSW Office of Environment.
- OEC. 2000. Environmental Code of Practice for the Mining Industry, Port Moresby: Papua New Guinea Office of Environment and Conservation.
- PIER. 2013. Pacific Island Ecosystems at Risk. Online resource at <http://www.hear.org/pier/>.
- SRK. 2007. Wafi-Golpu Seismic Hazard Analysis. Report prepared by SRK Consulting (Australasia) Pty Ltd. Sydney, Australia.
- SRK. 2018. Mine Material Geochemistry. Appendix E of the Wafi-Golpu Project Environmental Impact Statement. June 2018.
- Voluntary Principles. 2015. Voluntary Principles on Security and Human Rights. [Online] Available at: <http://www.voluntaryprinciples.org/>.
- WGJV. 2018. Wafi-Golpu Project Environmental Impact Statement. Report prepared by the Wafi-Golpu Joint Venture. June 2018.

World Bank. 2008. Pacific Catastrophe Risk Financing Initiative.



# Environmental Management Plan

## Module 2: Construction

## TABLE OF CONTENTS

2	INTRODUCTION.....	1
2.1	Air Quality and Greenhouse Gas Management.....	2
2.1.1	Introduction .....	2
2.1.2	Air Quality and Greenhouse Gas Management Plan.....	2
2.2	Noise and Vibration Management.....	4
2.2.1	Introduction .....	4
2.2.2	Noise and Vibration Management Plan .....	4
2.3	Terrestrial Flora and Fauna Management .....	6
2.3.1	Introduction .....	6
2.3.2	Terrestrial Flora and Fauna Management Plan .....	6
2.4	Freshwater and Aquatic Flora and Fauna Management .....	8
2.4.1	Introduction .....	8
2.4.2	Freshwater and Aquatic Flora and Fauna Management Plan .....	8
2.5	Soils, Sediment and Erosion Management.....	11
2.5.1	Introduction .....	11
2.5.2	Soils, Sediment and Erosion Management.....	11
2.6	Waste Rock and Acid and Metalliferous Drainage Management .....	14
2.6.1	Introduction .....	14
2.6.2	Waste Rock and Acid and Metalliferous Drainage Management Plan .....	15
2.7	Marine Ecology Management .....	16
2.7.1	Introduction .....	16
2.7.2	Marine Ecology Management Plan .....	17
2.8	Hazardous Materials Management .....	19
2.8.1	Introduction .....	19
2.8.2	Hazardous Materials Management Plan.....	19
2.9	Non-Hazardous Materials .....	21
2.9.1	Introduction .....	21
2.9.2	Non-Hazardous Materials Management Plan .....	22
2.10	Weed and Pest Management .....	23
2.10.1	Introduction .....	23
2.10.2	Weed and Pest Management Plan .....	23
2.11	Rehabilitation .....	25
2.11.1	Introduction .....	25
2.11.2	Rehabilitation Management Plan .....	25
2.12	Environmental Incident Response .....	27
2.12.1	Introduction .....	27
2.12.2	Environmental Incident Response Management.....	28

### LIST OF TABLES

Table 2.1: Proposed air quality and greenhouse gas management plan .....	2
Table 2.2: Proposed Noise and vibration management plan .....	4
Table 2.3: Proposed Terrestrial flora and fauna management plan .....	6
Table 2.4: Freshwater and aquatic flora and fauna management plan .....	8
Table 2.5: Soils, sediment and erosion management plan .....	12
Table 2.6: Waste rock and AMD management plan.....	15
Table 2.7: Marine ecology management plan .....	17
Table 2.8: Hazardous material management plan .....	19
Table 2.9: Non-hazardous material management plan .....	22
Table 2.10: Weed and pest management plan .....	23
Table 2.11: Rehabilitation management plan .....	26
Table 2.12: Environmental incident response management plan .....	28

### LIST OF APPENDICES

APPENDIX A	INCIDENT RESPONSE PROCEDURES .....	31
A.1	Hydrocarbon Spill Response.....	31
A.2	Landslip Response.....	31
A.3	Over-clearance of Vegetation Response .....	31

Abbreviation/Acronym	Description
%	percent
AMD	acid and metalliferous drainage
ANZECC/ARMCANZ	Australian and New Zealand Environment Conservation Council/Agriculture and Resource Management Council of Australia and New Zealand
CEPA	Conservation and Environment Protection Authority (previously Department of Environment and Conservation)
EIS	environmental impact statement
EMS	Environmental Management System
IFC	International Finance Corporation
IUCN	International Union for the Conservation of Nature
km	kilometres
km <sup>2</sup>	square kilometres
KPI	Key Performance Indicator
LLG	Local Level Government
m	metres
mASL	metres above sea level
mbgl	metres below ground level
Mt	million tonnes
NAF	non-acid forming
OH&S	occupational health and safety
PAF	potentially acid forming
PM <sub>10</sub>	respirable particulates less than 10µm
PNG	Independent State of Papua New Guinea
SOP	standard operating procedure
WGJV	Wafi-Golpu Joint Venture
WHO	World Health Organization

Glossary	Description
acid sulphate soils	Naturally occurring soils, sediments or organic substrates formed under waterlogged conditions. These soils contain iron sulphide minerals or their oxidation products. In an undisturbed state below the water table, acid sulphate soils are benign. However, if the soils are drained, excavated or exposed to air by a lowering of the water table, the sulphides react with oxygen to form sulphuric acid.
decline	A sloping underground tunnel excavated for mobile equipment access from surface or from level to level.
environmental impact statement (EIS)	A document that provides a comprehensive assessment of potential environmental, social and cultural heritage impacts (or benefits) associated with a project, in accordance with Section 53 of the PNG <i>Environment Act 2000</i> .
erosion	The process by which material, such as rock or soil, is worn away or removed by wind or water.

Glossary	Description
greenhouse gas	A gas that contributes to the greenhouse effect by absorbing infrared radiation. Carbon dioxide and methane are examples of greenhouse gases.
Infrastructure Corridor	The area encompassing the proposed Project infrastructure linking the Mine Area and the Coastal Area, being corridors for pipelines and roads and associated laydown areas. The proposed concentrate pipeline, terrestrial tailings pipeline and fuel pipeline will connect the Mine Area to the Coastal Area. A proposed Mine Access Road and Northern Access Road will connect the Mine Area to the Highlands Highway. New single-lane bridges are proposed over the Markham, Watut and Bavaga rivers. Laydown areas will be located at key staging areas.
Mine Area	The area encompassing the proposed block cave mine, underground access declines and nearby infrastructure, including a portal terrace and waste rock dump supporting each of the Watut and Nambonga declines, the Watut Process Plant, power generation facilities, laydown areas, water treatment facilities, quarries, wastewater discharge and raw water make-up pipelines, raw water dam, sediment control structures, roads and accommodation facilities for the construction and operations workforces.
non-acid forming	Chemically-stable materials that will not generate any by-products which are likely to adversely affect the environment. A sample is usually defined as non-acid forming when it has a negative NAPP and the final NAG pH is greater than or equal to 5.
Port Area	Port of Lae including Lae Tidal Basin and surrounds
Port Facilities Area	Located at, or in proximity to, the Port of Lae, with a site adjacent to Berth 6 (also known as Tanker Berth) nominated as the preferred option. The proposed facilities will include the concentrate filtration plant and materials handling, storage, ship loading facilities and filtrate discharge pipeline. This area may in the future need to include fuel oil handling and storage facilities.
potentially acid forming	Material that contains sulphidic compounds with the potential to generate sulphuric acid under oxidising conditions.
Project Area	The land that is the subject of the proposed Project activities and Project facilities, being: <ul style="list-style-type: none"> <li>• The Mine Area</li> <li>• The Infrastructure Corridor</li> <li>• The Coastal Area</li> </ul>
ventilation shaft	A vertical or sub-vertical passage used in an underground mine to allow the flow of air either into, or out of the mine.



## 2 INTRODUCTION

The Wafi-Golpu Project (the Project) Environmental Management Plan (EMP) comprises three modules:

1. Module 1 – Introduction and Overview
2. Module 2 – Construction
3. Module 3 – Operations

This Module 2 – Construction includes detailed discussion of the key areas of environmental management relevant to the construction phase of the Project (including above ground and underground developments), including:

- Air quality and greenhouse gas
- Noise and vibration
- Terrestrial flora and fauna
- Aquatic flora and fauna
- Water
- Soils, sediment and erosion control
- Waste rock and acid and metalliferous drainage (AMD)
- Marine ecology
- Hazardous materials
- Non-hazardous materials
- Weed and pest
- Rehabilitation
- Environmental incident response

The responsibilities and proposed role descriptions in this EMP are subject change and may be expanded or altered at any time during the Project.

## 2.1 Air Quality and Greenhouse Gas Management

### 2.1.1 Introduction

Construction activities have the potential to affect air quality by, for example, generation of dust, and gaseous and particulate emissions. Fuel combustion and waste incineration are the key sources of gaseous and particulate emissions.

The assessment of air quality impacts during construction of the Project indicated that predicted pollutant concentrations at sensitive receptors during construction would be below the air quality criteria adopted for the Project.

The majority of particulate emissions during construction in the Mine Area are predicted to be from dust created from haulage of material from borrow pits, the quarry and gravel extraction, haulage of material to the waste rock dumps, and from exhaust discharges from the declines. The predicted concentrations of PM<sub>2.5</sub>, PM<sub>10</sub> and total suspended particulate matter at sensitive receptors are below the adopted Project air quality criteria for both the maximum 24-hour and annual average concentrations. The predicted dust deposition rates from construction activities are also well below the air quality criteria at sensitive receptors and it is predicted that there will be no noticeable change in the rate of dust deposition due to construction at these locations.

The majority of combustion emissions during construction in the Mine Area will be from on-site diesel generators, used to provide power until the power generation facilities are operational. The predicted concentrations of sulphur dioxide (SO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>) and carbon monoxide (CO) at sensitive receptors during construction are well below the adopted Project air quality criteria.

### 2.1.2 Air Quality and Greenhouse Gas Management Plan

Table 2.1 sets out the proposed activities to manage air quality and greenhouse gas during construction phase of the Project.

The objectives of air quality and greenhouse gas management are to:

- Maintain acceptable ambient air quality and amenity at sensitive receptors
- Meet State of PNG greenhouse gas reporting requirements

Table 2.1: Proposed air quality and greenhouse gas management plan

Proposed Management Measures		
ID	Action	Responsibility
<b>General</b>		
AQ-01	Maintain site access roads.	Surface Construction Manager
AQ-02	Procure fit-for-purpose vehicles, plant and machinery, and regularly inspect and maintain in accordance with manufacturer recommendations.	Maintenance Superintendents
AQ-03	Apply appropriate vehicle speed limits on Project roads and tracks.	OH&S Manager
TE-03	Plan the area to be cleared to be the minimum required to undertake works safely.	Surface Construction Manager and Clearing Applicant
TE-04	Obtain approval from the WGJV Environment Department prior to clearing vegetation in defined areas of relevant mining leases	Surface Construction Manager and Clearing Applicant, Environment Personnel

GE-01	Train and induct Project personnel and contractors in environmental awareness, prior to commencing work on the Project.	Environment Manager and Human Resources and Training Manager
AQ-04	Apply dust suppression in the vicinity of sensitive receptors (e.g., villages, schools, churches), as required during extended dry periods.	Earthworks Contractor
<b>Vegetation Clearing</b>		
TE-06	Minimise the length of time that disturbed areas are exposed through planning progressive clearing and progressive rehabilitation of disturbed areas (unless areas are planned for additional disturbance at a later date).	Earthworks Contractor (at the direction of Environment Personnel)
<b>Earthworks</b>		
SE-03	Maintain erosion and sediment control structures by: <ul style="list-style-type: none"> <li>• Cleaning accumulated material from behind sediment fences and barriers, cut-off drains and diversion drains associated with temporary erosion control berms. Dispose of sediment appropriately;</li> <li>• Cleaning accumulated material from, and where required, dewatering sediment ponds. Dispose of sediment to an appropriate location. Treat water if required prior to discharge to meet PNG environment permit conditions.</li> <li>• Maintaining sediment fences or barriers as required.</li> </ul>	Earthworks Contractor
<b>Fire</b>		
AQ-05	Avoid burning cleared or standing vegetation, wherever practicable.	Surface Construction Manager and All Personnel and Contractors
AQ-06	Prohibit unauthorised lighting of fires by Project personnel and contractors.	All Personnel and Contractors
<b>Greenhouse gas</b>		
AQ-07	Maintain an inventory of greenhouse gas emissions and report in accordance with the State of PNG requirements.	Environment Manager
<b>Proposed Monitoring and Reporting</b>		
<b>Action</b>	<b>Frequency</b>	<b>Responsibility</b>
Annual reporting of GHG emissions from the on-site diesel generators.	Annually	Environment Personnel
Collect and analyse samples regularly from dust deposition gauges.	Quarterly	Environment Personnel
Monitor energy use and (estimated) greenhouse gas emissions.	Annually	Environment Manager
Conduct environmental inspections of works and worksites, including: <ul style="list-style-type: none"> <li>• A visual inspection of dust generation</li> <li>• Inspection of the erosion and sediment controls</li> <li>• Inspection of rehabilitated areas</li> </ul>	Monthly or as required	Work Area Superintendents
Submit results of monitoring to the Director of Conservation and Environment Protection Authority (CEPA) as required by the environment permit.	Annually	Environment Manager

## 2.2 Noise and Vibration Management

### 2.2.1 Introduction

Construction activities are predicted to generate noise and vibrations from earthmoving, vegetation clearing, equipment and machinery operation, vehicle movements, materials transport and construction works. Underground development works and borrow pit activities will also involve blasting.

Potential vibration impacts are associated with:

- Blasting vibration and airblast
- Non-blasting activities including rock breaking, heavy vehicle movement and compaction activities (vibratory rollers)

The maintenance of existing noise levels in the Project Area, through compliance with adopted criteria, was predicted at all sensitive receptors except for Ziriruk, Papas and Hekeng.

Noise levels are predicted to exceed the adopted night time criteria during construction under enhanced conditions at Ziriruk, Papas and Hekeng. Enhanced conditions consist of temperature inversions, which while having potential to occur up to 40% of the year at the Mine Area, are typically only during the early morning or evening (i.e., periods where the day time criterion is more applicable), and are not generally present for long periods. Hekeng is also predicted to experience exceedances of the adopted night time criteria under neutral conditions, prior to resettlement.

Generally, terrestrial fauna are predicted to avoid areas where very high noise levels (sufficient to cause injury or damage) occur. It is anticipated that noise levels in excess of 100 decibels (A weighted) (dBA), over extensive periods, would be required to cause physical damage or injury. It is unlikely that any terrestrial fauna would remain in an area affected by noise levels of this magnitude and the construction will not include plant and equipment capable of generating noise levels required to cause such damage, even in very close vicinity to the plant and equipment.

Proposed management measures to be followed to minimise the impacts of noise and vibration generated during construction are described below.

### 2.2.2 Noise and Vibration Management Plan

Table 2.2 sets out the proposed noise and vibration management plan for construction activities.

The objective of noise and vibration management is to manage potential impacts on sensitive receptors such as villages in accordance with regulatory requirements.

Table 2.2: Proposed Noise and vibration management plan

Proposed Management Measures		
ID	Action	Responsibility
<b>Pre-construction</b>		
NV-01	Where practicable provide advanced notice of high noise activities to local communities.	Community Affairs and Lands Manager and Surface Construction Manager

Proposed Management Measures		
ID	Action	Responsibility
NV-02	Train Project personnel and contractors in environmental awareness including noise related aspects.	Environment Manager and Human Resources and Training Manager
<b>Construction</b>		
NV-03	Maximise the distance between noisy plant items and noise sensitive receptors, where practicable.	Work Area Superintendents
<b>Earthworks</b>		
NV-04	Where practicable, avoid or minimise heavy vehicle traffic near villages during the night.	Surface Construction Manager
NV-05	Where practicable, limit the hours of operation of high noise or vibration activities, especially vehicles, plant and equipment operating near sensitive receptors.	Surface Construction Manager
NV-06	Where safe, minimise exhaust braking in the vicinity of villages.	Surface Construction Manager
AQ-01	Maintain site access roads.	Surface Construction Manager
NV-07	Limit machinery and vehicle movements, where possible, to defined work areas and designated roads.	All Personnel and Contractors
AQ-02	Procure fit-for-purpose vehicles, plant and machinery, and regularly inspect and maintain in accordance with manufacturer recommendations.	Maintenance Superintendents
AQ-03	Apply appropriate vehicle speed limits on Project roads and tracks.	OH&S Manager
<b>Blasting Activities (Underground and Surface)</b>		
NV-08	Optimise surface blast design to reduce noise and vibration, where safe and practicable.	Mining Manager and Surface Construction Manager
NV-09	Inform potentially affected communities of planned surface blasting events.	Community Affairs and Lands Manager
NV-10	Restrict surface blasting to daylight hours.	Mining Manager and Surface Construction Manager
Proposed Monitoring and Reporting		
Action	Frequency	Responsibility
Monitor noise levels in accordance with environment permit conditions at nominated locations.	As required by environment permit conditions	Environment Manager
Implement vibration monitoring where required to evaluate conformance with environment permit conditions and/or the adopted Project vibration guideline levels.	Event-based	Environment Manager
Monitoring of blasting activities may be required at sensitive receptors in the vicinity of blasting activities required for construction of the Infrastructure Corridor.	Event-based	Environment Manager
Submit results of monitoring to the Director of CEPA as required by the environment permit.	Annually or as required	Environment Manager

## 2.3 Terrestrial Flora and Fauna Management

### 2.3.1 Introduction

Construction activities will involve vegetation clearance and land disturbance. Potential impacts of these construction activities on terrestrial flora and fauna include:

- Habitat loss
- Habitat degradation
- Reduced abundance of plant and animal populations.

To manage potential impacts where vegetation clearance is unavoidable, the extent of clearing will be minimised.

Weed and pathogen management is addressed in Weed and Pest Management (Section 2.10), and the management of rehabilitation works is addressed in Rehabilitation (Section 2.11).

### 2.3.2 Terrestrial Flora and Fauna Management Plan

Table 2.3 sets out the proposed terrestrial flora and fauna management plan for the construction activities,

The objectives of terrestrial flora and fauna management are to:

- Protect native flora and fauna species, where practicable
- Minimise the extent of vegetation clearance and ground disturbance
- Minimise the introduction and/or spread of pest animals and plants
- Rehabilitate disturbed areas using native species of local provenance

Table 2.3: Proposed Terrestrial flora and fauna management plan

Proposed Management Measures		
ID	Action	Responsibility
<b>Pre-construction</b>		
TE-01	Undertake preconstruction ecological clearance surveys in high conservation value areas, including areas around the proposed re-settlement village locations.	Environment Manager
TE-02	Minimise the creation and extent of new access corridors in undisturbed catchments.	Surface Construction Manager
TE-03	Plan the area to be cleared to be the minimum required to undertake works safely.	Surface Construction Manager and Clearing Applicant
TE-04	Obtain approval from the WGJV Environment Department prior to clearing vegetation in defined areas of relevant mining leases.	Surface Construction Manager, Clearing Applicant and Environment Personnel
AQ-03	Apply appropriate vehicle speed limits on Project roads and tracks.	OH&S Manager
GE-01	Train and induct Project personnel and contractors in environmental awareness, prior to commencing work on the Project.	Environment Manager and Human Resources and Training Manager

Proposed Management Measures		
ID	Action	Responsibility
<b>Vegetation Clearing</b>		
TE-05	Demarcate areas to be protected with boundaries clearly communicated.	Surface Construction Manager and Earthworks Contractor
TE-06	Minimise the length of time that disturbed areas are exposed through planning progressive clearing and progressive rehabilitation of disturbed areas, unless areas are planned for additional disturbance at a later date.	Earthworks Contractor (at the direction of Environment Personnel)
TE-07	Minimise vegetation clearing by using previously disturbed or degraded areas (e.g., existing access tracks or disturbed kunai grasslands, co-location of linear infrastructure such as the concentrate pipeline, power lines and access roads) as a first preference.	Surface Construction Manager
TE-08	Manage vegetation clearing in accordance with WGJV procedure, Permit for Land Disturbance.	Environment Personnel
<b>Earthworks</b>		
RH-01	Salvage topsoil, seed bank and seedlings and use in rehabilitation of temporary work sites as soon as practicable to enhance potential for natural regeneration.	Earthworks Contractor (under direction from Surface Construction Manager)
TE-09	Check excavations and trenches daily for trapped animals.	Earthworks Contractor
<b>General</b>		
GE-02	Implement an access protocol for Project-controlled roads.	OH&S Manager
TE-10	Prohibit Project personnel and contractors from hunting, harassing, capturing and keeping wildlife or gathering, possessing or selling wildlife products.	All Personnel and Contractors
Proposed Monitoring and Reporting		
Action	Frequency	Responsibility
Monitor impact and control sites to assess potential effects of SO <sub>2</sub> .	Annually	Environment Manager
Report wildlife deaths resulting from Project activities and implement corrective actions if required.	As required	Environment Manager
Record and investigate any unauthorised or accidental clearing beyond demarcated boundaries. Implement corrective actions where required.	As required	Environment Manager
Submit results of monitoring to the Director of CEPA as required by environment permit.	Annually or as required	Environment Manager

## 2.4 Freshwater and Aquatic Flora and Fauna Management

### 2.4.1 Introduction

Construction activities have the potential to result in a range of impacts on freshwater quality, surface water and groundwater flow regimes, and aquatic flora and fauna.

Surface water resources also support a range of beneficial uses for communities, such as for domestic (e.g., drinking water, washing, cooking) and agricultural purposes, as well as for alluvial mining.

### 2.4.2 Freshwater and Aquatic Flora and Fauna Management Plan

Table 2.4 sets out the freshwater and aquatic flora and fauna management plan for the construction activities.

The objectives of freshwater and aquatic flora and fauna management are to:

- Limit changes to water quality, flow regimes and aquatic habitats
- Minimise impact on water users downstream of the construction site

Table 2.4: Freshwater and aquatic flora and fauna management plan

Proposed Management Measures		
ID	Action	Responsibility
<b>Pre-construction</b>		
WA-01	Inform local villages downstream of works during construction that may affect surface water quality.	Community Affairs and Lands Manager
WA-02	Install diversion channels prior to clearing in-stream habitat and divert flows around in-stream work areas.	Surface Construction Manager
WA-03	Protect watercourse channel stability by applying measures such as limiting in-stream and bank disturbance, buffer zones and avoiding clearance of vegetation, where practicable.	Earthworks Contractor (under direction from Environment Manager)
GE-01	Train and induct Project personnel and contractors in environmental awareness, prior to commencing work on the Project.	Environment Manager and Human Resources and Training Manager
<b>Vegetation Clearing</b>		
TE-06	Minimise the length of time that disturbed areas are exposed through planning progressive clearing and progressive rehabilitation of disturbed areas, unless areas are planned for additional disturbance at a later date.	Earthworks Contractor at the direction of Environment Personnel)
WA-04	Avoid depositing stripped topsoil or cleared vegetation into watercourses or surface water drainage features where possible.	Earthworks Contractor
<b>Earthworks</b>		
WA-05	Install and maintain cobblestone protection at small watercourse fords to minimise fine sediment suspension and transport.	Earthworks Contractor



Proposed Management Measures		
ID	Action	Responsibility
WR-03	Actively manage PAF materials and control runoff and leachate from areas containing PAF material including: <ul style="list-style-type: none"> <li>Selective placement of PAF and NAF material in the waste rock dump in accordance with the waste rock dump design</li> <li>Diversion of clean surface water around the site</li> <li>Interception of leachate from the site and applying appropriate treatment methods if required prior to discharge</li> <li>Treatment of contaminated runoff and leachate prior to discharge to meet environment permit conditions</li> </ul>	Surface Construction Manager and Environment Manager
RH-09	Decommission and revegetate temporary infrastructure footprints and access routes and restore disturbed primary drainage paths, where practicable.	Environment Manager
Fuel and Chemical Storage and Handling		
WA-06	Service vehicles in designated areas unless emergency breakdown repairs are required.	All Personnel and Contractors
HZ-04	Store and handle hazardous materials including fuels, oils and chemicals in accordance with AS1940-2017: The storage and handling of flammable and combustible liquids.	Surface Construction Manager and Work Area Superintendents
HZ-01	Maintain spill response kits (with portable spill containment and clean up equipment) at each work area where hazardous materials are stored and used.	Emergency Response Superintendent
WA-07	Install and maintain oil-water separation facilities where required (e.g., at vehicle maintenance workshops). Recover and appropriately dispose of trapped hydrocarbons and hazardous materials to approved facilities.	Maintenance Superintendents
AQ-02	Procure fit-for-purpose vehicles, plant and machinery, and regularly inspect and maintain them in accordance with manufacturer recommendations.	Maintenance Superintendents
WA-08	Enforce washing of vehicles, plant and equipment in defined areas outside of watercourses.	All Personnel and Contractors
General		
WA-09	Maintain hydraulic connectivity along linear infrastructure corridors for pipelines and roads (e.g. install culverts and drains where required).	Surface Construction Manager
WA-10	Treat sewage in accordance with environment permit conditions.	Surface Construction Manager and Environment personnel
WA-11	Divert 'clean' rainwater around the Port Facilities Area into existing Port of Lae stormwater runoff infrastructure, keeping it separated from potentially contaminated runoff.	Surface Construction Manager
WA-12	Reduce potential for scouring, erosion and sediment transport, through the installation of energy dissipation structures where required for discharges to the receiving environment.	Surface Construction Manager
Water Quality Management		
WA-13	Manage discharge water quality and quantity to meet environment permit conditions at specified compliance points.	Earthworks Contractor and Environment Manager
Gravel Extraction		

Proposed Management Measures		
ID	Action	Responsibility
WA-14	Extract material from WGJV approved sites only.	All Personnel and Contractors
Works in or near a Watercourse		
WA-15	Inspect hydraulic, fuel and lubricating systems on machinery for leaks before using in watercourses.	Surface Construction Manager and Earthworks Contractor
WA-16	Install and maintain sediment control measures where required such as drainage diversion into surrounding vegetation, rip-rap aprons, sediment control ponds and sediment fences.	Earthworks Contractor and Environment Manager
Underground Developments		
WA-17	Monitor potential impacts on groundwater related to mining activities in accordance with environment permits and if potential impacts are measured, implement remedial actions.	Surface Construction Manager, Mining Manager and Environment Manager
WA-18	Regularly monitor for changes in surface water or groundwater quality at defined locations in accordance with environment permits and apply remedial actions where required if impacts are detected.	Surface Construction Manager, Mining Manager and Environment Personnel
WA-19	Develop a site water balance to quantify water extraction and discharge.	Mining Manager and Environment Manager
Proposed Monitoring and Reporting		
Action	Frequency	Responsibility
Monitor surface water and sediment quality, including specific details of parameters to be monitored, frequency and locations, and which also meets the requirements of the environment permit.	As required by the environment permit	Environment Manager
Undertake routine inspections of aquatic habitats near construction areas.	Quarterly	Environment Manager
Monitor the combined effects of potential water quality impacts on aquatic ecology by targeted sampling and assessment of aquatic flora and fauna in defined watercourses within the construction area.	Annually	Environment Manager
Regularly update a groundwater model for the Project.	Annually	Engineering Manager
Monitor water extracted from underground workings and assess quality for direct discharge or whether pre-discharge water treatment is required to meet environment permit criteria.	Annual reporting	Environment Manager
Install gauging stations where required to monitor water level and flow for reporting in accordance with environmental permits.	Annual reporting	Environment Manager
Monitor impacts to vegetation and surface water flows within the construction area due to potential water table changes.	Annual reporting	Environment Manager
Monitor weeds and/or invasive species of flora and fauna	Annual reporting	Environment Manager

Proposed Monitoring and Reporting		
Action	Frequency	Responsibility
Report water quality results to local communities.	Annually	Community Affairs and Lands Manager
Submit results of monitoring to the Director of CEPA as required by the environment permit.	Annually or as required	Environment Manager

## 2.5 Soils, Sediment and Erosion Management

### 2.5.1 Introduction

Construction activities will include vegetation clearance and earthworks. Exposure, disturbance and stockpiling of soils and spoil all have the potential to contribute significantly to sediment-laden runoff (and mobilising metals associated with sediment) from work sites to the environment.

Additionally, acid sulphate soils (ASS) and potential acid sulphate soils (PASS) may occur within vicinity of the Port Facilities Area as the soils in this location are known to have high sulphide content. These soils may also occur in other low-lying areas and floodplains of the Watut and Markham rivers traversed by the Infrastructure Corridor.

Potential impacts associated with the disturbance of ASS and PASS, include:

- Release of sulphuric acid (H<sub>2</sub>SO<sub>4</sub>) from the soil with elevated concentrations of iron and other heavy metals
- Acid reacting with, and affecting the integrity of, construction materials (e.g., rock, fill, gravels)
- Downstream impacts of acidic runoff and dissolved metals such as vegetation inhibition, seepage of acidic runoff into groundwater and surface watercourses, mortality of fish and other aquatic organism, and degradation or failure of concrete and steel structures

During the Project's construction phase, mobilised sediments from disturbed areas are expected to reach downstream as a consequence of rainfall driven erosion. This may lead to localised direct loss and degradation of aquatic habitats; loss of, or degradation to, aquatic plants, macroinvertebrates and animals; altered hydrology; and altered water quality (including increased suspended solids and turbidity and concentrations of metals and metalloids) in downstream watercourses.

The key subcatchments predicted to be impacted by the Project include Boganchong and Womul creeks and the lower Bavaga and Wafi rivers. On a sub-local scale (2 to 4km), large but short-term effects on these subcatchments are predicted as a result of loss of aquatic habitat, increased sediment loads, permanent modification to the natural flow regimes and increased TSS and turbidity due to construction of Project infrastructure.

Management of revegetation and rehabilitation is addressed in Rehabilitation Management (Section 2.11). The waste rock spoil generated by the construction of underground mine components and facilities is detailed in Section 2.6.

### 2.5.2 Soils, Sediment and Erosion Management

Table 2.5 sets out the soils, sediment and erosion management plan for the construction activities.

The objectives of soils, sediment and erosion management are to:

- Reduce erosion of Project-disturbed areas and sedimentation of watercourses
- Reduce the level of adverse impacts from disturbance of acid sulphate soils
- Protect downstream beneficial values of surface water and water resources

Table 2.5: Soils, sediment and erosion management plan

Proposed Management Measures		
ID	Action	Responsibility
<b>Erosion and Sediment Control</b>		
SE-01	Install erosion and sediment control structures to reduce fugitive sediment reporting to watercourses and surface water features.	Surface Construction Manager and Environment Personnel
SE-02	Construct erosion and sediment control structures prior to construction at each location.	Surface Construction Manager and Environment Personnel
SE-03	Maintain erosion and sediment control structures by: <ul style="list-style-type: none"> <li>• Cleaning accumulated material from behind sediment fences and barriers, cut-off drains and diversion drains associated with temporary erosion control berms. Dispose of sediment appropriately;</li> <li>• Cleaning accumulated material from, and where required, dewatering sediment ponds. Dispose of sediment to an appropriate location. Treat water if required prior to discharge to meet PNG environment permit conditions.</li> <li>• Maintain sediment fences or barriers as required.</li> </ul>	Surface Construction Manager and Earthworks Contractor
SE-04	Stabilise exposed areas susceptible to erosion using appropriate methods. For example, covering with vegetation debris, jute netting, geogrid matting, mulching or similar.	Surface Construction Manager
SE-05	Stabilise large landslips, slumping, washouts, undercuts and other instability.	Surface Construction Manager
<b>Pre-construction</b>		
SE-06	Undertake preconstruction sampling and mapping of ASS/PASS in high risk areas (e.g. oxbow lakes, mangroves) and map extent of confirmed ASS/PASS.	Environment Manager
GE-01	Train and induct Project personnel and contractors in environmental awareness, prior to commencing work on the Project.	Environment Manager and Human Resources and Training Manager
<b>Vegetation Clearing</b>		
SE-07	Manage Project-related disturbance and apply procedures to control access to undisturbed areas.	Surface Construction Manager
TE-04	Obtain approval from the WGJV Environment Department prior to clearing vegetation in defined areas of relevant mining leases.	Surface Construction Manager, Clearing Applicant and Environment Personnel
TE-06	Minimise the length of time that disturbed areas are exposed through planning progressive clearing and progressive rehabilitation of disturbed areas, unless areas are planned for additional disturbance at a later date.	Earthworks Contractor (at the direction of Environment Personnel)

Proposed Management Measures		
ID	Action	Responsibility
SE-08	Minimise the amount of vegetation removal on steep slopes.	Surface Construction Manager
<b>General</b>		
HZ-04	Store and handle hazardous materials including fuels, oils and chemicals in accordance with AS1940-2017: The storage and handling of flammable and combustible liquids.	Surface Construction Manager, Work Area Superintendents and Earthworks Contractor
HZ-01	Maintain spill response kits (with portable spill containment and clean up equipment) at each work area where hazardous materials are stored and used.	Emergency Response Superintendent
HZ-13	Maintain the minimum required quantities of chemical, fuel, and oil containers at worksites and return them to storage or disposal areas when not in use.	Work Area Superintendents
SE-09	Handle, store, treat, manage and dispose of ASS in accordance with the Queensland Acid Sulphate Soil Technical Manual: Soil Management Guidelines (2014).	Environment Manager
SE-10	Design and construct batter and embankment slopes to reduce the risk of failure and erosion. This may include methods such as: <ul style="list-style-type: none"> <li>• Benching at intervals</li> <li>• Shotcreting</li> <li>• Installing flow-dissipating material at intervals</li> <li>• Revegetation</li> <li>• Rock armouring watercourses and drainage channels</li> <li>• Diverting clean water runoff away from exposed surfaces</li> </ul>	Earthworks Contractor and Surface Construction Manager
<b>Pipelines</b>		
SE-11	Backfill pipeline trenches to minimise ponding.	Earthworks Contractor
<b>Watercourses</b>		
SE-12	Limit the amount of sediment entering watercourses at crossings (e.g. bridges, roads and pipelines) by installing and maintaining appropriate sediment control measures that may include drainage diversion into surrounding vegetation, rip-rap aprons, sediment control ponds and sediment fences.	Earthworks Contractor and Environment Manager
SE-13	Monitor stream banks downstream of discharge points and sediment basin spillways and manage scour and erosion where required.	Surface Construction Manager
<b>Stockpiles</b>		
SE-14	Divert runoff from soil stockpiles and direct it to sediment ponds where practicable prior to release to the environment based on size of stockpile and environmental risk.	Surface Construction Manager and Earthworks Contractor
<b>Contaminated Soils</b>		
HZ-06	Treat and dispose or manage contaminated soils based on the type and scale of contamination.	Environment Manager
<b>Slopes</b>		
SE-15	Report any large landslip as an incident for remediation where required.	All Personnel and Contractors
<b>Topsoil</b>		

Proposed Management Measures		
ID	Action	Responsibility
SE-16	Strip and stockpile topsoil and spoil separately in approved locations.	Earthworks Contractor
SE-17	Clearly sign stockpiles to identify that topsoil must remain separated from subsoils.	Surface Construction Manager
SE-18	Avoid compaction of topsoil stockpiles by restricting vehicle, plant and equipment movement over topsoil stockpiles.	Earthworks Contractor
Proposed Monitoring and Reporting		
Action	Frequency	Responsibility
Conduct routine inspection of erosion and sediment control devices to ensure they have been installed and maintained correctly and in accordance with this management plan.	Quarterly	Surface Construction Manager
Conduct routine inspections of topsoil and spoil stockpiles to ensure they are managed in compliance with this management plan.	Quarterly	Surface Construction Manager
Report potential damage to sediment ponds from erosion or other processes as an environmental incident.	Event based	All Personnel and Contractors
Undertake inspections of erosion and sediment control structures prior to and following prolonged heavy rainfall or storm events, and remove sediment build-up and blockages from drains and culverts.	Quarterly/ Event based	Surface Construction Manager and Environment Personnel
Undertake routine monitoring of turbidity in watercourses downstream of construction activities in accordance with the environment permit conditions.	As required	Environment Manager
Undertake regular liaison with local communities regarding construction activities and potential levels of environmental impacts in accordance with EIS predictions.	Quarterly or as required	Community Affairs and Lands Manager
Submit results of monitoring to the Director of CEPA as required by the environment permit.	Annually or as required	Environment Manager

## 2.6 Waste Rock and Acid and Metalliferous Drainage Management

### 2.6.1 Introduction

The waste rock dumps are designed to serve as the disposal site for non-acid forming (NAF) and PAF waste rock generated from the development of the declines.

Non-acid forming material will predominantly be used in the development of the waste rock dumps and other facilities. Potentially acid forming waste rock will be contained within engineered cells within the waste rock dumps to prevent acid generation.

Potential impacts arising from the exposure of acid-forming rock during construction include:

- Seepage of acid and metalliferous drainage (AMD) from PAF rock in the waste rock dumps into the surrounding environment and potential loss of aquatic and riparian vegetation
- Acidification of surface water and groundwater from AMD, potentially leading to leaching and mobilisation of heavy metals into the surrounding environment as well direct impacts due to low pH and elevated salinity

The waste rock dumps will require ongoing management during construction.

Rehabilitation management is described further in Section 2.11. Water Management is described further in Section 2.4.

## 2.6.2 Waste Rock and Acid and Metalliferous Drainage Management Plan

Table 2.6 sets out the waste rock management plan for the construction activities,

The objectives of waste rock and AMD management are to:

- Prevent the formation of AMD and offsite impacts from AMD as far as reasonably practicable
- Establish stable waste rock landforms that minimise long-term environmental impacts
- Minimise environmental impacts arising from the mining, storage and disposal of waste rock
- Manage and mitigate related impacts on land use, water use and environmental values

Table 2.6: Waste rock and AMD management plan

Proposed Management Measures		
ID	Action	Responsibility
<b>Pre-construction</b>		
GE-01	Train and induct Project personnel and contractors in environmental awareness, prior to commencing work on the Project.	Environment Manager and Human Resources and Training Manager
<b>Waste Rock Dump</b>		
WR-01	Classify excavated rock material as either PAF or NAF	Mining Manager, Surface Construction Manager and Environment Manager
WR-02	Dispose of PAF and NAF material in accordance with the mine plan and approved designs.	Mining Manager, Surface Construction Manager and Environment Manager
WR-03	Actively manage PAF materials and control runoff and potential leachate from areas containing PAF material. For example: <ul style="list-style-type: none"> <li>• Selective placement of PAF and NAF material in the waste rock dump in accordance with the waste rock dump design</li> <li>• Diversion of clean surface water where required</li> <li>• Interception of potential leachate from the site and applying appropriate treatment methods if required prior to discharge</li> <li>• Treat contaminated runoff and leachate if required prior to discharge to meet environment permit conditions</li> </ul>	Surface Construction Manager and Environment Manager
WR-04	Use a low permeability liner such as clay or NAF rock for waste rock dump basal layer.	Surface Construction Manager
WR-05	Install and maintain a drainage and seepage collection system on PAF cells.	Surface Construction Manager and Environment personnel
WR-06	Place and compact PAF material in designated cells to minimise oxidation of PAF material.	Surface Construction Manager
WR-07	Cap PAF cells to prevent oxidisation of PAF material in accordance with the waste rock dump design.	Surface Construction Manager
<b>Proposed Monitoring and Reporting</b>		

Proposed Management Measures		
ID	Action	Responsibility
Action	Frequency	Responsibility
Monitor surface water at key locations and collect samples for analysis in accordance with environment permit requirements. For example: <ul style="list-style-type: none"> <li>Weekly – Flow, pH, electrical conductivity (EC), total dissolved solids (TDS) and temperature (done in field), alkalinity, acidity, sulphate, calcium, aluminium, antimony, arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver and zinc</li> </ul>	Weekly/ As required	Environment Manager
Analyse seepage and surface side drain monitoring results to allow early AMD identification associated with the operational PAF cell.	Monthly	Environment Manager
Where monitoring of waste rock dumps indicates AMD, investigate opportunities to remediate in situ or reprocess stockpiled material through process plant once online.	As required	Surface Construction Manager
Submit results of monitoring to the Director of CEPA as required by the environment permit.	Annually or as required	Environment Manager

## 2.7 Marine Ecology Management

### 2.7.1 Introduction

Construction of facilities in the Coastal Area has the potential to result in adverse impacts on marine water and sediment quality from:

- Uncontrolled release of solid and liquid waste products from facility construction
- Pollutants released via stormwater runoff
- Increased localised air emissions (dust and exhaust) from vehicle and machinery activity
- Increased noise levels during construction activities
- Spills of hazardous materials, both from on land storage and containment areas, or when working in and above water
- Marine fauna boat strike
- Introduction of marine pests

Project activities are predicted to have little impact on the ecology of the marine environment. Construction of the Outfall Area is predicted to result in temporary disturbance to a small area, a temporary increase of suspended sediment in nearshore waters, and intermittent and short-term emissions of noise. At the Outfall Area, impacts to nearshore marine fauna and habitats will be short term (i.e., in most cases limited to several days but over a construction period of 11 months) with the environment likely to return to its original condition following construction. Potential disturbance to the Critically Endangered west Pacific leatherback turtle (*Dermochelys coriacea*) will need to be managed during trenching across the beach at the Outfall Area. Although these turtles prefer to nest on the beaches more than 15km to the south of Lae, small numbers may nest near the Outfall Area during the construction period.

Management measures specific to marine ecology are described below. Management of hazardous and non-hazardous material and waste products is described further in



sections 2.8 and 2.9. Air quality and noise management are described further in sections 2.1 and 2.2.

### 2.7.2 Marine Ecology Management Plan

Table 2.7 sets out the marine ecology management plan for the construction activities, environment protection objectives, KPIs, management measures, responsibility for implementation of management measures and monitoring and reporting.

The objectives of marine ecology management are to:

- Protect marine flora and fauna species, where practicable
- Minimise the introduction and/or spread of pest species
- Minimise the extent of marine habitat disturbance

Table 2.7: Marine ecology management plan

Proposed Management Measures		
ID	Action	Responsibility
<b>Pre-construction</b>		
GE-01	Train and induct Project personnel and contractors in environmental awareness, prior to commencing work on the Project.	Environment Manager and Human Resources and Training Manager
<b>Nearshore marine habitat</b>		
ME-01	Reinstate trenched areas as soon as practicable after completion of trenching.	Environment personnel
ME-02	Consult with a suitable local authority and define actions for protection of leatherback turtle nesting during shoreline construction. For example, install fences around turtle nests between Wagang and Busu River, where a nest is identified during shoreline construction within the nesting season (i.e., November to March).	Surface Construction Manager and Environment personnel
<b>Disturbance to fauna</b>		
ME-03	Aim to direct lighting installed for Project vessels and facilities at the Outfall Area toward the shore based facilities to meet minimum requirements for safety and security (and reduce light directed toward potential turtle nesting areas).	Surface Construction Manager
ME-04	Visually monitor for the presence of turtles and nests during construction and, if they are observed, record their location, avoid them where practicable and contact the Project environmental team for guidance.	Construction personnel
ME-05	If a west Pacific leatherback turtle is present within an area about to be disturbed by the Project, suspend construction until the turtle moves away.	Surface Construction Manager, Environment personnel and Work Area Superintendents
ME-06	Employ soft start (or ramp up) procedures during construction in the nearshore marine environment (where practicable) to minimise startling of turtles or other marine fauna from underwater noise associated with trenching or other loud disturbing activities.	Surface Construction Manager, Environment personnel and Work Area Superintendents
<b>Waste discharge and spills</b>		

Proposed Management Measures		
ID	Action	Responsibility
HZ-04	Store and handle hazardous materials including fuels, oils and chemicals in accordance with AS1940-2017: The storage and handling of flammable and combustible liquids.	Surface Construction Manager, Work Area Superintendents and Earthworks Contractor
HZ-01	Maintain spill response kits (with portable spill containment and clean up equipment) at each work area where hazardous materials are stored and used.	Emergency Response Superintendent
HZ-13	Maintain the minimum required quantities of chemical, fuel, and oil containers at worksites and return them to storage or disposal areas when not in use.	Work Area Superintendents
IR-05	Conduct regular drills to practice timely and effective emergency and spill response.	Emergency Response Superintendent
Offshore construction		
WP-12	Develop and implement a quarantine management plan, which will include requirements for contractor vessels to comply with PNG and relevant International Maritime Organization guidelines and standards including ballasting and hull-cleaning and antifouling requirements.	Surface Construction Manager
ME-07	Operate offshore construction vessels to: <ul style="list-style-type: none"> <li>• Maintain appropriate speed limits to minimise the likelihood of marine fauna boat strike</li> <li>• Maintain a look out for large marine fauna (e.g., whales/turtles/dolphins, etc.) within 100m of the vessel</li> <li>• Reduce speed and/or temporarily suspend vessel operations if vessel approached by marine fauna</li> <li>• Record contacts with large marine fauna</li> <li>• Report sightings and contacts to responsible authority on request</li> </ul>	Surface Construction Manager
Proposed Monitoring and Reporting		
Action	Frequency	Responsibility
Complete baseline monitoring of nearshore water quality, and spatial and temporal changes in biological communities (plankton, micronekton and benthic communities) prior to construction, and continue validation monitoring thereafter.	Risk based monitoring ranging from monthly to annual depending on the specific parameter	Environment Manager
Prior to operations, conduct oceanographic profiling (in addition to the studies completed during the EIS) to ensure that the base of the surface mixed layer remains above the DSTP outfall depth.	Monthly	Environment Manager
Prior to operations, monitor tissue metal and metalloid burdens in deep-slope and pelagic fish (in addition to the studies completed during the EIS) that have the potential to be caught and consumed by local people. Continue sampling of deep-slope fish species for tissue metal and metalloid concentrations prior to DSTP start up and continue during operations to determine the presence of bioaccumulation and/or biomagnification of tailings contaminants.	Annually	Environment Manager
Undertake routine inspections for potential changes to nearshore marine habitats at and adjacent to construction areas.	Quarterly	Environment Manager

Proposed Management Measures		
ID	Action	Responsibility
	Monitor nearshore marine water quality and sediment quality, in accordance with environment permits.	As required by the environment permit Environment Manager
	Visually monitor for the presence of west Pacific leatherback turtles on the beach during construction of the shoreline pipeline crossing at the Outfall Area and record any sightings and avoid interaction where possible.	Ongoing during shoreline pipeline crossing construction Environment personnel
	Submit results of monitoring to the Director of CEPA as required by the environment permit.	Annually or as required Environment Manager

## 2.8 Hazardous Materials Management

### 2.8.1 Introduction

Construction activities will require the use of hazardous materials, such as fuels, oils, lubricants, hydraulic fluids and solvents.

This hazardous materials management plan details procedures to be followed for the safe handling, transport, transfer and storage of hazardous materials during construction and for disposal of hazardous wastes. It also provides procedures for the prevention of hazardous material spills.

The management of non-hazardous materials is addressed separately in Section 2.9.

### 2.8.2 Hazardous Materials Management Plan

Table 2.8 sets out the hazardous materials management plan for the construction activities,

The objectives of hazardous materials management are to:

- Ensure hazardous materials are identified, handled, stored, transferred, transported and disposed of in an environmentally responsible manner
- Minimise the risk of spills and/or releases of hazardous materials
- Minimise environmental impacts in the case of a spill or release

Table 2.8: Hazardous material management plan

Proposed Management Measures		
ID	Action	Responsibility
<b>Pre-construction</b>		
HZ-01	Maintain spill response kits (with portable spill containment and clean up equipment) at each work area where hazardous materials are stored and used.	Emergency Response Superintendent
HZ-02	Make available copies of relevant MSDS where hazardous materials are stored or used.	OH&S Manager
GE-01	Train and induct Project personnel and contractors in environmental awareness, prior to commencing work on the Project.	Environment Manager and Human Resources and Training Manager
<b>Storage, Handling and Transportation</b>		
HZ-03	Apply appropriate containment for hazardous materials when servicing mobile equipment away from designated workshop areas.	Maintenance Superintendents

Proposed Management Measures		
ID	Action	Responsibility
HZ-04	Store and handle hazardous materials including fuels, oils and chemicals in accordance with AS 1940-2017: The storage and handling of flammable and combustible liquids.	Surface Construction Manager, Work Area Superintendents and Earthworks Contractor
HZ-05	Transport and dispose of dangerous goods and hazardous materials including wastes in accordance with legislative requirements to nominated handling and/or disposal facilities. Verify that transport providers are trained in safe transport and emergency and spill response procedures.	Logistics Superintendents
HZ-06	Treat and dispose or manage contaminated soils based on the type and scale of contamination.	Environment Manager
HZ-07	Display appropriate warning signs where hazardous materials are stored or while being transported.	OH&S Manager and All Personnel and Contractors
HZ-08	When shipping hazardous materials: <ul style="list-style-type: none"> <li>• Clearly label containers with type and quantity of contents</li> <li>• Include MSDS for each hazardous material</li> <li>• Include shipping document with supplier/shipper and inventory of hazardous materials</li> </ul>	Logistics Superintendents
HZ-09	Select packaging of the appropriate volume, nature and integrity for the type and quantity of hazardous material being transported and for the mode of transport.	Logistics Superintendents
HZ-10	Arrange collection and safe transport of hazardous materials including fuels, oils, chemicals, hazardous waste, solvents, paints and solid chemical waste (e.g., batteries) in secure containers to designated waste management areas for treatment and/or disposal.	Logistics Superintendents
HZ-11	Store, handle, apply and dispose of all herbicides in accordance with the relevant MSDS sheet.	Logistics Superintendents and Environment Personnel
<b>Explosives</b>		
HZ-12	Store explosive materials in accordance with regulatory requirements.	Surface Construction Manager and Environment personnel
<b>Fuel Storage and Refuelling</b>		
HZ-13	Maintain the minimum required quantities of chemical, fuel, and oil containers at worksites and return them to storage or disposal areas when not in use.	Surface Construction Manager
HZ-14	When refuelling, take measures to prevent spills by using appropriate hoses, pumps, spouts and funnels.	All Personnel and Contractors
<b>Spill Preparedness and Response</b>		
HZ-15	Train personnel and contractors in fuel transfer and filling operations, and spill prevention and response procedures.	Surface Construction Manager and Human Resources and Training Manager
IR-05	Conduct regular drills to practice timely and effective emergency and spill response.	Emergency Response Superintendent

Proposed Management Measures		
ID	Action	Responsibility
<b>General</b>		
HZ-16	Report leaks or spills and manage in accordance with emergency and spill response procedures.	All Personnel and Contractors
AQ-02	Procure fit-for-purpose vehicles, plant and machinery, and regularly inspect and maintain in accordance with manufacturer recommendations.	Maintenance Superintendents
HZ-17	Do not store incompatible materials together. Avoid reuse of tanks for different products without first ensuring material compatibility.	Logistics Superintendents (under instruction from OH&S Manager)
HZ-18	Take appropriate measures to prevent ignition sources within flammable materials storage and handling areas.	OH&S Manager
HZ-19	Capture and treat if required runoff from fuel and hazardous materials storage areas before discharge to the receiving environment.	Maintenance Superintendents
Proposed Monitoring and Reporting		
Action	Frequency	Responsibility
Monitor and inspect hazardous materials storage locations to check the condition of storage containers and vessels, check compliance with relevant MSDS storage recommendations, and ensure appropriate labelling of containers and vessels and adequate house-keeping.	Monthly	OH&S Manager
Regularly inspect work areas for compliance with hazardous materials management procedures.	Quarterly	OH&S Manager
Inspect spill response kits so they remain well maintained and stocked.	Quarterly	Emergency Response Superintendent
Maintain a registry of dangerous goods and hazardous substances used by the Project.	Ongoing	OH&S Manager
Undertake regular inspections of infrastructure (e.g. bund walls, settlement pond, storage sheds etc.) that support the application of the Hazardous Material management measures.	Quarterly	Environment Manager
Inspect construction sites to identify contaminated soil that requires remediation. Transport contaminated soil to remediation sites for treatment.	Quarterly	Surface Construction Manager
Submit results of monitoring to the Director of CEPA as required by the environment permit.	Annually or as required	Environment Manager

## 2.9 Non-Hazardous Materials

### 2.9.1 Introduction

Construction activities will use non-hazardous materials and generate non-hazardous wastes. The non-hazardous waste streams that can be expected to be produced during construction include:

- Construction waste, including excess fill materials (not addressed in this section), scrap wood, plastic, scrap metal, drums and concrete

- General waste from offices, accommodation facilities and kitchens, including organic waste (e.g., food scraps)

Planning for waste management associated with construction has considered the waste management hierarchy with a view to minimising the volume of waste materials for disposal by prioritising waste avoidance and assessing reduction, reuse and recycling options before disposal.

The management measures described below are to be followed for the safe handling, transport, storage and disposal of non-hazardous material.

The management of hazardous materials is covered separately in hazardous materials management (Section 2.8).

### 2.9.2 Non-Hazardous Materials Management Plan

Table 2.9 sets out the non-hazardous materials management plan for the construction activities,

The objectives of non-hazardous materials management are to:

- Minimise waste generation
- Manage waste in a way that minimises adverse impacts on the environment
- Promote efficient use and conservation of resources
- Prevent the attraction or foraging of feral and/or native animals

Table 2.9: Non-hazardous material management plan

Proposed Management Measures		
ID	Action	Responsibility
<b>Pre-construction</b>		
NZ-01	Design and operate waste landfills and incineration infrastructure in accordance with the PNG Environmental Code of Practice for Mining and Environmental Code of Practice for Sanitary Landfill Sites, as the minimum standard.	Operations Services Manager
NZ-02	Isolate landfill drainage from adjoining watercourses and groundwater by employing design options such as lining with HDPE, diversion drains, or turkey's nest design, where practicable.	Surface Construction Manager and Work Area Superintendents
GE-01	Train and induct Project personnel and contractors in environmental awareness, prior to commencing work on the Project.	Environment Manager and Human Resources and Training Manager
<b>Construction</b>		
NZ-03	Manage non-hazardous waste by: <ul style="list-style-type: none"> <li>• Implementing a waste management hierarchy</li> <li>• Segregating and storing waste in labelled bins</li> <li>• Covering or protecting waste from dispersal by wind or water</li> <li>• Transporting and disposing of waste at approved handling and disposal facilities</li> <li>• Regularly transporting waste to approved handling and disposal facilities to avoid waste stockpiling at work sites and Project facilities</li> <li>• Maintaining an inventory of waste disposal.</li> </ul>	Work Area Superintendents
NZ-04	Apply inventory control during construction to reduce the generation of waste.	Operations Services Managers

Proposed Management Measures		
ID	Action	Responsibility
Proposed Monitoring and Reporting		
Action	Frequency	Responsibility
Inspect work sites regularly to assess effectiveness of waste management processes in accordance with this management plan.	Monthly	Work Area Superintendents
Monitor waste discharges in accordance with the environment permit requirements.	As prescribed by the environment permit	Environment Manager
Undertake compliance audits as required.	Annually or as required	Environment Manager
Submit results of monitoring to the Director of CEPA as required by the environment permit.	Annually or as required	Environment Manager

## 2.10 Weed and Pest Management

### 2.10.1 Introduction

During the construction phase of the Project, earthworks, vehicle and personnel movements have the potential to introduce and spread existing weeds, pest animals and plant pathogens (invasive alien species) to and from work areas.

The most effective measure for preventing the introduction of weeds, pests and pathogens is the implementation of good quarantine and hygiene practices. This section has been developed to provide procedures that should be followed during the construction phase to prevent the introduction and spread of weeds and pathogens.

### 2.10.2 Weed and Pest Management Plan

Table 2.10 sets out the weed and pest management plan for the construction activities, incorporating management measures, and monitoring and reporting.

The objective of weed and pest management is to prevent the introduction and spread of weeds, plant pathogens and pest fauna into the construction area as a result of construction activities.

Table 2.10: Weed and pest management plan

Proposed Management Measures		
ID	Action	Responsibility
Pre-construction		
WP-01	Prohibit the cultivation of invasive exotic species on Project sites and discourage the translocation of exotic fish species.	Surface Construction Manager
WP-02	Implement risk-based control of weeds and plant pathogens, for example: <ul style="list-style-type: none"> <li>• Weed and plant pathogen identification manual for contractors and personnel, and training in its use</li> <li>• Visual inspection of vehicles, plant and equipment for soil, seeds and weed material</li> <li>• Risk-based wash down of vehicles, plant and equipment before arrival at site</li> </ul>	Surface Construction Manager and Environment personnel

Proposed Management Measures		
ID	Action	Responsibility
	<ul style="list-style-type: none"> <li>Removal of weeds using appropriate methods</li> </ul>	
WP-03	Conduct pre-construction surveys of weeds and potential vegetation dieback, and record the location and extent of infestations for inclusion in GIS database.	Environment Personnel
WP-04	Inspect new disturbance areas and surrounds for evidence of weed infestations and vegetation dieback and manage identified infestations.	Environment Personnel
GE-01	Train and induct Project personnel and contractors in environmental awareness, prior to commencing work on the Project.	Environment Manager and Human Resources and Training Manager
<b>General</b>		
GE-02	Implement an access protocol for Project-controlled roads.	OH&S Manager
WP-05	Select herbicides (if required) that: <ul style="list-style-type: none"> <li>Are low in toxicity to and have minimal effects on non-target species and the environment</li> <li>Are known to be effective against target species</li> <li>Package herbicides in safe containers, clearly labelled for safe and proper use, and have been manufactured by an appropriately licensed organisation. Adhere to environmental and safety requirements including instructions on product labels and MSDS sheets.</li> </ul>	Environment Personnel
WP-06	Monitor and manage washdown areas to avoid weed establishment.	Surface Construction Manager, Environment personnel and Work Area Superintendents
WP-07	Do not use known or potential weed species in rehabilitation or revegetation activities.	Environment Personnel
WP-08	Store food waste in containers with lids and regularly transport to the designated waste management facility for disposal to avoid spillage and dispersal and avoid attracting wildlife.	All Personnel and Contractors
TE-10	Prohibit Project personnel and contractors from hunting, harassing, capturing and keeping wildlife or gathering, possessing or selling wildlife products.	All Personnel and Contractors
WP-09	Keep to designated access tracks where possible.	All Personnel and Contractors
HZ-11	Store, handle, apply and dispose of all herbicides in accordance with the relevant MSDS sheet.	Logistics Superintendents and Environment Personnel
WP-10	Do not transfer weed-infested topsoil from identified high-risk infestation areas to uninfested areas.	Environment Personnel
<b>Marine</b>		
WP-11	Develop and implement a quarantine management plan, which will include requirements for contractor vessels to comply with PNG and relevant International Maritime Organization guidelines and standards including ballasting and hull-cleaning and antifouling requirements.	Surface Construction Manager, Environment Manager and Work Area Superintendents



Proposed Monitoring and Reporting		
Action	Frequency	Responsibility
Monitor weed and plant pathogen control, using mapping and photos to record changes in the extent of weed populations.	Monthly	Environment Manager
Regularly monitor areas considered to possess high potential for, or likelihood to, exhibit infestation from weeds or exotic species, both flora and fauna. This may include areas of cleared vegetation, along roads or near Project facilities (particularly waste storage areas and around water sources).	Bi-annually	Environment Manager
Submit results of monitoring to the Director of CEPA as required by the environment permit.	Annually or as required	Environment Manager

## 2.11 Rehabilitation

### 2.11.1 Introduction

The WGJV plans to carry out progressive rehabilitation of disturbed areas as far as is practicable during construction and operations.

A Conceptual Closure and Rehabilitation Plan has been prepared that describes the proposed closure and rehabilitation strategies for the Project. The Conceptual Closure and Rehabilitation Plan focuses more on the long-term rehabilitation and post-closure land use of the Project Area, whereas measures outlined in the Project EMP are designed for use predominantly during the construction phase of the Project.

Construction activities will impact on the natural environment as a result of removing vegetation, disturbing topsoil, surface rock and subsoil, and establishing Project infrastructure. These activities can alter local hydrology and negatively impact on biodiversity by contributing to habitat fragmentation and degradation.

Rehabilitation is the process by which impacts on the environment are repaired and generally consists of the following two stages:

1. Landform design and reconstruction of a stable land surface
2. Revegetation (or development of an alternative land use) on the reconstructed landform

This rehabilitation management plan details procedures to be followed to rehabilitate and revegetate land following ground disturbance associated with construction activities.

### 2.11.2 Rehabilitation Management Plan

Table 2.11 sets out the rehabilitation management plan for the construction activities.

The objectives of construction rehabilitation management are to:

- Rehabilitate disturbed ground so it is stable and suitable for an agreed land use after the completion of construction activities

Table 2.11: Rehabilitation management plan

Proposed Management Measures		
ID	Action	Responsibility
<b>Pre-construction</b>		
GE-01	Train and induct Project personnel and contractors in environmental awareness, prior to commencing work on the Project.	Environment Manager and Human Resources and Training Manager
RH-02	Establish a nursery to support progressive rehabilitation.	Environment Manager
<b>Vegetation Clearing</b>		
RH-03	Where practicable, manage cleared vegetation by: <ul style="list-style-type: none"> <li>• Stockpiling cleared vegetation for use in rehabilitation/revegetation activities and erosion control.</li> <li>• Stockpiling for composting or mulching for use in rehabilitation/revegetation activities.</li> <li>• Scattering over temporary work sites to promote natural regeneration, preventing dust emissions, and provide habitat</li> <li>• Stockpiling cleared vegetation away from watercourses or surface water features</li> </ul>	Surface Construction Manager and Environment personnel
RH-04	Rehabilitate pipeline construction right of ways and temporary laydown areas, as soon as practicable after completion of trenching and pipe laying activities.	Surface Construction Manager, Earthworks Contractor and Environment personnel
RH-05	Reinstate and revegetate temporary work sites as soon as practicable after disturbance to stabilise soils and reduce runoff.	Surface Construction Manager, Earthworks Contractor and Environment personnel
RH-06	Use native species of local provenance where practicable in revegetation and rehabilitation.	Earthworks Contractors, Environment Personnel
RH-07	Trial appropriate plant species to determine optimal plant species for quick effective revegetation of disturbed areas. Establish a database of plant species to be used for rehabilitation.	Environment personnel
TE-06	Minimise the length of time that disturbed areas are exposed through planning progressive clearing and progressive rehabilitation of disturbed areas, unless areas are planned for additional disturbance at a later date.	Earthworks Contractors (at the direction of Environment Personnel)
<b>Earthworks</b>		
RH-08	Decommission and revegetate temporary infrastructure footprints and access routes and restore disturbed primary drainage paths, where practicable.	Earthworks Contractors (at the direction of Environment Personnel)
RH-09	Cover areas to be revegetated with a suitable growth medium, or cover temporarily with mulch prior to revegetation.	Earthworks Contractors (at the direction of Environment Personnel)
WP-07	Do not use known or potential weed species in rehabilitation or revegetation activities.	Environment Personnel

Proposed Monitoring and Reporting		
Action	Frequency	Responsibility
Maintain a record of the timing and extent (ha) of rehabilitation of temporarily cleared areas	Variable (as per Rehabilitation Plan requirements)	Environment Manager
Undertake routine inspection of rehabilitation works, after completion of revegetation. Inspections to be documented.	Quarterly	Environment Manager
Undertake routine inspection of topsoil stockpiles.	Quarterly	Environment Manager
Undertake follow-up inspections after planting to assess the range of species established, and whether there is a need for remedial actions.	Annual	Environment Manager
Review rehabilitation work undertaken and the results of any new rehabilitation investigations and trials.	Annual	Environment Manager
Submit results of monitoring to the Director of CEPA as required by the environment permit.	Annually or as required	Environment Manager

## 2.12 Environmental Incident Response

### 2.12.1 Introduction

An environmental incident is defined as any unplanned or unintentional event that may lead to material or serious environmental harm, as defined under the *Environment Act 2000*, or any activity resulting in regulatory non-compliance or the breach of company policies, standards or commitments.

The WGJV Incident Management, Reporting and Notification document governs the incidence response workflow to be followed in the event of an incident or unplanned event. For external notification, in accordance with Section 8 of the *Environment Act 2000*, CEPA must be informed as soon as practicable (i.e., within 24 hours) of any instance where serious environmental harm has occurred. Under the Act, serious environmental harm is taken to mean harm that fulfils any of the following criteria:

- Irreversible, of a high impact or widespread
- Occurs to an area of high conservation value or special significance
- Results in costs exceeding Papua New Guinea Kina (PGK)100,000 being incurred due to loss or damage
- Results in costs exceeding PGK100,000 being incurred in taking appropriate action to prevent or minimise the harm, or to restore the environment to its condition before the harm occurred.

Construction personnel and contractors would need to adhere to the following procedures in relation to environmental incident response:

- Hydrocarbon spill response (Appendix A1)
- Landslip response (Appendix A2)
- Over-clearance of vegetation response (Appendix A3)
- The WGJV Incident Management, Reporting and Notification procedure
- The WGJV Crisis, Emergency and Incident Management Plan

Personnel and contractors must be trained, qualified, and inducted for the work they are undertaking, as well as for the incident response and reporting procedures.

In the case of an environmental incident at any construction site managed under this Environmental Management Plan, personnel and contractors are to follow the relevant procedures and measures outlined in Appendix A, Incident Response Procedures.

### 2.12.2 Environmental Incident Response Management

Table 2.12 sets out the environmental incident response management plan for the construction activities.

The objectives of environmental incident response are to:

- Ensure emergency response plans and incident response procedures are developed and updated regularly
- Manage major incidents in accordance with the WGJV Incident Management, Reporting and Notification plan and WGJV Crisis, Emergency and Incident Management Plan
- Ensure appropriate communication with local communities, government and internally regarding environmental incidents

Table 2.12: Environmental incident response management plan

Proposed Management Measures		
ID	Action	Responsibility
<b>Pre-construction</b>		
IR-01	Train key construction and operations Project personnel and contractors in emergency and spill response procedures.	Emergency Response Superintendent and Human Resources and Training Manager
GE-01	Train and induct Project personnel and contractors in environmental awareness, prior to commencing work on the Project.	Environment Manager and Human Resources and Training Manager
<b>General</b>		
IR-02	Erect fencing or warning signs as appropriate to exclude non-Project personnel from mine workings.	Work Area Superintendents
IR-03	Implement a risk-based emergency and spill prevention and response plan that includes: <ul style="list-style-type: none"> <li>• Measures to reduce risks to as low as reasonably practicable.</li> <li>• Training and induction requirements for Project personnel and contractors.</li> <li>• Regular inspection and maintenance of emergency and spill response equipment.</li> <li>• Regular inspection of hazardous materials storage and handling facilities.</li> <li>• Regular inspection and maintenance of fire suppression and fire-fighting equipment.</li> <li>• Regular drills to practice timely and effective response to an emergency or spill.</li> <li>• Protocol for notifying potentially affected communities of emergency or spill.</li> <li>• Protocol for coordinating response with relevant PNG authorities and governments.</li> <li>• Protocol for coordinating medical evacuations.</li> </ul>	Emergency Response Superintendent

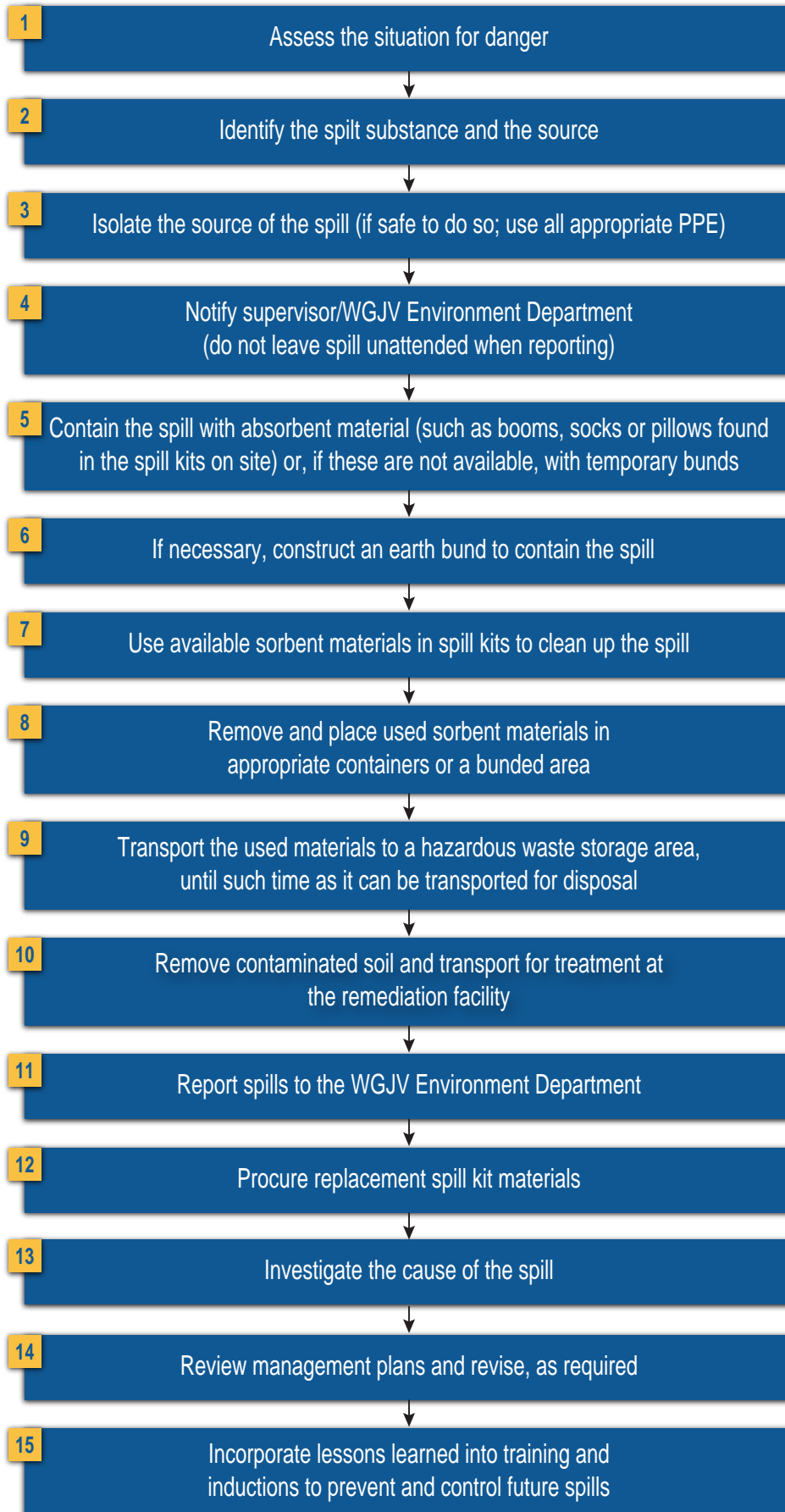
Proposed Management Measures		
ID	Action	Responsibility
IR-04	Maintain a trained emergency response team on site.	Emergency Response Superintendent and Human Resources and Training Manager
IR-05	Conduct regular drills to practice timely and effective emergency and spill response.	Emergency Response Superintendent
IR-06	Implement the incident reporting procedure for emergencies and spills.	All personnel and contractors
IR-07	Monitor alerts from the Pacific Tsunami Warning Centre.	Emergency Response Superintendent and OH&S Manager
IR-08	Categorise seismic events to trigger appropriate actions and detailed reviews.	Emergency Response Superintendent and OH&S Manager
IR-09	Maintain surface and underground firefighting equipment with rescue capability.	Emergency Response Superintendent and OH&S Manager
IR-10	Implement emergency response procedures for unplanned events.	Emergency Response Superintendent and OH&S Manager
IR-11	Install appropriate fire detection and suppression systems.	Emergency Response Superintendent and OH&S Manager
IR-12	Communicate WGJV's planned response to natural events to potentially affected communities.	Emergency Response Superintendent and Community Affairs and Lands Manager
IR-13	Notify incidents in accordance with the WGJV Incident Management, Reporting and Notification plan.	All Staff and Contractors
Earthworks		
IR-14	Manage response to natural disaster (such as tsunami, flood, bushfire, or earthquake) in accordance with WGJV Crisis, Emergency and Incident Management Plan.	Emergency Response Superintendent and OH&S Manager
Proposed Monitoring and Reporting		
Action	Frequency	Responsibility
Carry out monitoring activities as per the monitoring requirements in each management plan.	As required	Environment Manager
Report incidents as per the procedures listed in this section.	Event based	Environment Manager
Report all significant environmental incidents (Level 4 and Level 5 as defined in WGJV Incident Management, Reporting and Notification) to the Director of CEPA within 24 hours of occurrence.	Event based	Environment Manager
Submit a summary of incidents for the year to the Director of CEPA at the end of each calendar year as part of the annual environmental report.	Annual	Environment Manager

Proposed Management Measures		
ID	Action	Responsibility
	Report wildlife mortalities resulting from site activities to the WGJV Environment Department, assess the cause and implement corrective actions to reduce wildlife mortalities where appropriate.	Event based All Personnel and Contractors
	Report unauthorised clearing as an environmental incident, and initiate response in accordance with the Over-clearance of Vegetation Response (Appendix A3).	Event based All Personnel and Contractors
	Report hydrocarbon spills as environmental incidents, and initiate responses in accordance with the Hydrocarbon Spill Response (Appendix A1).	Event based All Personnel and Contractors
	Report large landslips associated with construction activities as an environmental incident, and initiate response in accordance with Landslip Response (Appendix A2).	Event based All Personnel and Contractors
	Report potential overtopping of sediment ponds as an environmental incident to the WGJV Environment Department. Regularly inspect the condition of sediment ponds and conduct maintenance as required.	Event based All Personnel and Contractors

## **Appendix A** Incident Response Procedures

- A.1 Hydrocarbon Spill Response**
- A.2 Landslip Response**
- A.3 Over-clearance of Vegetation Response**

## Hydrocarbon spill response

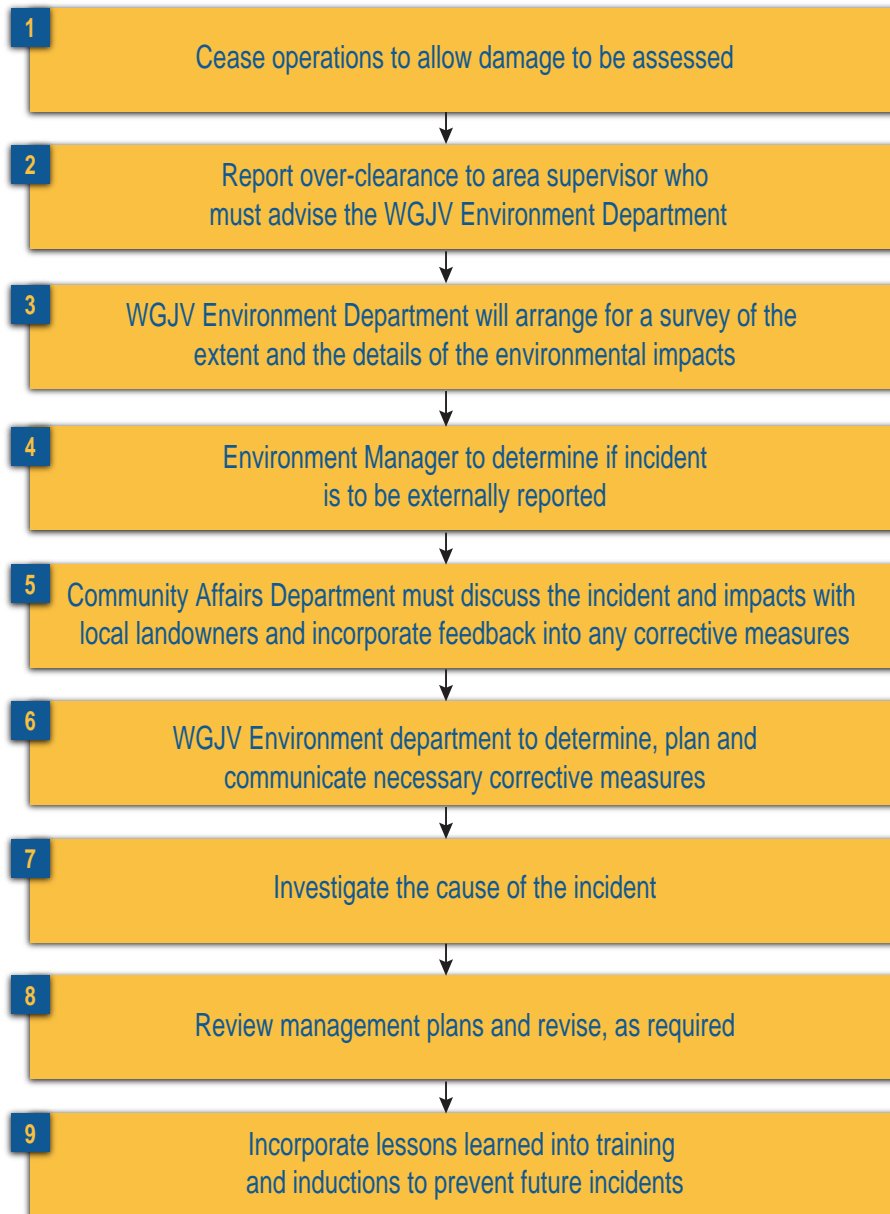




## Landslip response



## Over-clearance of vegetation response







# Environmental Management Plan

## Module 3: Operations

## TABLE OF CONTENTS

3	INTRODUCTION.....	1
3.1	Air Quality and Greenhouse Gas Management.....	1
3.1.1	Introduction .....	1
3.1.2	Air Quality and Greenhouse Gas Management Plan.....	2
3.2	Noise and Vibration Management.....	3
3.2.1	Introduction .....	3
3.2.2	Noise and Vibration Management Plan .....	4
3.3	Terrestrial Flora and Fauna Management .....	5
3.3.1	Introduction .....	5
3.3.2	Terrestrial Flora and Fauna Management Plan .....	5
3.4	Freshwater and Aquatic Flora and Fauna Management .....	7
3.4.1	Introduction .....	7
3.4.2	Freshwater and Aquatic Flora and Fauna Management Plan .....	7
3.5	Soils, Sediment and Erosion Management.....	9
3.5.1	Introduction .....	9
3.5.2	Soils, Sediment and Erosion Management Plan .....	9
3.6	Waste Rock and Acid and Metalliferous Drainage Management .....	11
3.6.1	Introduction .....	11
3.6.2	Waste Rock Dump and Acid and Metalliferous Drainage Management Plan .....	11
3.7	Marine Ecology Management .....	12
3.7.1	Introduction .....	12
3.7.2	Marine Ecology Management Plan .....	12
3.8	Hazardous Materials Management .....	14
3.8.1	Introduction .....	14
3.8.2	Hazardous Materials Management Plan.....	14
3.9	Non-Hazardous Materials Management .....	17
3.9.1	Introduction .....	17
3.9.2	Non-Hazardous Materials Management Plan.....	17
3.10	Weed and Pest Management .....	18
3.10.1	Introduction .....	18
3.10.2	Weed and Pest Management Plan .....	18
3.11	Rehabilitation .....	20
3.11.1	Introduction .....	20
3.11.2	Rehabilitation Management Plan .....	21
3.12	Environmental Incident Response .....	22
3.12.1	Introduction .....	22
3.12.2	Environmental Incident Response Management Plan.....	23

### LIST OF TABLES

Table 3.1: Air quality and greenhouse gas management.....	2
Table 3.2: Noise and vibration management.....	4
Table 3.3: Proposed terrestrial flora and fauna management.....	6
Table 3.4: Proposed freshwater and aquatic flora and fauna management .....	7
Table 3.5: Proposed soils, sediment and erosion management .....	10
Table 3.6: Proposed waste rock and AMD management.....	11
Table 3.7: Proposed marine ecology management.....	13
Table 3.8: Proposed hazardous materials management.....	15
Table 3.9: Proposed non-hazardous materials management .....	18
Table 3.10: Proposed weed and pest management.....	19
Table 3.11: Proposed rehabilitation management.....	21
Table 3.12: Proposed environmental Incident response management.....	23

### LIST OF APPENDICES

APPENDIX A	INCIDENT RESPONSE PROCEDURES .....	26
A.1	Hydrocarbon Spill Response.....	26
A.2	Landslip Response.....	26

Abbreviation/Acronym	Description
%	percent
AMD	acid and metalliferous drainage
ANZECC/ARMCANZ	Australian and New Zealand Environment Conservation Council/Agriculture and Resource Management Council of Australia and New Zealand
CEPA	Conservation and Environment Protection Authority (previously Department of Environment and Conservation)
EIS	environmental impact statement
EMS	Environmental Management System
IFC	International Finance Corporation
IUCN	International Union for the Conservation of Nature
km	kilometres
km <sup>2</sup>	square kilometres
KPI	Key Performance Indicator
LLG	Local Level Government
m	metres
mASL	metres above sea level
mbgl	metres below ground level
Mt	million tonnes
NAF	non-acid forming
OH&S	occupational health and safety
PAF	potentially acid forming
PM <sub>10</sub>	respirable particulates less than 10µm
PNG	Independent State of Papua New Guinea
SOP	standard operating procedure
WGJV	Wafi-Golpu Joint Venture
WHO	World Health Organization

Glossary	Description
acid sulphate soils	Naturally occurring soils, sediments or organic substrates formed under waterlogged conditions. These soils contain iron sulphide minerals or their oxidation products. In an undisturbed state below the water table, acid sulphate soils are benign. However, if the soils are drained, excavated or exposed to air by a lowering of the water table, the sulphides react with oxygen to form sulphuric acid.
decline	A sloping underground tunnel excavated for mobile equipment access from surface or from level to level.
environmental impact statement (EIS)	A document that provides a comprehensive assessment of potential environmental, social and cultural heritage impacts (or benefits) associated with a project, in accordance with Section 53 of the PNG <i>Environment Act 2000</i> .
erosion	The process by which material, such as rock or soil, is worn away or removed by wind or water.

Glossary	Description
greenhouse gas	A gas that contributes to the greenhouse effect by absorbing infrared radiation. Carbon dioxide and methane are examples of greenhouse gases.
Infrastructure Corridor	The area encompassing the proposed Project infrastructure linking the Mine Area and the Coastal Area, being corridors for pipelines and roads and associated laydown areas. The proposed concentrate pipeline, terrestrial tailings pipeline and fuel pipeline will connect the Mine Area to the Coastal Area. A proposed Mine Access Road and Northern Access Road will connect the Mine Area to the Highlands Highway. New single-lane bridges are proposed over the Markham, Watut and Bavaga rivers. Laydown areas will be located at key staging areas.
Mine Area	The area encompassing the proposed block cave mine, underground access declines and nearby infrastructure, including a portal terrace and waste rock dump supporting each of the Watut and Nambonga declines, the Watut Process Plant, power generation facilities, laydown areas, water treatment facilities, quarries, wastewater discharge and raw water make-up pipelines, raw water dam, sediment control structures, roads and accommodation facilities for the construction and operations workforces.
non-acid forming	Chemically-stable materials that will not generate any by-products which are likely to adversely affect the environment. A sample is usually defined as non-acid forming when it has a negative NAPP and the final NAG pH is greater than or equal to 5.
Port Area	Port of Lae including Lae Tidal Basin and surrounds
Port Facilities Area	Located at, or in proximity to, the Port of Lae, with a site adjacent to Berth 6 (also known as Tanker Berth) nominated as the preferred option. The proposed facilities will include the concentrate filtration plant and materials handling, storage, ship loading facilities and filtrate discharge pipeline. This area may in the future need to include fuel oil handling and storage facilities.
potentially acid forming	Material that contains sulphidic compounds with the potential to generate sulphuric acid under oxidising conditions.
Project Area	The land that is the subject of the proposed Project activities and Project facilities, being: <ul style="list-style-type: none"> <li>• The Mine Area</li> <li>• The Infrastructure Corridor</li> <li>• The Coastal Area</li> </ul>
ventilation shaft	A vertical or sub-vertical passage used in an underground mine to allow the flow of air either into, or out of the mine.



### 3 INTRODUCTION

The Environmental Management Plan comprises three modules:

1. Module 1 – Introduction and Overview
2. Module 2 – Construction
3. Module 3 – Operations

This Module 3 – Operations, includes detailed discussion of the key areas of environmental management relevant to the operation phase of the Wafi-Golpu Project (the Project), including:

- Air quality and greenhouse gas
- Noise and vibration
- Terrestrial flora and fauna
- Aquatic flora and fauna
- Water
- Soils, sediment and erosion control
- Waste rock and acid and metalliferous drainage (AMD)
- Marine ecology
- Hazardous materials
- Non-hazardous materials
- Weed and pest
- Rehabilitation
- Environmental incident response

The responsibilities and proposed role descriptions in this EMP are subject to change and may be expanded or altered at any time during the Project.

#### 3.1 Air Quality and Greenhouse Gas Management

##### 3.1.1 Introduction

Health-related and nuisance impacts of emissions to air from the operation are expected to be very localised and minor.

The maintenance of existing air quality in the Project Area, through compliance with adopted criteria, is predicted at all sensitive receptors during operations with the exception of Ziriruk and Fly Camp. Impacts to air quality are predicted at both Ziriruk and Fly Camp through the generation of combustion emissions (sulphur dioxide) from the power generation facilities during operations. The WGJV is committed to achieving compliance with adopted air quality criteria, and will implement design measures (such as scrubbers on the power generation facilities' stacks or increasing the exhaust gas exit velocity) as required. Targeted monitoring of ambient sulphur dioxide (SO<sub>2</sub>), at Ziriruk and Fly Camp will be undertaken during the early stages of the operations phase to assess compliance with the adopted air quality criteria.

The main sources of greenhouse gas emissions during ongoing operations are diesel combustion and electricity consumption.

### 3.1.2 Air Quality and Greenhouse Gas Management Plan

Table 3.1 sets out the proposed air quality and greenhouse gas management plan for operations.

The objectives of air quality and greenhouse gas management are to:

- Maintain acceptable ambient air quality and amenity at sensitive receptors
- Meet State of PNG greenhouse gas reporting requirements

**Table 3.1: Air quality and greenhouse gas management**

Proposed Management Measures		
ID	Action	Responsibility
<b>Greenhouse gas</b>		
AQ-07	Maintain an inventory of greenhouse gas emissions and report in accordance with the State of PNG requirements.	Environment Manager
AQ-08	Implement mechanisms to promote review of energy efficiency during operations, with opportunities for efficiency improvements identified and implemented as appropriate.	Mining, Processing and Operations Managers
<b>Air quality</b>		
AQ-01	Maintain site access roads.	Operations Services Manager
AQ-04	Apply dust suppression in the vicinity of sensitive receptors (e.g., villages, schools, churches), as required during extended dry periods.	Operations Services Manager
AQ-03	Apply appropriate vehicle speed limits on Project roads and tracks.	OH&S Manager
SE-03	Maintain erosion and sediment control structures by: <ul style="list-style-type: none"> <li>• Cleaning accumulated material from behind sediment fences and barriers, cut-off drains and diversion drains associated with temporary erosion control berms. Dispose of sediment appropriately.</li> <li>• Cleaning accumulated material from, and where required, dewatering sediment ponds. Dispose of sediment to an appropriate location. Treat water if required prior to discharge to meet PNG environment permit conditions.</li> <li>• Maintaining sediment fences or barriers.</li> </ul>	Maintenance Superintendents
AQ-05	Avoid burning cleared or standing vegetation, wherever practicable.	All Personnel and Contractors
AQ-02	Procure fit-for-purpose vehicles, plant and machinery, and regularly inspect and maintain in accordance with manufacturer recommendations.	Maintenance Superintendents
AQ-09	Cover the concentrate storage area and ship loading conveyors in order to contain concentrate dust and equip conveyors with rain/dust covers and suitable drip/spillage trays.	Work Area Superintendents
AQ-10	Load the ship hatch through enclosed structures such as cement hatch hoppers.	Work Area Superintendents
AQ-11	Clean the mobile conveyors of concentrate residue after each ship loading event.	Work Area Superintendents
GE-01	Train and induct Project personnel and contractors in environmental awareness, prior to commencing work on the Project.	Environment Manager and Human Resources and Training Manager

Proposed Monitoring and Reporting		
Action	Frequency	Responsibility
Monitor energy and fuel use and greenhouse gas emissions.	Annually	Environment Manager
Monitoring of emissions from the on-site power generation facilities and waste incinerators for: <ul style="list-style-type: none"> <li>• Oxides of nitrogen (NO, NO<sub>2</sub> and NO<sub>x</sub>)</li> <li>• Sulphur dioxide (SO<sub>2</sub>)</li> <li>• Carbon monoxide (CO)</li> <li>• Particulate matter</li> <li>• Metals</li> <li>• Volatile organic compounds</li> </ul> Exhaust gas conditions from the power generation facilities (e.g., temperature, exit velocity, oxygen and moisture contents)	Quarterly	Environment Personnel
Targeted monitoring of ambient SO <sub>2</sub> at Ziriruk and Fly Camp during early stages of operations.	Monthly during first 12 months of operations then as required on a risk basis	Environment Personnel
Collect and analyse samples regularly from dust deposition gauges for analysis, in accordance with the Australian Standard AS/NZS3580.10.1:2003.	Monthly or as required	Environment personnel
Liaise with local communities regarding air quality issues related to operation, particularly dust-related nuisance.	Ongoing	Community Affairs and Lands Manager
Conduct regular environmental inspections of the work area for dust generation, particularly during dry periods.	Variable	Environment Manager, Maintenance Superintendents
Submit monitoring results to the Director of Conservation and Environment Protection Authority (CEPA) as required by the environment permit.	Annually	Environment Manager

## 3.2 Noise and Vibration Management

### 3.2.1 Introduction

Operational activities having the potential to cause adverse noise and vibration impacts include:

- Block cave mining, including blasting and infrequent subsidence events
- Operations at the Coastal Area
- Process plant and equipment operation (including grinding of ore)
- Support infrastructure operation including power generation, refrigeration system, tailings pumps, water treatment plants, and Fere Accommodation Facility
- Vehicle movements
- Concentrate pipeline pump stations

Potential vibration impacts are associated with heavy truck movements.

The maintenance of existing noise level amenity in the Project Area during operations, through compliance with adopted criteria, is predicted at all sensitive receptors except for Ziriruk. Throughout operations, noise levels are predicted to exceed adopted night time criteria at Ziriruk, under both neutral and enhanced meteorological conditions. This is due

to the predicted noise emissions from the power generation facilities located approximately 800m north of the village.

Generally, terrestrial fauna are predicted to avoid areas where very high noise levels (sufficient to cause injury or damage) occur. Operations will not include plant and equipment capable of generating noise levels that would cause damage to fauna, even in very close vicinity to the plant and equipment.

### 3.2.2 Noise and Vibration Management Plan

Table 3.2 sets out the proposed noise and vibration management plan for operations.

The objective of noise and vibration management is to manage potential impacts on sensitive receptors such as villages in accordance with regulatory requirements.

**Table 3.2: Noise and vibration management**

Proposed Management Measures		
ID	Action	Responsibility
<b>Noise</b>		
AQ-01	Maintain site access roads.	Operations Services Manager
NV-07	Limit machinery and vehicle movements, where possible, to defined work areas and designated roads.	All Staff and Contractors
NV-03	Maximise the distance between noisy plant items and noise sensitive receptors, where practicable.	Operations, Processing and Mining Managers
NV-01	Where practicable, provide advanced notice of high noise activities to local communities.	Community Affairs and Lands Manager, Mining Manager
AQ-03	Apply appropriate vehicle speed limits on Project roads and tracks.	OH&S Manager
NV-06	Where safe, minimise exhaust braking in the vicinity of villages.	Logistics Superintendents
NV-05	Where practicable, limit the hours of operation of high noise or vibration activities, especially vehicles, plant and equipment operating near sensitive receptors.	Operations Services Manager
NV-04	Where practicable, avoid or minimise heavy vehicle traffic near villages during the night.	Logistics Superintendents
NV-11	Inform potentially affected communities of noise and vibration associated with operations, including caving activities.	Community Affairs and Lands Manager
NV-12	Install acoustic enclosures on permanent facilities and noise generating equipment, where required and practicable to meet PNG environment permit conditions.	Operations Services Manager
GE-01	Train and induct Project personnel and contractors in environmental awareness, prior to commencing work on the Project.	Environment Manager and Human Resources and Training Manager
Proposed Monitoring and Reporting		
Action	Frequency	Responsibility
Conduct ongoing liaison with local communities regarding noise issues related to the operation, including documentation of complaints related to noise.	As required	Community Affairs and Lands Manager
Monitor noise levels in accordance with environment permit conditions at nominated locations.	As required by environment	Environment Manager

Proposed Management Measures		
ID	Action	Responsibility
		permit conditions
	Submit monitoring results to the Director of CEPA as required by the environment permit.	Annually or as required Environment Manager

### 3.3 Terrestrial Flora and Fauna Management

#### 3.3.1 Introduction

Operational activities having the potential to adversely impact on terrestrial flora and fauna include:

- Vehicle movements
- Industrial plant and equipment operation in previously undeveloped areas
- Subsidence above the block caves and surrounding area
- Surface water abstraction, dewatering of groundwater and discharges to surface waters resulting in altered hydrology, water quality and water flows
- Vegetation clearing and cleared areas causing erosion
- Introduction and spread of pest animals, invasive weeds and pathogens
- Hazardous and non-hazardous waste material handling

Potential impacts of these operational activities on flora and fauna include:

- Habitat loss
- Habitat degradation from edge effects, barrier effects, deposition of eroded sediments, colonisation by invasive species, contamination caused by spills or discharges
- Reduced abundance of plant and animal populations.

Weed and pathogen management is addressed in Section 3.10, and the management of rehabilitation works is addressed in Section 3.11.

#### 3.3.2 Terrestrial Flora and Fauna Management Plan

Table 3.3 sets out the proposed terrestrial flora and fauna management plan for operations.

The objectives of terrestrial flora and fauna management are to:

- Protect native flora and fauna species, where practicable
- Minimise the extent of vegetation clearance and ground disturbance
- Rehabilitate disturbed areas using native species of local provenance

**Table 3.3: Proposed terrestrial flora and fauna management**

Proposed Management Measures		
ID	Action	Responsibility
<b>Flora</b>		
TE-04	Obtain approval from the WGJV Environment Department prior to clearing vegetation in defined areas of relevant mining leases.	Operations Services Manager, Clearing Applicant and Environment Personnel
TE-08	Manage vegetation clearing in accordance with WGJV procedure, Permit for Land Disturbance.	Operations Services Manager
AQ-06	Prohibit unauthorised lighting of fires by Project personnel and contractors.	Operations Services Manager
RH-09	Decommission and revegetate temporary infrastructure footprints and access routes and restore disturbed primary drainage paths, where practicable.	Operations Services Manager and Environment Manager
<b>Fauna</b>		
TE-10	Prohibit Project personnel and contractors from hunting, harassing, capturing and keeping wildlife or gathering, possessing or selling wildlife products.	All Staff and Contractors
WP-08	Store food waste in containers with lids and regularly transport to the designated waste management facility for disposal to avoid spillage and dispersal and avoid attracting wildlife.	All Staff and Contractors
<b>General</b>		
TE-11	Shield external lights and direct lights onto work areas, wherever practicable.	Operations Services Manager
AQ-03	Apply appropriate vehicle speed limits on Project roads and tracks.	OH&S Manager
GE-01	Train and induct Project personnel and contractors in environmental awareness, prior to commencing work on the Project.	Environment Manager and Human Resources and Training Manager
Proposed Monitoring and Reporting		
Action	Frequency	Responsibility
Monitor spatial and temporal changes in forest extent and condition (as an indicator of biodiversity habitat and monitor the effectiveness of mitigation and management measures) and the number of dwellings (as an indicator of in-migration and local population growth) across the local region through the analysis of high-resolution satellite imagery.	Variable (as per Conceptual Closure and Rehabilitation Plan requirements)	Environment Manager
Monitor impact and control sites to assess potential effects of sulphur dioxide (SO <sub>2</sub> ).	Annually	Environment Manager
Monitor selected fauna (to be determined in consultation with PNG regulator) for abundance, composition and condition of fauna species.	Annually	Environment Manager
Report fauna injury and mortality resulting from Project activities and implement corrective actions if required.	Event-based	All Staff and Contractors
Monitor dust levels, downstream water quality, operational noise and changes in weed density and distribution as per this EMP.	As required	Environment Manager
Submit monitoring results to the Director of CEPA as required by the environment permit.	Annually or as required	Environment Manager

### 3.4 Freshwater and Aquatic Flora and Fauna Management

#### 3.4.1 Introduction

Activities associated with the operations have the potential to impact on water quality, surface water flow regimes, groundwater aquifers and aquatic ecology.

Surface water resources also support a range of beneficial uses for communities, such as for domestic (e.g., drinking water, washing, cooking) and agricultural purposes, as well as for alluvial mining.

#### 3.4.2 Freshwater and Aquatic Flora and Fauna Management Plan

Table 3.4 sets out the proposed freshwater and aquatic flora and fauna management plan for operations.

The objectives of freshwater and aquatic flora and fauna management are to:

- Limit changes to water quality, flow regimes and aquatic habitats
- Minimise impact on water users downstream of the construction site

**Table 3.4: Proposed freshwater and aquatic flora and fauna management**

Proposed Management Measures		
ID	Action	Responsibility
<b>Controlling Surface Water Runoff</b>		
WR-03	Actively manage PAF materials and control runoff and potential leachate from areas containing PAF material. For example: <ul style="list-style-type: none"> <li>• In situ treatment or reprocessing stockpiled material through the Watut Process Plant</li> <li>• Diversion of clean surface water where required</li> <li>• Interception of potential leachate from the site and applying appropriate treatment methods if required prior to discharge</li> </ul>	Mining, Processing Operations Services Managers and Environment Personnel
WA-20	Capture and treat mine wastewater where necessary prior to discharge, to meet environment permit conditions	Mining, Processing and Operations Services Managers
<b>General</b>		
AQ-03	Apply appropriate vehicle speed limits on Project roads and tracks.	OH&S Manager
TE-11	Shield external lights and direct lights onto work areas, wherever practicable.	Operations Services Manager
WA-06	Service vehicles in designated areas unless emergency breakdown repairs are required.	All Staff and Contractors
AQ-02	Procure fit-for-purpose vehicles, plant and machinery, and regularly inspect and maintain in accordance with manufacturer recommendations.	Maintenance Superintendents
RH-09	Decommission and revegetate temporary infrastructure footprints and access routes and restore disturbed primary drainage paths, where practicable.	Operations Services Manager and Environment Manager
HZ-04	Store and handle hazardous materials including fuels, oils and chemicals in accordance with AS1940-2017: The storage and handling of flammable and combustible liquids.	Work Area Superintendents
WA-21	Inform local villages downstream of works during operations that may affect surface water quality.	Community Affairs and Lands Manager
WA-08	Enforce washing of vehicles, plant and equipment in defined areas outside of watercourses.	All Staff and Contractors

Proposed Management Measures		
ID	Action	Responsibility
WA-15	Inspect hydraulic, fuel and lubricating systems on machinery for leaks before using in watercourses.	Maintenance Superintendents
GE-01	Train and induct Project personnel and contractors in environmental awareness, prior to commencing work on the Project.	Environment Manager and Human Resources and Training Manager
Water Quality Management		
WA-19	Develop a site water balance to quantify water extraction and discharge.	Mining, Processing and Operations Services Managers
WA-22	At the Port Facilities Area, capture contaminated runoff and combine the runoff with the concentrate filtrate prior to wastewater treatment to meet environmental permit conditions before discharge to the marine environment.	Mining, Processing and Operations Services Managers
WA-11	Divert 'clean' rainwater around the Port Facilities Area into existing Port of Lae stormwater runoff infrastructure, keeping it separated from potentially contaminated runoff.	Mining, Processing and Operations Services Managers
WA-12	Reduce potential for scouring, erosion and sediment transport, through the installation of energy dissipation structures where required for discharges to the receiving environment discharges.	Mining, Processing and Operations Services Managers
WA-20	Capture and treat mine wastewater where necessary prior to discharge to meet environment permit conditions.	Mining, Process and Operations Services Managers and Environment personnel
WA-10	Treat sewage in accordance with environment permit conditions.	Mining, Process and Operations Services Managers and Environment personnel
WA-13	Manage discharge water quality and quantity to meet environment permit conditions at specified compliance points.	Operations Services Manager and Environment personnel
HZ-19	Capture and treat if required runoff from fuel and hazardous materials storage areas before discharge to the receiving environment.	Maintenance Superintendents
SE-14	Divert runoff from soil stockpiles and direct it to sediment ponds where practicable prior to release to the environment based on size of stockpile and environmental risk.	Operations Services Manager
WA-18	Regularly monitor for changes in surface water or groundwater quality at defined locations in accordance with environment permits and apply remedial actions where required if impacts are detected.	Environment personnel and Operations Services Manager
WA-07	Install and maintain oil-water separation facilities where required (e.g., at vehicle maintenance workshops). Recover and appropriately dispose of trapped hydrocarbons and hazardous materials to approved facilities.	Maintenance Superintendents
WA-23	Ensure water and wastewater treatment facilities are properly maintained.	Maintenance Superintendents
Groundwater		
WA-17	Monitor potential impacts on groundwater related to mining activities in accordance with environment permits and if potential impacts are measured, implement remedial actions.	Environment Manager



Proposed Monitoring and Reporting		
Action	Frequency	Responsibility
Monitor surface water and sediment quality, including specific details of parameters to be monitored, frequency and locations, and which also meets the requirements of the environment permit.	As required by environment permit	Environment Manager
Monitor water extracted from underground workings and other potentially contaminated sites to determine if it is of suitable quality for direct discharge to the downstream environment or whether pre-discharge water treatment is required to meet environment permit criteria.	Ongoing	Environment Manager
Monitor groundwater levels and quality, and surface water flows and quality in the vicinity of the mine and Project infrastructure using gauging stations.	Ongoing	Environment Manager
Regularly update a groundwater model for the Project.	Annually	Engineering Manager
Monitor turbidity and suspended solids levels in the affected rivers (upstream and downstream) following the cessation of gravel extraction operations.	Event based	Environment Manager
Undertake routine inspections of aquatic habitats near operations areas.	Quarterly	Environment Manager
Report incidents (e.g., animal deaths, injuries or entrapments) as a result of operations.	Event-based	Environment Manager
Submit monitoring results to the Director of CEPA as required by the environment permit.	Annually	Environment Manager

## 3.5 Soils, Sediment and Erosion Management

### 3.5.1 Introduction

Key operational activities with the potential to be sources of erosion and sediment runoff include the waste rock dumps, borrow pits, process plant and decline terraces, ore stockpiles, topsoil stockpiles and unpaved roads. The potential for erosion across the mine area is particularly significant given the unstable soils (i.e., colluvium, residual and slope wash soils), steep terrain and large areas of land disturbed, combined with high rainfall. Natural landslips are common in the region and have the potential to be exacerbated by mine-related land disturbance. There is low potential for hydrological, sediment transport or water quality impacts from the Infrastructure Corridor and Coastal Area during operations, and these can be managed by erosion and sediment control measures.

Soil erosion and degradation can result in the following adverse environmental impacts:

- Reduction of available topsoil, hindering rehabilitation efforts
- Sedimentation of watercourses, impacting water extraction for drinking and domestic purposes, alluvial mining, aquatic ecosystem health, flooding regime, and use of aquatic flora and fauna resources
- Contamination of soils by spills and leaks of industrial chemicals

Management of water and aquatic flora and fauna is described in Section 3.4.

### 3.5.2 Soils, Sediment and Erosion Management Plan

Table 3.5 sets out the proposed soils, sediment and erosion management plan for operations.

The objectives of soils, sediment and erosion management are to:

- Reduce erosion of Project-disturbed areas and sedimentation of watercourses
- Protect downstream beneficial values of surface water and water resources

**Table 3.5: Proposed soils, sediment and erosion management**

Proposed Management Measures		
ID	Action	Responsibility
<b>Erosion and Sediment Control</b>		
SE-03	Maintain erosion and sediment control structures by: <ul style="list-style-type: none"> <li>• Cleaning accumulated material from behind sediment fences and barriers, cut-off drains and diversion drains associated with temporary erosion control berms. Dispose of sediment appropriately.</li> <li>• Cleaning accumulated material from, and where required, dewatering sediment ponds. Dispose of sediment to an appropriate location. Treat water if required prior to discharge to meet environment permit conditions.</li> <li>• Maintain sediment fences or barriers as required.</li> </ul>	Environment personnel and Operations Services Manager
SE-13	Monitor stream banks downstream of discharge points and sediment basin spillways and manage scour and erosion where required.	Operations Services Manager
<b>Contamination</b>		
HZ-06	Treat and dispose or manage contaminated soils based on the type and scale of contamination.	Operations Services Manager and Environment Manager
<b>General</b>		
GE-01	Train and induct Project personnel and contractors in environmental awareness, prior to commencing work on the Project.	Environment Manager and Human Resources and Training Manager
Proposed Monitoring and Reporting		
Action	Frequency	Responsibility
Conduct routine inspections of erosion and sediment control devices to ensure they have been installed and maintained correctly and in accordance with this management plan.	Quarterly	Operations Services Manager
Conduct routine assessments (including photographs) of potential erosion, bank slumping and scouring, and monitor regularly during operation.	Variable (daily or weekly as required)	Operations Services Manager
Inspect erosion and sediment control structures in line with design.	Variable	Operations Services Manager
Liaise with local communities regarding operations activities and potential levels of environmental impacts in accordance with EIS predictions.	Quarterly or as required	Community Affairs and Lands Manager
Submit monitoring results to the Director of CEPA as required by the environment permit.	Annually or as required	Environment Manager

### 3.6 Waste Rock and Acid and Metalliferous Drainage Management

#### 3.6.1 Introduction

Waste rock requiring disposal to the waste rock dumps will be generated during the construction phase of underground development (discussed in Module 2 of this plan). Waste rock generated during operations (mining) is not expected; however, the waste rock dumps will require ongoing monitoring during the Life of Mine (LOM). The downstream end of the Watut Declines Waste Rock Dump will not have a conventional waste rock dump toe but will abut the process plant terrace, forming one continuous footprint housing Project infrastructure. Upon completion of mining activities the waste rock dumps will be fully decommissioned and rehabilitated as part of the overall closure program (refer to the Project Conceptual Closure and Rehabilitation Plan (CCRP)).

During operations, ore will be stockpiled temporarily at surface until it is processed through the plant.

Potential impacts arising from the exposure of acid-forming rock during the operation include:

- Seepage of acid and metalliferous drainage (AMD) from PAF rock at the waste rock dumps into the surrounding environment and potential loss of aquatic and riparian vegetation.
- Acidification of surface water and groundwater from AMD, potentially leading to leaching and mobilisation of heavy metals into the surrounding environment as well as direct impacts due to low pH and elevated salinity.

Rehabilitation management is described further in Section 3.11, while water management is described further in Section 3.4.

#### 3.6.2 Waste Rock Dump and Acid and Metalliferous Drainage Management Plan

Table 3.6 sets out the proposed waste rock management plan for the operation phase of the mine.

The objectives of waste rock and AMD management are to:

- Prevent the formation of AMD and offsite impacts as far as reasonably practicable
- Establish stable waste rock landforms that minimise long-term environmental impacts
- Minimise environmental impacts arising from the mining, storage and disposal of waste rock
- Manage and mitigate related impacts on land use, water use and environmental values

**Table 3.6: Proposed waste rock and AMD management**

Proposed Management Measures		
ID	Action	Responsibility
<b>General</b>		
WR-03	Actively manage PAF materials and control runoff and potential leachate from areas containing PAF material such as: <ul style="list-style-type: none"> <li>• In situ treatment or reprocessing stockpiled material through the Watut Process Plant</li> <li>• Diversion of clean surface water where required</li> <li>• Interception of potential leachate from the site and applying appropriate treatment methods if required prior to discharge</li> </ul>	Mining, Processing Operations Services Managers and Environment Personnel

Proposed Management Measures		
ID	Action	Responsibility
WR-05	Maintain drainage and seepage collection system on PAF cells.	Mining, Processing Operations Services Managers and Environment Personnel
GE-01	Train and induct Project personnel and contractors in environmental awareness, prior to commencing work on the Project.	Environment Manager and Human Resources and Training Manager
Proposed Monitoring and Reporting		
Action	Frequency	Responsibility
Monitor seepage from the waste rock dumps and surface side drains.	Monthly	Environment Manager
Monitor surface water at key locations and collect samples for analysis in accordance with environment permit requirements. For example: <ul style="list-style-type: none"> <li>• Weekly – Flow, pH, EC, TDS and temperature (done in field), alkalinity, acidity, aluminium, antimony, arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver and zinc</li> </ul>	Weekly/ As required	Environment Manager
Undertake PAF cell routine monitoring to allow early detection of potential seepage and AMD identification. In the unlikely event that AMD generation is encountered due to cell containment issues, remediate in-situ or other appropriate re-handling.	Quarterly	Environment Manager
If necessary, monitor through installation of oxygen sampling and temperature probes at selected locations as appropriate.	As required	Environment Manager
Submit monitoring results to the Director of CEPA as required by the environment permit.	Annually or as required	Environment Manager

## 3.7 Marine Ecology Management

### 3.7.1 Introduction

Activities during Project operations have the potential to impact upon the marine environment.

The principal management measures for offshore ecology relate to the design and operation of the proposed DSTP system in accordance with the draft guidelines for new DSTP systems in PNG. Proposed operational management measures specific to marine ecology are described below.

Management of invasive marine species is described in Section 3.10. Management of hazardous and non-hazardous material and waste products is described further in sections 3.8 and 3.9, respectively. Air quality and noise related management measures are described further in sections 3.1 and 3.2, respectively.

### 3.7.2 Marine Ecology Management Plan

Table 3.7 sets out the proposed marine ecology management plan for operations.

The objectives of marine ecology management are to:

- Minimise changes to the marine environment as a result of the Project

**Table 3.7: Proposed marine ecology management**

Proposed Management Measures		
ID	Action	Responsibility
<b>General</b>		
GE-03	Capture and treat, if required, runoff from operational sites before discharge to the receiving environment.	Mining, Processing and Operations Services Managers
HZ-04	Store and handle hazardous materials including fuels, oils and chemicals in accordance with AS1940-2017: The storage and handling of flammable and combustible liquids.	Work Area Superintendents
HZ-13	Maintain the minimum required quantities of chemical, fuel, and oil containers at worksites and return them to storage or disposal areas when not in use.	Maintenance Superintendents
HZ-16	Report leaks or spills and manage in accordance with emergency and spill response procedures.	All Staff and Contractors
IR-05	Conduct regular drills to practice timely and effective emergency and spill response.	Processing Manager and Emergency Response Superintendent
GE-01	Train and induct Project personnel and contractors in environmental awareness, prior to commencing work on the Project.	Environment Manager and Human Resources and Training Manager
ME-03	Aim to direct lighting installed for Project vessels and facilities at the Outfall Area toward the shore based facilities to meet minimum requirements for safety and security (and reduce light directed toward potential turtle nesting areas).	Environment Manager
<b>DSTP</b>		
WR-08	Providing adequate de-aeration of the tailings slurry prior to discharge to avoid air being entrained into the DSTP outfall pipelines.	Operations Services Manager
WR-09	Ensuring that the tailings slurry has a higher density than the receiving ocean water so that a density current will form and flow by gravity down the submarine slope.	Operations Services Manager
Proposed Monitoring and Reporting		
Action	Frequency	Responsibility
Monitor marine water quality and sediment quality in accordance with the environment permit.	As required by environment permit	Environment Manager
Inspect the integrity of bund walls, settlement ponds, storage sheds, DSTP infrastructure etc.	Monthly	Maintenance Superintendents
Report incidents (e.g., animal deaths) as a result of operational activities.	Event-based	All Staff and Contractors
Conduct validation and ongoing DSTP performance monitoring in line with the SAMS Draft Guidelines for Deep-sea Tailings Placement. This will include validation ground-truthing of modelling predictions and recalibration of models where necessary.	No later than 18 months after the commencement of full production	Environment Manager
Develop and implement methods to trace the tailings after deposition. This may include development of a conceptual model identifying the pathways for tailings and how these may differ from natural sediments. Such a model would inform a monitoring program (potentially incorporating trace element signature and mineralogy	No later than 18 months after the commencement of full production	Environment Manager

Proposed Management Measures		
ID	Action	Responsibility
	analysis) that is appropriate to detect the extent of near- and far- field distribution of deposited tailings.	
	Validate the tailings liquor and solids quality prior to discharge and correlate the pre-discharge quality with compliance with receiving water quality criteria at the edge of the mixing zone.	No later than 18 months after the commencement of full production Environment Manager
	Routinely sample the physico-chemical properties of tailings to characterise tailings liquor and tailings solids chemistry prior to discharge (i.e., after mixing with return seawater and de-aeration).	Weekly mix tank monitoring Environment Manager
	Assess compliance with receiving water quality criteria at the mixing zone boundary, to confirm that the tailings behaves as predicted and that there is sufficient dilution between the point of discharge and the mixing zone boundary.	Quarterly for ambient mixing zone monitoring for first two years, then annual Environment Manager
	Prior to and during operations, conduct oceanographic profiling to monitor the depth of the base of the surface mixed layer.	Monthly Environment Manager
	Conduct baseline sampling of the zooplankton and micronekton communities to identify differences in the depth strata spatially and temporally occupied by these pelagic communities.	At least 6 months prior to the commissioning of the DSTP system Environment Manager
	Conduct precautionary monitoring, prior to and during operations, of tissue metal and metalloid burdens in deep-slope and pelagic fish that have the potential to be caught and consumed by local people. Continue sampling of deep-slope fish species for tissue metal and metalloid concentrations prior to DSTP start up and continue during operations to monitor for potential bioaccumulation and/or biomagnification of tailings contaminants.	At least 6 months prior to the commissioning of the DSTP system Every 12 months during operations Environment Manager
	Continue the benthic sediment geochemistry and infauna sampling program during operations.	Annually Environment Manager
	Submit monitoring results to the Director of CEPA as required by the environment permit.	Annually or as required Environment Manager

## 3.8 Hazardous Materials Management

### 3.8.1 Introduction

During operations a range of hazardous materials such as fuels, oils, lubricants, hydraulic fluids, solvents, explosives and process chemicals will be used that need to be managed during transportation, storage and disposal.

This hazardous materials management plan details procedures to be followed for the safe handling, transport, transfer, storage and disposal of hazardous materials during operations.

The management of non-hazardous materials is addressed separately in Section 3.9, while the management of waste rock is addressed separately in Section 3.6.

### 3.8.2 Hazardous Materials Management Plan

Table 3.8 sets out the proposed hazardous materials management plan for operations.

The objectives of hazardous materials management are to:

- Ensure hazardous materials are identified, handled, stored, transferred, transported and disposed of in an environmentally responsible manner

- Minimise the risk of spills and/or releases of hazardous materials
- Minimise environmental impacts in the case of a spill or release

**Table 3.8: Proposed hazardous materials management**

Proposed Management Measures		
ID	Action	Responsibility
<b>Storage, Handling and Transportation</b>		
HZ-20	Design and operate mobile plant and equipment refuelling, lubrication and oil change facilities at maintenance workshops in accordance with AS1940:2017.	Operations Services Manager, Maintenance Superintendents and Logistics Superintendents
HZ-21	Construct enclosed bunds in key process, treatment and handling areas to contain spillages and prevent the possible uncontrolled mixing of acidic and alkaline materials, and to allow for the collection of effluent in sumps and its return in a controlled manner.	Operations Services Manager, Processing Manager and Maintenance Superintendents
HZ-02	Make available copies of relevant MSDS where hazardous materials are stored or used.	OH&S Manager
HZ-09	Select packaging of the appropriate volume, nature and integrity for the type and quantity of hazardous material being transported and for the mode of transport.	Processing Manager and Logistics Superintendents
HZ-08	When shipping hazardous materials: <ul style="list-style-type: none"> <li>• Clearly label containers with type and quantity of contents</li> <li>• Include MSDS for each hazardous material</li> <li>• Include shipping document with supplier/shipper and inventory of hazardous materials</li> </ul>	Logistics Superintendents
HZ-04	Store and handle hazardous materials including fuels, oils and chemicals in accordance with AS1940-2017: The storage and handling of flammable and combustible liquids.	Work Area Superintendents
HZ-13	Maintain the minimum required quantities of chemical, fuel, and oil containers at worksites and return them to storage or disposal areas when not in use.	Maintenance Superintendents
HZ-22	Prohibit stacking or storage of hazardous materials storage containers on top of one another.	All Staff and Contractors
HZ-07	Display appropriate warning signs where hazardous materials are stored or while being transported.	All Staff and Contractors
HZ-05	Transport and dispose of dangerous goods and hazardous materials including wastes in accordance with legislative requirements to nominated handling and/or disposal facilities. Verify that those transporting hazardous materials are trained in proper transport and emergency and spill response procedures.	OH&S Manager, Logistics Superintendents
HZ-15	Train personnel and contractors in fuel transfer and filling operations, and spill prevention and response procedures.	Human Resources and Training Manager, OH&S Manager
HZ-06	Treat and dispose or manage contaminated soils based on the type and scale of contamination.	Environment Manager
<b>Fuel Storage and Refuelling</b>		
HZ-01	Maintain spill response kits (with portable spill containment and clean up equipment) at each work area where hazardous materials are stored and used.	Emergency Response Superintendent

Proposed Management Measures		
ID	Action	Responsibility
HZ-14	When refuelling, take measures to prevent spills by using appropriate hoses, pumps, spouts and funnels.	All Staff and Contractors
HZ-19	Capture and treat if required runoff from fuel and hazardous materials storage areas before discharge to the receiving environment.	Maintenance Superintendents
Spill Preparedness and Response		
HZ-03	Apply appropriate containment for hazardous materials when servicing mobile equipment away from designated workshop areas.	Maintenance Superintendents
IR-05	Conduct regular drills to practice timely and effective emergency and spill response.	Emergency Response Superintendent
IR-06	Implement the incident reporting procedure for emergencies and spills.	All Staff and Contractors
General		
HZ-10	Arrange collection and safe transport of hazardous materials including fuels, oils, chemicals, hazardous waste, solvents, paints and solid chemical waste (e.g., batteries) in secure containers to designated waste management areas for treatment and/or disposal.	Logistics Superintendents
WA-06	Service vehicles in designated areas unless emergency breakdown repairs are required.	All Staff and Contractors
HZ-17	Do not store incompatible materials together. Avoid reuse of tanks for different products without first ensuring material compatibility.	Logistics Superintendents
HZ-18	Take appropriate measures to prevent ignition sources within flammable materials storage and handling areas.	OH&S Manager
HZ-11	Store, handle, apply and dispose of all herbicides in accordance with the relevant MSDS sheet.	Logistics Superintendents and Environment Personnel
WA-07	Install and maintain oil-water separation facilities where required (e.g., at vehicle maintenance workshops). Recover and appropriately dispose of trapped hydrocarbons and hazardous materials to approved facilities.	Maintenance Superintendents
AQ-02	Procure fit-for-purpose vehicles, plant and machinery, and regularly inspect and maintain in accordance with manufacturer recommendations.	Maintenance Superintendents
GE-01	Train and induct Project personnel and contractors in environmental awareness, prior to commencing work on the Project.	Environment Manager and Human Resources and Training Manager
Proposed Monitoring and Reporting		
Action	Frequency	Responsibility
Monitor and inspect hazardous materials storage locations to check the conditions of storage containers and vessels, check compliance with relevant MSDS storage recommendations, and ensure appropriate labelling of containers and vessels and adequate house-keeping.	Monthly	OH&S Manager
Regularly inspect work areas for compliance with hazardous materials management procedures.	Quarterly	OH&S Manager



Proposed Management Measures			
ID	Action	Responsibility	
	Inspect spill response kits so they remain well maintained and stocked.	Quarterly	Emergency Response Superintendent
	Maintain a registry of dangerous goods and hazardous substances used by the Project.	Ongoing	OH&S Manager
	Record volumes of hazardous materials managed onsite and removed offsite.	Event based	Logistics Superintendents
	Audit compliance with waste tracking system.	Quarterly	Environment Manager
	Submit monitoring results to the Director of CEPA as required by the environment permit.	Annually or as required	Environment Manager

### 3.9 Non-Hazardous Materials Management

#### 3.9.1 Introduction

Gaseous, liquid and solid wastes will be generated throughout the operational activities. Waste can cause adverse public health, environmental and aesthetic impacts if not properly managed.

There will be a dedicated waste management facility for the Project located in the Mine Area. Power and water reticulation will be extended to this facility. All wastes will be collected and sorted at the waste management facility and then managed according to waste type.

A variety of waste management technologies and facilities will be employed to manage non-hazardous wastes generated by the Project. These include:

- Reuse and recycling
- Waste oil processing
- Landfills
- Incinerators
- Waste water treatment plants

Hazardous materials management is covered in Section 3.8.

#### 3.9.2 Non-Hazardous Materials Management Plan

Table 3.9 sets out the proposed non-hazardous materials management plan for operations.

The objectives of non-hazardous materials management are to:

- Establish a waste management system that minimises waste generation and potential adverse impacts on the environment
- Promote efficient use and conservation of resources
- Prevent the attraction or foraging of pest and/or native animals

**Table 3.9: Proposed non-hazardous materials management**

Proposed Management Measures		
ID	Action	Responsibility
<b>Storage, Handling and Transportation</b>		
NZ-03	Manage non-hazardous waste by: <ul style="list-style-type: none"> <li>• Implementing a waste management hierarchy</li> <li>• Segregating and storing waste in labelled bins</li> <li>• Covering or protecting waste from dispersal by wind or water</li> <li>• Transporting and disposing of waste at approved handling and disposal facilities</li> <li>• Regularly transporting waste to approved handling and disposal facilities to avoid waste stockpiling at work sites and Project facilities</li> <li>• Maintaining an inventory of waste disposal.</li> </ul>	Work Area Superintendents
<b>General</b>		
GE-01	Train and induct Project personnel and contractors in environmental awareness, prior to commencing work on the Project.	Environment Manager and Human Resources and Training Manager
WP-08	Store food waste in containers with lids and regularly transport to the designated waste management facility for disposal to avoid spillage and dispersal and avoid attracting wildlife.	All Staff and Contractors
NZ-01	Design and operate waste landfills and incineration infrastructure in accordance with the PNG Environmental Code of Practice for Mining and Environmental Code of Practice for Sanitary Landfill Sites, as the minimum standard.	Operations Services Manager
Proposed Monitoring and Reporting		
Action	Frequency	Responsibility
Inspect work sites regularly to assess effectiveness of waste management processes in accordance with this management plan.	Monthly	Work Area Superintendents
Monitor waste discharges in accordance with the environment permit requirements.	As prescribed by the environment permit	Environment Manager
Undertake compliance audits as required.	Annually or as required	Environment Manager
Submit monitoring results to the Director of CEPA as required by the environment permit.	Annually or as required	Environment Manager

### 3.10 Weed and Pest Management

#### 3.10.1 Introduction

Vehicle, vessel and personnel movements associated with operational activities have the potential to introduce and spread weeds, pest animals and plant pathogens (invasive alien species) to and from work areas.

The most effective measure for preventing the introduction of weeds, pests and pathogens is the implementation of good quarantine and hygiene practices. This section has been developed to provide procedures that should be followed during the operation phase to prevent the introduction and spread of weeds and pathogens.

#### 3.10.2 Weed and Pest Management Plan

Table 3.10 sets out the proposed weed and pest management plan for operations.

The objective of weed and pest management is to:

- Prevent the introduction and spread of weeds and plant pathogens and pest animals into the operational area as a result of operational activities

**Table 3.10: Proposed weed and pest management**

Proposed Management Measures		
ID	Action	Responsibility
<b>Weeds</b>		
GE-02	Implement an access protocol for Project-controlled roads.	OH&S Manager
WP-02	Implement risk-based control of weeds and plant pathogens, for example: <ul style="list-style-type: none"> <li>• Weed and plant pathogen identification manual for contractors and personnel, and training in its use</li> <li>• Visual inspection of vehicles, plant and equipment for soil, seeds and weed material</li> <li>• Risk-based wash down of vehicles, plant and equipment before arrival at site</li> <li>• Removal of weeds using appropriate methods</li> </ul>	Operations Services Manager, Environment personnel
WP-09	Keep to designated access tracks where possible.	All Staff and Contractors
WP-10	Do not transfer weed-infested topsoil from identified high-risk infestation areas to uninfested areas.	All Staff and Contractors
RH-06	Use native species of local provenance where practicable in revegetation and rehabilitation.	Environment Manager
WP-07	Do not use known or potential weed species in rehabilitation or revegetation activities.	Environment Manager
HZ-11	Store, handle, apply and dispose of all herbicides in accordance with the relevant MSDS sheet.	Logistics Superintendents and Environment Personnel
WP-06	Monitor and manage washdown areas to avoid weed establishment.	Environment Personnel
WP-04	Inspect new disturbance areas and surrounds for evidence of weed infestations and vegetation dieback and manage identified infestations.	Environment Personnel
WP-05	Select herbicides (if required) that: <ul style="list-style-type: none"> <li>• Are low in toxicity to and have minimal effects on non-target species and the environment</li> <li>• Are known to be effective against target species</li> </ul> Package herbicides in safe containers, clearly labelled for safe and proper use, and have been manufactured by an appropriately licensed organisation. Adhere to environmental and safety requirements including instructions on product labels and MSDS sheets.	Environment Manager
<b>Pest Fauna</b>		
WP-01	Prohibit the cultivation of invasive exotic species on Project sites and discourage the translocation of exotic fish species.	Operations Services Manager
WP-08	Store food waste in containers with lids and regularly transport to the designated waste management facility for disposal to avoid spillage and dispersal and avoid attracting wildlife.	All Staff and Contractors
<b>Marine</b>		

Proposed Management Measures		
ID	Action	Responsibility
WP-11	Develop and implement a quarantine management plan, which will include requirements for contractor vessels to comply with PNG and relevant International Maritime Organization guidelines and standards including ballasting and hull-cleaning and antifouling requirements.	Environment Manager and Logistics Superintendents
<b>General</b>		
GE-01	Train and induct Project personnel and contractors in environmental awareness, prior to commencing work on the Project.	Environment Manager and Human Resources and Training Manager
Proposed Monitoring and Reporting		
Action	Frequency	Responsibility
Monitor weed and plant pathogen control, using mapping and photos to record potential changes in the extent of weed populations.	Monthly	Environment personnel
Regularly monitor areas considered to possess high potential for, or likelihood to, exhibit infestation from weeds or exotic species, both flora and fauna. This may include areas of cleared vegetation, along roads or near Project facilities (particularly waste storage areas and around water sources).	Bi-annually	Environment personnel
Monitor vessels associated with Project operations to ensure compliance with quarantine plan	Ongoing	Environment Manager
Submit monitoring results to the Director of CEPA as required by the environment permit.	Annually or as required	Environment Manager

### 3.11 Rehabilitation

#### 3.11.1 Introduction

The WGJV plans to carry out progressive rehabilitation of disturbed areas as far as is practicable during construction and operations.

A CCRP has been prepared and details the proposed closure and rehabilitation strategies for the environmental and social aspects. Rehabilitation during the operation phase should follow the management measures in this section and refer to the Project CCRP where relevant. The Project CCRP focuses more on the long-term rehabilitation and post-closure land use of the operational area, whereas measures outlined in the Project EMP are designed for use predominantly during operation.

Inappropriate rehabilitation of disturbed areas during operation in a timely and effective manner may result in the following impacts:

- Surface water impacts as a result of release of sediment from disturbed land surfaces, engineered landforms or materials stockpiles.
- Water quality impacts arising from release of AMD, or saline or neutral mine drainage from the waste rock dumps, other contaminants from process areas.
- Poor revegetation outcomes resulting from ineffective topsoil salvage, storage and placement practices.
- Ecosystem impacts associated with ineffective control of weed establishment and spread in disturbed areas. These might include reduction in species richness and/or abundance and alteration of ecosystem processes.

### 3.11.2 Rehabilitation Management Plan

Table 3.11 sets out the proposed rehabilitation management plan for operations.

The objectives of rehabilitation are to:

- Create stable, self-draining landforms
- Create conditions conducive to natural regeneration of self-sustaining, locally-endemic native vegetation
- Rehabilitate disturbed ground so that it is stable and suitable for an agreed land use after the completion of operational activities

**Table 3.11: Proposed rehabilitation management**

Proposed Management Measures		
ID	Action	Responsibility
RH-03	Where practicable, manage cleared vegetation by: <ul style="list-style-type: none"> <li>• Stockpiling cleared vegetation for use in rehabilitation/revegetation activities and erosion control.</li> <li>• Stockpiling for composting or mulching for use in rehabilitation/revegetation activities.</li> <li>• Scattering over temporary work sites to promote natural regeneration and provide habitat</li> <li>• Stockpiling cleared vegetation away from watercourses or surface water features</li> </ul>	Earthworks Contractor, Environment personnel
RH-10	Cover areas to be revegetated with a suitable growth medium, or cover temporarily with mulch prior to revegetation.	Environment personnel
RH-05	Reinstate and revegetate temporary work sites as soon as practicable after disturbance to stabilise soils and reduce runoff.	Environment personnel
RH-11	Rehabilitate and revegetate disturbed areas not required for ongoing operations with species compatible with the end land use.	Environment personnel
RH-06	Use native species of local provenance where practicable in revegetation and rehabilitation.	Environment Manager
RH-01	Salvage topsoil, seed bank and seedlings and use in revegetation of temporary work sites as soon as practicable to enhance potential for natural regeneration.	Earthworks Contractor
RH-07	Trial appropriate plant species to determine optimal plant species for quick effective revegetation of disturbed areas. Establish a database of plant species to be used for rehabilitation.	Environment Manager
RH-12	Design and construct the final landform to have stable slopes that limit erosion to the extent reasonably practicable and support self-sustaining vegetation.	Environment Manager
GE-01	Train and induct Project personnel and contractors in environmental awareness, prior to commencing work on the Project.	Environment Manager and Human Resources and Training Manager
Proposed Monitoring and Reporting		
Action	Frequency	Responsibility
Maintain a record of the timing and extent (ha) of rehabilitation of temporarily cleared areas.	Variable (as per Conceptual Closure and Rehabilitation Plan requirements)	Environment Manager

Proposed Management Measures		
ID	Action	Responsibility
	Monitor progressive rehabilitation of disturbed areas by taking photos and progressive site and revegetation assessments. For example, gather information on: <ul style="list-style-type: none"> <li>• Species and family levels of plant classification</li> <li>• Areas of revegetation</li> <li>• Number of plants</li> <li>• Plant density</li> <li>• Stem diameter</li> <li>• Plant height</li> <li>• Establishment of exotic species</li> <li>• Growth performance and signs of attack by pests and nutrient deficiency</li> <li>• Weed infestation percentage</li> <li>• Diversity of vegetation</li> </ul>	Quarterly or as required  Environment Manager
	Review rehabilitation work undertaken and the results of any new rehabilitation investigations and trials. Particular focus should be on revegetated sections of the waste rock dumps, areas surrounding road verges and surrounding the Fere Accommodation Facility.	Variable (weekly initially progressing to monthly as cover develops)  Environment Manager
	Submit monitoring results to the Director of CEPA as required by the environment permit.	Annually or as required  Environment Manager

## 3.12 Environmental Incident Response

### 3.12.1 Introduction

An environmental incident is defined as any unplanned or unintentional event that may lead to material or serious environmental harm, as defined under the *Environment Act 2000* (Environment Act), or any activity resulting in regulatory non-compliance or the breach of company policies, standards or commitments.

The WGJV Incident Management, Reporting and Notification document governs the incidence response workflow to be followed in the event of an incident or unplanned event. For external notification, in accordance with Section 8 of the Environment Act, CEPA must be informed as soon as practicable of any instance where serious environmental harm has occurred. Under the Act, serious environmental harm is taken to mean harm that fulfils any of the following criteria:

- Irreversible, of a high impact or widespread
- Occurs to an area of high conservation value or special significance
- Results in costs exceeding Papua New Guinea Kina (PGK) 100,000 being incurred due to loss or damage
- Results in costs exceeding PGK100,000 being incurred in taking appropriate action to prevent or minimise the harm, or to restore the environment to its condition before the harm occurred

Operational personnel and contractors would need to adhere to the following procedures in relation to environmental incident response:

- Hydrocarbon spill response (Appendix A.1)
- Landslip response (Appendix A.2)

- WGJV Crisis, Emergency and Incident Management Plan

### 3.12.2 Environmental Incident Response Management Plan

Table 3.12 sets out the proposed environmental incident response management plan for operations.

The objectives of environmental incident response are to:

- Protect the environment from threats (actual or potential) arising from environmental incidents
- Ensure appropriate communication with local communities, government and internally regarding environmental incidents
- Ensure credible environmental incident scenarios, including major incidents and natural hazards, are identified
- Ensure emergency response plans and incident response procedures are developed and updated regularly
- Manage major incidents in accordance with the WGJV Incident Management, Reporting and Notification procedure and WGJV Crisis, Emergency and Incident Management Plan

**Table 3.12: Proposed environmental Incident response management**

Proposed Management Measures		
ID	Action	Responsibility
<b>Spill Response</b>		
HZ-16	Report leaks or spills and manage in accordance with emergency and spill response procedures.	All Staff and Contractors
IR-05	Conduct regular drills to practice timely and effective emergency and spill response.	Emergency Response Superintendent
IR-06	Implement the incident reporting procedure for emergencies and spills.	All Staff and Contractors
<b>General</b>		
IR-02	Erect fencing or warning signs as appropriate to exclude non-Project personnel from mine workings.	Work Area Superintendents
IR-03	Implement a risk-based emergency and spill prevention and response plan that includes: <ul style="list-style-type: none"> <li>• Measures to reduce risks to as low as reasonably practicable.</li> <li>• Training and induction requirements for Project personnel and contractors.</li> <li>• Regular inspection and maintenance of emergency and spill response equipment.</li> <li>• Regular inspection of hazardous materials storage and handling facilities.</li> <li>• Regular inspection and maintenance of fire suppression and fire-fighting equipment.</li> <li>• Regular drills to practice timely and effective response to an emergency or spill.</li> <li>• Protocol for notifying potentially affected communities of emergency or spill.</li> <li>• Protocol for coordinating response with relevant PNG authorities and governments.</li> <li>• Protocol for coordinating medical evacuations.</li> </ul>	Emergency Response Superintendent

Proposed Management Measures		
ID	Action	Responsibility
IR-14	Manage response to natural disaster (such as tsunami, flood, bushfire, or earthquake) in accordance with WGJV Crisis, Emergency and Incident Management Plan.	Emergency Response Superintendent and OH&S Manager
IR-07	Monitor alerts from the Pacific Tsunami Warning Centre.	Emergency Response Superintendent and OH&S Manager
IR-15	Routinely monitor suspected geotechnical weak areas and high-risk areas for early warning of an imminent failure.	Emergency Response Superintendent, OH&S Manager and Work Area Superintendents
IR-16	Inspect and maintain pipelines in accordance with applicable standards.	Emergency Response Superintendent, OH&S Manager and Work Area Superintendents
IR-17	Regularly inspect waste rock dump for any physical indicators of reduced structural integrity.	Emergency Response Superintendent, OH&S Manager and Work Area Superintendents
IR-18	Ensure that temporary or premature Project closure is undertaken in accordance with the State of PNG law and WGJV policies and procedures.	Emergency Response Superintendent and OH&S Manager
IR-08	Categorise seismic events to trigger appropriate actions and detailed reviews.	Emergency Response Superintendent and OH&S Manager
IR-01	Train key construction and operations Project personnel and contractors in emergency and spill response procedures.	Emergency Response Superintendent and Human Resources and Training Manager
IR-19	Train plant operators in the safe handling and spill prevention and response procedures for process solutions and reagents held onsite.	Emergency Response Superintendent and Human Resources and Training Manager
IR-04	Maintain a trained emergency response team on site.	Emergency Response Superintendent and Human Resources and Training Manager
IR-12	Communicate WGJV's planned response to natural events to potentially affected communities.	Emergency Response Superintendent and Community Affairs and Lands Manager
IR-10	Implement emergency response procedures for unplanned events.	Emergency Response Superintendent and OH&S Manager
SE-15	Report any large landslip as an incident for remediation where required.	All Staff and Contractors
IR-20	Clear vegetation around key Project infrastructure to create a firebreak.	Operations Services Manager and Environment Personnel
IR-11	Install appropriate fire detection and suppression systems.	Emergency Response Superintendent and OH&S Manager

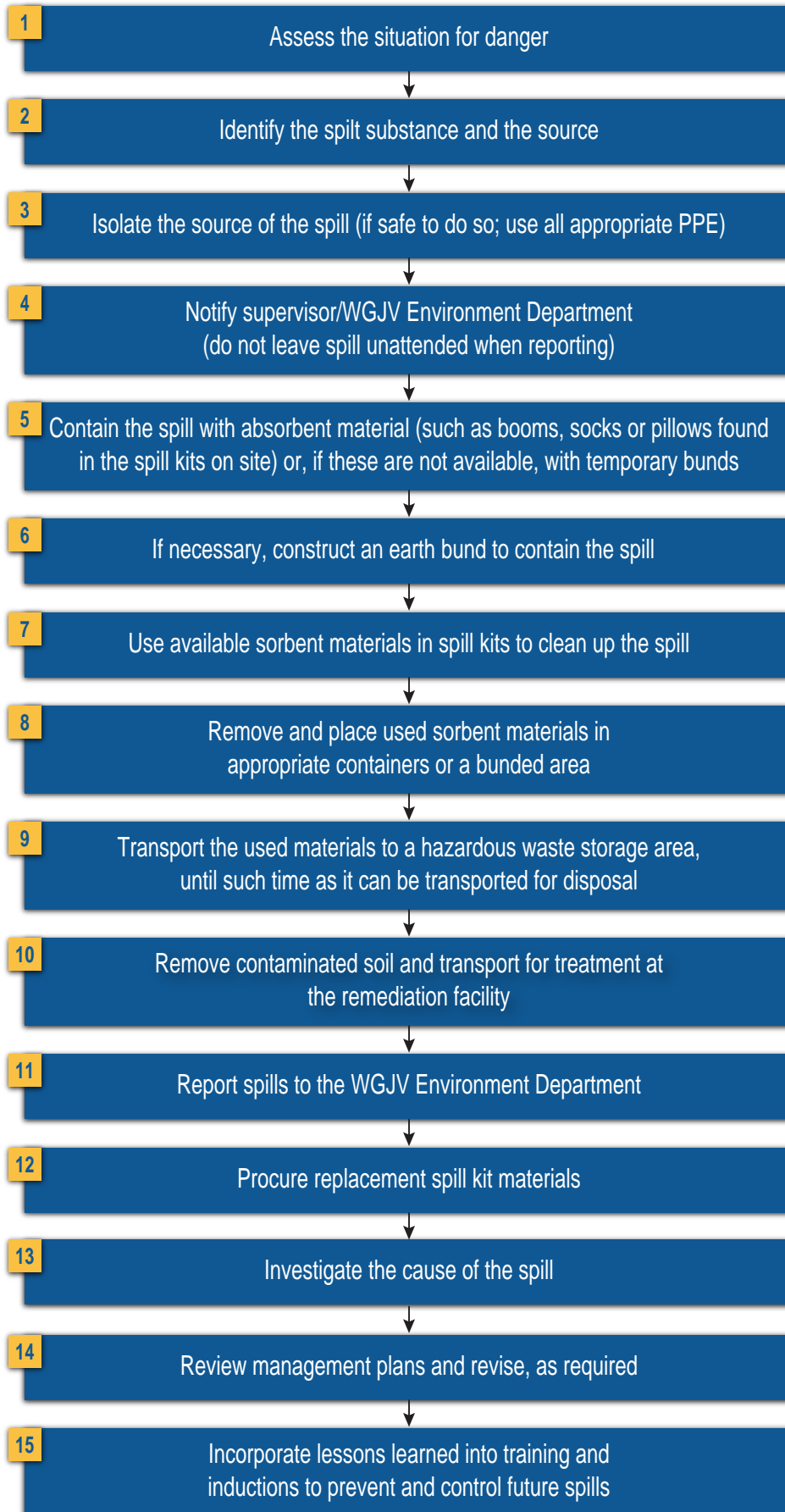


Proposed Management Measures		
ID	Action	Responsibility
IR-09	Maintain surface and underground firefighting equipment with rescue capability.	Emergency Response Superintendent and OH&S Manager
IR-13	Notify incidents in accordance with the WGJV Incident Management, Reporting and Notification plan	All Staff and Contractors
Proposed Monitoring and Reporting		
Action	Frequency	Responsibility
Carry out monitoring activities as per the monitoring requirements in each management plan.	As required	Environment Manager
Report incidents as per the procedures listed in this section.	Event based	All Staff and Contractors
Report all significant environmental incidents (Level 4 and Level 5 as defined in WGJV Incident Management, Reporting and Notification) to the Director of CEPA within 24 hours of occurrence.	Event based	Environment Manager
Implement a regular monitoring and maintenance program to enable early detection of potential weaknesses or faults in critical infrastructure.	As required	Mining, Processing and Operations Services Managers
Undertake regular audits of operations to assess actual environmental impacts against those predicted in the EIS.	Annual	Environment Manager
Submit a summary of incidents to the Director of CEPA as part of the annual environmental report.	Annually	OHS, Environment and Community Manager

## **Appendix A Incident Response Procedures**

- A.1 Hydrocarbon Spill Response**
- A.2 Landslip Response**

## Hydrocarbon spill response



## Landslip response

