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Batu Hijau Mine

Environmental and Social Impact Assessment for a Tailings Storage Facility

Document Information

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Glossary

AEP	Annual Exceedance Probability
AMDAL	Analisis Mengenai Dampak Lingkungan (Environmental Impact Assessment)
AMNT	PT Amman Mineral Nusa Tenggara
ANDAL	Analisis Mengenai Dampak Lingkungan Hidup (Environmental Impact Assessment)
B3	GoI classification code for Hazardous and Toxic Materials
CPUE	Catch Per Unit Effort
DSTP	Deepsea Tailings Placement
EDC	Environmental Design Criteria
EHS	Environmental, Health and Safety (Keselamatan & Kesehatan Kerja dan Lindung Lingkungan)
ESDM	Kementerian Energi dan Sumber Daya Mineral (Indonesian Ministry of Energy and Mineral Resources)
ESIA	Environmental and Social Impact Assessment
GEL	Generally Expected Limit
GIIP	Good International Industry Practices
GoI	Government of Indonesia
HDPE	High Density Poly Ethylene
HSE	Health, Safety, and Environment
IFC	International Finance Corporation
IUPK	Izin Usaha Pertambangan Khusus (Special Mining Business Licence)
KLHK	Indonesian Ministry of Environment and Forestry
ktpa	kilo-tonnes (kt) per annum
LIPI	Lembaga Ilmu Pengetahuan Indonesia (Indonesia Institute of Sciences)
LOM	Life of Mine
NAG	Non-Acid-Generating
NNT	PT Newmont Nusa Tenggara
Mtpa	Million tonnes (Mt) per annum
PAG	Potentially Acid-Generating
PFS	Preliminary Feasibility Study
PGAs	Potential Ground Accelerations
PLTS	Pembangkit Listrik Tenaga Surya (Solar Power Plant)
PP	Peraturan Pemerintah (Government Regulation)
PS	Performance Standard
PUPR	Ministry of Public Works and Public Housing
RKL-RPL	Rencana Pengelolaan Lingkungan Hidup - Rencana Pemantauan Lingkungan Hidup (Environmental Management-Monitoring Plan)
ROV	Remote operating vehicle
RWD	Return Water Dam
TSF	Tailings Storage Facility
UPK	Unit Pengelola Kegiatan (Activity Management Unit)

Executive Summary

This report has been compiled to describe the environmental and social impacts and the risks that could be expected if PT Amman Mineral Nusa Tenggara (AMNT) were to develop a terrestrial Tailings Storage Facility (TSF) (or tailings dam) for waste from the mill processing of the copper-gold ores mined at the Batu Hijau operation on the southwest of Sumbawa Island, West Nusa Tenggara Province, Indonesia. Such a facility could replace the Deepsea Tailings Placement (DSTP) system at Batu Hijau that has been disposing all process plant tailings with minimal impacts and without incident since 2000,.

An onshore TSF would represent a major change in the Batu Hijau operation. This Environmental and Social Impact Assessment (ESIA) provides an in-depth illustration of the effects of such a change.

For the existing DSTP system, the impacts have already been experienced over 21 years and no new impacts are predicted, even with an expansion as is being planned by AMNT. The DSTP system has performed as intended. No tailings have been introduced into productive marine ecosystems. The main impact has been the burial of benthic organisms in deep water where productivity and biodiversity are very low in the natural state. Once DSTP ceases, the seabed habitat is predicted to recover within a few years. No long-term adverse impacts will be associated with DSTP.

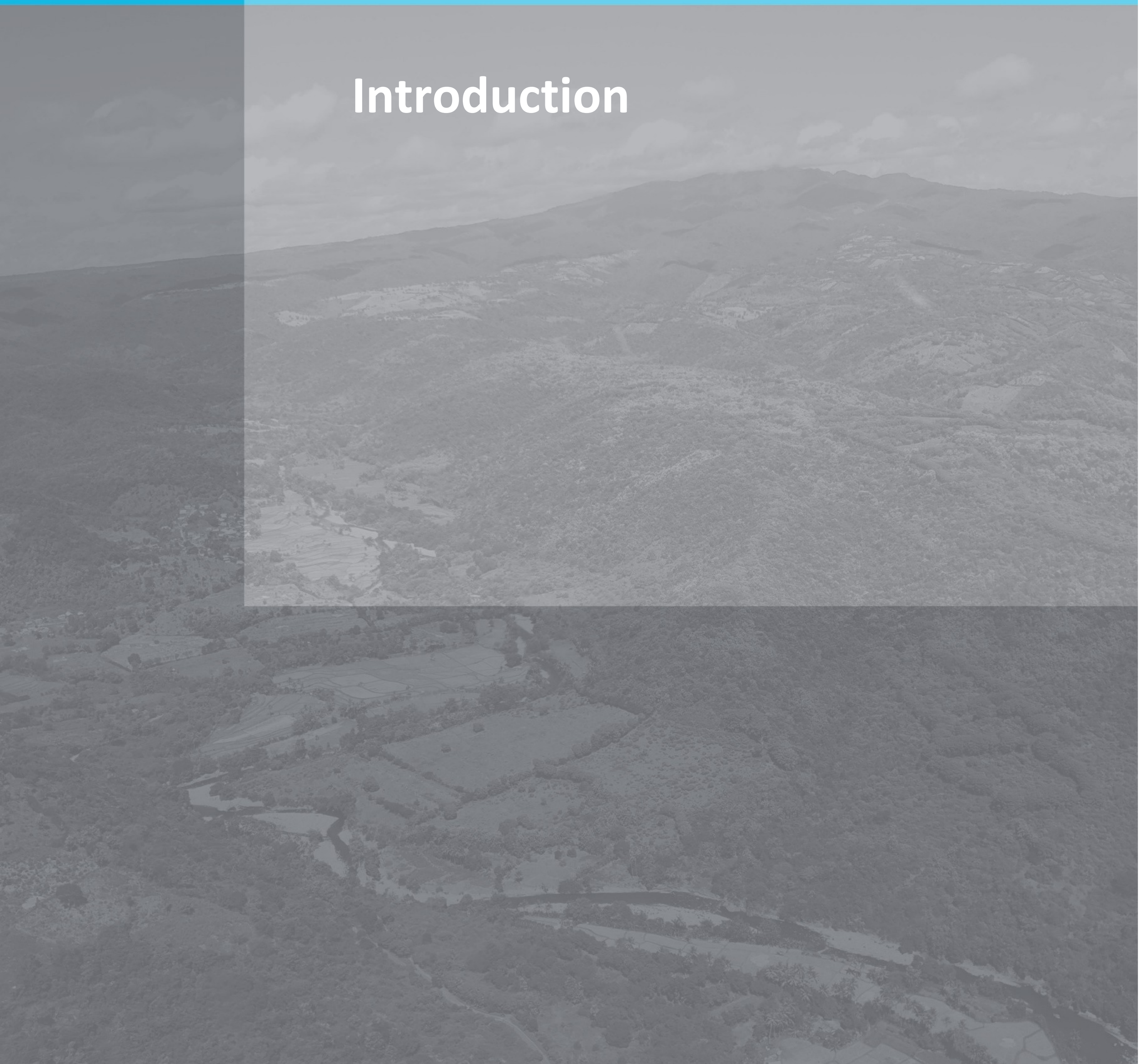
The proposed TSF alternative to DSTP would have severe adverse environmental impacts, including the loss of around 450 Ha of high-quality forest vegetation and a diverse range of resident fauna. In addition, 5 km of riverine habitat would also be destroyed. While the surface of the TSF could eventually be rehabilitated, it would take decades, possibly centuries, before these areas could be returned to the diversity and productivity of their natural state.

Of even more concern than the environmental impacts associated with a TSF scheme is the risk of embankment collapse. There is no precedent for a dam of this magnitude in a region of high earthquake risk. While some risks can be reduced by more detailed investigation and design and management safeguards, severe risks to life, property and the natural environment will remain, not only during the operating period but in perpetuity. The ongoing operation of the Batu Hijau DSTP system has no such serious risks associated with it and no long-term risks whatsoever.

The Batu Hijau DSTP system has proved to be robust and reliable; its impacts are well understood and have been shown to be readily reversible. Therefore, this assessment concludes that there is no reason to consider a TSF scheme further. The unavoidable environmental impacts that would occur and the inherent risk of potentially catastrophic failure clearly show that a TSF is not an acceptable option for Batu Hijau tailings.

01

Introduction



1 Introduction

This introductory section briefly provides an overview of the Batu Hijau Mine, its rationale and importance, identifying the owner and location, as well as aspects with respect to tailings management and feasible alternatives.

1.1 The Batu Hijau Mine

From 1990 mineral exploration by Newmont Mining Corporation (through its subsidiary PT Newmont Nusa Tenggara, or NNT) on the island of Sumbawa, Indonesia resulted in the discovery of copper and gold mineralization that led to the development of the Batu Hijau Mine. In 1999 mine construction at Batu Hijau was completed, and the design capacity of ore production was achieved from 2000.

The open pit copper/ gold mine is now owned and operated by PT Amman Mineral Nusa Tenggara (AMNT) since acquiring NNT in November 2016. AMNT is almost entirely owned by Amman Mineral International, with 0.1% owned by PT AP Investment. The mine is the second largest copper/ gold mine in Indonesia and is located in the West Nusa Tenggara province, approximately 1,500 km east of the Indonesian capital, Jakarta (Figure 1-1). The operation is situated slightly inland, with the process plant and the open pit located approximately 5½ and 10 km from the coast, respectively.

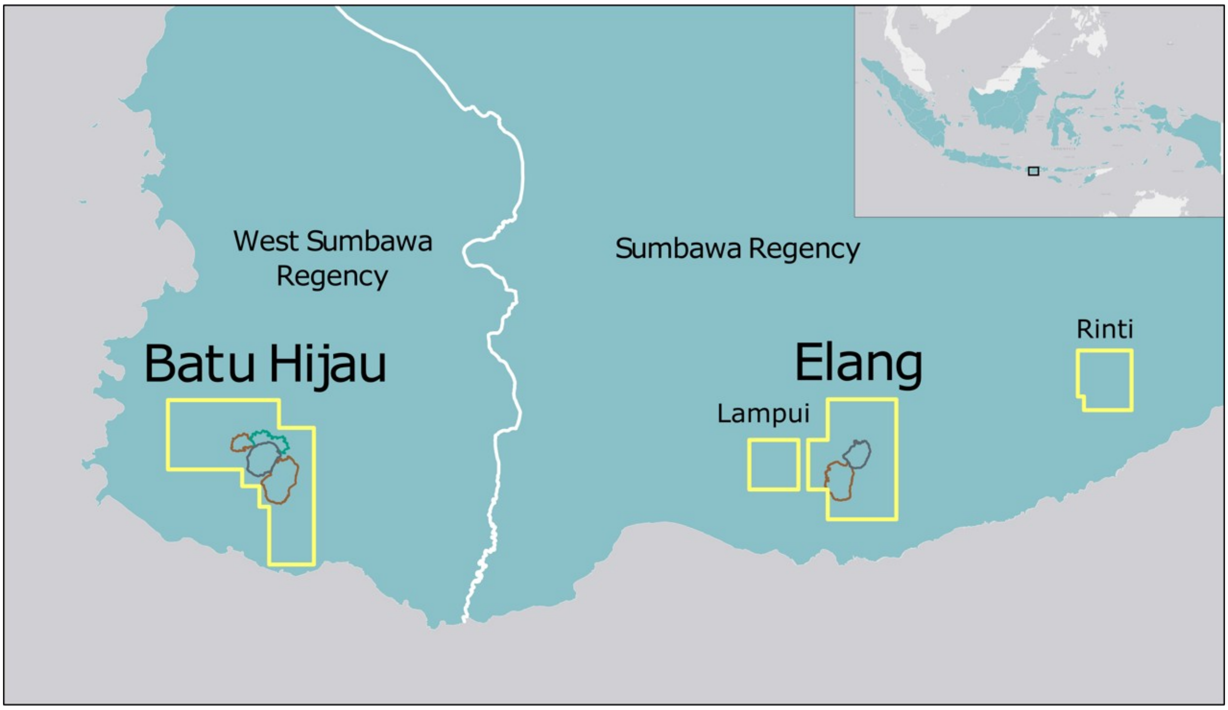


Figure 1-1 Batu Hijau Mine Location

From 2000 to mid-2021, the Batu Hijau Mine has produced 4.0 million tonnes of copper and 8.7 million troy ounces of gold. In recent years, the operation has typically processed about 35-40 million tonnes per annum (Mtpa) of ore to produce around 500-700 kilo-tonnes per annum (ktpa) of copper/ gold concentrates.

Deepsea tailings placement (DSTP) has been Batu Hijau's system for tailings disposal since September 1999. The tailings outflow is via a 6 km terrestrial steel pipeline and a 3.3 km HDPE pipeline from the coastline to a submarine discharge point at around 125 m depth. The discharge is at the entrance of the Senunu sub-sea canyon that extends to 3,000 m depth. The canyon is situated within the Lombok Basin and extends over 50 km southwards from the coastline of Sumbawa.

AMNT is planning to extend the life of the Batu Hijau open pit from 2025 to 2030 by an additional cut-back containing 460 million tonnes (Mt) of ore, bringing total pit ore inventory to 650 Mt. The expansion involves widening and deepening the pit. Subject to GoI approvals, processing rates would increase to around 80-90 Mtpa for the last six years of pit operation, primarily in order to offset declining copper grades and maintain concentrate production for Amman's smelter, which is scheduled to be operative from 2024 (Figure 1-2).

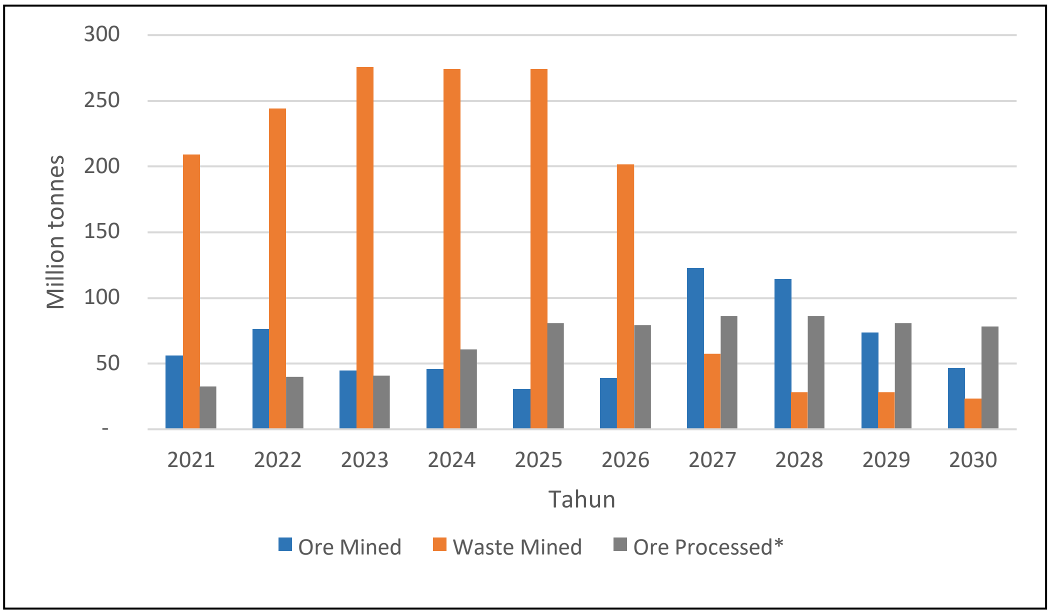


Figure 1-2 Expanded Pit and Process Production Plan 2021 – 2030

*including material from long term stockpile

1.2 Report Structure

The contents of this document are organised as follow.

1. **Introduction** briefly provides an overview of the Batu Hijau Mine, its history, importance, ownership, and location, as well as relevant aspects of tailings management.
2. **Environmental and Social Design Criteria** presents detailed standards and their underlying policies and procedures for environmental aspects of TSF design, drawn from the Government of Indonesia (GoI) and international requirements and guidelines.
3. **TSF Description** provides a detailed description of on-land Tailings Storage Facility construction and operation, focusing on the environmental and social impacts and inherent risks.
4. **DSTP Description** provides a detailed description of the current Deepsea Tailings Placement System focusing on known environmental and social impacts.
5. **Environmental and Social Setting** provides descriptions of environmental and social baseline conditions in relevant aspects of the atmosphere, lithosphere, hydrosphere, terrestrial and aquatic biosphere, and sociocultural and economic spheres.

6. **Identification of Environmental and Social Risks and Impacts** provides a summary assessment of potentially significant impacts and risks that must be managed for a TSF operation.
7. **Comparative ESIA** compares known and expected impacts and risks associated with DSTP and TSF tailings management schemes.
8. **Conclusions** summarises the key deductions from the assessment process.

1.3 Report Compiler

PT Greencorp Konsultan Indonesia (Greencorp) in Indonesia has prepared comparative Environmental and Social Impact Assessments from two perspectives:

- As an environmental consultant considering environmental and social challenges and opportunities; and
- From considering engineering risks which in turn result in environmental and social risks.

As such, the ESIA has been compiled by a team of International and national consultants and engineers with proven relevant expertise.

Dr Karlheinz Spitz MBA holds dual advanced degrees in civil engineering and business administration. Dr Spitz is an environmental consultant of international repute with more than 25 years of working experience in Indonesia. He is the lead author of the definitive textbook *'Mining and the Environment - From Ore to Metal'* published by Taylor & Francis/CRC Press (2nd edition in 2019), and the textbook *'Environmental Social Governance – Managing Risk and Expectations'*, published in 2021. His primary interest is the environmental assessment of large resource projects. Dr Spitz has worked on most major new mine developments in Indonesia since the early 1990s, covering a wide range of minerals and a diverse spectrum of environmental and social settings.

John Trudinger has more than 50 years of professional experience, including 30 years with Dames & Moore. Trained as a geologist, John has a solid background in geotechnical engineering as well as environmental sciences. This combination has proved most effective in assessing issues associated with mine tailings and waste rock disposal. John has worked throughout the world, specializing in the management of mine wastes and environmental impact assessment. Since 1985, John has been a frequent visitor to Indonesia, where he has consulted on most of Indonesia's major mining projects. On the Batu Hijau Project, his initial involvement was as Team Leader for the environmental permitting of the mine in the 1990s, followed by subsequent assignments. With Dr Spitz, John is co-author of *'Mining and the Environment – from Ore to Metal'* and *'The World of Mining.'*

Robert McDonough offers 45 years of experience in environmental management and assessment, including five years working as Environmental Safeguard Specialist for the World Bank in Washington. He has spent more than 25 years investigating, managing, and reviewing environmental projects in the United States, China, and Southeast Asia (particularly Indonesia), with experience in Africa, Latin America, Eastern Europe, and Iran. Projects have included mines, oil & gas fields, major manufacturing facilities and chemical plants, intercity roads, power stations, pipelines, ports, pulp mills, tree plantations, and tourism developments. Mr McDonough was based in Indonesia throughout the 1990s.

Risqia Fajrina MEM (Riri) who graduated from Bandung Institute of Technology majoring in environmental engineering, earned a master's degree in Environmental Management from the University in Madrid, Spain. Riri has worked as a consultant for large mining companies such as Adaro Group and Harita Group, and AMNT on the Batu Hijau mine expansion. She has been instrumental in completing mining feasibility studies and environmental impact assessments. She assisted in compiling the ESIA to support project financing of the MetCoal Project development in Kalimantan and the 2019 feasibility study for AMNTs' Elang Mine project located 60km east of Batu Hijau.

Zakirman Ibros is an Environmental Consultant with a bachelor's degree in Water Resource Management from Riau University in Indonesia. As a GIS specialist, Zakirman offers more than 20 years of experience in spatial and non-spatial data management, spatial analysis, image analysis and spatial modelling to assess the impact of activities and the ideal site selection.

1.4 Disclaimer

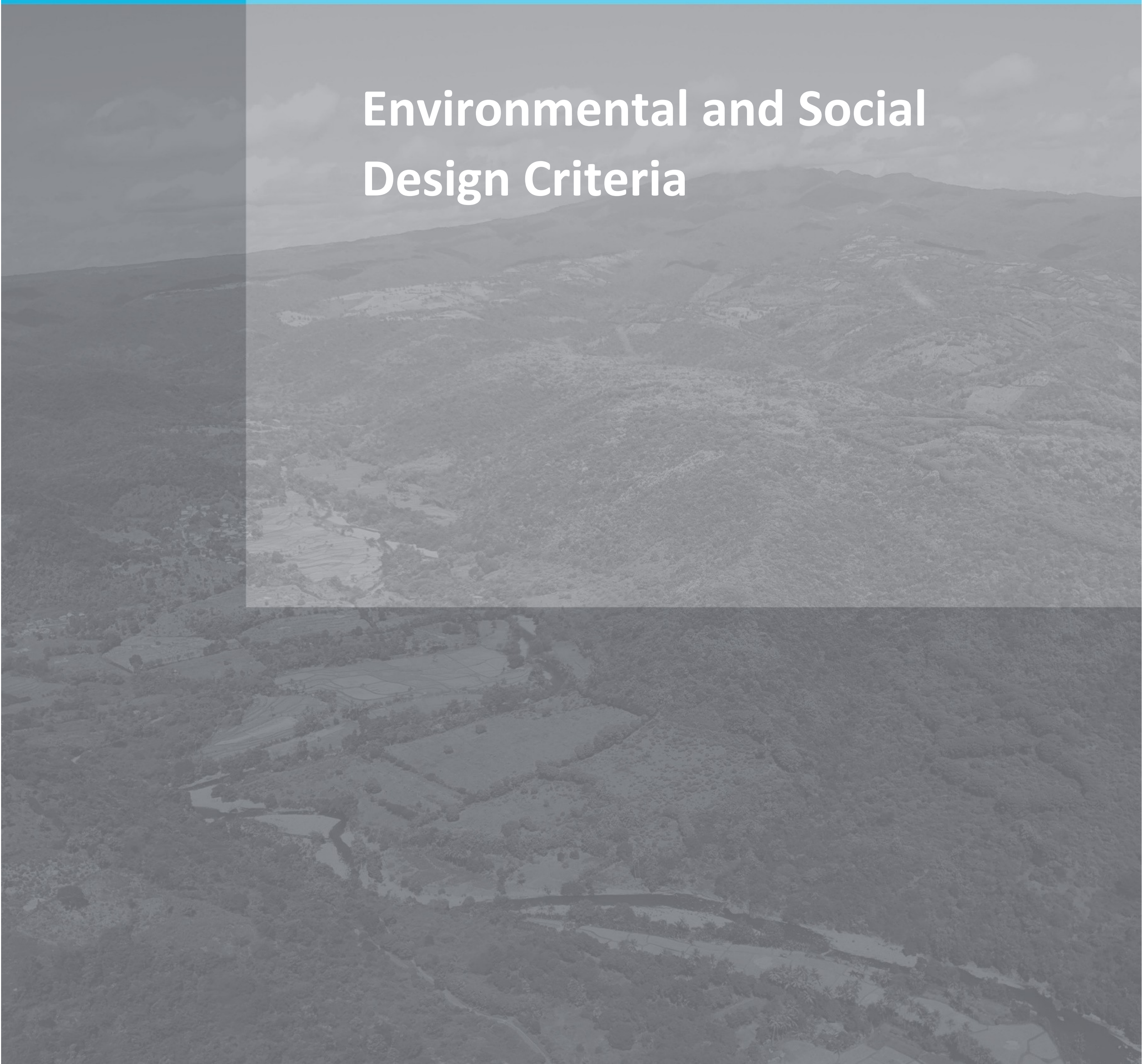
This report (the Report) has been produced independently by PT Greencorp Konsultan Indonesia (Greencorp) at the request of AMNT. The information, statements, calculations, and commentary (together the 'Information') contained in the Report have been prepared by Greencorp from publicly available material and from information provided by AMNT. Greencorp does not express an opinion as to the accuracy or completeness of the information provided, the assumptions made by the parties that provided the information or any conclusions reached by those parties. Greencorp has based the Report on information received or obtained on the basis that such information is accurate and, where it is represented to Greencorp as such, complete.

The Report (including any enclosures and attachments) has been prepared for the exclusive use and benefit of the AMNT and solely for the purpose for which it is provided. Greencorp does not accept any liability if the Report is used for an alternative purpose from which it is intended, nor to any third party in respect of the Report.

Greencorp has prepared the Report based on an agreed scope of work and acts in all professional matters as an advisor to AMNT, and exercises all reasonable skill and care in the provision of its professional services in a manner consistent with the level of care and expertise exercised by members of the environmental profession. Greencorp has provided its services effectively within the limitations imposed by the scope of work and the timeline and budgets allocated by AMNT.

02

Environmental and Social Design Criteria



2 Environmental and Social Design Criteria

This Design Criteria chapter presents the standards applied for environmental aspects of a TSF design, focusing not on the technical details but noting the underlying regulatory policies and rationale drawn from the Government of Indonesia (GoI) and international requirements and guidelines. Additionally, general applicable Environmental Design Criteria (EDC) are presented in the Appendix. To minimise environmental impacts, drive resource efficiency, limit waste, and assure compliance with GoI regulations and meet Good International Industry Practices (GIIP), EDC set detailed binding and nonbinding environmental performance standards.

Most of the environmental and social regulatory framework for tailings management, whether DSTP continuation or TSF development, remains as outlined in the 2021 Batu Hijau Addendum AMDAL and the requirements summarized in the Appendix of this report. AMNT is also bound to uphold its Health, Safety, and Environment (HSE) Statement of Commitment.

2.1 General Environmental Design Criteria

In common with the overall Batu Hijau mining operation, tailings management is subject to qualitative and quantitative EDCs, the latter ones defining allowable limits based on national and/or international regulations or guidelines for specific environmental aspects.

Regulatory limits are stipulated in Indonesia's national and provincial regulations. The regulatory, administrative framework applicable to the Batu Hijau tailings management is described in the 2021 Addendum AMDAL for the planned Batu Hijau expansion, in process at the time of this ESIA compilation, which is summarised in the Appendix of this report. It includes all Indonesian environmental, safety, and mining laws and applicable regulations. The Batu Hijau Project is also subject to social and land use regulations and international treaties and agreements to which Indonesia is a signatory.

It should be noted that some applicable regulations have been superseded/replaced by Government Regulation (PP) No 22 of 2021. The key aspects of the regulatory framework are summarised below, with further discussions of how these aspects apply to the DSTP and TSF tailings management schemes being addressed in the subsequent sections of this report.

- *Waste Rock Management*: Waste rock is rock that is excavated to expose the ore in quantities that depend on the topography, geometry, depth and mineralised grade of the ore body, along with the economic pit design which also depends of the geotechnically assessed stability of the rocks. With no specific regulations in Indonesia to guide waste rock management, relevant IFC guidelines provide the EDC and recommended management practices for waste rock dumps. These guidelines address:
    - Bench width and height specifications to minimise erosion and reduce safety risks, allowing for chemical or biologically catalysed weathering.
    - Management of Potentially Acid Generating (PAG) wastes consistent with Good International Industry Practices.
    - Mine Water Management system, including surface run-off management, collection, and treatment to meet relevant discharge standards.

- *Discharges to Water*: Criteria for effluent discharges involve a combination of discharge quality controls and ambient environmental quality standards, with the impact of effluent discharges on the receiving environment estimated using mathematical or numerical modelling. Applicable standards as set by Environment Minister Decree No 202 of 2004 are detailed in the 2021 Addendum AMDAL. Ambient water quality standards are established by the "omnibus" PP No 22 of 2021, Appendix VI, which maintains the quality classification of PP No 82 of 2001 on Water Quality Management and Water Pollution Control.
- *Stormwater Discharges*: Rainfall run-off is separated between undisturbed and disturbed areas at the mine and infrastructure sites. Clean water is diverted away from disturbed areas and directed into the natural watershed. "Dirty" water run-off is discharged to a settling pond system. Contaminated water collected in the mine pit and from workshops and stockpiles is collected and used in the process plant as process water. Runoff from the waste rock dumps and groundwater are channelled to settlement ponds before being as added to the process water. While stormwater management regulations exist, most of these considerations are based on Good International Industry Practices.
- *Waste Management*: Applicable laws and regulations differentiate non-hazardous and hazardous waste. The primary mine wastes are tailings and waste rock. These are high-volume waste streams whose management systems represent core aspects of the mining operations. Tailings from copper-gold processing are considered hazardous wastes, which obviously affect management systems. Ordinary non-hazardous wastes (trash and garbage) are not an aspect of tailings management.

Good International Industry Practices (GIIP) are applied where no in-country limits are available, with values for non-binding targets based on International Finance Corporation (IFC) or other appropriate international guidelines, such as those of the World Health Organization (WHO). Where levels and measures in regulations differ from those found in international guidelines, the most stringent values are used.

The IFC EHS Guidelines are technical reference documents with general and industry-specific examples of GIIP, as defined in IFC Performance Standard (PS) 3: Resource Efficiency and Pollution Prevention. Compliance with IFC requirements is considered as GIIP, commonly acceptable to International Financial Institutions and/or international lenders involved in project financing. As such, GIIP are derived from IFC guidelines, specifically the following:

- IFC Performance Standards;
- IFC General EHS Guidelines; and
- IFC EHS Guidelines for Mining.

2.2 Deepsea Tailings Placement Design Criteria

The Indonesian Ministry of Environment and Forestry (KLHK) has classified tailings from copper/gold mineral processing as B3 waste. An extensive study of AMNT's DSTP system by the Indonesian Institute of Sciences (LIPI) and others provided the basis for the National policy on DSTP (as reflected in PP 101/2014; see below).

The two key regulatory frameworks for both offshore and onshore tailings management are:

- PP 101/2014 on Hazardous and Toxic Waste Management, and
- PP 22/2021 on Provisions for Environmental Protection and Management, Appendix I, Table 4.

PP 101 of 2014 on Toxic and Hazardous Waste Management in Appendix I, Table 4, defines the requirements for DSTP, which closely match the conditions at the Batu Hijau DSTP location. Mine tailings are categorised as hazardous and toxic waste (appreciated as B3 waste in Indonesia) from a specific source (B3 waste code B416, Hazard Category 2). KLHK PP 12/2018 on Requirements and Procedures for Waste Disposal in the Sea provides further directives for DSTP. Appendix I of this regulation sets maximum total metal concentrations permissible in tailings disposed into the sea, as listed below.

Table 2-1 Maximum Total concentration permissible in tailings disposed into the sea

Metal	Symbol	Limit in mg/kg dry weight
Arsenic	As	500
Cadmium	Cd	100
Chromium	Cr	500
Copper	Cu	750
Lead	Pb	1,500
Mercury	Hg	75
Molybdenum	Mo	1,000
Nickel	Ni	3,000
Selenium	Se	50
Zinc	Zn	3,750

2.3 Tailings Storage Facility Development and Operation Design Criteria

The TSF, involving a dam built by a mining operation to contain wastes, would be subject to regulation by three ministries. This framework is addressed in the paper "Postmining Regulatory Framework for Tailings Dams in Indonesia" (Nur Anbiyak, Jajat Sudrajat and Putri Elma Oktavya, 2020). In brief, the regulators and their authorities are:

- Ministry of Energy and Mineral Resources (ESDM) regulates mining in general and tailings dams under PP No 78 of 2010 on Reclamation and Post-mining.
- Ministry of Public Works and Public Housing (PUPR) regulates planning, construction, operation, and elimination of dams under Ministerial Decree No 27 of 2015 on Dams.
- Ministry of Environment and Forestry (KLHK) regulates the placement of tailings that classify as hazardous and toxic waste under PP No 101 of 2014 on Hazardous Waste Management (as partially superseded by PP No 22/2021).

The authors conclude that, while tailings dam post-closure must aim at minimizing the risk of long-term structural failure that can impact the environment and society, the biggest challenge in Indonesia is the absence of policies that clarify maintaining and monitoring tailings dams after production operations have ceased.

The preliminary design and conceptual functioning of the Batu Hijau TSF are described in some detail in Chapter 4 of this document. It is important to understand that the decision to proceed with such an action would modify numerous elements of the Batu Hijau mining operation, including the Environmental Design Criteria outlined in section 2.1 above. These modifications are briefly identified below.

Waste Rock Management: Large quantities of the overburden excavated in the mine pit would be used to construct the TSF, at great financial cost and requiring massive expenditures in energy moving this material to the TSF site. With few specific regulations in Indonesia to guide the construction of tailings management structures, relevant international best practices and a detailed geotechnical-structural design would provide the Environmental Design Criteria and recommended management practices for the TSF. As noted in the TSF Description, after some years, the structure would represent a nearly unprecedented scale of the tailings dam, particularly among those constructed in seismically active humid tropical settings. (Nothing resembling it exists, or is likely to exist, in Indonesia.)

Discharges to Water: While the same criteria for effluent discharges as apply to the mining operation would also apply to the TSF, over time, the facility would become a structure on a similar scale as the mine pit and rock dumps. The problems of managing water in contact with tailings solids represent a large part of the challenge and the reason a recovery dam downstream of the main embankment is needed to allow recycling water to the mill.

Stormwater Discharges: Rainfall runoff within the Tebisu watershed would be a major part of the water management challenge represented by the TSF. The conceptual design description in this document addresses some of the inherent challenges. A detailed engineering design would be needed to address these in sufficient detail.

Waste Management: Massively accumulating tailings within the TSF will remain legally classified as toxic-hazardous (B3) wastes under Indonesian law. The TSF would thus be considered a B3 waste final disposal site, subject to regulation more or less as a landfill. As noted above, PP No 22 of 2021 (based on PP 101/2014) on Management of Hazardous and Toxic Wastes is the applicable rule. It does not appear to have completely superseded PP 101/2014.

PP No 101 of 2014) superseded PP No 85 of 1999; Indonesia's waste regulatory program, which has evolved since the early 1990s, reflects US Environmental Protection Agency and European Union experience in hazardous waste management. Additional considerations are established by two recent Environment and Forestry Minister Regulations: No 10 of 2020 on Alternative Solutions for Managing B3 Wastes and No 18 of 2020 on Beneficial Use of B3 Waste. The concept of regulating mine mill tailings as hazardous waste may be unique to Indonesia; the decision to classify copper-gold processing tailings as B3 waste also dates back to the early 1990s and reflects a high level of discomfort over PT Freeport Indonesia’s tailings management program.

Community Health and Safety: The discussion of riak in this document (Chapter 6 identification and Chapter 7 comparison of the two tailings management schemes) places in context the regulatory challenges the TSF would pose. If properly operated, the environmental impacts can be considered acceptable, if somewhat greater (and more visible) than the DSTP impacts. The risks are another matter and present threats of much more significant social and environmental effects.

The key issue regulators would need to deal with is the massive risk of embankment failure that would not only be inherent to the TSF but would also increase over time. While likely only a small number of residents in Tatar Village could be affected by such a catastrophic failure, additional risks need to be considered.

As outlined in Chapters 6 and 7, the Brang Tebisu bridge and the coastal road (Jalan Raya Tebisu in this area) for some distance to the east and west would be destroyed. The intertidal and shallow reef ecosystems and much of the reef slope at Teluk Tebisu would be buried in tailings and waste rock debris. Worse, the fine tailings material would be transported and redeposited for some distance east and west along the coast, causing damage to subsistence fisheries for at least some years. The reputational damage to AMNT would likely be much greater.

The paper referenced above alludes to the key problem with tailings dams being in the post-closure period. (The authors are from the Directorate for Coal and Mineral Engineering and Environment, Ministry of Energy and Mineral Resources; they presented this paper at the TPT XXIX PERHAPI 2020 conference.) They stated that there are currently 11 companies operating tailings dams in Indonesia, including only one company (Kelian Equatorial Mining), now in the post-mining/closure stage (since 2005).

ESDM requires a mining company to complete its Closure Plan prior to starting production, with post-closure management and monitoring of tailings dams in accordance with the Plan. The paper's authors speculate that, since a mining permit can extend to a maximum of 40 years, that could establish the limits on post-closure care. KLHK requires environmental monitoring for 30 years after the termination of waste (tailings) placement. PUPR requires the management of dams after their function ceases for an unlimited period.

While the DSTP risks diminish to nil after mine closure, the TSF risks will at best remain the same. In fact, the risks are likely to increase with time and the inevitable reduction of maintenance and monitoring. The ESDM authors clearly identify their ministry's issues with this regulatory challenge and identify the only solution being to "synchronise policies."

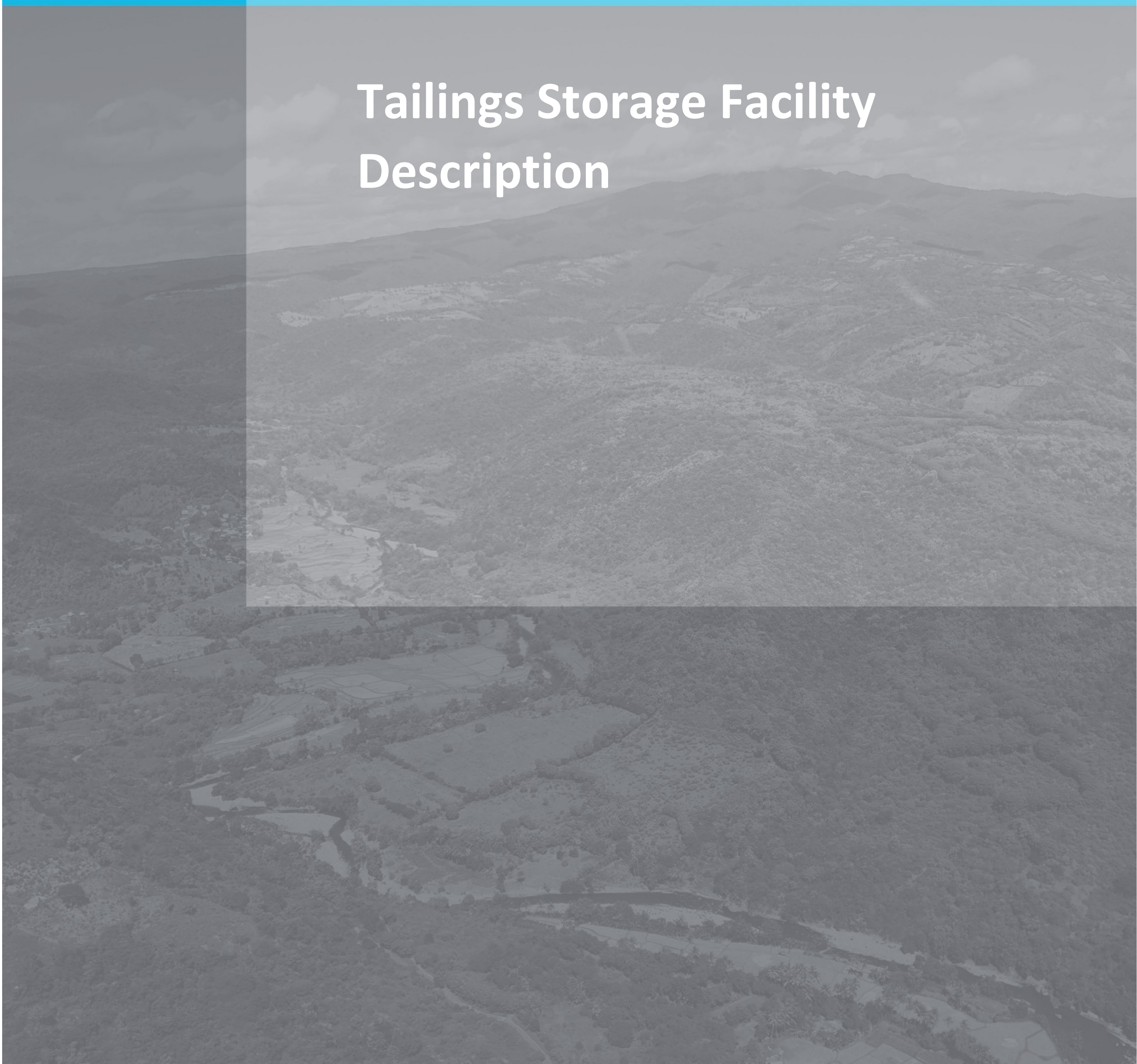
KLHK's thinking is oriented toward a toxic waste landfill. By 30 years after closure, any structural integrity or contaminant transport problems should have been identified and resolved, and the facility presumably will reach a stable state.

Only Public Works has regulations that reflect the reality that a dam structure in place remains a permanent public safety hazard. Their general orientation is, of course, to public sector proponents, who normally remain in business indefinitely.

Approached as a permitting effort to be synchronised among at least three ministries, plus local and regional governments, regulatory approval of the Tebisu TSF would be far from a foregone conclusion.

03

Tailings Storage Facility Description



3 Tailings Storage Facility Description

Two site selection studies were carried out to indicate the most suitable site for a potential TSF based on safety, environmental, proximity to processing plant, mining and infrastructure lease boundaries and cost considerations. Both studies indicated that the Tebisu Valley, located to the south of the main Tongoloka waste rock dump, is preferable to other possible locations. Subsequently, a preliminary feasibility study (PFS) for a TSF at this location was carried out by engineering consulting firm Pells Sullivan Meynink (PSM). The project description that follows is based on a draft of PSM's PSF Batu Hijau TSF draft report (September 2021).

[Note: Some documents refer to the Brang Tebisu watercourse and drainage area as Brang Puna, which is the very small coastal watershed immediately west of the southern (downstream) portion of the Tebisu watershed (in Indonesian DAS, meaning river flow area). This confusion may reflect inconsistent local usage.]

3.1 Conceptual Design

Figure 3-1 shows the overall layout of the existing Batu Hijau mine together with the preliminary TSF located in the southeast corner of the IUPK lease boundary.

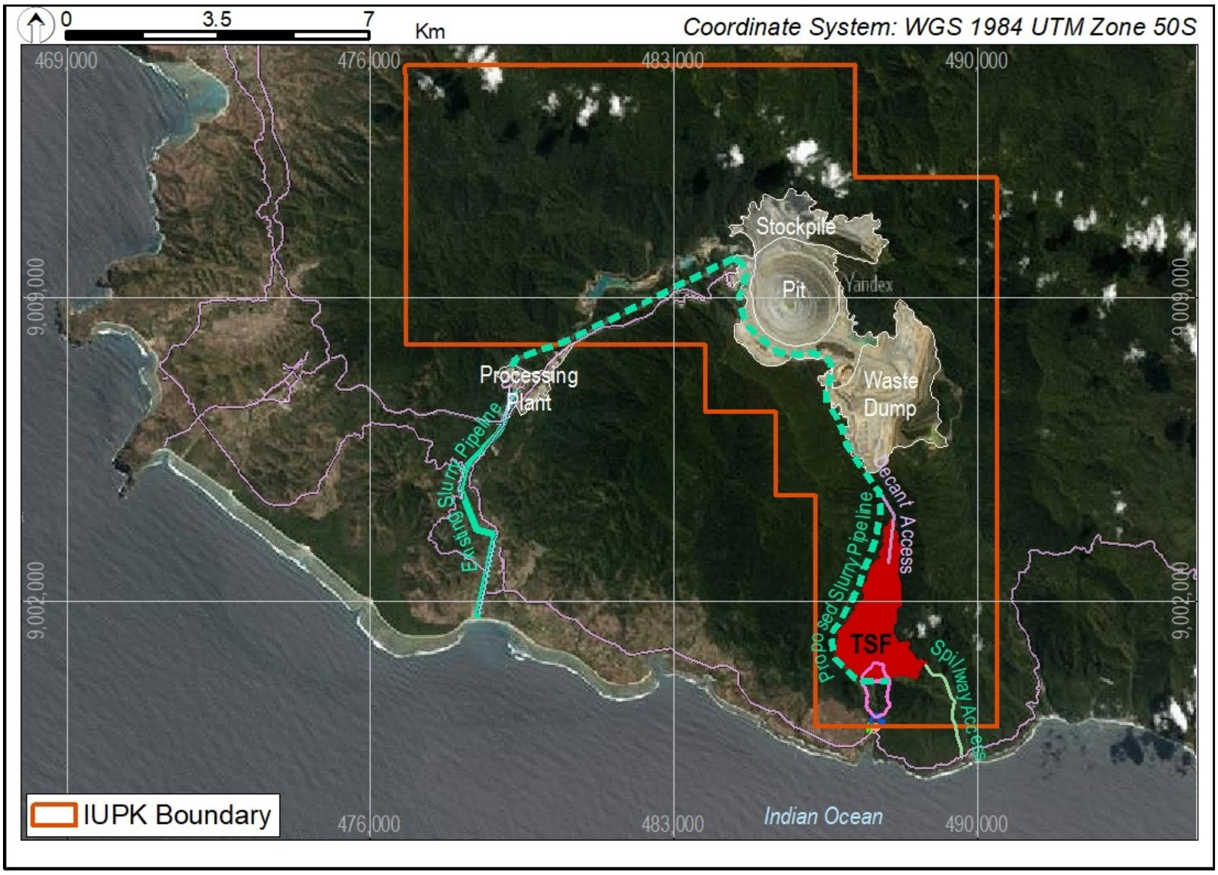


Figure 3-1 Site Overview

A two stage TSF would include the following:

- Final rockfill embankment, 270 m in height, constructed in two stages using waste rock from the Batu Hijau open pit.
- 0.5 m thick compacted clay layer placed on the upstream face of the embankment and a permeable rock underdrain zone placed at the base.
- Decant system comprising a series of decant inlets draining to a decant pipe extending beneath and emerging downstream beach from the embankment.
- Operation stage spillway system with a vertical spillway inlet that would be raised periodically above the tailings storage level, leading to an outfall near the coastline via a tunnel beneath the embankment.
- Initial Return Water Dam (RWD) located immediately downstream of the downstream face of the Stage 1 embankment with a subsequent RWD constructed downstream of the Stage 2 embankment.
- Closure of the TSF would include re-contouring and capping the surface to direct drainage to a new spillway, to be excavated through the valley wall into the adjacent valley to the east, followed by rehabilitation of the TSF surface.

Figure 3-2 and Figure 3-3 show the plan layouts of Stages 1 and 2.

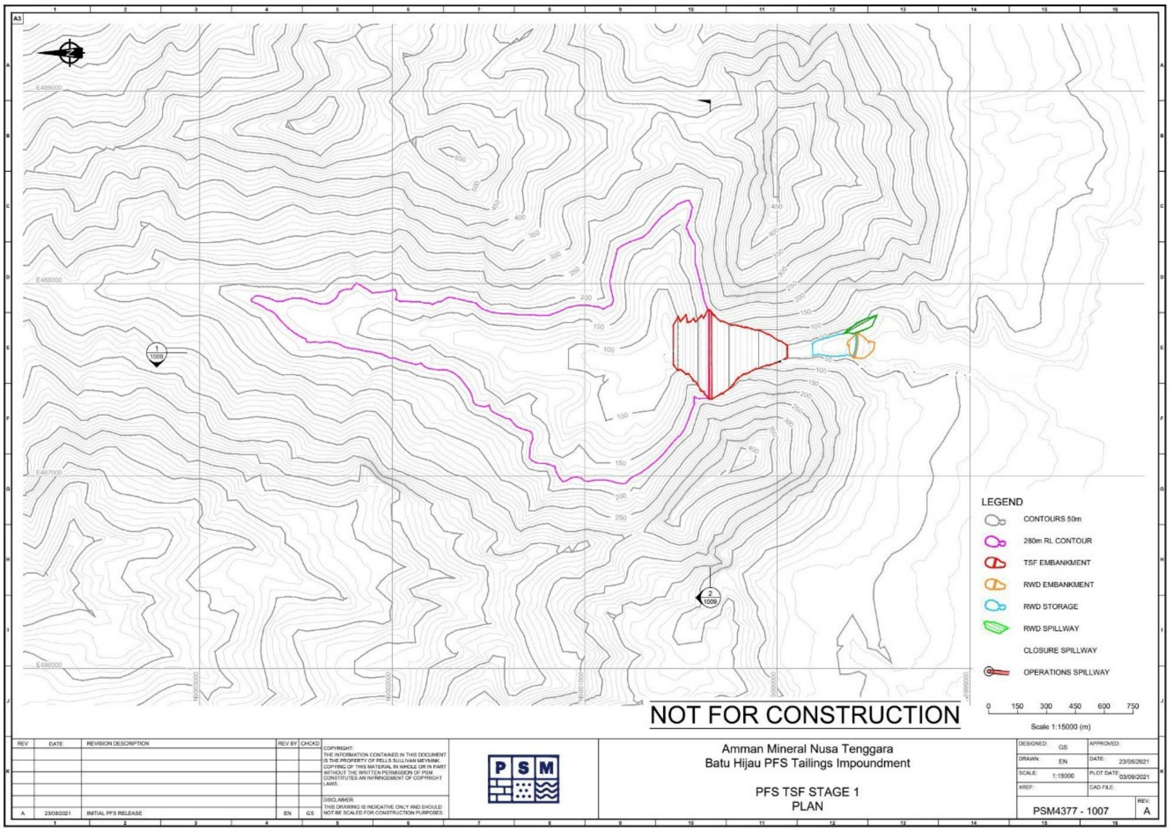


Figure 3-2 TSF Stage 1 Plan

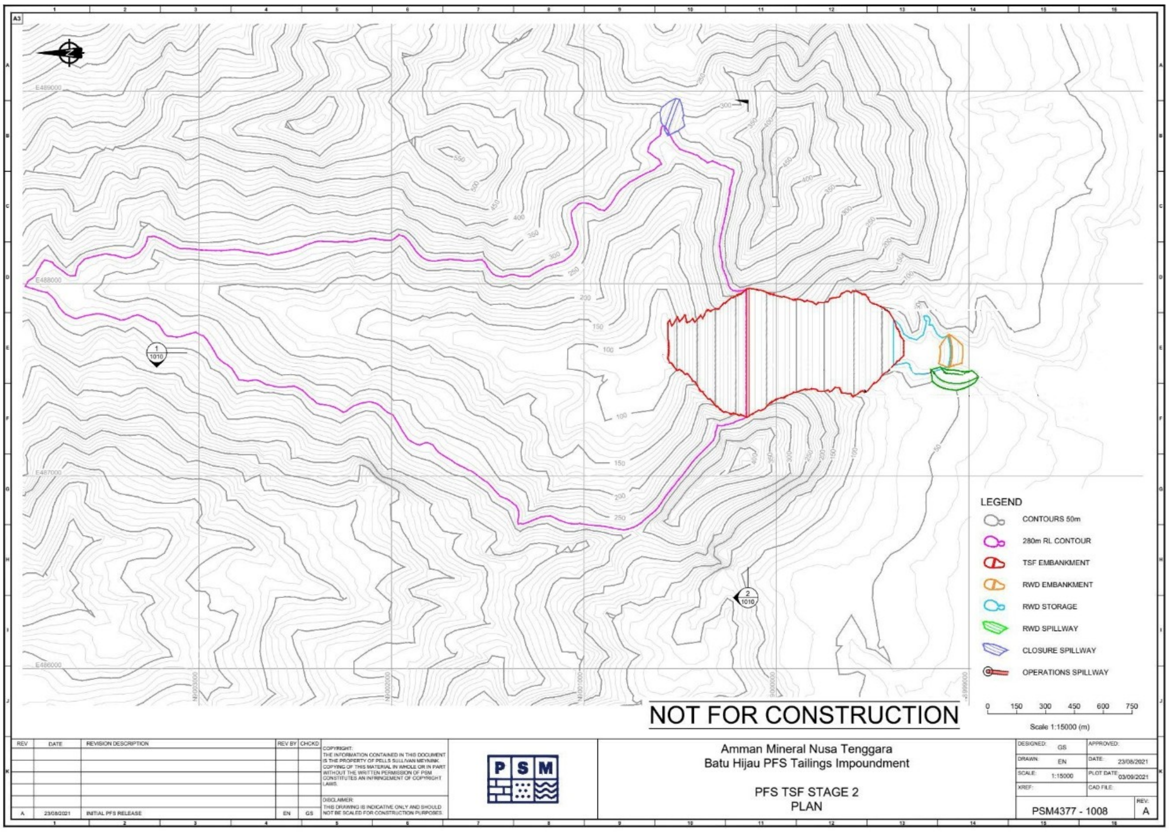


Figure 3-3 TSF Stage 2 Plan

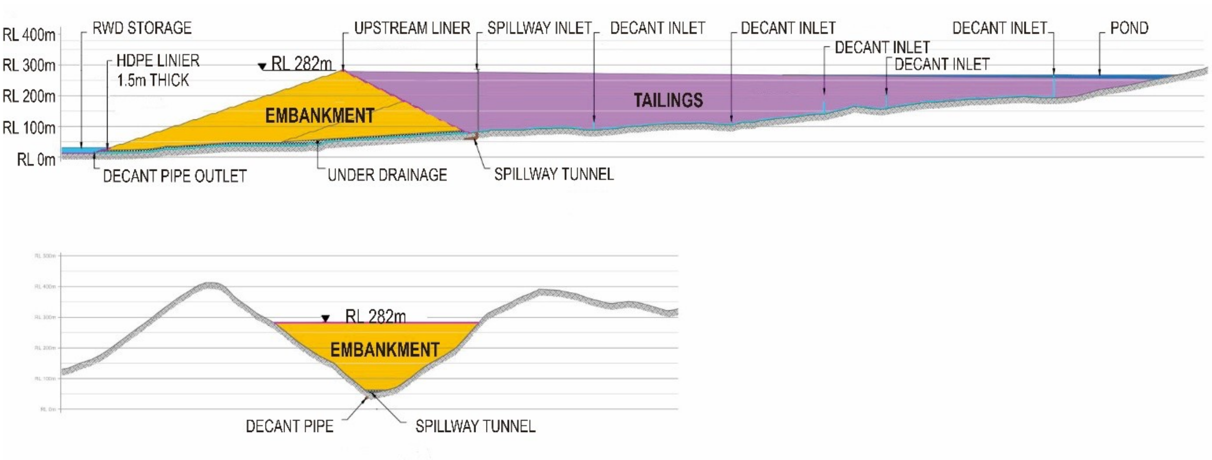


Figure 3-4 Longitudinal Section and a Cross-section through the TSF

The main dimensions and quantities associated with the preliminary TSF design are shown in Table 3-1. The design is based on limited site investigations supplemented by assumptions. Accordingly, if geotechnical and hydrology studies were undertaken, the design, dimensions and quantities could change.

Table 3-1 Preliminary TSF Design – Dimensions and Quantities

Dimensions and Quantities	Stage 1	Stage 1 and Stage 2
Embankment height	144 m	270 m
Embankment length	460 m	665 m
Crest width	12 m	12 m
Overall slope of upstream face	2H:1V (26.6°)	2H:1V (26.6°)
Overall slope of downstream face	3H:1V (18.4°)	3H:1V (18.4°)
Benches on downstream and upstream faces	10 m benches every 20 m height	10 m benches every 20 m height
Volume of rockfill required	6.2 million m^3	38.1 million m^3
Volume of Clay Liner Required	34,500 m^3	65,500 m^3
Embankment footprint area	15 Ha	53 Ha
TSF footprint area	153 Ha	385 Ha
Tailings storage capacity	92 million dry tons	433 million dry tons
Minimum operating freeboard	2 m	2 m
Indicative time to fill[a]	1.7 years	9.7 years
Length of streambed buried	3,170 m	4,960 m
RWD footprint area	3.7 Ha	7.7 Ha[b]
RWD height	28.5 m	18.5 m[c]
RWD storage volume	182 million litre	613 million litre[d]
RWD catchment area	42.2 Ha	60.6 Ha

[a]Based on Estimates made in the PFS.

[b]Excludes Stage 1 RWD area as that is included in Stage 2 embankment footprint area.

[c]Excludes Stage 1 RWD height as that is included in Stage 2 embankment.

[d]Excludes Stage 1 volume.

3.2 Construction

The TSF would be constructed in two stages: Stage 1 embankment would be 144 m in height and Stage 2 would extend to a total height of 270 m. Construction would include the following activities:

- Removal of vegetation, stockpiling of salvageable timber, and grubbing of roots.
- Stripping of topsoil to an average assumed depth of 30 cm and stockpiling in designated area located outside the TSF footprint.
- Installation of the decant pipe with initial decant inlet.
- Construction of 2,000 m spillway to the coast.
- Connection of initial spillway inlet.

- Waste rock from the Batu Hijau pit transported and placed as the underdrainage rock layer.
- Construction of the embankment with waste rock placed in thin layers and compacted by the construction equipment traffic.
- Placement and compaction of 50-cm thick clay layer on the upstream face of the embankment.
- Construction of the RWD and associated spillway including synthetic liners.

3.3 Operations

The TSF's operation would include:

- Tailings, as a slurry with 36% solids by mass, delivered by pipeline from the process plant.
- Discharge of the tailings from a series of spigots located along the upstream face of the embankment.
- The coarser tailings solids deposit near the embankment forming a beach with a pool of supernatant water located further upslope: Raising the spigots the beach level rises.
- Water is decanted from the supernatant pool through the decant inlets connected to the decant pipe discharging to the RWD.
- Drainage from the embankment and local stormwater run-off collected in the RWD.
- Water is recycled from the RWD to the process plant for use.
- The decant inlet is raised periodically to maintain clear decant water.
- Additional decant inlets are established further upstream from the embankment as the level of deposited tailings beach rises.
- Daily visual inspections and continuous instrumental measuring of key parameters such as water levels and underdrainage flow rates used to monitor the tailings operation.

3.4 Closure

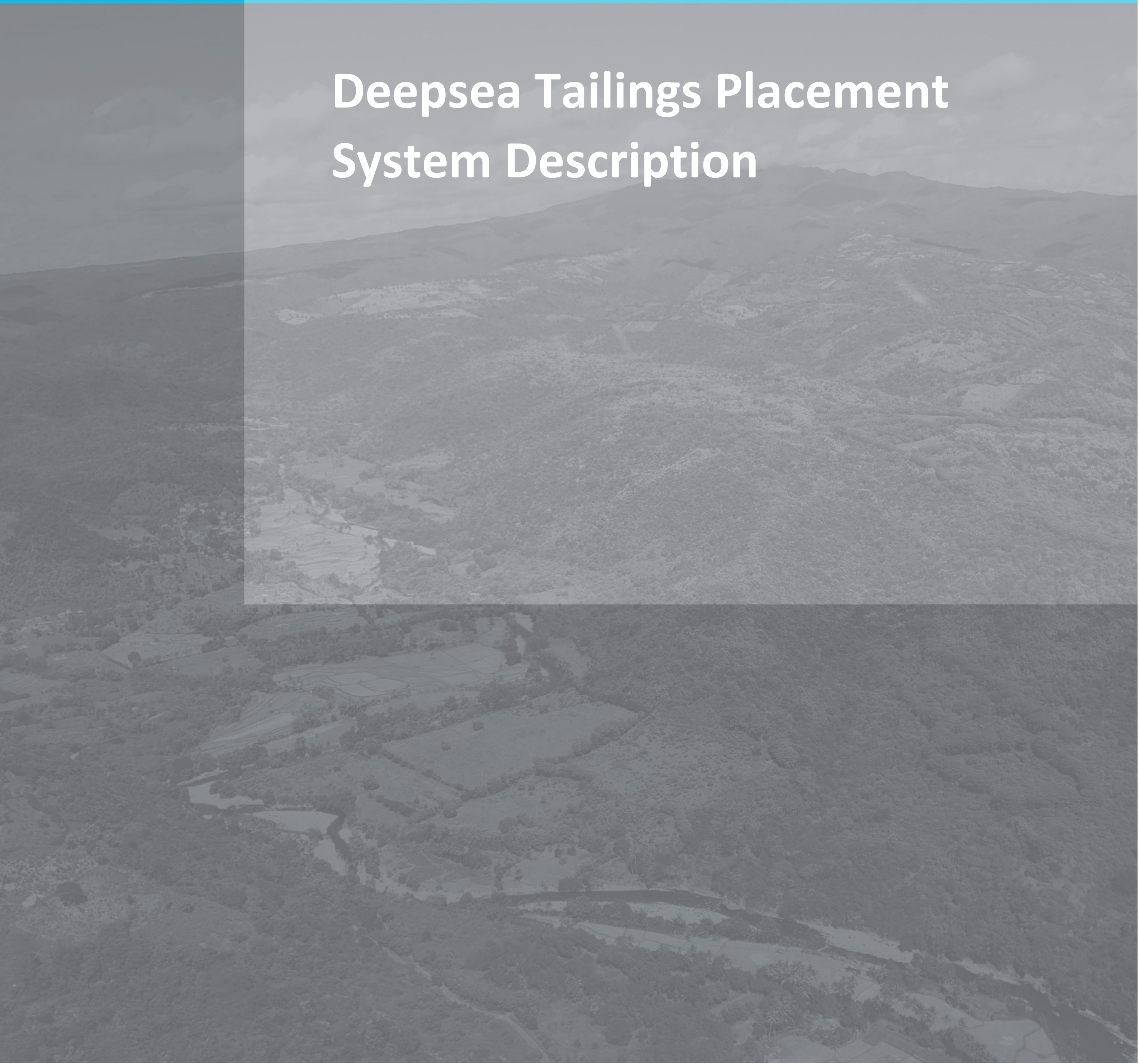
Prior to the cessation of tailings disposal into the TSF, a closure plan would be required to address:

- Sourcing of material required for capping of TSF surface,
- Re-contouring plan of the surface to ensure adequate surface water management in pertpetuity,
- Scheduling of the re-contouring and capping activities based on predicted consolidation and trafficability conditions,
- Re-handling and spreading of stockpiled topsoil,
- Revegetation, and
- Monitoring schedule and procedures.

Greencorp understands that the TSF Closure Plan would need to be submitted to GoI authorities for approval. Any additional requirements from the authorities would need to be incorporated into the plan prior to its implementation.

04

Deepsea Tailings Placement System Description



4 Deepsea Tailings Placement System Description

Large quantities of tailings have been discharged into the deep sea since the Batu Hijau project commenced production in late 1999. The total quantity of tailings deposited up to the end of 2020 amounted to nearly 800 million dry metric tons. Under the DSTP system, the tailings are discharged as a slurry (containing 25% to 30% solids) through one or more outfalls located just above the seabed at a water depth of 125 m. Under the proposed expansion scenario, the discharge would increase from rates of up to 48 million dry metric tons per year to a maximum of 83 million dry metric tons per year, with an estimated total quantity of deposited tailings of 1,560 million dry metric tons by the end of production in 2032.

The existing DSTP system involves 6 km long overland pipeline to the coast, connecting with a 3.5 km subsea pipeline on the seabed, terminating in an outfall at a water depth of 125 m. (There are in fact two subsea pipelines, one in use and the other on standby.) From the outfall, the tailings slurry flows down the axis of a submarine canyon as a bottom-attached density current. Some tailings solids temporarily settle on the canyon floor, but slumping events subsequently transport these deposits into very deep water.

The most significant impact of DSTP is the burial of organisms along the canyon axis and on the abyssal plain below a water depth of 4,000 m. In assessing this impact, it is essential to recognise that the deep-water ecosystem has very low biodiversity and low productivity. In the original Batu Hijau ANDAL, it was predicted that tailings would not rise above the outfall depth of 125 m. Extensive monitoring over the past 20 years has confirmed this prediction. This is highly significant because the productive marine ecosystems, including coral reef, phytoplankton and pelagic fish habitats, are located within the photic zone, extending from the surface to a depth of less than 100 m.

4.1 Construction

Tailings from the new processing plant would be handled similarly to the existing arrangement, except that there would be an additional thickening stage. Tailings from the thickener would flow by gravity to a new deaeration tank which would ensure that the tailings slurry no longer carries air bubbles when entering the tailings pipe. From the deaeration tank, which is at an elevation of 106 m above sea level, the tailings would flow by gravity through an above-ground 1105 mm diameter steel tailings pipeline for approximately 6 km to the coast. At the coast, the tailings would enter a 3.5 km HDPE (high density polyethylene) pipeline installed on the seabed, extending to a depth of 125 m below sea level.

This new DSTP system includes one onshore tailings pipeline and two marine tailings pipes (one on duty and one on standby). Thus, after the development plan is implemented, there would be two marine tailings pipes operating (one existing pipe and one new pipe) while the other two marine pipes (one existing pipe and one new pipe) would be on standby. The land required for the additional onshore pipeline is about 15 Ha in forest areas and 8 Ha in non-forest areas. An additional 6.6 Ha will be required for supporting facilities.

The existing and future DSTP outfalls would be separated as shown on Figure 4-1, but all have been sited to discharge into the Senunu Canyon, which serves to direct the tailings flow down the seabed slope to a water depth of around 4000 m.

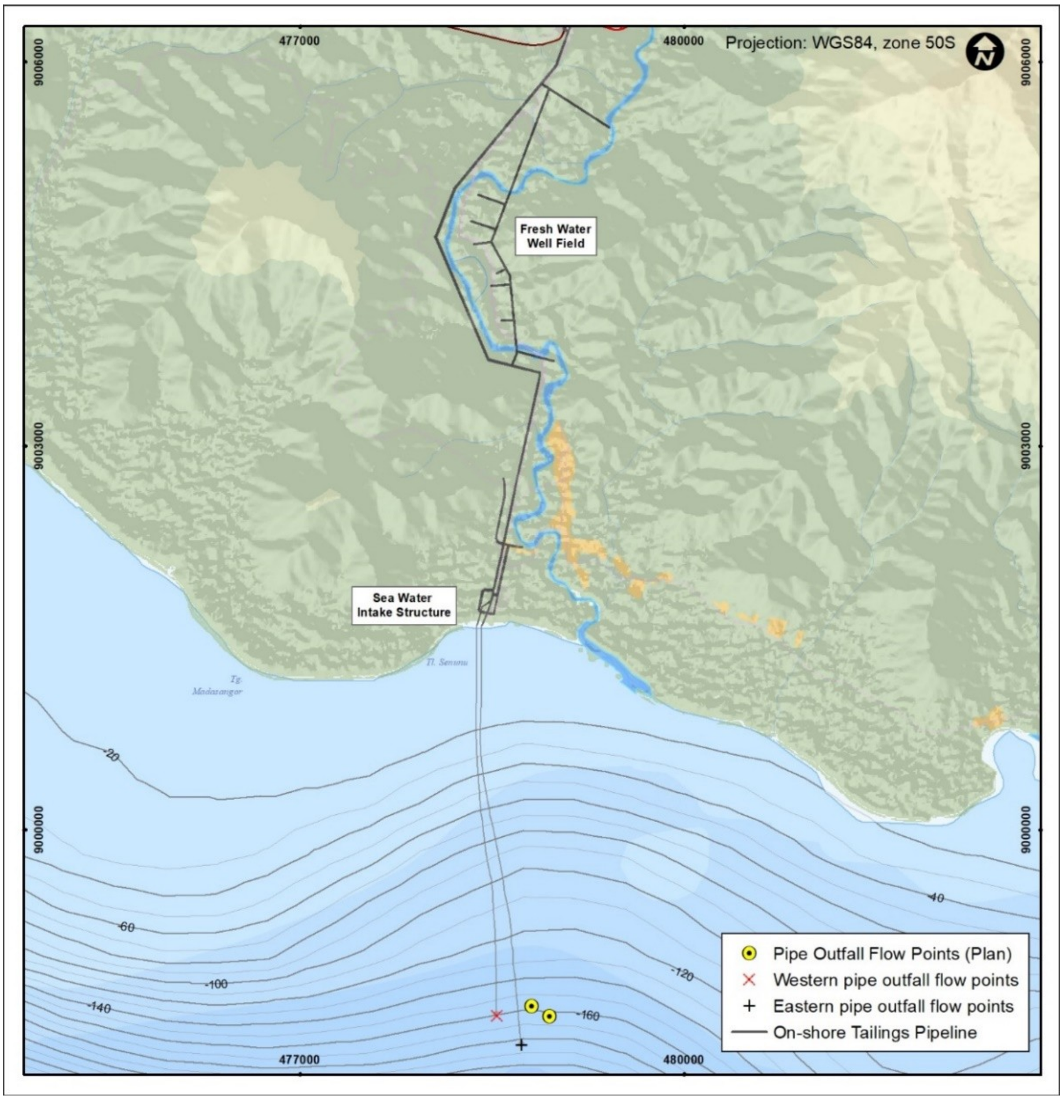


Figure 4-1 DSTP Pipeline and Outfall Locations

4.2 Operation

The management of tailings from the auxiliary treatment facility will be like the existing operations, with an additional thickening stage before the tailings flow by gravity to the deaeration tank. This serves to ensure that the tailings slurry no longer carries air bubbles when entering the tailings pipe. From the deaeration tank at an elevation of 106 m above sea level, the tailings flow by gravity through a 1.12 m diameter tailings pipe for 6 km to the beach, thence through the seabed tailings pipe for approximately 3.5 km to the outfall at a water depth of 125 m below sea level in the upper reaches of the Senunu Canyon.

To maintain the stability of the tailings flow in the pipe, the slurry surface height in the deaeration tank is maintained by automatically adjusting the addition of process water in the tailings channel leading to the deaeration tank.

Monitoring procedures include:

Onshore pipeline

- Twice each shift - visual inspection by operational patrols
- 6 monthly (aligned with Total Plant Shutdown) internal inspections
- Ongoing 24/7:
    - Upstream and Downstream choke pressure is regularly monitoring by field and control room operator.
    - Tailbox level is monitored.
    - Make up water addition flow control is monitored.

Offshore pipeline

- Six month/yearly operation Inline inspection uses smart pigging system to measure thickness and welding joint condition.
- Weekly External measurement uses non-destructive testing at transition area (just close to onshore joints).
- Monthly Subsea ROV (remote operating vehicle) inspection of all seabed pipelines includes permanent anchors and clamp weights.

4.3 Closure

Following completion of production, the pipelines would be flushed with water and then retrieved, with the potential to be re-used for the same or different purposes. Associated facilities would also be removed, and the pipeline corridor would be revegetated. No rehabilitation would be carried out in affected seabed areas, as studies have shown that seabed organisms readily repopulate deposited tailings. At least one detailed marine survey would be carried out to monitor the progress of biological recovery.

05

Environmental and Social Project Setting

5 Environmental and Social Project Setting

5.1 Atmosphere

The climate of eastern Indonesia, including Sumbawa Island, can generally be categorized into two distinct seasons due to monsoon and trade winds. Dry south-easterly trade winds from May to October result in the dry season. From November to April, the wet season is due to north-westerly winds originating from mainland Asia and the Indo-west Pacific Ocean carrying air masses. Over 85% of average rainfall occurs during the wet season, also referred to as the west monsoon. This period is also characterized by higher humidity and warmer temperatures.

AMNT monitors meteorological conditions (wind speed, wind direction, relative humidity, temperature, and pressure) at weather stations WS-1B near the mine site, and WS-2A near the port site.

5.1.1 Temperature

As shown in Figure 5-1 the temperatures at WS-1B are fairly constant throughout the year with a diurnal variation typically around 10 °C.

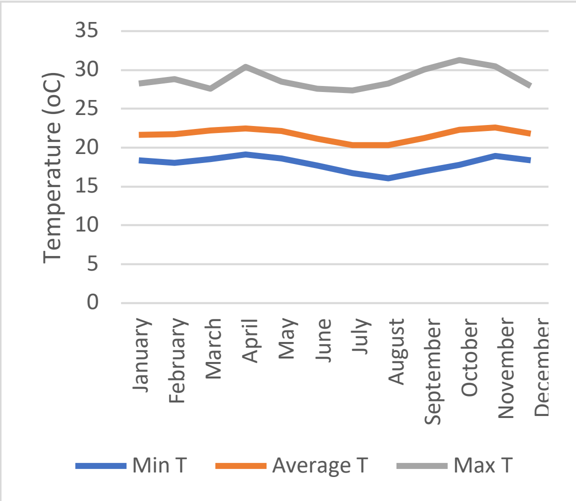


Figure 5-1 Average Monthly Temperatures Near Batu Hijau Mine Site

5.1.2 Rainfall

AMNT has been collecting rainfall data in the Batu Hijau mine area since 1994, for the purpose of calculating the frequency and intensity of heavy storms and floods. These data are important for water management. AMNT operates 14 automatic rain gauges in and around the Batu Hijau mine operations. Figure 5-2 shows three of these monitoring stations, each located at a different elevation: RF2A (Brang Tartalorka) is located at around 120 m above mean sea level (msl); RF4 (Brang Rengit) is located around 325 m above msl, and RFEV3 (Concentrator) is located at around 50 m above msl.

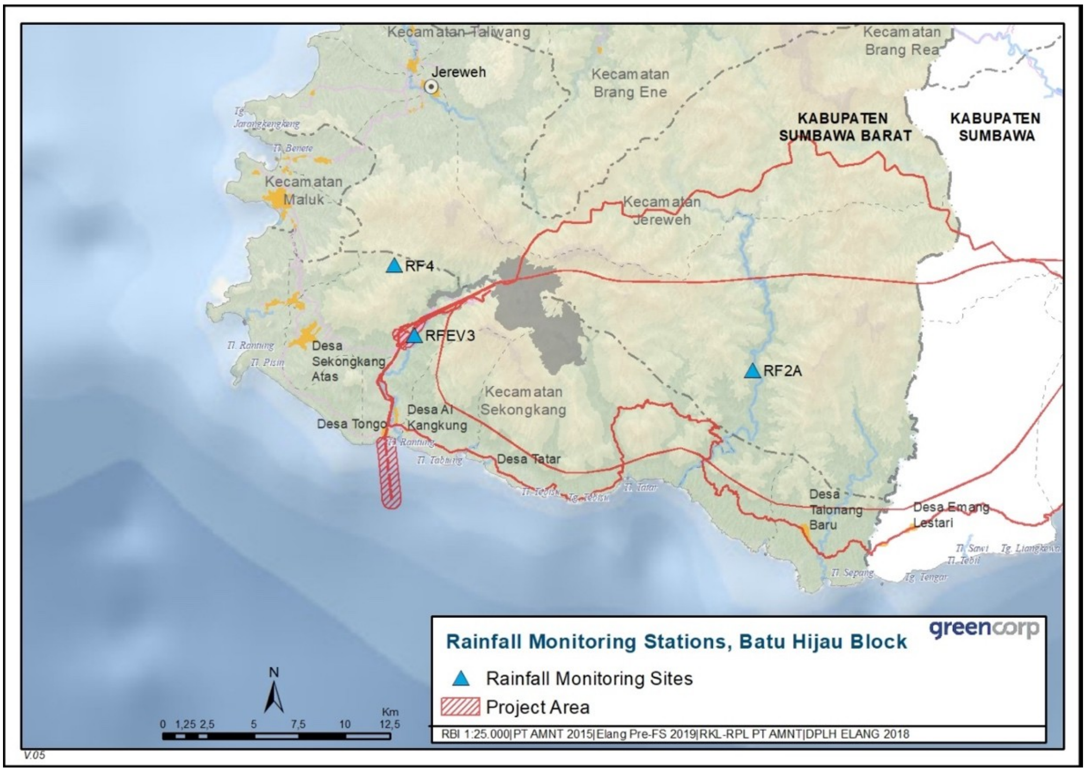


Figure 5-2 Rainfall Monitoring Locations

Rainfall data from the Batu Hijau area shows annual rainfall ranging from 942 mm to 3,381 mm at different rainfall stations, with the higher totals generally occurring at higher elevations. Low rainfall is typically observed from May to October (dry season), while high rainfall tends to occur from November to April (wet season). Figure 5-3 shows monthly rainfall (2013-2017) at stations RF2A, RF4, and RFEV3. The average annual rainfall among the three stations was 1,869 mm, with the highest annual rainfall at the high-altitude site, RF4).

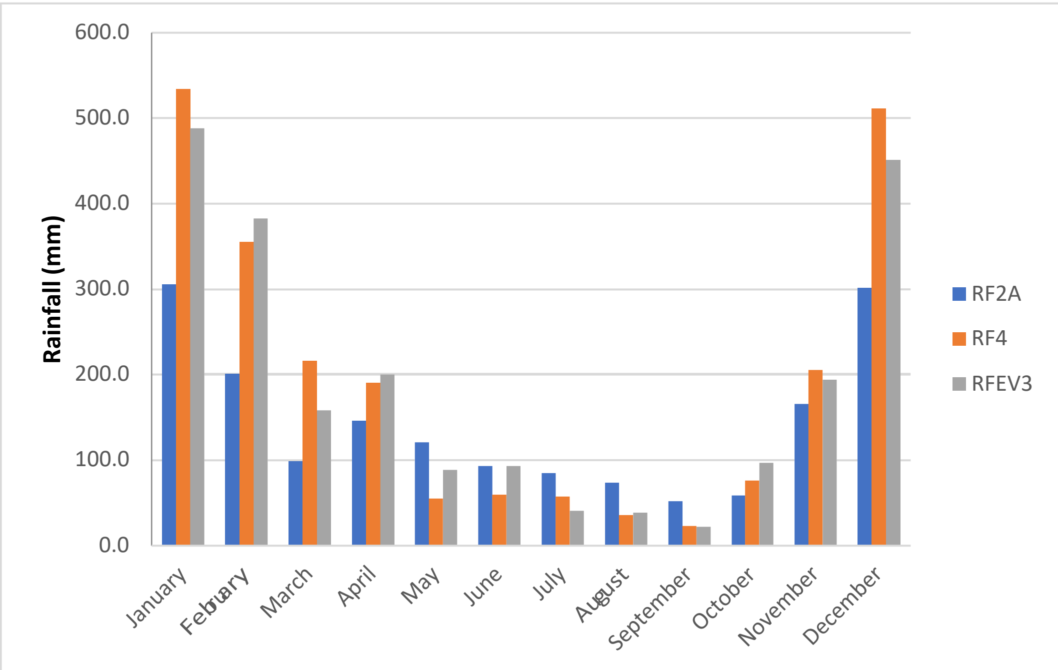


Figure 5-3 Monthly Average Rainfall at Three Stations

5.1.3 Wind

Wind speed is monitored at Weather Station WS-1B near the mine site, and the results of monitoring between 2013 and 2021 are summarized in Figure 5-4. Average monthly wind speeds tended to cycle regularly, with peaks occurring late in the dry season. At WS-1B, average wind speeds ranged from a high of 3.7 m/s to a low of 1.2 m/s. The dominant wind direction is from the southeast.

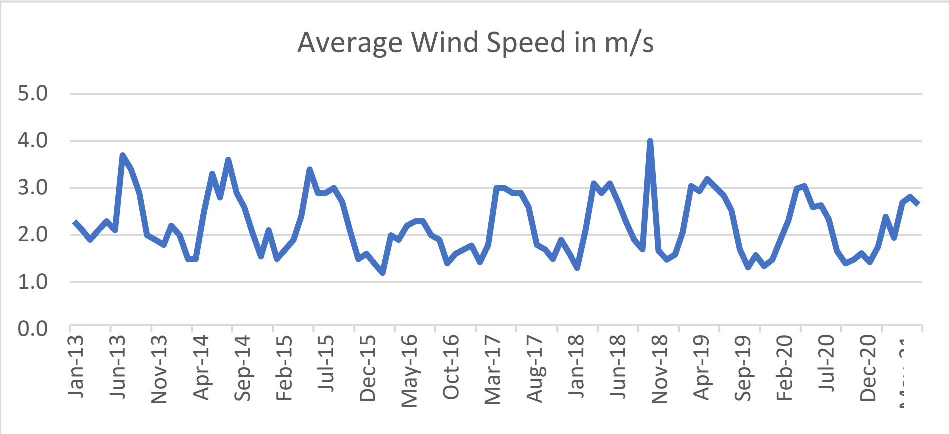


Figure 5-4 Average Wind Speeds Near Batu Hijau Mine Site

5.1.4 Air Quality

AMNT monitors air quality at three locations: Benete, Sejorong and Sekongkang. At all these locations, monitoring has demonstrated that air quality parameters meet regulatory standards. As the TSF location is further from potential sources of air pollution, it could be expected that concentrations of potential pollutants would be even lower - well below regulatory standards. There could, however, be occasions when airborne particulates enter the TSF area from burning activities in agricultural areas to the west.

5.2 Lithosphere

Indonesia lies within the “Ring of Fire”, an area known for volcanic eruptions and earthquakes due to frequent collisions between tectonic plates, particularly subduction. On Sumbawa Island, there are several inactive volcanoes and one active volcano, known as Mount Tambora. Mt. Tambora erupted in 1815, causing volcanic ash rains as far away as Borneo and an estimated death toll of 70,000. At the northeast of the Island, there is another active volcano called Sangeang Api on Sangeang island, part of the lesser Sunda Island. It last erupted in 2014 with ashes extending 15-20 km into the atmosphere with ash accumulations more than 1.0 m thick in the Batu Hijau area .

5.2.1 Topography

The TSF site is located within the Tebisu Valley, one of numerous valleys draining from a ridge in the north reaching elevations up to 840 masl, for a distance of 6.7 km to the south coast of western Sumbawa. The Tebisu Valley is relatively small: up to 2.4 km wide with an area of around 11.6 km^2. Slopes are around 20 ° near the valley base, steepening to around 30 ° toward the ridgelines. The main riverbed gradient ranges from 1 in 20 (3°) in the central part of the TSF footprint, to steeper than 1 in

10 (6°) near its headwaters. A small bay – Teluk Puna - forms the coastline at the mouth of the Tebisu River with little or no estuary. A coastal plain up to 2 km wide extends west from Teluk Puna.

5.2.2 Geology

The main geological units around Batu Hijau are Tertiary andesitic metavolcanics, including ash, lapilli tuff, and breccias. The bedrock beneath the TSF site is likely to be mainly volcanic breccia and volcaniclastic tuff. The bedrock is extensively weathered, typically to a depth of 20m and up to 50 m at higher elevations. Colluvial soils are present on valley slopes, and alluvial terraces are present along the valley floor with alluvial sand, gravel and boulder deposits generally 1 to 5 m thick.

5.2.3 Seismicity

The Indonesian archipelago is one of the world's most tectonically active areas. Numerous earthquakes with magnitudes up to 7.0 have occurred within 200 km of Batu Hijau, with earthquake depths varying from shallow to 640 km. Many of the largest of these earthquakes are associated with movement along plate boundaries to the south. As well as causing damaging ground motion, the larger earthquakes have the potential to cause serious tsunamis affecting the south coast of Sumbawa.

As part of the PFS for the TSF, a site-specific, probabilistic seismic hazard assessment was carried out by PSM to assess the likely level of earthquake shaking that a TSF could experience. Based on an assumed shear wave velocity of 400 m/s, Potential Ground Accelerations (PGAs) were estimated for Annual Exceedance Probabilities (AEPs) ranging from 1 in 475 to 1 in 10,000, with results shown in Table 5-1.

Table 5-1 Potential Ground Accelerations for Different Annual Exceedance Probabilities

Earthquake Annual Exceedance Probability	Peak Ground Acceleration (Mean Value)
1 in 475	0.39 g
1 in 1000	0.48 g
1 in 2000	0.59 g
1 in 2,500	0.63 g
1 in 5,000	0.74 g
1 in 10,000	0.87g

Source: PSM's PSF Batu Hijau TSF draft report (September 2021)

g is acceleration due to gravity

These PGA values are very high to extreme. It should be noted that no seismic hazard due to potential movement along local faults has been considered in this assessment.

5.3 Hydrosphere

The TSF watershed totals about 1,192 hectares, much of it being occupied by the TSF at the final development stage. Brang Tebisu, like the other coastal drainage streams on the Sumbawa South Coast, is short in length, with a steep gradient in its upper reach and a limited estuarine habitat near the coast.

5.3.1 Surface Water

Stream flow measurements have not been carried out in the Tebisu catchment but relevant data are available from nearby catchments. As is the case with other streams in the area, flows can be expected to range from very low or zero late in the dry season, to high following intense, wet season rainfall events.

AMNT operates seven stream gauges in catchments in the vicinity of Batu Hijau. Data from individual gauges spans periods of 22 to 25 years. From comparison of the catchment areas, mainstream lengths and streambed slopes of the gauged catchments with those of the TSF catchment, PSM has calculated peak flows to the TSF for a range of Annual Exceedance Probabilities, as shown in Table 5-2.

Table 5-2 TSF Catchment Peak Flows

Annual Exceedance Probability	Peak Flow (m^3/sec)
1 in 2	9.7
1 in 3	16.5
1 in 5	25.4
1 in 10	37.0
1 in 20	49.9
1 in 50	69.6
1 in 100	84.6
1 in 200	105.6
1 in 500	129.7
1 in 1000	149.4
1 in 2000	170.5
1 in 5000	200.7
1 in 10000	225.7
1 in 20000	252.8
1 in 50000	292.1
1 in 100000	325

Source: PSM's PSF Batu Hijau TSF draft report (September 2021)

The design flood, which is the 1000 AEP event, has an estimated peak flow of 149.4 m^3/sec and a total flow of 8.6 million m^3.

5.3.2 Groundwater

By comparison with areas for which data are available, it is expected that ground water levels will be at or close to the streambed levels within the TSF footprint area, rising away from the stream to depths of 20 m to 30 m below the ridge crests. Significant annual fluctuations in groundwater levels can also be expected, particularly beneath elevated areas. There are no data on ground water quality in the TSF area.

5.4 Biosphere

The biosphere discussion is divided into subsections Terrestrial Biodiversity and Aquatic and Marine Biodiversity.

- *Terrestrial Biodiversity* addresses ecology and habitats with respect to terrestrial vegetation and land fauna on and around the TSF site (Project area) in the Tebisu watershed.
- *Aquatic and Marine Biodiversity* addresses ecology and habitats of the freshwater biota on and near the TSF site as well as the marine life conditions at the discharge of the Brang Tebisu watercourse and immediately adjacent waters, in Teluk (Tl-Cove/Bay) Tebisu.

It must be noted that some descriptions apply the place names Puna and Tebisu more or less interchangeably.

5.4.1 Terrestrial Biodiversity

The overall Batu Hijau operation is in the Lesser Sundas Deciduous Forests Ecoregion, which extends from Lombok Island, across Sumbawa Island to Flores Island, and is considered the southwestern most part of the Wallacean Zone, named for the famed biologist Alfred Russel Wallace. This zone is characterized by high flora and fauna biodiversity and endemicity, influenced by both the Asia and Australia biorealms, and is a transitional zone between them. A complete description of the regional ecology is provided in the AMNT's Batu Hijau 2021 Addendum AMDAL, from which the information presented here is derived.

5.4.1.1 Ecosystems and Vegetation Associations

The Ecosystem types in the Project area are dry deciduous forests in the lower-elevation zones, with dry evergreen forests at higher elevations. The natural and human-influenced ecosystems within and around the Project area, and the entire Batu Hijau region, were extensively studied for and described in the Environmental Impact Assessments (ANDALs) of Batu Hijau (PT Newmont Nusa Tenggara, 1996 and AMNT, 2021). Figure 5-5 illustrates the distribution of natural and modified ecosystems. Natural vegetation associations were defined based on naturally occurring ecosystem characteristics, such as structure and species composition, topography, and soil condition, while modified ecosystems refer to agriculture or anthropogenic activity.

The Tebisu watershed (DAS in Indonesian, meaning river flow area) in which the TSF will be located south of the Batu Hijau mining area, within which the vegetation has been intensively studied. Flora commonly found in this area are mature trees of various species that include Pola (*Pseudovaria reticulata*) and Majaq (*Syzgium longiflorum*) which dominate the tree vegetation. Other species are Langer, followed by Rapat Bewe and Majaq as well as fruit-producing plants such as *Ficus* species and species of the Artocaspus, Tabernaemontana, and Meliaceae families. These trees are quite important food sources for wildlife. Although the area is relatively low in diversity, these species are quite abundant.

The natural ecosystems are delineated in the Figure. Based on analysis for this study, the calculated areas in square metres of each ecosystem type within the Project area and of the land to be disturbed by the TSF development are listed in Table 5-3, which indicates the plans will affect less than 1,200 hectares (12 km^2) of land, mostly (86%) rain forest. The land use and ecosystem types are briefly described below, from the beach to the watershed divide.

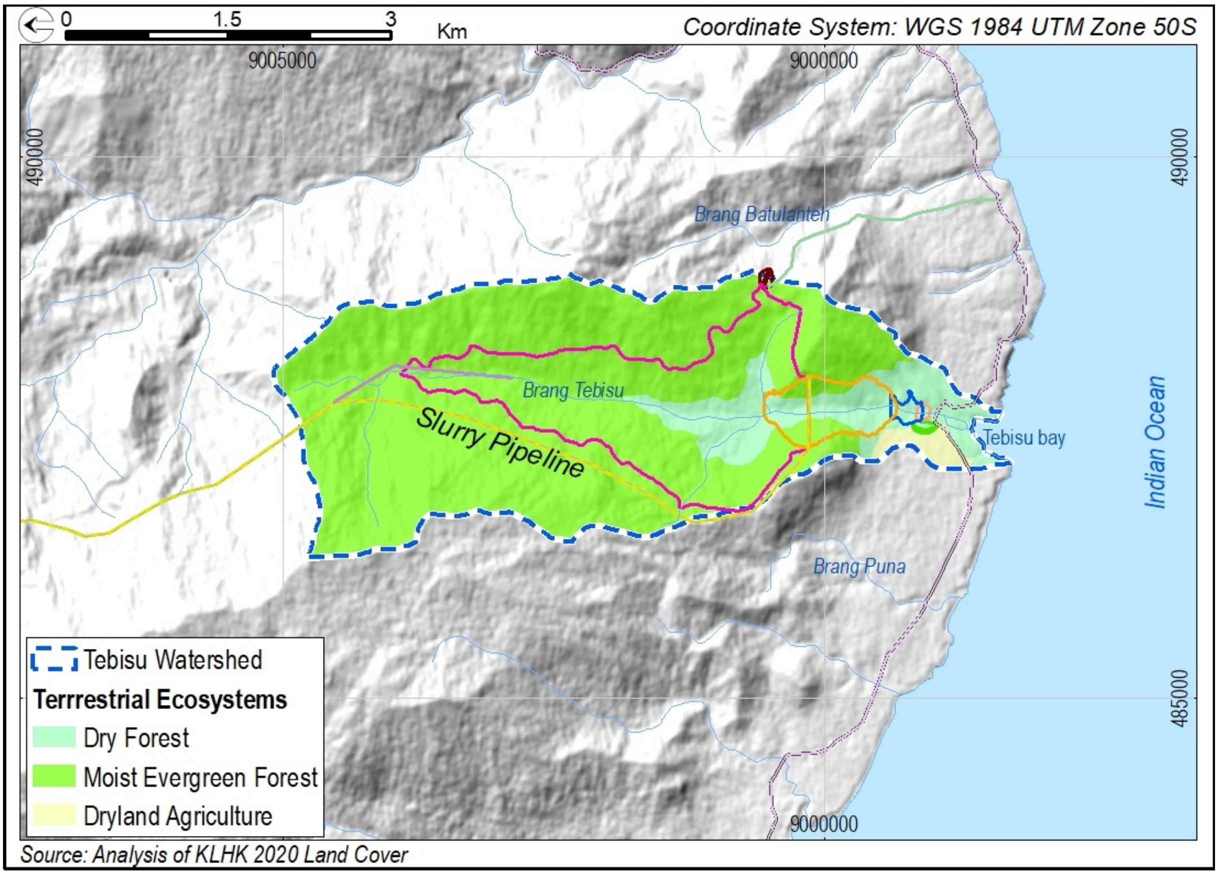


Figure 5-5 Terrestrial Ecosystems in TSF Watershed (Tebisu)

Table 5-3 Land Usage and Ecosystem Types in TSF Watershed

(Site for Dam, Impoundment, and Infrastructure, in hectares)

Terrestrial Ecosystem	Area (Ha)
Dry Forest	153
Moist Evergreen Forest	1,020
Dryland Agriculture	21
Total	1,192

Coastal Ecosystems: The coastal ecosystem complex represents a narrow band along the coastline; tides, storm surges, and salt spray from the sea influence this area, which receives less than 1,000 mm of annual rainfall. The vegetation composition is representative of the soil type characteristics, which vary between unconsolidated sandy soils and consolidated soils. The dominant features of this complex within the Project area are the sand-gravel bar in Teluk Tebisu at the mouth of Brang Tebisu and the estuarine channel reach extending inland from this.

Habitat types of the coastal ecosystem are shrubby beach communities, coastal heath, grassland, and some narrow mangrove ecosystems. Flora species growing in the unconsolidated sandy soils comprise primarily *Spinifex littoralis* (locally *Rumput lari / Rumput angin*), *Ipomoea pes-caprae* (Bay-hops), and *Crotalaria* sp. (Rattlepods), while consolidated sands further inland are dominated by *Baringtonia* formations and tree species such as *Pandanus* sp (Screw pine) *Scaevola* sp. (Fan-flowers), and *Terminalia catappa* (Sea almond, locally *Ketapang*).

Mangroves along the coastline are rare and exist only as small isolated stands along the banks of tidally inundated creeks. Low mangrove abundance in the area is a consequence of the steep shoreline gradient, the high energy environment, and a lack of the continuous river flows and muddy estuarine environments required for the growth and development of mangroves. Even the large river estuaries on the South Coast have little suitable area for the development of mangroves. The main mangrove genera in the region include *Excoecaria, Sonneratia, Avicennia, Bruguiera, Xylocarpus,* and *Heritiera*.

Dry Forest: Two types of ecosystems, dry deciduous forest, and mixed *Corypha* (Gebang) make up the Dry Forest, which is widespread from sea level up to 100 masl. The vegetation zone boundary is however unclear in some areas, with the composition of dry forest vegetation also associated with moist evergreen and riparian forests. Environmental factors are low precipitation (<1,000 mm annual rainfall), low elevation, and soil conditions. Dry forest makes up 13% of the Tebisu watershed, and a very large percentage of the TSF footprint, along the river and estuarine channel.

Dry deciduous forest is characterized by homogenous forest canopy stratification with tree height up to 20 m, while the lower stratum comprises shrubs, lianas, and small trees. Dominant species in this forest type are *Protium javanicum, Schleichera oleosa, Melia azederach*, and Leguminosae family trees. Mixed *Corypha* forests typically grow on flat slopes on clay soil, and are dominated by *Corypha* sp. (Arecaceae family) along with several other tree species including dry deciduous and moist evergreen types, with canopy heights of approximately 30 m.

Moist Evergreen Forest: This is the dominant forest cover around Batu Hijau, occupying 86% of the Tebisu watershed and more than half of the land in the TSF Project footprint. It is characterized by an abundance of liana and rattans, creating a multi-layer forest structure as well as a diverse ground cover from variations in topography. The forest structure is characterized by diverse canopy stratification, with heights of approximately 15 to 20 m common on steep hillsides, and 30 to 60 m on flat slopes. The ecosystem is dominated by the genera *Ficus, Heritiera, Dipterocarpus, Artocarpus*, and *Planchonella*.

Riparian Forest: On lowland areas up to 150 m masl along the river channel. With alluvial sediment soil on the valley floor. The forest structure is similar to moist evergreen forests but with sparser canopy cover. Dominant species that were recorded are *Lagerstromia speciosa, Eugenia subglauca*, *Tetrameles nudiflora,* and *Serianthes* sp. The presence of the last two, which are emergent tree species, distinguishes riparian forest from other forest types. As noted above, the ecosystem delineated along the Tebisu channel at the TSF project site has been classified as a dry forest so that it can effectively be considered synonymous with a riparian forest at this site.

Forest Plantations (Kebun): These modified habitats can be abandoned dry land agriculture fields or planted forest areas that require no intensive maintenance. Forest plantations typically consist of economically valuable plants dominated by coconut and banana. Other species that occur in smaller amounts are jackfruit, mango, papaya, candlenut, palms, and coffee. In former forest areas, some native flora species are found, such as Gaharu, Keruing, Kelicung, Ipil, Rimas, Binong, Majak, Bungur, Sauh, and Sentul. Local communities utilize these species as raw materials for houses, furniture, and other needs. Rattan (Rotan) is a climbing palm (subfamily Calamoideae), an economic ecosystem resource that is sold commercially, as are Ajang kelicung (D*iospyros macrophylla*) and Gaharu (*Aquilaria malaccensis* or agarwood)-the last-named species that can have a particularly high economic value. (Also called Eaglewood; if infected by a specific mould, Gaharu wood is an aromatic much sought after for incense, perfume, and small carvings.)

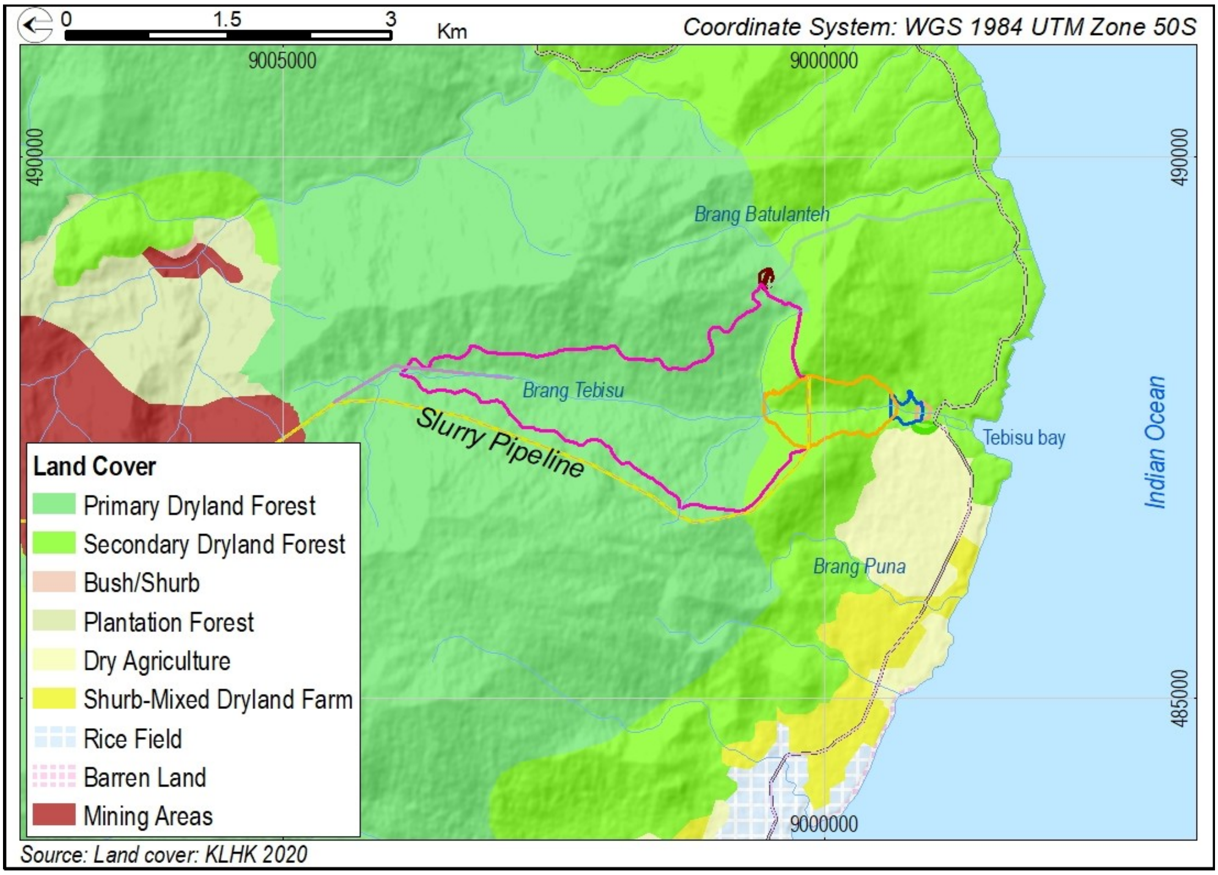


Figure 5-6 Land Cover in Vicinity of TSF Development Plan

Agriculture: Modified habitats surrounding settlements include wetland agriculture (paddy fields) and mixed gardens that provide local communities with their daily needs, including vegetables, medicinals, fruit, hardwood, and decorative plants. These gardens may be similar in composition to the forest plantations described above, distinguished by location nearer the cultivators' residence.) Agriculture areas appear restricted to the coast

Vegetation species commonly cultivated in the region include sweet potato, string bean, chilli pepper, tomato, spinach, pumpkin, soybean, clove, cacao, coconut, mango, soursop, and limes. Orchids are a common decorative plant as in most tropical areas, while medicinal plants include puring, cordili, fern, cycas, basil, fence castor, and ginger.

Agricultural settlements in the TSF Project area appear restricted to the first one to two kilometres inland from the coast, and only to the west of Brang Tebisu. Forest plantings may extend further inland and to the east of the river.

Terrestrial Vegetation Species of Conservation Importance: Only about half the floral (mostly tree) species in the Batu Hijau area have been assigned an IUCN status, and most are "Least Concern." Two "Near Threatened" species have been identified:

- *Intsia bijuga* (Colebr.) Kuntze Ipil / Moluccan Ironwood
- *Aglaia edulis* (Roxb.) Wall Menyong

The single "Vulnerable" species found is a rare and highly valuable commodity (sold by the gram), as explained above.

- *Aquilaria filaria* (Oken) Merr   Gaharu / Agarwood (also known as Aloeswood).

The 70 most common floral species in the region are listed in Table 5-4. While it is unknown if all of these species are present within the TSF site area, it is likely this list encompasses most of the vegetation types in the TSF site area.

Table 5-4 Terrestrial Flora Species Known in Batu Hijau Region

Family	Species (Common)	Local
Anacardiaceae	*Dracontomelon dao* (Blanco) Merr.& Rolfe	Dao
	Mangifera sp.	Pok
Annonaceae	*Monoon lateriflorum* (Blume) Miq.	Tanuk
	Pseuduvaria reticulata (Blume) Miq.	Pola
Apocynaceae	*Alstonia spatulata* Blume	Kayu Batu
	Voacanga grandifolia (Miq.) Rolfe	Piko
Burseraceae	*Canarium asperum* Benth	Kesi
Calophyllaceae	*Calophyllum soulattri* Burm.f.	Mentangir
Cannabaceae	*Trema orientale* (L.) Blume (Pigeon Wood)	Moeng
Combretaceae	*Terminalia catappa* L. (Tropical Almond)	Ketapang
Clusiaceae	*Garcinia celebica* L.	Monar
Dipterocarpaceae	*Dipterocarpus* sp.	Keruing
	Shorea sp.	Meranti
Ebenaceae	*Diospyros macrophylla* Blume	Ayan
Euphorbiaceae	*Macaranga tanarius* (L.) Müll.Arg.	Tutumpada
	Mallotus paniculatus (L.) Müll.Arg.	Balik Angin
	Mallothus sp.	Balik Layar
Fabaceae	*Albizia chinensis* (Osbeck) Merr. (Chinese Albizia)	Besiraq
	Intsia bijuga (Colebr.) Kuntze (Moluccan Ironwood)	Ipil
	Parkia timoriana (DC.) Merr.	Kopang
Lauraceae	*Cryptocarya ferrea* Blume	Engal
	Litsea diversifolia Blume	Paoq
Lecythidaceae	*Barringtonia racemosa* (l.) Spreng.	Putat
	Chydenanthus excelcus (Blume) Miers	Kujung
Lythraceae	*Lagerstroemia speciosa* (L.) Pers. (Queen Crepe Myrtle)	Bungur
	Duabanga moluccana Blume	Rajumas
Malvaceae	*Heritiera littoralis* Aiton (Looking-Glass Tree)	Dungun
	Pterospermum javanicum Jungh.	Bajur
Meliaceae	*Aglaia edulis* (Roxb.) Wall.	Menyong

Family	Species (Common)	Local
	Dysoxylum cyrtobotryum Miq.	Kayu Tong
	Dysoxylum densiflorum (Blume) Miq.	Buah Lolo
	Sandoricum koetjape (Burm.f.) Merr.	Sentul
	Toona sureni (Blume) Merr.(Red Cedar)	Suren
Moraceae	*Artocarpus sericicarpus* F.M.Jarrett	Salam
	Ficus fistulosa Reinw. Ex Blume	Siur
	Ficus sp.	Araq
Myristicaceae	*Knema kunstleri* (King) Warb.	Dara Selaki
Myrsinaceae	*Ardisia javanica* A.DC.	Prinaq
Myrtaceae	*Syzygium littorale* (Blume) Amshoff	Tempoak
	Syzygium nervosum A.Cunn. ex DC.	Majaq
Oleacea	*Chionanthus* sp.	Semelu Dawa
Phyllanthaceae	*Bischofia javanica* (Bishop Wood)	Dangar
	Drypetes longifolia (Blume) Pax & K.Hoffm.	Rapat Bewe
Putranjivaceae	*Drypetes neglecta* (Koord.) Pax & K.Hoffm.	Benaro
Rubiaceae	-	Keta
	Neonauclea purpurea (Roxb.) Merr.	Lempayan
Sapindaceae	*Schleichera oleosa* (Lour.) Oken	Kesami
Sapotaceae	*Donella lanceolata* (Blume) Aubrév.	Kayu Bulu
	Planchonella obovata (R.Br.) Pierre	Sao
Tetramelaceae	*Tetrameles nudiflora* R. Br	Binong
Thymelaeceae	*Aquilaria filaria* (Oken) Merr.(Agarwood)	Gaharu
An additional 19 species with local names remain otherwise unidentified:		

Bilu Buah Puin Dadap Elak	Jelatang Kalamuta Kayu Api Kayu Besi	Kayu Santan Kayu Telor Ketutup Laban	Mentara Otak Bote Pakam Pilo	Seraran Tanyung Yerti

5.4.1.2 Terrestrial Fauna

The 1996 baseline Environmental Impact Assessment (PT Newmont Nusa Tenggara, 1996) recorded 201 local land vertebrate species, including 7 amphibians, 27 reptiles, 144 birds, and 25 mammals within or near the Batu Hijau operation area. The 15 fauna species in the vicinity of the mining area to the north of the TSF site are as identified in recent AMNT monitoring, are listed in Table 5-5. It is likely that most of these are at least occasionally present around the TSF site. (The last entry covers bats, of which some 14 species have been identified beyond the one specifically noted, the species most frequently encountered.)

Table 5-5 Terrestrial Fauna Species in TSF Vicinity

Local Name		Scientific Name
Babi Celeng	Wild boar	*Sus scrofa*
Rusa Timor	Timor deer (Javan rusa/Sunda sambar)	*Rusa timorensis*
Codot Nusatenggara	Nusatenggara short-nosed fruit bat	*Cynopterus nusatenggara*
Bentet Coklat	Brown Shrike	*Lanius Cristatus*
Cucak Kutilang	Sooty-headed bulbul	*Pycnonotus aurigaster*
Merbah Cerukcuk	Yellow-vented bulbul	*Pycnonotus goaivier*
Kepodang Kuduk Hitam	Black-naped oriole	*Oriolus chinensis*
Walet Sapi	Glossy swiftlet	*Collocalia esculenta*
Srigunting Wallacea	Wallacean drongo	*Dicrurus densus*
Ayam Hutan Hijau	Green junglefowl	*Gallus varius*
Burung Cabai Gesit	Thick-billed flowerpecker	*Dicaeum agile*
Burung Cabai Dahi Hitam	Black-fronted flowerpecker	*Dicaeum igniferum*
Walet Sarang Putih	Edible-nest swiftlet	*Collocalia fuchipagus*
Elang Bondol	Brahminy kite	*Haliastur indus*
Elang Flores	Flores hawk-eagle	*Nisaelus floris*
Kelelawar	Bats	Order Chiroptera species

Source: AMNT, 2020

More information on the overall regional faunal populations is presented in the text below; the applicability of this information within the relatively limited TSF site area, again, is not known. However, most, or all may be present in the area, at least occasionally.

Mammals: The 1996 Batu Hijau baseline Environmental Impact Assessment recorded a total of 25 species of mammals, including 15 bats, 1 insectivore, 3 rodents, 3 carnivores, 2 ungulates, and 1 primate. Areas of secondary forest had the highest number of species (19 species), followed by moist evergreen forest (12 species). Bats were the most common group at both locations. There was no significant season-based change in diversity. The Lesser Sunda (or Short-nosed) fruit bat (*Cynopterus brachyotis*) was the most common species trapped in the mist net surveys.

Three rodent species were recorded: Polynesia rat, Sunda shrew, and an unidentified rodent. Carnivore species recorded included the Lombok flying fox, Common palm civet, Little Indian civet, and an unidentified felid cat. The Long-tailed macaque was the only species of primate encountered during the study. Wild pigs and Timor deer are common, and their distribution is widespread in the Batu Hijau landscape, in forest as well as in disturbed areas. Recent (2020) monitoring in the area of the Batu Hijau mine development plan to the north of the TSF are recorded 11 species of mammals. The highest density populations were Short-nosed fruit bats, Kra monkeys, and wild Boars.

Domestic mammals found in community areas included dogs, cats, goats, Bali cattle, horses, and water buffaloes. One observed mammal species is on the IUCN Red List of Threatened Species: The Javan

Deer (IUCN rating Vulnerable). This species is targeted by local inhabitants for hunting, and is Threatened for this reason, though it is common in the area.

Birds: The 1996 baseline study recorded 143 bird species. The coastal habitat type had the highest species richness (68 species), followed by secondary forest (62 species), and moist evergreen forest (61 species). Common species observed during the surveys at Batu Hijau were the Black-naped Oriole, Glossy Swiftlet, Wallacean Drongo, and Green Jungle fowl. Widespread species that were recorded across several habitat types included the Brahminy kite, Green Jungle fowl, Glossy Swiftlet, and the Black-naped Oriole.

A bird-monitoring survey conducted at five disturbed sites in 2016 recorded 46 species and 330 individual birds in April, while in October, 47 species and 210 individuals were seen. Fluctuations in bird abundance and diversity are mostly seasonal and affected by weather conditions and food availability. A 2018 baseline study recorded 41 bird species. Birds in these areas are targeted by local hunters or trappers. Songbirds are most sought after because of their high market prices. Hunting techniques include using glue and cage traps with decoy/bait birds. The baseline study recorded two threatened species: the Tenggara Hill Myna (IUCN = Endangered) and the Rainbow Lorikeet (IUCN = Vulnerable).

Reptiles and Amphibians: The Batu Hijau Environmental Impact Assessment Baseline Study recorded a total of 27 reptiles, including snakes (10 species), lizards (15 species), turtles (1 species), and a crocodile; as well as 7 amphibians including six frogs and one toad species. Twenty-one species (62%) were found in the moist evergreen forest habitat. *Rana limnocharis* (Asian grass frog) is a widespread amphibian species in Batu Hijau, recorded in four of six habitat types.

In addition to being the most dominant species in the moist evergreen forest habitat, the Microhylid frog (*Oreophryne jeffersoniana*) also was found in two habitats: the moist evergreen forest and riparian forest. Several species with a wide distribution throughout the Project area are the Tokay gecko (*Gecko gecko*), Sun skink (*Mabuya multifasciata*), Asian water monitor (*Varanus salvator*), and Green pit viper (*Trimesurus alboralis*). In the coastal habitat type, dominant species recorded were the Estuarine crocodile, Shore skink, *Riopa* sp. (Snake skink), and the Dog-faced water snake. The Southeast Asian Box turtle (*Cuora amboniensis*) was observed to the north in Lake Taliwang but, to date, not recorded on the rivers of the Batu Hijau study area.

A total of 20 species from 13 families of herpetofauna (amphibians and reptiles) were recorded during the survey activities in four moist evergreen forest areas in the mining area to the north of the TSF site. These findings could be taken generally to indicate the herpetofauna population diversity is quite like what it was in the early 1990s.

5.4.2 Aquatic and Marine Biodiversity

This description of freshwater and marine ecosystems in and around the operational area is based on the 1996 Batu Hijau Environmental Impact Analysis, supplemented by recent AMNT monitoring activities.

5.4.2.1 Freshwater and Estuarine Biota

Brang Tebisu, like the other coastal drainage streams on the Sumbawa South Coast, is short in length, with a steep gradient in its upper reach and a limited estuarine habitat near the coast. Water quality in the upper and middle reaches is likely very good, as it has experienced little human disturbance to date. The estuarine habitat is extremely restricted with poorly developed mangroves, individual plants rather than stands. While 21 species of freshwater fish have been identified in the Batu Hijau region, the limited reach of year-round flow in Brang Tebisu channel makes it likely only a few exist in this watercourse.

Macro-invertebrates: The majority (86%) of invertebrate fauna found in the freshwater streams studied were insect taxa. Diptera (flies), Trichoptera (caddisflies), and Coleoptera (beetles) were the most diverse orders, comprising 20, 12, and 10 species, respectively. Other insect orders were represented by fewer than 10 species. In the original baseline survey, the total abundance at each site ranged from 40 to 259.

The order Ephemeroptera (mayflies) was by far the most numerous group in terms of the overall number of individuals collected, accounting for 77 percent of all samples combined. Six of the nine genera were found at all sites. The most abundant groups were of the genera *Ephemerella*, *Paraleptophlebia,* and *Baetis*. The most common caddisflies were *Polycdntropus* sp and *Wormaldia* sp. 1, while the most common dipteran was *Eukiefferiella* sp. The most abundant beetle (Coleoptera) species recorded was *Narpus* sp.

In an October 2019 survey, 46 macro-invertebrate taxa (38 insect genera) were recorded in the area, with abundance between 14 and 816 individuals/m^2. The diversity index for insects ranged from 1.42 to 2.32l insects were predominantly *Baetis* of the order Ephemeropter.

Fish: In the original Batu Hijau baseline studies in the mid-1990s, a total of 70 fish species from 27 families were recorded during the surveys of the South Coast streams. Estuarine and coastal sites had the highest number of species with 57; it is likely most of the Brang Tebisu fish populations will be in the lowest reach.

Species likely existing in the drainage can be assumed from those most found in earlier studies. The most frequent group recorded (37% of all fish species) was the order Gobiidei (gobies), represented by 26 species from 4 families. These families were Rhyacicthyidae (loach gobies), Eleotrididae (gudgeons), Kraemariidae (sand gobies), and Gobiidae ("true" gobies). The other major family represented was the Mugilidae (mullets), with at least 9 species. The Marbled eel (*Anguilla marmorata*) was found to be widely distributed in the region.

Other Aquatic Fauna: Species of crustaceans commonly found in the region's streams include freshwater shrimp, especially from the family Atyidae, including *Atyiopsis moluccensis* and *Caridina paninsularis. S*ix species from the family Palaemonidae (freshwater and shallow marine shrimps) were also identified, five from the genus *Macrobrachium* (locally Udang galah), plus one Potamonidae (*Potamon* sp). Numerous freshwater mollusks were also collected from the streams.

No freshwater turtles were recorded, and local people interviewed stated that turtles do not occur in these river systems. Estuarine snakes such as *Cerberus rynchops* (Bockadam snake) and *Acrochordus granulatus* (Little file snake) are also known to be present. The Asian water monitor (*Varanus salvator*), a large, semi-aquatic lizard, is frequently observed along the rivers in the area.

5.4.2.2 Marine Biota

The marine biota discussion draws on the original 1996 ANDAL and recent monitoring. Addressed are relevant habitat types, coral reefs, fish communities, plankton, demersal fish, and marine turtles. Note again that, dating back to the original studies, the watercourses (*brang*) Tebisu and Puna seem to be used interchangeably; similarly, the bays (*teluk*) Tebisu and Puna into which they empty.

Beaches: The beach along the South Coast of the study area, to the east of Tanjung Mangkun as far as Brang Puna, consists of a narrow sandy strip between coastal dune vegetation and an extensive intertidal reef platform. The Tebisu estuary drains through a mouth bar predominantly consisting of grey, terrigenous medium to fine sand. The bar does not show any distinctive zones of faunal or floral colonization because of the high wave energy. Away from the mouth bar, the beach grades to a rockier and bouldered character.

Intertidal Reefs and Coastal Landforms: The most extensive intertidal reef system occurs along the south coast, from Tanjung Mangkun to the estuary of Brang Tebisu, approximately 5 km east of Teluk Senutak. The fringing reef is up to 300 m wide and forms a distinctive line of surf from the oceanic swell. Throughout its length, the reef has a pronounced spur and groove formation which extends from the subtidal area to the low and mid-intertidal zone. Several small breaks occur along the south coast reef where lagoon water returns seaward in currents or rips during the tidal ebb. No seagrass habitats are observed in the vicinity of Teluk Tebisu.

To the east of Brang Puna and throughout Teluk Puna/Tebisu, the intertidal reef platform is narrow or nonexistent. In this section, the coast is dominated by eroding cliffs consisting of limestone (low headlands from Teluk Senutak to Brang Puna) and low volcanic cliffs (to the east of Brang Puna). Along this coastal area, fragments of eroded cliff and rocks extend subtidally only a short distance beyond the surf zone because of the steep offshore gradient.

Generally, along the South Coast of western Sumbawa, the sloping beach sand at the high tide area gives way to flat reef platform (Figure 5-7) with rocky pools containing seagrass (Thalassia), and macroalgal species *Ulva* and *Turbinaria*. The mid-shore is characterized mainly by extensive flats of coral rubble, much of which is partially cemented together by coralline algae and colonial ascidians. The low tide area is characterized by a series of parallel ridges and surge gutters in spur and groove habitat of the surf zone. Here algal species such as *Turbinaria, Ulva*, and *Halimeda* are dominant. All algal species have typically short fronds in response to the strong wave action on the reef platform. Corals are limited mainly to encrusting forms and some soft corals and sponges are also present. Sea urchins and brittle stars are the most abundant invertebrate fauna throughout the reef area.

Where the intertidal reef platform exists, the dominant intertidal algae are *Turbinaria* and *Ulva*. *Thalass*ia also grows in relatively sheltered deeper pools on the reef platform. To the east of Brang Puna, there is abrupt discontinuation of the intertidal reef platform. Here, fragments of eroded cliff form both intertidal and subtidal shorelines. Viewed from the air, the fauna (mainly encrusting corals) and flora appear like the rocky substratum of the reef platform.

Figure 5-7 Typical Intertidal Reef Along South Coast of Sumbawa

Subtidal Reefs: Exposure to heavy swell and surf from the Indian Ocean strongly influences the development of coral reefs around the coast of southwest Sumbawa. High wave energy has resulted in development of fringing reefs and wave-cut platforms along much of the south coast. Reef crests and seaward slopes of the fringing reefs have pronounced spur and groove formations resulting from the surge and backwash of the swell carrying sand and broken coral fragments, forming a series of parallel surge channels. On the reef spurs between the erosion channels, corals and other attached organisms tend to adopt an encrusting growth pattern, presenting little vertical profile so that the subtidal reef habitat is predominantly two-dimensional. Within the study area, there is little reef slope, reef crest back reef, and lagoon habitat, as would be typical of coral reef development in more sheltered areas. Apart from the exposed fringing reefs, coral outcrops do exist in scattered patches of reef flats and small coral bommies in some sheltered cove areas,

Scuba diving surveys off the south coast confirmed that wave surge was still pronounced in water depths of 20 to 25 m, and that the spur and groove formation extended beyond these depths. However, at these depths, the grooves are shallower and wider with the sand fanning out and, in some areas, covering the spurs in a thin layer. The spurs remain evident, however, as encrusting species (mainly sponges and soft corals) that protrude through the thin sand layers. Reef fish are present but not in abundance because of the limited refuge habitat compared with more typical reef areas.

Reef Fish and Other Organisms: Reef fish census observations concentrated mainly on the Pomacentridae and Chaetodontidae, families of reef-dependent species. Other groups were also included in the census if abundant. In the original baseline studies, at least 46 species were found within the coral reefs of the study area. Fish abundance was lowest in the exposed reef slope areas. Diversity of coral fish was generally low to medium. Coral reefs throughout the study area are predominantly two-dimensional (relatively flat), and consequently lack the structural diversity of habitat to encourage an abundance of coral fish. In general coral reefs in the study area are relatively healthy.

The 2020 reef fish monitoring on the South Coast recorded a total of 41 types of fish. Fish abundance ranged from 80 to 147 individuals, from 17 to 23 taxa at each station. All South Coast stations show moderate diversity indexes in the range of 2.39 to 2.72. Reef fish are dominated by the Pomacentridae and Labridae families, and particularly by Kepondangan biasa or Goldbelly damsel (*Pomacentrus auriventris*). During 2018 surveys along the South Coast fish abundance ranged from 55 to 157 individuals, among a total of 10 to 28 taxa. All South Coast sites showed low to intermediate diversity. Reef fish observed were dominated by fish of family Labridae (wrasses) and Pomacentridae (damselfish and clownfish).

In general, the condition of reef fish in the 2018 through 2020 surveys differed little from observations of previous years and indeed throughout the historical record of the mine operation.

Other Reef Organisms: In the generally high-energy reef areas, other typical reef organisms such as urchins, starfish, clams, sea cucumbers, and crabs tend to seek out cryptic (concealing) habitat. This makes them difficult to observe and abundance is therefore difficult to assess. Subsistence fishers often fish in the intertidal areas at low tide by means of crowbars, breaking open holes and crevices to obtain varieties of urchins, abalone, sea cucumbers, and small fish (including pufferfish and stonefish).

Plankton: Approximately 20 species of phytoplankton and eight dominant groups of zooplankton were recorded in the coastal waters of the study area. Phytoplankton abundance varied, with the most abundant species being *Astreionella*. The abundance of zooplankton also varied markedly, the most dominant organism being the copepod *Calanus* (>6,000 individuals/liter). Species diversity varied considerably, among sites. Seasonal differences in the abundance of plankton were marked, with much higher abundances observed during September (dry season) sampling events.

Benthic Fauna: In the original baseline studies in the 1990s, 35 species of macro-zoobenthos (large-animal life forms) consisting of 19 gastropod species, 12 bivalve species, 1 scaphopod (tusk shell) species, and 3 polychaete (bristle worm) species were recorded within the marine study area. Abundance ranged from 300 individual/m^2 to 1,615 individual/m^2 I

In 2019, the number of meiobenthos taxa outside tailings affected sites ranged from 1 to 10 and abundance ranged from 20 to 129 individuals/sample. The low to medium diversity index ranged from 0 to 2.16. Meiobenthos sampled were dominated by nematodes, followed by Harpacticauda (crustaceans). Monitoring results in 2018 were similar.

Demersal Fish Metals: Monitoring of the concentrations of heavy metals in demersal fish is carried out twice a year. The locations for obtaining these monitoring specimens have been stipulated in the permit for deep sea tailings placement, Station DFS28 is located 3 km southwest of Tg Senutak, west of the TSF study area. Monitoring results for the first semester of 2020 show metals concentrations in fish muscle tissue in the impact area are generally like the results of specimens caught in the control areas and in the Alas Strait.

All samples contained Arsenic (As) less than 10 mg/kg, while Mercury (Hg) and Lead (Pb) were below the maximum limit. Manganese (Mn), Cadmium (Cd), and Chromium (Cr) were detected in low concentrations. The total Copper (Cu) concentrations were below the Median GEL (Generally Expected Limit) for Cu, while the Zinc (Zn) concentration in most specimens were below the Median GEL (5mg/kg). In specimens caught at the South Coast stations, there has never been a sample that exceeded the 90 Percentile GEL in the last 10 years in which this monitoring has been carried out. In general, when compared to controls and locations elsewhere, the metals concentrations in the muscle tissue of demersal fish specimens have not shown significant effect from the disposal activities to date.

Fish Catch Monitoring: Capture fisheries surveys are required annually in the AMNT Environmental Monitoring Plan, which compiles and analyzes fisheries data provided by the government. The trend of catch per unit effort (CPUE) data from 2006 to 2019 show that CPUE values fluctuate but consistently remain within a range that seldom exceeds 20 kg/trip. Given most small boats lack ice, this may reflect the catch level where the main incentive is to immediately market or process the catch. Fluctuations will reflect episodic/seasonal increases in catch for certain species that become temporarily abundant, especially those tending to large schools such as squid, sardines, tuna, and Kembung/Indian mackerel,

Sea Turtles: In the original Batu Hijau baseline studies, numbers and frequency of nesting sea turtle tracks on beaches within the study area were primarily surveyed by helicopter and augmented with some ground surveys. Visual inspection from ground surveys confirmed that old turtle nesting pits are present on most beaches where sand extends above the highest tide level. These depressions remain visible for many months after eggs are laid. Turtles favoured specific beaches in the study area over others. The TSF site area was not found to be heavily used by nesting turtles.

All beaches surveyed are frequently visited by local people during their normal daily movements to and from villages and markets. Most of the main turtle nesting beaches along the south coast were occupied by a nearby beach camp used by egg collectors. Sea Turtle Conservation is carried out through an education program AMNT initiated in 2018. Activities have included surveys of nesting beaches, measurement of turtles, transfer and incubating of turtle eggs at a hatchery at Talonang (about 20 km east of Teluk Tebisu), and education in sea turtle conservation.

5.5 Sociocultural and Economic Spheres

Information presented here on socioeconomic and sociocultural conditions in the Batu Hijau region were primarily obtained from field studies in the area in 2019 through interviews with people who live in the villages neighbouring the mining operations. Additional information was obtained from AMNT's routine environmental and social monitoring programs (Environmental Management and Monitoring Plan Implementation reports for 2019 and the first semester of 2020).

The village nearest the TSF site, Desa Tatar, was considered outside the Batu Hijau impact area, and consequently not addressed during these studies.

(No cultural heritage resources have been identified in vicinity of the TSF site, and so this subject is not addressed here.)

5.5.1 Population and Community Structure

The latest official statistics for the year 2018 indicate the total population in the study area (i.e., the impact area) of Batu Hijau Copper-Gold Mine and Supporting Facilities) in 2018 in Sekongkang, Jereweh, and Maluk Kecamatans (Districts, often translated subdistricts) was then 23,227 residents and 5,985 households. The southeasternmost portion of Sekongkang District on the South Coast of Sumbawa Island, which District in 2019 had a total population of 10,447, is the specific impact area of the TSF construction and operation. The villages (from west to east) nearest the TSF site are Tongo, Ai Kangkung, and Tatar

- Tongo Village at its centre is roughly 9.35 kilometres west-northwest from the TSF site (measured from the Jalan Raya Tebisu bridge over Brang Puna).

- Tongo's 2018 population was 1,497 in 337 households (about 4.4 persons per household).
- Males slightly outnumber females, with a gender ratio of 102 (number of males equals 102% the number of females).
- Tongo's village territory is 78 km^2, giving it a crude population density of 19.16 person/km^2.

- Ai Kangkung Village has its centre about 7.15 km west-northwest of the TSF site.
  - With a population of 1,388 in 345 households, the average household size is about four persons.
  - With a relatively larger number of males, the gender ratio is 111.
  - Territory is 60 km^2 and the population density about 23.13 person/km^2.

The three villages are near the coastline, and their official jurisdictions extend north into the highland forests, and include areas being used by AMNT; this likely includes for Tatar Village (below) the area that will be occupied by the TSF facility. The village territories and population density might be somewhat misleading, as the residential and intensively cultivated and grazed areas are more concentrated near the coast road. The village residents do hunt and collect forest products over large areas in the forests and cultivate gardens (*kebun*) some distance into the forest areas.

Tatar Village is more dispersed along the coast and the coast road, without a clear village centre. Measuring from the intersection where the coast road changes name from Jalan Raya Senutuk to Jalan RayaTebisu, the average distance from the TSF site is about 2.2 km west-northwest. However, the nearest structures in Tatar are just over 400 metres southwest of the bridge. The nearest cluster of what are clearly residences is 690 metres southwest of the bridge, while the westernmost subvillage of Tatar is perhaps 4.4 km northwest of the TSF site. If the roughly 70 structures visible on available imagery are taken to represent households averaging about four persons, this could indicate a population of at least 300 persons for Tatar.

Clearly, Tatar is the only settlement unambiguously within the TSF impact area. The nearest structures to the east of the site are located about 4 kilometres east-northeast of the Bang Puna/Tebisu bridge, and appear to be part of a small mining operation with no nearby village.

Population Composition: Age and gender composition data for the Batu Hijau region population, including the southeast part of Sekongkang District, is dominated by the productive age category of 20 to 44 years. Of the "dependent" (old and young) age groups, youth (under 15 years) greatly outnumber those aged 65 years and older. The population is largely composed of young families, as is typical for a rural area in a developing nation.

The dependency ratio (numbers or percentage of youth plus elderly divided by the productive group) in the study area districts is like that for West Sumbawa Regency as a whole, which is 54%. This is interpreted as effectively meaning every 100 people of working age (considered productive) have as many as 54 dependents who are considered not yet, or no longer, productive. This statistic has serious implications for the society's provision of education to the young as well as fulfilling basic human needs for both the young and the elderly. For Indonesia as a whole, this ratio is 47.5; for comparison, China's dependency ratio is 42.2 and that of the USA 53.9. This ratio of course changes every year as the population ages. Indonesia (and West Sumbawa) has many more young people entering the productive years than elders leaving them, so the ratio will probably drop for another decade. Of course, the in-migrant mining work force containing many single persons (dominantly males), many of whom do not stay permanently, also affects the current age structure of the population and its future dynamics.

The 2019 National Labor Force Survey indicated 94.5% of the labor force members in West Sumbawa were already working. The employed workforce is dominated by those with primary and high school educations in about equal numbers, while the middle school educated have the lowest labor force participation rate, followed by elementary school graduates. Many such individuals, while not formally employed, probably actually work as household or agricultural labor. This is in fact a productive population whose age structure indicates it will remain so for at least another generation.

5.5.2 Sociocultural Sphere

Ethnicity and Religion: Based on a 2013 Social Impact Assessment Study conducted by AMNT's predecessor, NNT communities around Batu Hijau are multi-ethnic, and include migrants from neighbouring Lombok Island and people from other parts of Sumbawa Island. The former mainly are Sasak, mostly Muslims, and some ethnically Balinese, mostly Hindus. The Hindus are the largest minority religion, while more than 90% of the region professes Islam. Within the Sumbawa origin group, migrants are mostly Tau Samawa, Mbojo, and (long resident) Javanese. Smaller numbers of Bugis, Bercu, and Chinese also occupy the land. Recent in-migration has mainly been of people attracted to the Batu Hijau operation for employment or business opportunities, effectively ensuring the ethnic heterogeneity of the area.

However, the southwestern portion of the Island reflects an area populated by transmigrants from government sponsored resettlement in the early 1990s. The original settlement unit was on the south coast near Tongo, and had families from Lombok and Bali, with some residents being provided with houses in the unit. It should be noted the Samawa/Sumbawa and Sasak languages and cultures are closely related, and traditional migration from Lombok, some for seasonal harvest work, long predated the transmigration project. Thus, there are numerous families of mixed backgrounds in this complex, multi-ethnic region that defies summary description.

Cultural Values, Traditions, and Social Change: Various studies (particularly the 2013 Social Impact Assessment) have indicated communities in in western Sumbawa strongly embrace specific social norms and values, characterized as centered around the virtues of helpfulness, unity, justice, honesty, and trust. Many of these values are based on their faith, religion, and spirituality. Prior studies by NNT stated that, prior to operation of the Batu Hijau mine, residents were "aggressively traditional," with strong and binding social norms and values.

Compromise, tolerance, and respect are said to be the values embraced by the people of Sumbawa. However, anger and violence have erupted in the past, dating back to the colonial era (UI, 2012). Raba (2003 [in UI 2012]) explained how Sumbawa values tend to revolve around *ila* (pride), *pamendi* (kindness, especially to newcomers and the unfortunate), and *janggi* (resignation to fate, possibly mixed with regrets). The first value – *ila* – is often attributed to conflicts that arise among the Sumbawan people, especially involving familial matters and disputes. Local traditions have been documented in these earlier studies that include art (*tari nguri, pego Bulaeng, pasaji, amuji, tari da dara bagandang, tari barodak*, and others), music (*gong genang, surune, palompang*, and others), community games (*barempuk, barapan kebo*), and friendship and marriage systems.

Since commissioning of the mine in 1997, many people from other parts of Indonesia have migrated to the area. This has contributed to a dynamic community structure whereby people from various cultures and socioeconomic backgrounds interact on a continuous basis. The largest changes resulting from this influx of people are associated with community lifestyle and cultural values. The former included changes in consumption patterns, with increased expenses for non-food goods and services; changes to housing structures; and ownership of more manufactured goods, including communication devices and personal transportation. The changes in cultural values have led to changes in community behavior, with residents described as "more cosmopolitan" in an NNT study (2015). While there have been tensions and conflicts, the local communities have generally adapted peacefully to the various changes brought by the mining industry

Vulnerable Groups: People who characteristically experience higher risks of impoverishment and social exclusion compared to the general population are considered vulnerable. Vulnerability may stem from an individual's or group's ethnicity/color, gender/gender identity, language, religion, age, disablement, political opinions, national or social origin, property, birth, and or status.

The 2013 Social Impact Assessment Study by NNT stated that transmigrants in Ai Kangkung Village were then the most vulnerable group associated with the Batu Hijau project area. They are economically vulnerable because of several factors:

- Lack of social network, such as families, for support.
- Geographically situated in relatively isolated areas.
- Relatively few opportunities to acquire employment with AMNT.
- Generally reliant on agriculture, which is a low-income sector.

Other than the first factor listed, all of these more or less apply to the non-transmigrant residents of Tongo, Ai Kangkung, and Tatar.

Perception of Tailings Disposal: The social survey and stakeholder mapping conducted by the Greencorp survey team in 2019 interviewed 60 from Ai Kangkung, Sekongkang Atas, and Tongo Villages respondents (20 respondents from each) to characterize residents' perceptions of the Company and its operations. From the interview data, it was learned that 95% of people in the latter two villages are aware of the existence of AMNT. However, in Ai Kangkung, 60% of respondents were unaware of the Company (even though the survey found 15% of households have a member working for the mining operation).

As was noted above, Ai Kangkung is a geographically isolated community and considered economically vulnerable. Tatar was not surveyed, as it was considered outside the impact area. Should a decision be reached to construct the TSF, with Tatar the only village within its direct impact area, both survey and public information disclosure operations would obviously become immediate priorities.

Among the varied perceptions of the communities surveyed, the issue requiring most consideration was job opportunities. While employment with the Company or a contractor is considered positive and beneficial by the respondents, the limitations on recruiting residents based on their education and experience qualifications chronically poses an issue. Positive economic impacts notwithstanding, the communities expected greater improvements in local welfare and more contributions to their society should be forthcoming. The main issues raised by these key stakeholders could be summarized as follows (with numbers of formal such complaints registered by AMNT's Grievance Management Mechanism during 2019):

- Labor employment issues, with demands for elimination of the contract system and transparency in labor recruitment, and particularly the policy of gradually reducing the numbers of workers (11);
- Environmental issues, especially marine pollution and reduced groundwater supply.
- Economic issues related to decreasing size of salaries and the requirements for nonlocal employees to live in the base camp with food service handled by the catering subcontractor, resulting in the absence of economic opportunities for the community in providing housing and subsistence.
- Issues of limited contributions to the surrounding communities' health and education infrastructure and services (3).

An earlier Stakeholder Mapping survey by AMNT (2017) revealed that some communities remain concerned about the risks of deepsea tailings disposal (DSTP). This is particularly true for people in Tongo Village in Sekongkang, where a contaminated-water event in 2017 was suspected to be caused by an overflow of mine waste into the Tongoloka River that resulted in a large fish kill. This led to an organized protest the Company; however, an official determination of the cause of the contamination has never been issued. This case causes many people to believe that such accidents could be repeated in the future. Other factors contributing to negative perceptions of the mine are a supposedly decreasing fish supply (although fishermen do not fish in the sea south of SW Sumbawa), and the reputed unwillingness of tourists to return to Sumbawa once they learn of the presence of tailings disposal in the area.

5.5.3 Socioeconomic Sphere

Thus, in moving to socioeconomics and fields of work, we continue to deal with local perceptions as a major factor in the human baseline. BPS (Government Statistical Bureau) data for West Sumbawa Regency in 2019 indicate there are three main employment fields for the local population, namely:

- Agriculture, forestry fisheries, and hunting
- Community, social, and individual services
- Wholesale and retail trade, restaurants, and hotels.

These sectors account for almost 70% of employment, while mining is less than 10% (note that it was a condition of transmigration programs that transmigrants farm the land so would theoretically be excluded from the mine workforce). Studies of the Batu Hijau region of course find larger numbers in mining, but the issues are neither simple nor straightforward. An AMNT study in 2018, for example, found 97% of employed persons in Ai Kangkung worked in agriculture, while the figure for Tongo was only 41%. Yet the 2019 study found 15% of Ai Kangkung households have a member working for the mining operation. The difference may in part be because former transmigrants must keep cultivating their land so as eventually to receive titles to it. More generally, many people in the region work seasonally in multiple sectors. And persons employed by contractors (rather than AMNT directly) on monthly or annual contracts may not consider themselves "employed" by the mine.

The Environmental Management-Monitoring (RKL-RPL) Implementation Report for the first semester of 2020 makes clear that, for local and regional workers, only one-third of the mine workforce is directly employed by Medco companies, and just 12% by AMNT itself. This indicates the significance of the common grievance (common to other mining operations as well) about contract employment. Working for the Company is always preferable, in terms of job security, salary, and status, to employment by "business partners" that are always under pressure to reduce costs, and thus headcount.

How this translates to the perceptions in Tatar Village can be conjectured. Though not included in previous "impact area" studies, Tatar is considered a "Ring 1" (close in) settlement. A Stakeholder Mapping study by AMNT (2017) surveyed 480 respondents in the Ring I villages around Batu Hijau mine (including Tongo, Ai Kangkung, and Tatar), and demonstrated that a plurality of respondents in the Ring I villages of the Batu Hijau mine are farmers, fishermen, or livestock breeders – approximately 37%, with only 5% employees in the mining sector. Many West Sumbawa residents working in mining, for AMNT or smaller operations, are likely from areas more distant from the mine.

Contributing to GRDP about USD 966 million in 2019, the Batu Hijau operation dominated the Regency economy, in numbers constituting three-quarters of it. Comparing GRDP and labor force data makes several things clear:

- Mining is 76% of the economy but less than 10% of the labor force.
- Agriculture (including forestry and fisheries) is 6% of the economy but more than 21% of the labor force.
- Construction is 3.3% of the economy and more than 10% of the work force.
- Trade and hospitality/food service is less than 6% of the economy and almost 21% of the labor force.
- Service sectors (including government) total almost 4% of the economy and nearly 33% of the workers.

West Sumbawa can probably be conceived as a three-tier economy, with mining staff and business owners at the top; better paid workers in construction and services in the middle; and probably 70 to 75% of the population at the bottom. In Sekongkang and Jereweh districts where most mine workers live, 64% of the heads of households are also still farmers (note that many mine workers are also still farmers).

Income and Expenditure: The Greencorp 2019 investigation social survey that interviewed 20 respondents from each of three villages in Sekongkang District (Ai Kangkung, Sekongkang Atas, and Tongo) developed data on household income from various sources. While the data are difficult to interpret, they provide strong indications that the average households in these villages had monthly income as high as, or even greater than, Rp 8 million.

Land Use: Land use in the Batu Hijau study area is allocated for rice fields, smallholder plantations (*kebun*) pasture, permanent and shifting crop fields, and state forests as well as other uses. The land usage in Sekongkang District, where the TSF will be sited, 23,404 km^2 of the total land area (of 29,384 km^2) is State Forests, or 80%. Only a small part of the land area is used for wet rice fields ("paddies") (3.8%), dry fields (2.3%), plantations (0.04%), and others. The kebun (plantation) areas could well be understated, as might be learned if the forest area in Tebisu/Puna watershed were to be surveyed for TSF development.

The release of State Forest for local management (*Hutan Rakyat*) has only been accomplished for a small part of Jereweh (<5 km^2), but this can be expected to increase. Though the vast expanses of State Forest (*Hutan Negara*) on Sumbawa are in fact a wilderness, usage of these lands is very important to the long-resident inhabitants of the Island. In addition to logging (legal if for local use), the forests are extensively used for grazing, hunting, and collection of rattan and a wide variety of other forest products. Much of this is carried out in the long dry season, since agriculture outside of irrigated areas is effectively dormant for more than half the year. It also needs to be kept in mind that without extensive intact forest cover in the highlands, there would be far less water available to the populated lowlands in the dry season.

Fisheries: Since the Batu Hijau region is directly adjacent to the sea, the Alas Strait on the West Coast and the Indian Ocean on the South Coast, fishing is important to the local residents, though a full-time occupation for relatively few. Inshore fishing and tidal flat collection of molluscs and other organisms are important in various inlets. Fishing is, in general, more common on the West Coast of Sumbawa than on the high-energy South Coast, where sea conditions are generally more hazardous, even inshore of the reef.

In 2017, the University of Mataram published a fishery survey of the villages of West Sumbawa (Sekongkang, Maluk, Taliwang, and Seteluk districts) as well as eastern Lombok across the Strait (Keruak and Jerowaru districts). Only 74 fishers were identified in all of Sekongkang District; the number did not change between 2015 and 2017. The survey found the majority of fishers use traditional methods and operate on a small-scale, generally referred to as "one-day fishing", and characterized by 6 to 7 metre-long and 0.5 to 1-metre-wide boats, with 5 to 7 horsepower engines, and having one to three people onboard. The survey revealed that fisher income levels tend to fluctuate throughout the year. In Ai Kangkung Village, monthly income levels ranged from Rp 1.4 million to Rp 7.5 million. Income levels in March tend to be higher because optimal weather conditions result in higher catch rates.

Most fishers in Sekongkang are traditional, small-scale fishers who were taught from an early age by their family members. The majority fish coral reefs and seagrass areas – widely acknowledged as important sources of fish for coastal communities. Almost half the survey respondents in Ai Kangkung Village surveyed between January and December of 2016 identified Labuan Senutuk as their preferred fishing ground. The remaining half of the respondents identified various other areas. Fishers typically favor specific fishing grounds, primarily because of two factors:

- Their target food items inhabiting coral reefs and seagrass ecosystems are semi-sedentary and tend not to migrate.
- Majority of fishermen own simple, small boats or sampans (smaller than 10 metres and equipped with 5.5 HP engines), which are unable to travel over large areas and generally do not enter the exposed sea areas.

5.5.4 Infrastructure and Public Health

Infrastructure elements discussed here include roads and transportation as well as electricity. The public health component includes disease potential, environmental health, and health facilities and infrastructure in the operational area of the Batu Hijau mining development, focusing on the southeast part of Sekongkang near the conceptually proposed TSF site.

Road Infrastructure: Though the region around the Batu Hijau operation has developed a great deal in recent decades, it remains the southwest corner of an island with largely undeveloped interior highlands. Only two access routes exist: a single north-south road from Taliwang to Jereweh and then Benete and Sekongkang; and a single east-west road (passing through Tongo, Ai Kangkung, and Tatar) to Lunyuk. Many intervillage and intra-village roads remain unimproved

Electricity and Energy: Most communities in the Batu Hijau mining development region are served by the State Electric Utility (PLN). Nearly all households in study area villages have grid electricity, except for the three Sekongkang District villages near the TSF site. (In Sekongkang Bawah, 1.7% of households (6 families) are not served by the electrical grid.)

- Tongo Village: All families in Tongo (379 households in 2018) use power sources other than PLN, including batteries, generators, and solar power installations (none managed by PLN).
- Ai Kangkung Village: About 8% of the population (some 30 families in 2018) in the isolated parts of Ai Kangkung lives completely without electricity. Residents are reported to use such lighting sources as kerosene (pressure lanterns and old-style wick lamps), carbide lanterns, battery lanterns and flashlights, flame torches, candles, and even wick lamps burning castor bean (*biji jarak* or *Ricinus communis*) oil as well as directly igniting candlenuts (kemiri or *Aleurites moluccanus*). Unsurprisingly, they also sometimes use firewood for cooking.

The description of Ai Kangkung is an indication of conditions that can be assumed to exist in Tatar. This also provides an indication of what village life was like in the 1980s and early 1990s.

Major Diseases and Health Conditions: According to data on disease prevalence in West Sumbawa Regency in 2019, the most common conditions requiring medical treatment were fever, gastrointestinal problems (gastritis and diarhea), together with upper respiratory tract Infections. Thus, a variety of minor infections is responsible for most ill-health. Chronic conditions such as high blood pressure, arthritis, and diabetes are also important.

Environmental Sanitation - Housing, Water, and Waste: The description of environmental conditions in the study area includes conditions and types of houses, unsuitable living conditions, sources of clean/drinking water, and toilets.

Housing Structures: In general, housing in the three South Coast villages is slightly better than the average for the region, though slightly worse than the other villages in Sekongkang.

Based on data on the physical types of houses in the study area in 2018, more than 59% of the families in the study area have *permanent* houses (compared to 66.2% in Tongo and 73.5% in Ai Kangkung), defined as having the walls of the house made of concrete or wood (high quality), the flooring is quality tile / ceramics / wood, and the roofing is galvanized sheet metal / tile / shingle / asbestos.

Meanwhile, less than 15% of the families own "*semi-permanent*" houses (8.9% in Tongo and 13.2% in Ai Kangkung), where the walls are *setengah tembok* (half wall) / brick without plaster / wood (low quality), the floor is low quality tiles / concrete / wood, and the roof is galvanized sheet / tile / shingle / asbestos.

Less than 31% of families live in "*non-permanent*" houses (24.9% in Tongo and 13.2% in Ai Kangkung), defined as having walls that are very simple (bamboo / planks / thatching), earth floor, and the roof is made of thatching or some combination of roof tiles / used metal roof sheet, and the like.

The data would indicate that, considering the data on employment, housing conditions very loosely correlate positively with mining employment and negatively with agricultural employment. Yet Kemuning, with 98% agricultural employment, also has 98% permanent houses.

Unsuitable Residential Sites. Upon examination, it was determined the great majority of the population in the study area are living on "suitable" housing sites. Unsafe housing locations in the study area are limited to those sited on or excessively near to riverbanks, a condition found in three of the villages. Four families in Ai Kangkung Village are considered to have their houses too close to the river channel. No residential structures in the Batu Hijau region were recorded as being below high tide elevations or in “slum” conditions (*kumuh*).

Clean Water Sources: The main sources for clean water (to be boiled for drinking) for residents in the study area are piped water (provided by the regional government, including all households in Tongo) and pumped wells (normally boreholes). In Ai Kangkung 100% of the population obtains their water from dug wells, the least desirable source other than using river water.

Sewage Disposal: Government assistance to install private toilets began in the study area in 1995. Defecation facilities for most of the population meet minimal modern sanitary requirements, with nearly 100% of families in the area around the mine having their own toilets. However, slightly less than 1% of families in the study area still rely on public latrines. This problem is slightly more persistent in Sekongkang, with 27 families using public latrines in Tongo Village. Conditions in Ai Kangkung and Tatar are assumed to be similar.

Public Health Facilities / Infrastructure: There is no full-service hospital or even clinic in the study area, other than those operated by AMNT. The Company has actively supported the local medical services since prior to mine operation.

Clinics and Posts: The facility most commonly operating in the study area villages is the Posyandu, a contraction for Integrated Service Post. While these can provide full medical services, they are staffed and operated on a rotating basis, normally once per month. Three of these set up in Tongo and three in Ai Kangkung.

The *Puskesmas Pembantu* or Auxiliary Clinics operating in four Sekongkang villages (including one in Tongo and one in Ai Kangkung) are permanent clinics but may not have full-time physicians on site.

The *Poskesdes*, a contraction for Village Health Post, is staffed with a paramedic to provide basic health services, concentrating on preventive and urgent/emergency care (there is one in Tongo). It is obvious the private physician practices in five of the villages (and particularly the one in Ai Kangkung) are of great local importance.

The *Polindes* (*Pondok Bersalin Desa* or Village Maternity Lodge) is normally staffed by a trained midwife supported by one or more traditional midwives, supervised by a government doctor not permanently onsite. These specialize in maternal and child health and family planning services. There is one in Tongo and one in Ai Kangkung.

The proliferation of facilities is less confusing if it is understood the villages are not all compact settlements. They are made up of *dusun*, subvillages (hamlets) that are somewhat isolated from each other, so that all these facilities are likely important and do not duplicate services.

Health Service Personnel: It can be presumed that the number of health workers in the study area is insufficient. As of 2018 there were no specialist doctors in the Batu Hijau study area and there were only two dentists in two villages in the study area. The roster of available health care personnel in the TSF study area indicate two trained midwives and four traditional midwives practice in Tongo. In Ai Kangkung, there is one general practitioner physician, one dentist, and one trained midwife. (It is unclear if, possibly, additional doctors rotate in from outside the area for the government clinics and posts.)

Given the World Health Organization's recommendation of one physician per 600 citizens (1:600), it is obvious that the study area does not meet this standard. Disregarding the villages in each of the three districts outside the Batu Hijau study area (which may have no doctors), the ratio in Sekongkang is 1:2094. (In Maluk it is 1:1866 and in Jereweh it is 1:2964.) For full context, however, it is important to know the ratio for Indonesia as a whole is about 1:6226. The current situation might be better than the conditions had the mine never opened; in 1992 there were only two doctors in this area.

5.5.5 Other Activities in Project Region

Two activities in the immediate vicinity of the TSF site region should be described for context in understanding the baseline human environment.

Solar Power Plant (PLTS) at Sejorong: The PLTS Sejorong, currently in development, is located in Tongo Village. This power plant will have a capacity of 26 MW, electricity that will be used as backup energy to support the operation of the seawater supply pipeline for the AMNT concentrate mill process. The PLTS is considered an expansion of the Batu Hijau power supply, and a step to reducing the carbon footprint of the operation. It does not supply electricity to the south coast villages.

Community Mining: Some people in West Sumbawa engage in small-scale gold mining. While some operations have community mining permits (IPR) from the local government, there are also unlicensed gold mining (PETI) operations. These are in the Tebisu and Puna areas and may overlap the TFS site. Processing of ore to obtain gold commonly uses *gelondong* and *tong,* basically small rotating drum mills that pulverize ore rock so that it can be separated by gravity and amalgamated with mercury. The ore process sites are in the Labuan watershed, just west of the Tebisu watershed.

06

Identification of Environmental and Social Risks and Impacts

6 Identification of Environmental and Social Risks and Impacts

This chapter briefly identifies the environmental and social impacts and risks of the two tailings management systems. The Chapter following makes a comparison and evaluation judgement on their relative acceptability, following IFC Performance Standard 1 on evaluating project alternatives.

6.1 Impacts of DSTP

The DSTP system has been designed with the goal of avoiding impacts on the highly productive and biodiverse marine habitats that occur in water depths less than 100 m. Extensive and intensive monitoring over 20 years has confirmed that this goal has been achieved. The main marine impact has been the burial of benthic seabed habitats that, at the depths where tailings deposit, have relatively low biodiversity and very low productivity.

The original ANDAL for the Batu Hijau project included the results of modelling to predict the deposition of tailings solids. Monitoring carried out by LIPI, using sophisticated deep-water survey and sampling techniques, has confirmed that the pattern of deposition is very similar to the model predictions. Further modelling has been carried out to predict deposition from the remaining years of mine production, based on the increased tailings discharge rate.

The modelling results, shown in Figure 6.1, indicate that future deposition will occur mainly within the area of existing tailings deposition. Deposition will continue the floor of Senunu Canyon as it becomes broader and flatter below 2,000 m depth and will extend to the abyssal plain around 4,000 m depth. Generally, in these areas, tailings will accumulate to thicknesses of 1 m to 2 m. Since future deposition will be in the same areas as past and present deposition, there will be little or no additional impact on seabed communities.

Meiofauna is by far the most diverse and abundant benthic organisms, and, together with organic detritus settling on the seabed, they provide the food for larger biota. Experiments have shown that meiofauna readily inhabits Batu Hijau tailings, and they have been found in samples of tailings recovered from the abyssal depths. The proposed expansion would lead to the completion of production in 2032, five years earlier than the schedule with no expansion. This means that natural recolonisation of the tailings would also be expedited by five years.

Socioeconomic and sociocultural impacts of the DSTP have generally been considered minor to non-existent. The only effects recorded are on public perception. Fishers are understandably nervous about the concept, though the effects of tailings disposal on the relatively minor and small-scale fishing that occurs on the South Coast have not been noted to date. Tourists are said to be upset with the idea of DSTP as well, but the minor existing tourism activities in the region are well to the northwest along the Alas Strait.

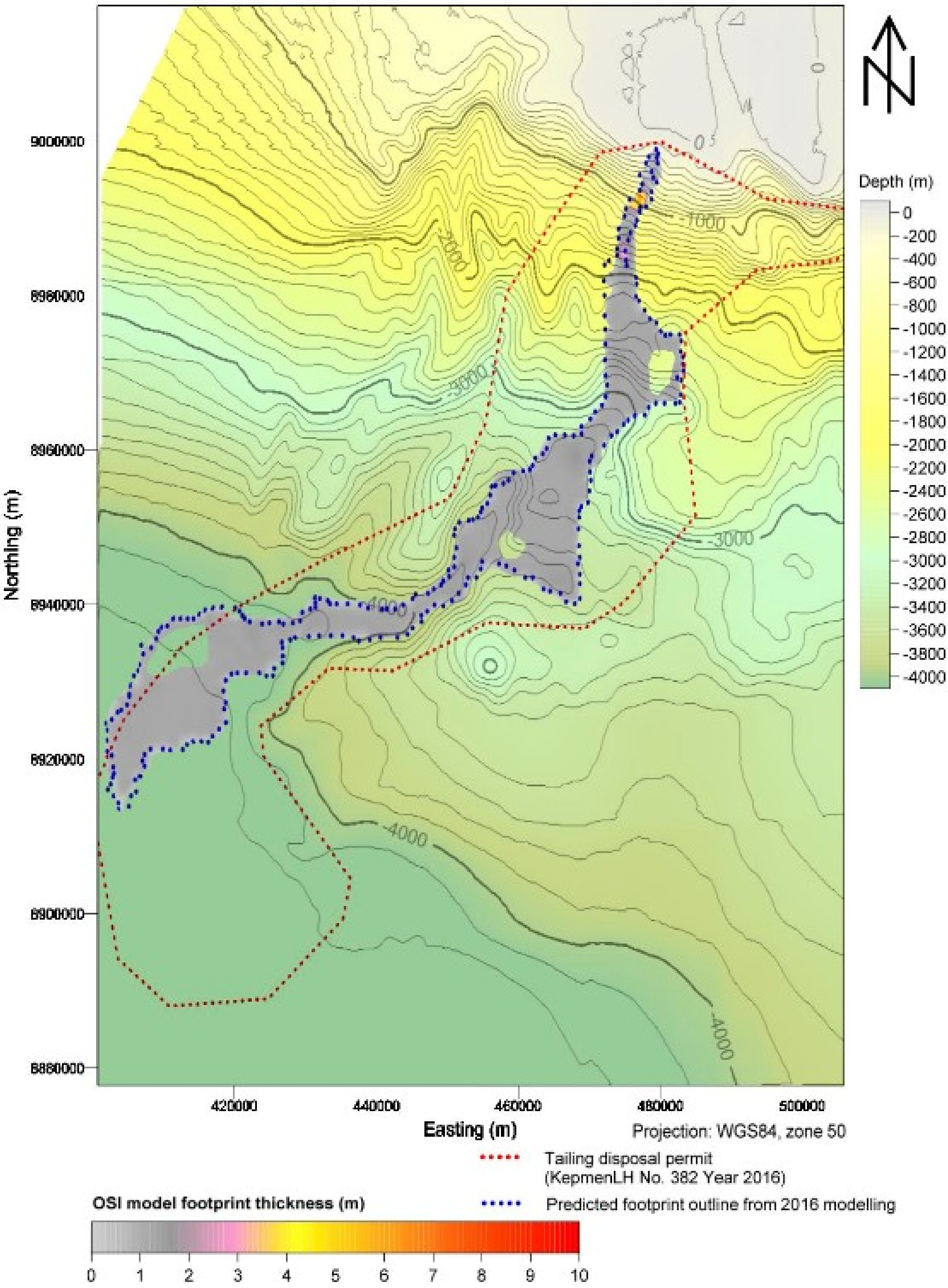


Figure 6-1 Predicted Tailings Deposition

6.2 Impacts of TSF

The TSF alternative would require removal of around 450 Ha of terrestrial forest and around 5 km of surface water stream and adjacent riparian vegetation. These areas are uninhabited and are for the most part essentially undisturbed. Apart from these direct disturbances, there would be indirect effects from erosion from the haulage road embankment, and dust generated by trucks hauling waste rock and other materials for construction of the TSF embankment. An area of around 13 Ha would also be required for temporary storage of topsoil stripped from the TSF footprint. If located on the crest of an existing waste rock dump, this could avoid the need for additional forest clearing. However, it would disrupt and delay dump reclamation.

The spillway structure to be constructed as part of the closure would require additional clearing of around 0.6 Ha of forest vegetation. Erosion protection measures along the flow path below the spillway would require further vegetation removal as would construction of a spillway access track.

Much of the remaining waste rock to be mined at Batu Hijau is potentially acid-generating. The existing practice for storing this material is to encapsulate it within broad zones of non-acid-generating (NAG) waste rock. This may prove difficult to achieve in construction of the TSF embankment. Some oxidations of sulphidic waste rock is likely, leading to acid leachate which would drain to the Return Water Pond. Post closure, this drainage would likely require treatment prior to discharge, possibly for decades.

Capping of the TSF surface after completion of tailings discharge may also be problematic if the waste rock used for capping contains sulphide minerals. Oxidation of capping material would likely hamper establishment of vegetation.

It is not yet clear whether tailings in the TSF would oxidise. No significant oxidation would occur while tailings are saturated. However, as drainage takes place and interstitial water is replaced by air, there may be the potential for widespread and prolonged oxidation. On the other hand, addition of lime in the process may produce sufficient alkalinity to neutralise acid that is generated.

6.3 Risks Associated with DSTP System

Risks that apply to the proposed DSTP system are relatively few and minor, and all can be readily minimised by design safeguards and operating procedures. Most importantly, once operations cease, even these small risks disappear and there are no residual risks.

The DSTP system is equipped with pressure and water level sensors which would alert control room operators in the event of pipeline blockage or rupture. Such an event would trigger an automatic shut-down, thereby limiting spillage to a single pipeline volume of tailings.

A major earthquake could damage the Deaeration tank and could also damage the DSTP pipelines. A tsunami could cause severe damage to the marine sections of the DSTP system. However, tailings discharged due to these events would be limited to the contents of the pipeline.

6.4 Risks Associated with TSF System

Construction, operation, and closure of a TSF to store the final 433 million tonnes of tailings from the Batu Hijau mine entails many risks. Risk factors include steep, potentially unstable slopes in and around the TSF site; high wet season rainfall and occurrence of intense rainfall events; and high risk of damaging seismic events. The contents of the TSF could liquefy under seismic shaking, adding to the overall risk.

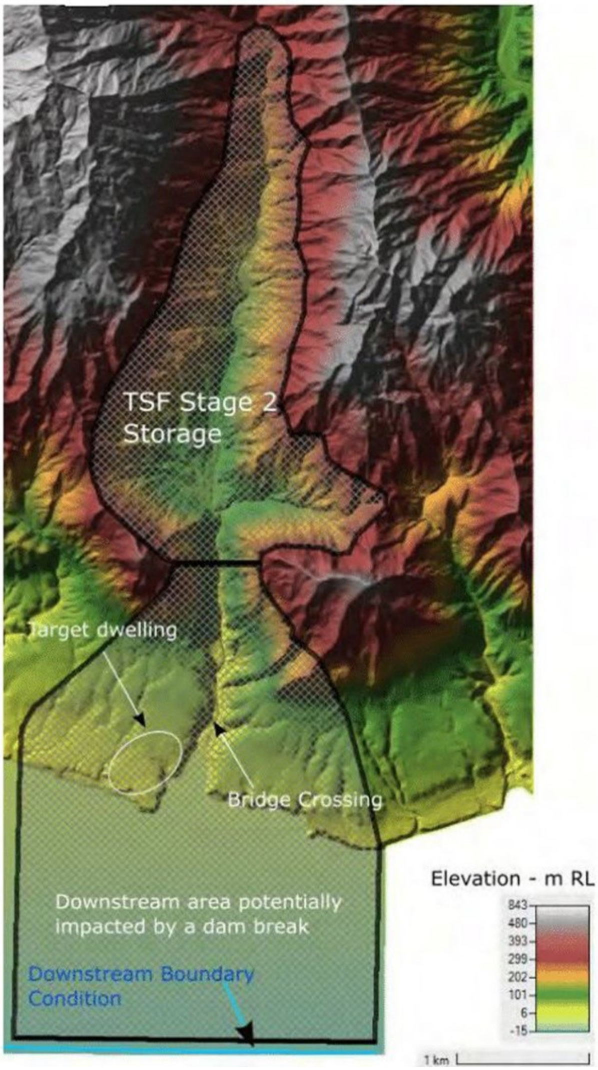
The subject TSF, at completion, would require a 270 m high embankment (almost as high as the Eiffel Tower) and would be, by far, the highest dam in Indonesia – almost three times the height of the Cirata Dam. For most potential failure modes, the higher the dam, the higher would be both the risk of failure and the consequences of failure. Worldwide, there are very few TSF embankments higher 270m and the few that do exist are not situated in areas subject to high rainfall and high seismicity. Of particular concern would be the long-term integrity of the TSF. Some of the risks could be minimised in the design and operation of the facility. However, eventually after closure, it is inevitable that management and monitoring would be reduced while some of the risks would remain in perpetuity.

Geotechnical consultants PSM have assessed the risk of embankment failure under static and dynamic conditions. Calculated factors of safety exceeded 1.5 for static conditions and 1.0 for dynamic conditions. The factors of safety meet the requirements of ANCOLD. However, while this may seem reassuring in relation to the failure modes that were assessed, there are other risks that have not been assessed, including:

- Foundation failure. At this stage, there has been no geotechnical investigation of foundation conditions at the TSF site and, accordingly, risk of foundation failure has not been evaluated. This is significant as foundation failure has been implicated in several major TSF failures.
- Earthquake causing surface displacement along existing faults. Such a fault is believed to be present beneath the axis of the Puna valley, passing beneath the embankment site (PSM – 2021 Figure 6).
- Damage to the spillway inlet due to earthquake or other mechanisms, leading to overtopping of the embankment crest. The spillway inlet is conceived as a series of 2 m diameter concrete ring segments stacked one above the other to form a tower with a total height of at least 260 m. Support for this structure would be provided by a zone of waste rock with radius of 10 m surrounding the inlet, placed in 2 m thick layers as the spillway inlet is raised.
- Overtopping of the embankment crest due to one or more seiche waves. Seiches could be caused by earthquake events or by one or more landslips into the TSF pool.
- Erosion of the downstream slope of the embankment due to tsunami generated by major earthquake south of Sumbawa.

Similarly, the spillway has been designed with sufficient capacity to handle the 1,000 Annual Exceedance Probability (AEP) flood event. Again, this meets the ANCOLD requirements. However, it assumes that flow through the spillway is not impeded. Floods commonly carry large quantities of floating debris, including fallen trees, which can accumulate and block spillway structures, causing pool levels to rise. While it may prove possible, although not easy, to ensure that spillway capacity is maintained during operations, it would not be feasible to do so after closure.

PSM also carried out a Dam Break Assessment to evaluate the potential consequences of TSF embankment failure. Figure 6-2 shows the potentially impacted area under the worst case scenario. Such a failure could result in human deaths and severe damage to property. It would also cause severe damage to the marine environment, including the productive near-shore habitats. While Figure 6-2 shows the modelled area that could be affected in the short term, waves and currents would distribute tailings over a very much wider area, affecting many kilometres of coastline.



Source: PSM's PSF Batu Hijau TSF draft report (September 2021)

Figure 6-2 Potential Area Affected by Dam Break

07

Comparative ESIA

7 Comparative ESIA

This Comparative ESIA discussion compares known and expected impacts and risks associated with both tailings management schemes to begin arriving at a judgement of their relative acceptability (following IFC PS 1 guidance on studying project alternatives).

7.1 Comparison of Impacts of DSTP with Impacts of TSF

The impacts associated with the expansion of the existing DSTP system are compared in Table 7-1 with the impacts that would be associated with the construction, operation, and closure of a TSF.

Table 7-1 Comparison of Impacts of Alternative Tailings Management Systems

Environmental Component	Deepsea Tailings Placement System	Tailings Storage Facility
Air quality during construction	Minor dust generation along the pipeline corridor	Moderate dust generation along access roads and embankment foundations
Air quality during operations	No effect	Possible dust from wind erosion during the dry season
Land area affected	29 Ha	446 Ha (excluding access roads, pipeline corridors and topsoil storage
Land habitats affected	Non-forest areas: 8 ha Dry forest Moist evergreen forest	Dry forest (including dry deciduous forest) Moist evergreen forest Riparian forest
New landform created	None	Elevated terrace replacing valley
Socioeconomic effects	Likely minor	Unquantified, likely minor
Streams affected	None	5 km of streambed buried
Shallow marine habitat affected	None	Suspended sediment and deposition during construction
Deepwater marine habitat affected	Continuation of slurry flowing down Senunu Canyon with deposition on canyon floor and on abyssal plain and intermittent slumping.	None
Acid generation and heavy metal mobilisation	None	Possible
Time for rehabilitation after closure	Less than 5 years	Many decades

It is clear from the above comparisons that the TSF would result in much more serious impacts than the proposed DSTP system. Fifteen times the area of terrestrial habitat would be affected including more than 20 times the area of high-quality forest. While DSTP affects a much larger area of seabed, the affected areas are of low biodiversity and very low productivity and the impacts have already occurred.

Analysis of available imagery does not indicate any obvious effects on residents. The riparian or dry forest along the Tebisu channel and the moist evergreen forest on the slopes do not seem to have any significant agricultural clearings. Local forest plantings (*kebun*) are, of course, generally very small and often not associated with obvious breaks in the forest canopy. The 21 Ha of dryland agriculture delineated in the watershed appears to be the easternmost cultivated area of Tatar Village, and none is needed for the TSF. If, like other residents of Sekongkang, Tatar villagers have forest plantings in the highland areas, they will logically be in the upper areas of the small Puna watershed. It appears unlikely that any would extend over the divide into the Tebisu drainage; even if such exist, they might not be within the TSF footprint.

The 5 km of streambed lost to the ultimate TSF configuration possibly includes a small seasonal estuarine area that may be occasionally used for fishing by nearby residents.

In general, there is no good reason to further study Tatar Village interests in the TSF site. Not only are the likely socioeconomic effects in any case likely to be minor, but there is also no reason to call attention to an action (TSF development) that is unlikely to ever be considered feasible or seriously considered due to its numerous impacts and serious risks.

7.2 Comparison of Risks Associated with TSF and DSTP Systems

Just as the TSF system causes more impacts than DSTP, there is an asymmetry in the risks posed by the alternative tailings management approaches. Table 7-2 attempts to compare the two sets of risk factors.

Table 7-2 Comparison of Risks of Alternative Tailings Management Systems

Risk Factor	Deepsea Tailings Placement System	Tailings Storage Facility
Seismic failure	Designed for moderate seismic events; automatic shutoff in pipeline rupture event	Massive structure at risk from liquefaction, embankment and foundation failure, fault displacement, seiche waves, embankment crest overtopping,
Tsunami	Designed for some tsunami risk; in the event of coastal component destruction, automatic shutoff limits further risks	Erosion of downstream slope of embankment in subsea quake could lead to major or catastrophic failure even in seismic event not directly destructive to facility.
Extreme rainfall	Severe erosion could undermine onshore pipeline foundations; automatic shutoff limits further risks.	Impedance of spillway intake, event in excess of 1,000-year return period possible
Risks to life	Effectively non-existent	Some residents of Tatar Village could be vulnerable in catastrophic failure
Socioeconomic risks	Likely minor, limited to tailings slurry spills of limited volume and duration	Farmland, coastal roadbed and bridge, beach and near-shore fisheries all at risk
Land use and terrestrial habitats at risk	Limited risks along pipeline corridor	Coastal, beach, and farmland areas
Freshwater and estuarine aquatic habitats at risk	Likely minor in the event of tailings slurry spills of limited volume and duration	Structure itself has eliminated such habitats within its watershed; possible overflow into river to east
Shallow marine habitats at risk	Likely minor in the event of tailings slurry spills of limited volume and duration if automatic shutdown failed	Structural failure or crest overtopping could release minor to massive volumes of tailings solids to be redistributed along coast, smothering lagoons and reefs
Deepwater marine habitats	Unlikely to increase above current impacts in any case	Possible, unlikely
Post-closure risks	All risks expected to diminish to nil when operations cease.	Effectively permanent threat of catastrophic failure, increasing over time with the inevitable reduction of maintenance and monitoring efforts.

It should be clear from the summary above, and from the Chapter 7 discussion that there are serious risks associated with a possible TSF system while the DSTP system all but avoids serious risks, with most risk factors readily minimised by design safeguards and operating procedures. Clearly, a tailings dam break could not only directly affect human life and property, but it would also seriously damage coastal, intertidal, reef, and shallow water ecosystems along the South Coast well beyond Teluk Tebisu. In contrast, the risks of even a complete rupture of the DSTP would be minor, as the pipeline flow would be quickly, if not immediately, stopped.

If the main risks are those presented by the final 433 million tonnes of tailings from the Batu Hijau mill, the major difference between the two systems can be summarised as:

- DSTP cumulatively stores this mass below thousands of metres of seawater, with only a limited volume at a time in a position to threaten life, land, or structures.
- TSF cumulatively stores the mass in a position and at an elevation where it remains a permanent threat.

08

Conclusions

8 Conclusions

After 21 years of operation, the impacts of Batu Hijau's DSTP system have already been experienced, and no new impacts are predicted, even with an expansion being planned by AMNT. The DSTP system has performed as intended. In particular, no tailings have been introduced into productive marine ecosystems. The main impact has been burying benthic organisms in deep water where productivity and biodiversity are very low. Once DSTP ceases, the deep seabed habitat is predicted to recover within a few years. No long-term adverse impacts will be associated with DSTP.

The TSF alternative that has been assessed in this report would have severe adverse environmental impacts, including the loss of around 450 Ha of high-quality forest vegetation and a diverse range of resident fauna. In addition, 5 km of riverine habitat would be destroyed. While the surface of the TSF could eventually be rehabilitated, it would take decades, possibly centuries, before these areas would be returned to the diversity and productivity of their natural state.

Of even more concern than the environmental impacts associated with a TSF is the risk of embankment collapse. There is no precedent for a dam of this magnitude in a region of high earthquake risk. While some risks can be reduced by more detailed investigation and design and management safeguards, serious risks to life, property, and the natural environment will remain, not only during the operating period but in perpetuity. There are no serious risks associated with the ongoing operation of the DSTP system, and no long-term risks whatsoever.

The Batu Hijau DSTP system has proved to be robust and reliable; its impacts are well understood and have been shown to be readily reversible. There is, therefore, no reason to further consider a TSF scheme. The unavoidable environmental impacts that would occur and the inherent risk of potentially catastrophic failure clearly show that a TSF is not an acceptable option for Batu Hijau tailings.

APPENDIX:

ENVIRONMENTAL AND SOCIAL DESIGN CRITERIA

For the design and operation phases of the TSF Project, besides the more specific EDC in the ESIA report, the criteria identified in this Appendix provide additional direction, standards, and guideline values for:

- Materials Handling
- Emissions to Air
- Discharges to Water
- Waste Management.

Design criteria are not provided for land acquisition and involuntary resettlement, as such activities are not anticipated to be significant within the TSF development plan. As well for this reason, no criteria are provided here for dealing with Indigenous Peoples (IP) communities. It is possible to argue both for and against the proposition that the long-established residents of Western Sumbawa meet international standards for defining IP communities (particularly communities to the east of the mine). There are active civil society organizations that adopt that argument. Some residents in parts of Ai Kangkung Village could meet the standards for *Komunitas Adat Terpencil* (KAT) or Remote Traditional Law Communities, the more narrowly defined Indonesian equivalent of IP. Should it prove necessary, AMNT has internal procedures specifically designed to meet National and international standards for managing relations with such communities. But this contingency is currently not considered likely.

1 Policy, Legal, and Administrative Framework

This Section lists applicable Company policies, Government of Indonesia (GoI) laws and regulations, international conventions, and GIIP, predominantly in form of the IFC EHS Guidelines.

1.1 AMNT Statement of Commitment

AMNT is committed to uphold its Health, Safety, and Environment (HSE) Statement of Commitment.

1.2 Indonesia Laws and Regulations

The regulatory administrative framework applicable to the TSF development effort comprises all Indonesian environmental, safety, and mining laws and regulations applicable to the Project; the regulatory environmental assessment of the Project (see 2021 ANDAL-RKL-RPL Addendum), social and land use regulations, and international treaties and agreements to which Indonesia is a signatory.

To understand this framework, it is important to know Indonesia is divided into five administrative layers (Figure A.1). At the top level is the Nation, the Republic of Indonesia, which consists of 34 *provinsi* (provinces). Each province is headed by a *gubernur* (governor). The various *provinsi* (otherwise known as Level 1 regions) are further subdivided into *kabupaten* or regencies (Level 2 regions, headed by the *bupati* or regent), which are further subdivided into *kecamatan* (districts) and *desa* (villages). Within the provinces, there are municipalities or city governments, which have the same Level 2 status as regencies. These metropolitan regencies are referred to as *kota* (or city). Each city is led by a *walikota* (mayor).

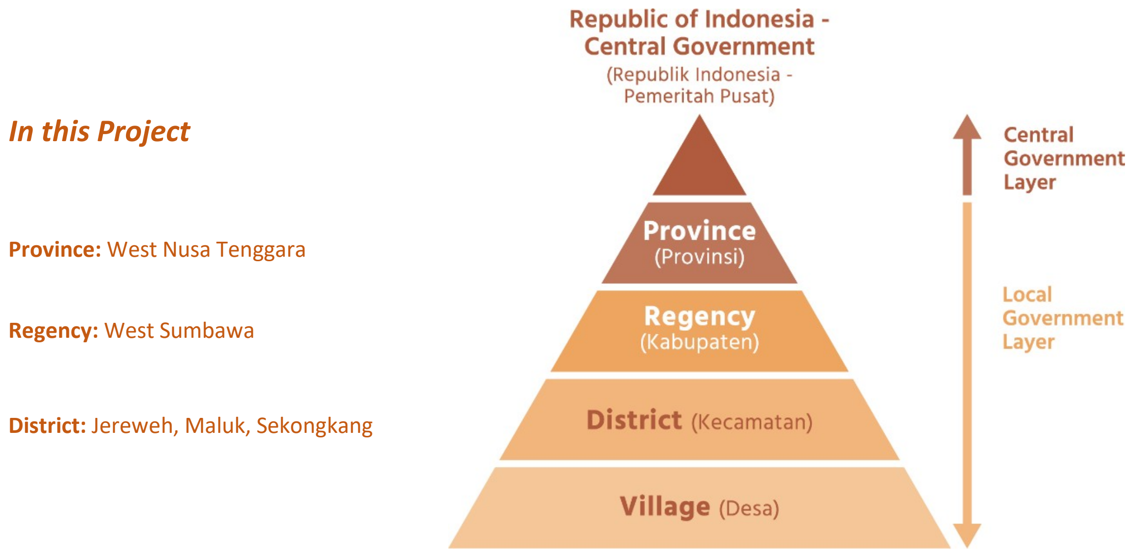


Figure A.1 Five Administrative Layers of Government of Indonesia

The Central Government issues laws and regulations relating to or directly governing environmental management and protection in Indonesia. These are complemented by environmental regulations at province and regency levels that supplement (and at times may contradict central National legislation or Nationally-issued regulations. The Project must comply with both National and regional/local regulations.

1.2.1 Indonesia Regulations Governing Air Quality, Noise, and Vibration

Relevant National regulations governing air quality, noise and vibration are as follows:

- Minister of Environment Regulation No 21 of 2008 on Emission Standards for Thermal Power Generation;
- PP No 22 of 2021 on Provisions for Environmental Protection and Management, Appendix VII;
- Minister of Environment Decree No 49 of 1996 on Vibration Level Standards;
- Minister of Environment Decree No 48 of 1996 on Noise Level Standards.

1.2.2 Indonesia Regulations Governing Water Quality

Relevant National regulations governing water quality are as follows:

- Health Minister Regulation No. 416 of 1990 on Requirements and Monitoring of Clean Water Quality.
- PP No 82 of 2001 on Water Quality Management and Pollution Control;
- Minister of Environment Decree No 112 of 2003 on Domestic Wastewater Quality Standards
- Law No 7 of 2004 on Water Resources;

- Minister of Environment Decree No 22 of 2004 on Effluent Quality Standards for Gold and/or Copper Mining;
- PP No 42 of 2008 on Water Resources Management;
- Minister of Environment Regulation No 1 of 2010 on Water Pollution Control Procedures;
- Minister of Environment Regulation No 5 of 2014 on Wastewater Quality Standards;
- Minister of Energy and Mineral Resources Regulation No 31 of 2018 on Guidelines for Establishing Groundwater Conservation Zones.
- Minister of Environment and Forestry Regulation No 12 of 2018 on Requirements and Procedures for Waste Disposal in the Sea;
- PP No 22 of 2021 on Provisions for Environmental Protection and Management, Appendix VI, Appendix VIII.

1.2.3 Indonesia Regulations Governing Waste and Hazardous Waste Management

Relevant National regulations governing waste management include:

- Environmental Impact Management Agency Decree No 3/BAPEDAL/09 of 1995 on Technical Requirements for Hazardous and Toxic Waste Treatment;
- Environmental Impact Management Agency Decree No 2/BAPEDAL/09 of 1995 on Hazardous and Toxic Waste Manifests;
- Environmental Impact Management Agency Decree No. 1/BAPEDAL/09 of 1995 on Procedures and Requirements for Storage and Collection of Hazardous and Toxic Waste;
- PP No 74 of 2001 on Hazardous Material Management;
- Law No 18 of 2008 on Municipal Solid Waste Management;
- Minister of Environment Regulation No 2 of 2008 on Hazardous Waste Utilization
- Law No 18 of 2008 on Waste Management;
- Minister of Environment Regulation No 18 of 2009 on Permit Procedures for Hazardous Waste Management;
- Interior Minister Regulation No 33 of 2010 on Guidelines for Waste Management;
- Minister of Interior Regulation No 33 of 2010 on Guidelines for Waste Management;
- PP No 81 of 2012 on Management of Household Waste and Household-like Waste;
- PP No 101 of 2014 on Hazardous and Toxic Waste Management;
- Presidential Regulation No 83 of 2018 on the National Action Plan to Combat Marine Debris;
- Environment and Forestry Minister Regulation No 18 of 2020 on Beneficial Use of B3 Waste;
- Environment and Forestry Minister Regulation No 10 of 2020 on Alternative Solutions for Managing B3 Wastes;
- PP No 27 of 2020 on Specific Waste Management;
- Environment and Forestry Minister Regulation No 12 of 2020 on Storage of Toxic and Hazardous (B3) Substances.
- PP No 22 of 2021 on Provisions for Environmental Protection and Management, Appendices IX, X, XI, XII, XIII, XIV.

1.2.4 International Conventions Adopted by Indonesia

International treaties and conventions ratified to date by the Republic of Indonesia are summarized below.

International Convention/Treaty	Ratification by Indonesian Laws and Regulations
Air and Atmosphere	
United Nations Framework Convention on Climate Change	Law No 6 of 1994
Kyoto Protocol to the United Nations Framework Convention on Climate Change	Presidential Decree No 92 of 1998
Paris Agreement to the United Nations Framework Convention on Climate Change	Law No 16 of 2016
Kyoto Protocol to the United Nations Framework Convention on Climate Change	Law No 17 of 2004
United Nations Framework Convention on Climate Change	Law No 06 of 1994
Montreal Amendment to the Montreal Protocol Substances that Deplete the Ozone Layer	Presidential Regulation No 46 of 2005
Beijing Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer	Presidential Regulation No 33 of 2005
Montreal Protocol on Substances that Deplete the Ozone Layer, Copenhagen, 1992	Presidential Decree No 92 of 1998
Vienna's Convention for the Protection of the Ozone Layer and Montreal Protocol on Substances that Deplete the Ozone Layer as Adjusted and Amended by the Second Meeting of the Parties London	Presidential Decree No 23 of 1992
Biodiversity	
International Plant Protection Convention	Presidential Decree No 2 of 1977
Convention on International Trade in Endangered Species of Wild Fauna and Flora	Presidential Decree No 43 of 1978
ASEAN Agreement on the Conservation of Nature and Natural Resources	Presidential Decree No 26 of 1986
Amendment 1979 to Convention on International Trade in Endangered Species of Wild Fauna and Flora, 1973	Presidential Decree No 1 of 1987
Convention concerning the Protection of the World Cultural and Natural Heritage	Presidential Decree No 17 of 1989
Cartagena Protocol on Biosafety to the Convention on Biological Diversity	Law No 21 of 2004
Ramsar Convention on Wetlands	Presidential Decree No 48 of 1991
Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity	Law No 11 of 2013

International Convention/Treaty	Ratification by Indonesian Laws and Regulations
Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks	Law No 21 of 2009
Cartagena Protocol on Biosafety to the Convention on Biological Diversity	Law No 21 of 2004
United Nations Convention on Biological Diversity	Law No 05 of 1994
Agreement on Establishment of Regional Secretarial of the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security	Presidential Regulation No 19 of 2014
Convention of the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean	Presidential Regulation No. 61 of 2013
International Tropical Timber Agreement, 1994	Presidential Decree No 04 of 1995
Convention on Wetlands od International Importance especially as Waterfowl Habitat	Presidential Decree No 48 of 1991
Convention concerning the Protection fo the World and Natural Heritage	Presidential Decree No 17 of 1989
Amendment 1979 on Convention on International Trade in Endangered Species of Wild Fauna and Flora, 1973	Presidential Decree No 01 of 1987
Asean Agreement on the Conservation of Nature and Natural Resources	Presidential Decree No 26 of 1986
Convention on International Trade in Endangered Species of Wild Fauna and Flora which had been Signed in Washington on Marc 3rh 1973	Presidential Decree No 43 of 1978
International Plant Protection Convention which had been Signed by the Delegation of the Government of the Republic of Indonesia in Rome	Presidential Decree No 02 of 1977
Forestry	
International Tropical Timber Agreement	Presidential Decree No 4 of 1995
Labor / Children / Women	
ILO Conventions	Law No19 of 1999, Law No20 of 1999, Law No 21 of 1999
Maritime Labour Convention, 2006	Law No 15 of 2016
International Convention on the Protection of the Right of All Migrant Workers and Members of their Families	Law No 06 of 2012
Convention on the Right of Persons with Disabilities	Law No 15 of 2016
Protocol to Prevent, Suppress and Punish Trafficking in Persons, Especially Women and Children, Supplementing the United nations Convention Against Transnational Organized Crime.	Law No 06 of 2012

International Convention/Treaty	Ratification by Indonesian Laws and Regulations
ILO Convention No. 81 concerning Labour Inspection in Industry and Commerce	Law No 19 of 2011
Convention ILO No. 138 regarding Minimum Age of Labor	Law No 14 of 2009
Convention on the Elimination of all Forms of Discrimination Against Women	Law No 21 of 2003
Convention Concerning for Occupational Safety and Health/Convention 198, 2006	Law No 20 of 1999
Instrument for the Amendment to the Constitution of the International Labor Organization 1997	Law No 07 of 1984
ILO Convention No. 88 Concerning The Organization Of The Employment Service	Presidential Regulation No 34 of 2015
Convention on the Rights of the Child	Presidential Decree No 36 of 1990
Convention 144 concerning Tripartite Consultations to Promote Implementation of International Labour Standard	Presidential Decree No 26 of 1990
Hazardous Materials and Waste	
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemical and Pesticides in International Trade	Law No 10 of 2013
Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management	Presidential Regulation No 84 of 2010
Amendment to the Convention on the Physical Protection of Nuclear Material	Presidential Regulation No 46 of 2009
Framework Agreement between the Government of Indonesia and the Secretariat of the Basel Convention on the Control of the Transboundary Movement of Hazardous Wastes and their Disposal on the Establishment of a Basel Convention Regional Centre for Training and Technology Transfer for Southeast Asia	Presidential Regulation No 60 of 2005
Amendment to the Basel Convention on the Control of Transboundary Movement of Hazardous Waste and their Disposal	Presidential Regulation No 47 of 2005
Protocol 9 Dangerous Goods	Presidential Decree No 21 of 2003
Basel Convention on the Control of Transboundary Movement of Hazardous Waste and their Disposal	Presidential Decree No 61 of 1993
Health	
United Nations Convention Against Illicit Traffic in Narcotic Drugs and Psychotropic Substances, 1988	Law No 07 of 1997
Convention on Psychotropic Substances 1971	Law No 08 of 1996
Social	

International Convention/Treaty	Ratification by Indonesian Laws and Regulations
International Covenant on Economic, Social and Cultural Rights	Law No 11 of 2005
Convention for the Safeguarding of Intangible Cultural Heritage	Presidential Regulation No 78 of 2007
Others	
Stockholm Convention on Persistent Organic Pollutants	Law No 19 of 2009
Ratification of Asean Petroleum Security Agreement	Presidential Regulation No 07 of 2013
Protocol on the Authentic Quinquelingual Tex of the Convention on International Civil Aviation, Chicago 1944	Presidential Regulation No 05 of 2005

1.2.5 Good International Industry Practices

The IFC EHS Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP), as defined in IFC Performance Standard (PS) 3: Resource Efficiency and Pollution Prevention. The IFC EHS Guidelines contain the performance levels and measures that are normally acceptable to IFC and that are generally considered to be achievable in new facilities at reasonable costs by existing technology. Compliance with IFC requirements is considered as GIIP, commonly acceptable international lenders involved in project financing. As such, this ESIA derives Good International Industry Practices from IFC guidelines, specifically the following:

- IFC Performance Standards;
- IFC General EHS Guidelines; and
- IFC EHS Guidelines for Mining.

2 Emissions to Air

This section contains EDC for source emissions to air and details of applicable Ambient Air Quality Standards (AAQS) including ambient noise levels. Odors are excluded because they are commonly not an impact in mining activities.

In Indonesia, most environmental policies involve some combination of emission controls and ambient environmental quality standards. For instance, particulates emissions are capped by emission standards while permissible ambient particulate matter concentrations are regulated by AAQS (Figure A.2). It follows that EDC need to consider both emission limits and ambient environmental quality standards.

Figure A.2 Combination of Emission Controls and Ambient Air Quality Standards to Protect Environment

The relevance of emission standards is intuitive: government authorities worldwide impose limits on permissible emissions of pollutants at the source, as illustrated in Figure A.2. Ambient environmental quality standards are developed to protect both human and ecological (vegetation, wildlife) receptors. They are not measured at the emission source (e.g., stack), but are measured (during operation phase) or modeled (during design phase) at the receptor (e.g., ground level in case of air emissions, usually at the property boundary or the nearest location where people live or work; i.e., homes, schools, or hospitals). The Project is designed to comply with both applicable emission and ambient environmental quality standards.

2.1 Point Source Emission Limits

There are no point emission sources directly related to the TSF development. For emission limits related to mine operation, see 2021 AMNT BH Mine Addendum AMDAL.

2.2 Dust Emissions

Copper-gold mining activities typically generate dust (particulates), particularly from land clearing, drilling, blasting, and material transport and dumping. Minimization of dust is key to improved worker health. No specific limits apply for emissions of particulate matter from copper mining operations, with the exception that ambient air quality standards must be met. According to Indonesian regulations on air quality control (PP No 22 of 2021, Appendix VII), the emissions standard for dust or Total Suspended Particulates (TSP) that must be met is 230 $\mu g/Nm^3$ (24 hours) or 90 $\mu g/Nm^3$ (1 year).

IFC EHS Guidelines for Mining suggest control measures for dust that include:

- Dust suppression techniques (including wetting down, use of all-weather surfaces, use of agglomeration additives) applied to roads and work areas, with optimization of traffic patterns and reduction of travel speeds.
- Exposed soils and other erodible materials should be revegetated or covered promptly.
- New areas should be cleared and opened only when absolutely necessary.
- Surfaces should be revegetated or otherwise rendered non-dust-forming when inactive.
- Storage of dusty materials should be enclosed or operated with efficient dust suppressing measures.

- Loading, transfer, and discharge of materials should take place with a minimum drop, be shielded against the wind, and consider use of dust suppression spray systems.
- Conveyor systems for dusty materials should be covered and equipped with measures for cleaning return belts.

2.3 Greenhouse Gas Emissions

Though Indonesia has a climate change action program and goals, there are no specific Indonesian Greenhouse Gas (GHG) emission standards at this time. IFC Performance Standard 3, Resource Efficiency and Pollution Prevention, does not regulate GHG emissions as such, but does require quantification and reporting. IFC Guidance Note 3 requires that projects expected to produce more than 100,000 metric tons of CO_2 equivalent annually will quantify direct emissions from the facilities owned or controlled within the physical project boundary, as well as indirect emissions associated with the off-site production of energy used by the project. For the TSF development, quantification of GHG emissions will not be required, as expected associated GHG emissions fall below this threshold.

2.4 Ambient Air Quality Standards

Ambient air quality standards (AAQS) are provided to ensure that communities and protected areas around the facility are not adversely affected by project emissions. Concentrations are measured and documented in milligrams per cubic metre of gas (mg/m^3) over specified averaging periods. AAQS include various thresholds for different averaging periods, all of which have to be met. The regulation does not specify where limits apply: at site boundary, at the receptor, or at the maximum point of impingement.

Table A.1 shows the comparative limits of ambient air quality based on Indonesian National PP No 22 of 2021, Appendix VII (which is a repromulgation of in PP No 41/1999) and WHO Guidelines which are also used in IFC EHS guideline.

Table A.1 Ambient Air Quality Standards

Parameter	Indonesian Regulation (GR 22 of 2021)		WHO Guidelines[1,2]		
	µg/Nm^3	Averaging Period	Interim Targets (µg/Nm^3)	µg/Nm^3	Averaging Period
PM2.5	65	24 hours	75	25	24 hours
	15	1 year	35[Notes 3]	10	1 year
PM10	150	24 hours	150	50	24 hours
			70[Notes 3]	20	1 year
NO_2	400	1 hour		200	1 hour
	150	24 hours			
	100	1 year		40	1 year
SO_2	900	1 hour	125	20	24 hours
	365	24 hours			
	60	1 year			
O_3	235	1 hour	160	100	8 hours
	50	1 year			
CO	30,000	1 hour			
	10,000	24 hours			
	-	1 year			

Parameter	Indonesian Regulation (GR 22 of 2021)		WHO Guidelines[1,2]		
	µg/Nm³	Averaging Period	Interim Targets (µg/Nm³)	µg/Nm³	Averaging Period
Pb	2	24 hours			
	1	1 year			
Total Suspended Particulates (TSP)	230	24 hours			
	90	1 year			
Dust Deposition	10 tonne/km² /mo residential)	30 days			
	20 tonne/km² /mo (industrial)				
Hydrocarbon (HC)	16	3 hours			

Notes
[1] Values stated are in the 99th percentile
[2] Reference temperature is local ambient temperature at time of sampling.
[3] Use of PM2.5 guideline value is generally preferred over the PM10 value; however the PM10 value can be used in the absence of PM2.5 data.

IFC General EHS Guidelines require that projects with significant sources of air emissions and potential for significant impacts to ambient air quality, should prevent or minimize impacts by ensuring that emissions do not result in pollutant concentrations that reach or exceed relevant ambient quality guidelines and standards by applying national legislated standards, or in their absence, the current WHO Air Quality Guidelines. Since the government has established ambient quality guidelines and standards, limits as defined by the government serve as EDC.

2.5 Ambient Noise Level Standards

Minister of Environment Decree No 48 of 1996 on Noise Standards defines National noise emission standards dependent on the area designation, with lower limits for residential and natural areas compared to industrial and commercial areas (Table A.2). The IFC General EHS Guidelines on Noise (also Table A.2) are from World Health Organization Guidelines for Community Noise (1999).

In Indonesia, noise level measurements are taken off-site at specific times over the course of a day using a noise level meter. A 24-hour weighted average is calculated based on the measurements, with greater weighting given to measurements taken at night. It is the 24-hour weighted average that is compared to the regulatory noise limits.

Table A.2 Noise Level Standards in dBA

Receptors	MoE Decree No 48 of 1996	IFC[1]	Stringent Limit
Houses and residential areas	55	55 Daytime (7:00 to 22:00) 45 Nighttime (22:00 to 07:00)	55 45
Trade and services	70	70 Daytime (07:00 to 22:00) 70 Nighttime (22:00 to 07:00)	70
Offices and trade	65	70 Daytime (07:00 to 22:00) 70 Nighttime (22:00 to 07:00)	65
Green open spaces	50	-	50
Industrial	70	70 Daytime (07:00 to 22:00) 70 Nighttime (22:00 to 07:00)	70
Government and public facilities	60	-	60
Recreation	70	-	70
Seaports	70	-	70
Hospitals, schools, and religious buildings	55	55 Day time(07:00 to 22:00) 45 Night time (22:00 to 07:00)	55 45

[1] IFC General EHS Guidelines

3 Discharges to Water

This section contains Environmental Design Criteria for discharges to water and details the applicable Ambient Water Quality Standards (AWQS). As is true for discharges to air, environmental policies involve a combination of effluent discharge controls and ambient environmental quality standards (Figure A.3). It follows that EDC need to consider both discharge limits and ambient environmental quality standards. IFC EHS Guidelines further specify that:

- Effluents should be separated along industrial, utility, sanitary, and stormwater categories (also a requirement of Indonesian regulations).
- Opportunities should be identified to prevent or reduce wastewater through prevention, reuse, and recycling.

Figure A.3 Mixing Zone Concept

- Treatment of wastewater should be based on national and local standards, assimilative capacity of receiving environment, intended use of receiving water, presence of sensitive receptors, and good industry practice.
- Discharge of wastewater should not result in contaminant concentrations in excess of local ambient water quality criteria, or in the absence of local criteria, other sources of ambient water quality.
- Compliance with effluent limits is demonstrated through quarterly/biannual reports to the relevant government authorities as per approved Environmental Permit. Reporting includes details on daily flow measurements, monthly production, and quarterly sampling data.

3.1 Domestic Wastewater

This document defines sewage as wastewater containing human excrement and/or household wastewater that originates from sanitary conveniences of a dwelling, business, building, or industrial facility. It does not include storm water or industrial effluents.

Minister of Environment Decree No 112 of 2003 on Domestic Wastewater Quality Standards defines domestic wastewater as wastewater originating from business and/or resident activity (real estate), restaurant, office complex, commerce, apartments, and dormitories. Table A.3 summarizes applicable domestic wastewater discharge limits.

Table A.3 Domestic Wastewater Discharge Limits

Parameter	Units	Indonesia MoE Decree No 112 of 2003	IFC[1]
pH	pH	6 - 9	6 - 9
BOD	mg/l	100	30
Total Suspended Solids (TSS)	mg/l	100	50
Oil and Grease	mg/l	10	10

Parameter	Units	Indonesia MoE Decree No 112 of 2003	IFC[1]
COD	mg/l	-	125
Total Nitrogen	mg/l	-	10
Total Phosphorus	mg/l	-	2
Total Coliform Bacteria	MPN[2]/100 ml	-	4006

Notes: [1] IFC EHS Guidelines – General EHS Guidelines: Environmental 2007
[2] MPN= Most Probable Number

3.2 Stormwater Discharges

Stormwater run-off will be separated from undisturbed and disturbed areas at the mine and infrastructure sites. Water can be classed into three types as follow:

- **Clean Water:** water run-off from undisturbed land. Clean water will be channeled away from areas affected by the Elang project and directed into the natural watershed;
- **Dirty Water:** run-off affected by mining operation, processing plant, haul roads and ancillary activities. Surface run-off from the mine site, haul roads and other auxiliary facilities will be discharged to a settling pond system.
- **Contaminated water:** water collected in the mine pit including settling ponds. Wastewater from the workshop and stockpile will be collected, channeled into settling pond system, treated as necessary and discharged into the environment if the water quality meets the effluent discharge standards. Runoff from the waste rock dumps will be channeled to settlement ponds. The combination of groundwater and run-off from the mine site will flow to the mine pit or drainage structure and then to settling ponds.

Water will be released to the environment only if its quality meets the relevant point source standards as shown in the Table A.4. Since the IFC EHS Guidelines does not possess specific requirements for wastewater quality standard, the EDC will refer to GoI regulations.

Table A.4 Wastewater Quality Standards for Gold and/or Copper Mining

Parameter	Unit	Threshold Value[1]
pH	-	6 – 9
TSS	mg/l	200
Cu*	mg/l	2
Cd*	mg/l	0.1
Zn*	mg/l	5
Pb*	mg/l	1
As*	mg/l	0.5
Ni*	mg/l	0.5
Cr*	mg/l	1
Hg*	mg/l	0.005

Notes: [1] Indonesia Environment Minister Decree No 202 of 2004
** As ion of dissolved metal concentration*

If the natural state of water pH in the water body is below or above the water quality standard, then with the Minister's recommendation, the Provincial Government can set the maximum level for pH parameter according to the natural condition of the environment. To meet the wastewater quality standards, the level of wastewater parameter is not allowed to be achieved by diluting with water directly taken from a water source.

3.3 Ambient Water Quality Standards

The Batu Hijau mining and proposed TSF operations must comply with both applicable discharge limits identified above and the ambient water quality standards. PP No 22 of 2021, Appendix VI, requires that the expansion project shall perform an assessment of the effects of its wastewater discharge on the receiving water resources, considering effects on cultivation of fish, cattle, and plants; on soil quality and groundwater quality; and effects on community health. Wastewater will include discharge from pit dewatering and run-off from ore stockpiles and waste rock dumps. If the TSF is adopted, supernatant discharge falls under the categogry of mine water discharge,

Based on the previous regulatory standard, PP No 82 of 2001 on Water Quality Management and Water Pollution Control, the applicable surface water classification standard for Batu Hijau, which applies to fresh water quality after mixing zone and defines expected water quality based on defined water usage (Classes I to IV), is considered to be Class IV. PP No 22 of 2021 has maintained these classes.

4 Waste Management

The main mine wastes are of course tailings and waste rock; these are both high-volume waste streams, and their management are core aspects of the mining operations.

4.1 Non-hazardous Wastes

The waste management strategy for non-hazardous waste (food scraps, paper wastes, plastic wrap, etc.) will incorporate the use of colored bins for the purpose of segregating waste, at source, according to waste type, and determining where it will be temporarily stored. Sorting of waste will be carried out at a designated waste storage area where material can be sorted for re-use or recycling (i.e., scrap metal, cardboard, scrap wood, etc.). The remainder of wastes will be disposed at an authorized engineered landfill according to local requirements.

Applicable solid/non-hazardous waste laws and regulations are Law No 18 of 2008 on Municipal Solid Waste Management; Interior Minister Regulation No 33 of 2010 on Guidelines for Waste Management; PP No 81 of 2012 on Management of Household Waste and Household-like Waste; PP No 27 of 2020 on Specific Waste Management; and Presidential Regulation No 83 of 2018 on the National Action Plan to Combat Marine Debris. Management of household waste from treating COVID-19 victims is discussed in the next section.

4.2 Hazardous Wastes

Based on Indonesian regulations, waste is considered to be hazardous waste (abbreviated *Bahan Berbahaya dan Beracun* or B3) if it is derived from:

- A listed hazardous waste from a nonspecific source;
- Expired chemical products or hazardous product rejects that do not meet specifications;
- A listed hazardous waste from a specific source (general specific source or specific industry source); or
- A waste that has one or more of the following properties: Explosive, Combustible, Reactive, Toxic, Infectious, or Corrosive.

A sequence of characteristics tests are undertaken to categorize the waste into B3 waste Category 1 or B3 waste Category 2. The characteristics tests have detailed criteria stated in PP No 101 of 2014 (PP 101/2014), Appendix II; this is now superseded by PP No 22 of 2021 (PP 22.2021), Appendix X). The criteria comprise characteristics parameter tests for explosivity, combustibility, reactivity, infectiousness, and corrosivity; toxicity characteristics test through the TCLP (Toxicity Characteristic Leaching Procedure) test; and toxicity characteristics test through LD50 (50% Lethal Dose) Acute and Subchronic Toxicity (toxicology) testing.

PP 22/2021 (based on PP 101/2014) on Management of Hazardous and Toxic Wastes also provides a listing of hazardous wastes (Appendix IX) and addresses requirements for management of hazardous and toxic (B3) solid wastes in Indonesia. The 2014 Regulation superseded PP No 85 of 1999, and Indonesia's waste regulatory program, which has evolved since the early 1990s, reflects US Environmental Protection Agency and European Union experience in hazardous waste management. Additional considerations are established by two recent Environment and Forestry Minister Regulations: No 10 of 2020 on Alternative Solutions for Managing B3 Wastes and No 18 of 2020 on Beneficial Use of B3 Waste.

There also needs to be consideration of Environment Minister Circular Letter No 2 of 2020 (SE.2/MENLHK/PSLB3/LB.3/3/2020) on Managing Infectious Waste (B3 Waste) and Household Waste from Treating Coronavirus Disease (COVID-19) of 24 March 2020.

4.3 Tailings Management

EDC related to tailings management is discussed in the EDC section of the main report, and not repeated here.