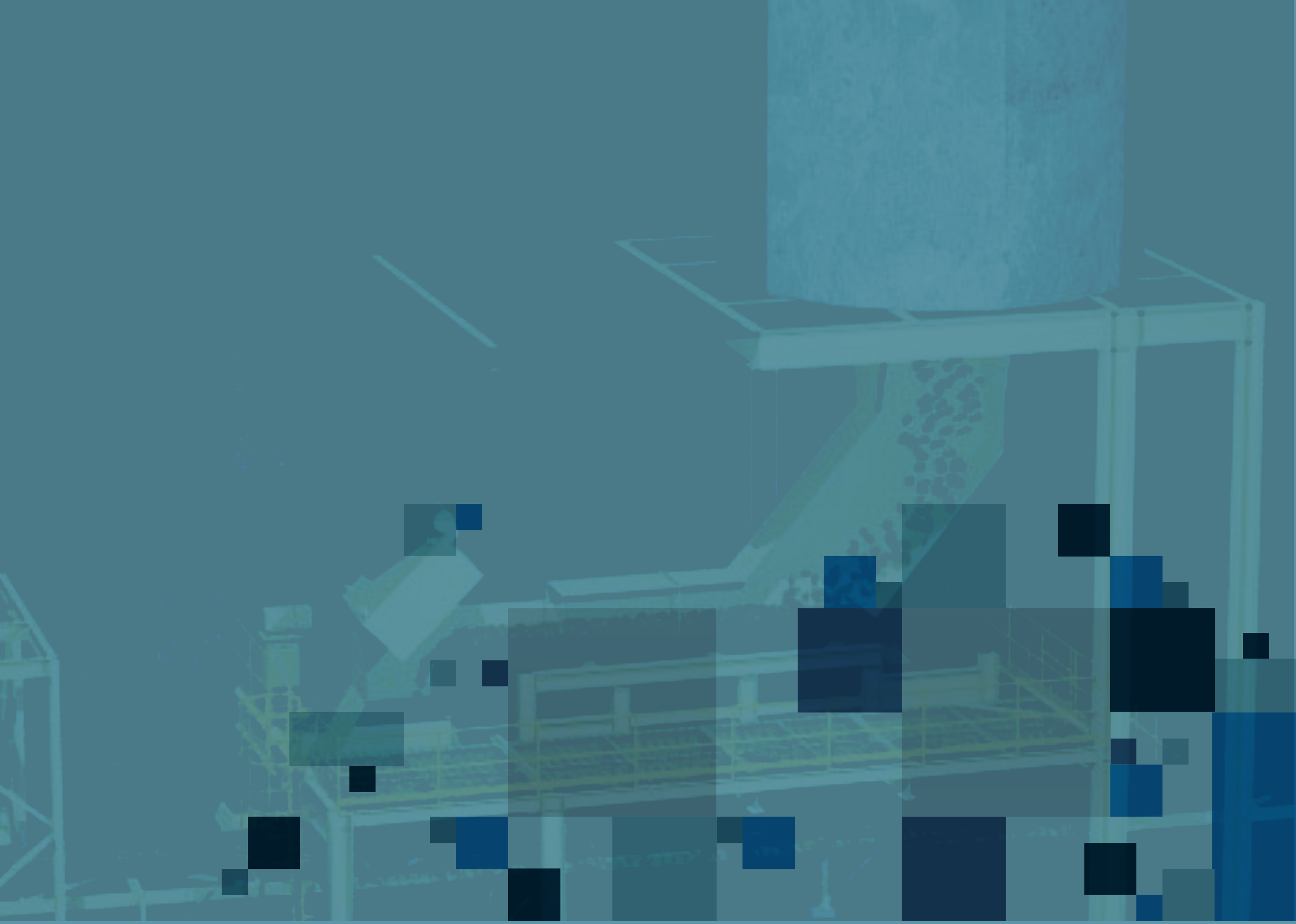
Wafi-Golpu Project Environmental Impact Statement

Executive Summary

June 2018

WAFI-GOLPU JOINT VENTURE



The key components of the proposed Wafi-Golpu Project (the Project) are described in this Environmental Impact Statement (EIS). Future development of the Project remains subject to ongoing deep orebody drilling and definition (after underground access has been achieved), technical studies, completion of statutory permitting processes and securing Government and WGJV Participants' approvals. Engineering design and other studies are continuing and there is potential that aspects of the proposed Project design, layout and timetable described in this EIS may change.

DISCLAIMER

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

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

Purpose of EIS

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

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

Ownership and Copyright

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

Reliance and Use

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

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

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- expressly disclaim any liability for any consequential, special, contingent or penal damages whatsoever.

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

Disclosure for Authorised Purpose

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

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

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

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

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

NEWCREST MINING LIMITED DISCLAIMER

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

Forward Looking Statements

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

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

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

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

Non-IFRS Financial Information

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

Ore Reserves and Mineral Resources Reporting Requirements

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

Competent Person's Statement

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

HARMONY GOLD MINING COMPANY LIMITED DISCLAIMER

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

Forward Looking Statements

These materials contain forward-looking statements within the meaning of the safe harbor provided by Section 21E of the Securities Exchange Act of 1934, as amended, and Section 27A of the Securities Act of 1933, as amended, with respect to our financial condition, results of operations, business strategies, operating efficiencies, competitive positions, growth opportunities for existing services, plans and objectives of management, markets for stock and other matters. These include all statements other than statements of historical fact, including, without limitation, any statements preceded by, followed by, or that include the words "targets", "believes", "expects", "aims", "intends", "will", "may", "anticipates", "would", "should", "could", "estimates", "forecast", "predict", "continue" or similar expressions or the negative thereof.

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

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

Competent Person's Statement

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

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

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Introduction to this Environmental Impact Statement

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1.1 Overview

The Wafi-Golpu Joint Venture (WGJV) is currently investigating the feasibility of constructing, operating and (ultimately) closing an underground copper-gold mine and associated ore processing, concentrate transport and handling, power generation, water and tailings management and related support facilities and services (hereafter referred to in the document as the "Wafi-Golpu Project" or the "Project") in the Morobe Province of the Independent State of Papua New Guinea (PNG).

The proposed underground copper-gold mine will be located beneath Mt Golpu, approximately 300 kilometres (km) north-northwest of Port Moresby and 65km southwest of Lae. Proposed support facilities include access roads to the mine and pipelines from the mine to the Port of Lae and to new coastal facilities near the village of Wagang.

Geographically, the Project occupies a footprint that extends from the Mine Area to the Coastal Area with an Infrastructure Corridor that links the two areas. Together these discrete areas make up the proposed Project Area (Figure 1.1). The Mine Area, encompassing the proposed mine and related ancillary facilities, is located on the northern side of the Owen Stanley Ranges of PNG, in the foothills of the Lower Watut River catchment. Much of the Mine Area is steep, mountainous and heavily forested, transitioning to the broad, flat to gently undulating Lower Watut River valley to the west. The Infrastructure Corridor follows the broad flat plains of the Lower Watut River and Markham River valleys and connects the Mine Area to the Coastal Area. The Coastal Area encompasses both the proposed Port Facilities Area, located at the Port of Lae, where copper-gold concentrate will be exported, and the Outfall Area, where it is proposed that mine tailings management will take place via deep sea tailings placement (DSTP).

The Project is predicted to discharge 360 million tonnes (Mt) of tailings over a period of 28 years. The WGJV has extensively investigated options for tailings management for the life of the Project both on land and by DSTP. These investigations have confirmed DSTP as the WGJV's preferred method of tailings management based on consideration of long-term safety, engineering, environmental, social, cultural heritage and economic factors.

The total onshore area of land expected to be directly disturbed by Project activities is approximately 1,405 hectares.

Applications have been submitted to the Mineral Resources Authority for a special mining lease and related ancillary tenements.

1.2 Purpose of the EIS Executive Summary

This environmental impact statement (EIS) has been prepared as the statutory basis for the environmental, social and cultural heritage assessment of the Project under the *Environment Act 2000*. The EIS will inform an environmental permitting decision by the PNG government on whether the Project should proceed and, if so, under what conditions.

The EIS Executive Summary provides an overview of:

- The purpose of the EIS
- The Wafi-Golpu Joint Venture
- The existing environmental, social and cultural heritage conditions in the Project Area
- The location of proposed Project-related activities and facilities
- Details of the stakeholder engagement program which the WGJV has implemented to ascertain and record stakeholders' views and interests in the Project
- The anticipated environmental, social and cultural heritage impacts of the Project (including Project-derived benefits), and the measures the WGJV proposes to implement to manage those impacts
- Proposed post-closure management
- How stakeholders can view and comment on the EIS

1.3 Structure of the EIS

The EIS has the following structure:

- **Executive Summary (this document).** A stand-alone summary report, prepared in English and Tok Pisin, that provides a summary of the proposed Project, impact assessment and management measures.
- **Volume 1 – Main Report.** A stand-alone environmental, social and cultural heritage assessment that can generally be understood without reference to the supporting (technical) studies upon which it is based.
- **Volume 2 – Attachments.** Supplementary material to the main report including a reconciliation of the EIS with relevant State of PNG guidelines, as well as environmental, social and cultural heritage management plans.
- **Volumes 3 to 8 – Appendices.** A series of technical reports on the various investigations that have informed the main report.

Readers seeking more detailed information on any aspect of the EIS are referred to EIS Volumes 1 to 8.

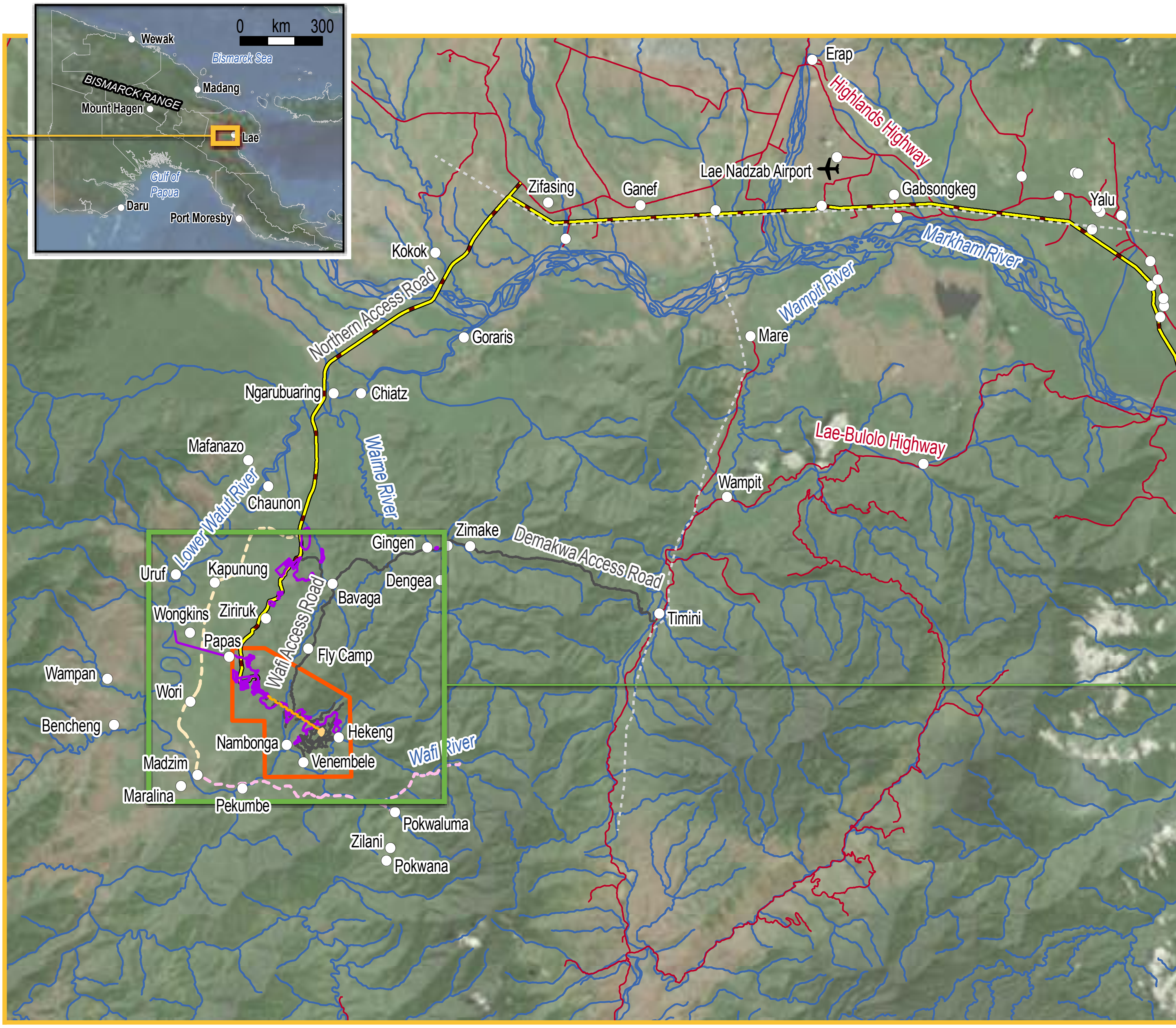
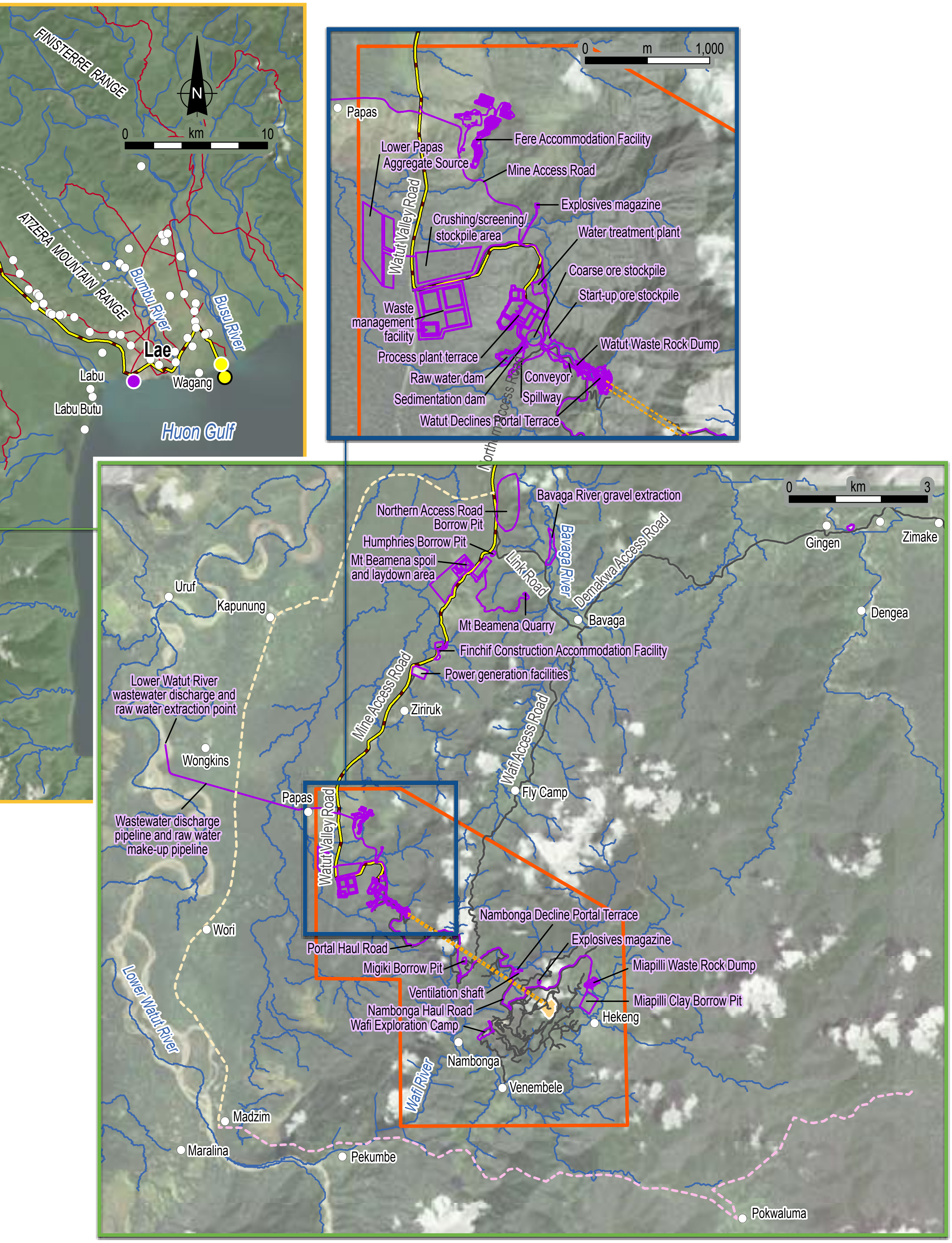
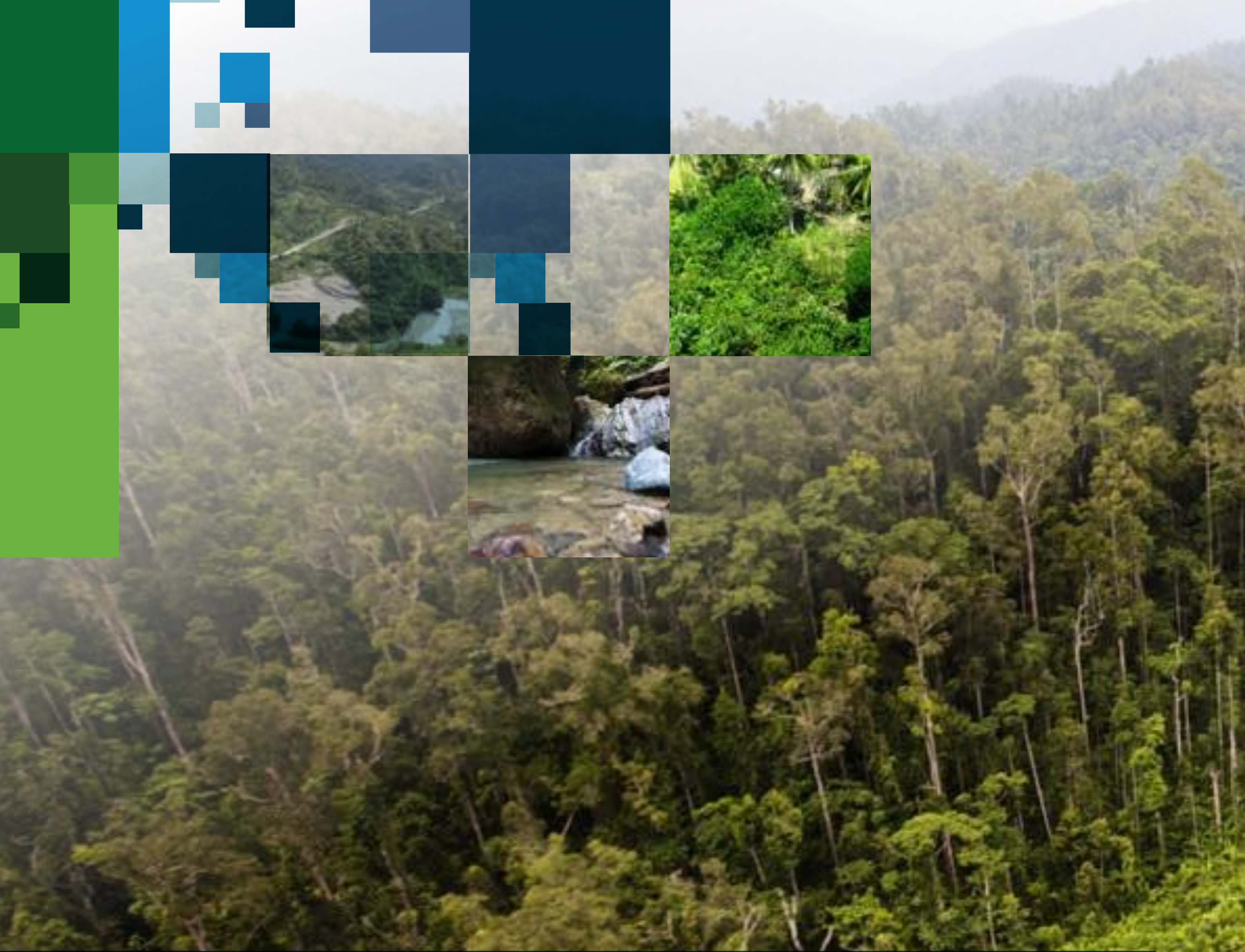


Figure 1.1: Project overview

LEGEND		PROPOSED INFRASTRUCTURE	
○	Village/Settlement	Yellow dot	Outfall Area
Grey dashed line	Existing power network	Yellow dot with black outline	DSTP outfall
Dark grey line	Project road	Purple dot	Port Facilities Area
Red line	Road	Yellow and black line	Infrastructure Corridor
Blue line	Watercourse	Purple line	Infrastructure footprint
Orange box	Orebody	Orange dashed line	Watut Declines
Orange outlined box	Special Mining Lease (SML) 10 application area	**INDICATIVE RESETTLEMENT ROADS**	
		Pink dashed line	Potential Resettlement Road
		Cream dashed line	Potential Watut Services Road


FINISTERRE RANGE
N
0 km 10
ATZERA MOUNTAIN RANGE
Bumbu River
Busu River
Lae
Labu
Wagang
Labu Butu
Huon Gulf
0 m 1,000
Papas
Lower Papas Aggregate Source
Fere Accommodation Facility
Mine Access Road
Explosives magazine
Watut Valley Road
Crushing/screening/ stockpile area
Water treatment plant
Coarse ore stockpile
Start-up ore stockpile
Waste management facility
Process plant terrace
Watut Waste Rock Dump
Raw water dam
Conveyor
Sedimentation dam
Spillway
Watut Declines Portal Terrace
Northern Access Road
0 km 3
Bavaga River gravel extraction
Northern Access Road Borrow Pit
Humphries Borrow Pit
Mt Beamena spoil and laydown area
Link Road
Bavaga River
Demakwa Access Road
Gingen
Zimake
Uruf
Kapunung
Bavaga
Dengea
Mt Beamena Quarry
Finchif Construction Accommodation Facility
Power generation facilities
Mine Access Road
Ziriruk
Lower Watut River wastewater discharge and raw water extraction point
Wongkins
Wafi Access Road
Fly Camp
Papas
Watut Valley Road
Wastewater discharge pipeline and raw water make-up pipeline
Nambonga Decline Portal Terrace
Explosives magazine
Wori
Portal Haul Road
Migiki Borrow Pit
Miapilli Waste Rock Dump
Ventilation shaft
Miapilli Clay Borrow Pit
Nambonga Haul Road
Hekeng
Wafi Exploration Camp
Lower Watut River
Nambonga
Wafi River
Venembele
Madzim
Maralina
Pekumbe
Pokwaluma



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The Wafi-Golpu Joint Venture

Wafi Mining Limited and Newcrest PNG 2 Limited (the "WGJV Participants") are equal participants in the Wafi-Golpu Joint Venture (the WGJV). The Project is 100% owned by the WGJV Participants. The operator of the Project is Wafi-Golpu Services Limited, which is also owned in equal shares by the WGJV Participants.

The ultimate parent companies of the WGJV Participants are (in the case of Wafi Mining Limited) Harmony Gold Mining Company Limited of South Africa and (in the case of Newcrest PNG 2 Limited) Newcrest Mining Limited of Australia.

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Setting of the Project

The following details of the Project setting are sourced from environmental, social and cultural heritage studies conducted across the Project Area by the WGJV. These studies, and associated stakeholder engagement and fieldwork undertaken, are further described in EIS Volume 1.

3.1 Environmental

The Mine Area is predominantly situated on steep, heavily forested terrain of the Owen Stanley Ranges, within a region which has been the subject of mineral exploration for more than 50 years. Signs of these exploration activities, such as the Wafi Camp and scattered clearings from roads and drill pads, are visible within the local landscape.

The Infrastructure Corridor traverses the alluvial plains and foothill terraces of the Lower Watut River valley, continuing downstream along the Lower Markham River valley and finally to the Coastal Area located between the Markham and Busu rivers near the Port of Lae at the western end of the Huon Gulf. The Infrastructure Corridor to the north of the Markham River is generally situated within grazing land, oil palm plantations and small subsistence gardens.

The Lower Watut River lowlands are characterised by floodplains with meandering channels, oxbow lakes and backwater swamps (Figure 3.1). Other landforms within the Project Area include lowland freshwater swamps and, close to the coast, saline and brackish swamps and beach ridges and flats.

Figure 3.1: Watut River floodplain and alluvial forest

The Coastal Area encompasses both the proposed Port Facilities Area and the Outfall Area. The Port Facilities Area is proposed to be located within the existing commercial Port of Lae; this is the only part of the Project Area which is already zoned for industrial use. The Outfall Area is located approximately 6km east of the port near the village of Wagang. This area of the coast consists of beach plant communities close to the shoreline and mixed swamp forest in the vicinity of the mouth of the Busu River.

Climate

Papua New Guinea has a tropical climate. The coastal and island regions tend to be hot and humid, with daytime temperature averages ranging from 20 degrees Celsius (°C) in the cooler months (June, July and August) to 32°C in the warmer months (November, December and January).

The Mine Area has a high rainfall and two distinct seasons: a dry season (June to September) and a wet season (December to March). The average annual rainfall for the Mine Area is 2,836 millimeters (mm). The Mine Area is also characterised by low wind speeds, high humidity and warm temperatures with average minimum and maximum temperatures of 21°C and 28°C, respectively.

The Coastal Area experiences trade winds during mid-May to October and annual rainfall of between 3,900 to 4,500mm, with rainfall peaking between May and August. From December to April, the major influence on weather in the Coastal Area is the northwest monsoon (originating in Asia) and warming sea temperatures of the Southern Hemisphere.

Air and Noise

Ambient air quality and noise levels in the Mine Area reflect the remote, forested location and prevailing subsistence lifestyle of the local villages. The main influences on the current air quality are fires used for cooking or during forest clearance (for subsistence gardens and growing cocoa). Vehicles travelling along the only access road currently servicing the Mine Area (the Demakwa Access Road) often generate dust during dry periods. Noise sources include insects, birds, domesticated animals and typical village domestic activities. Those villages in proximity to the Demakwa Access Road may also hear vehicles.

Ambient air quality has not been monitored for the Infrastructure Corridor and at the Outfall Area because there are no predicted material emissions into the air from the Project in these areas (other than dust during construction). The existing air quality and noise levels at the Port Facilities Area are influenced by emissions from the current port activities, as well as other commercial, industrial and residential sources located within Lae.

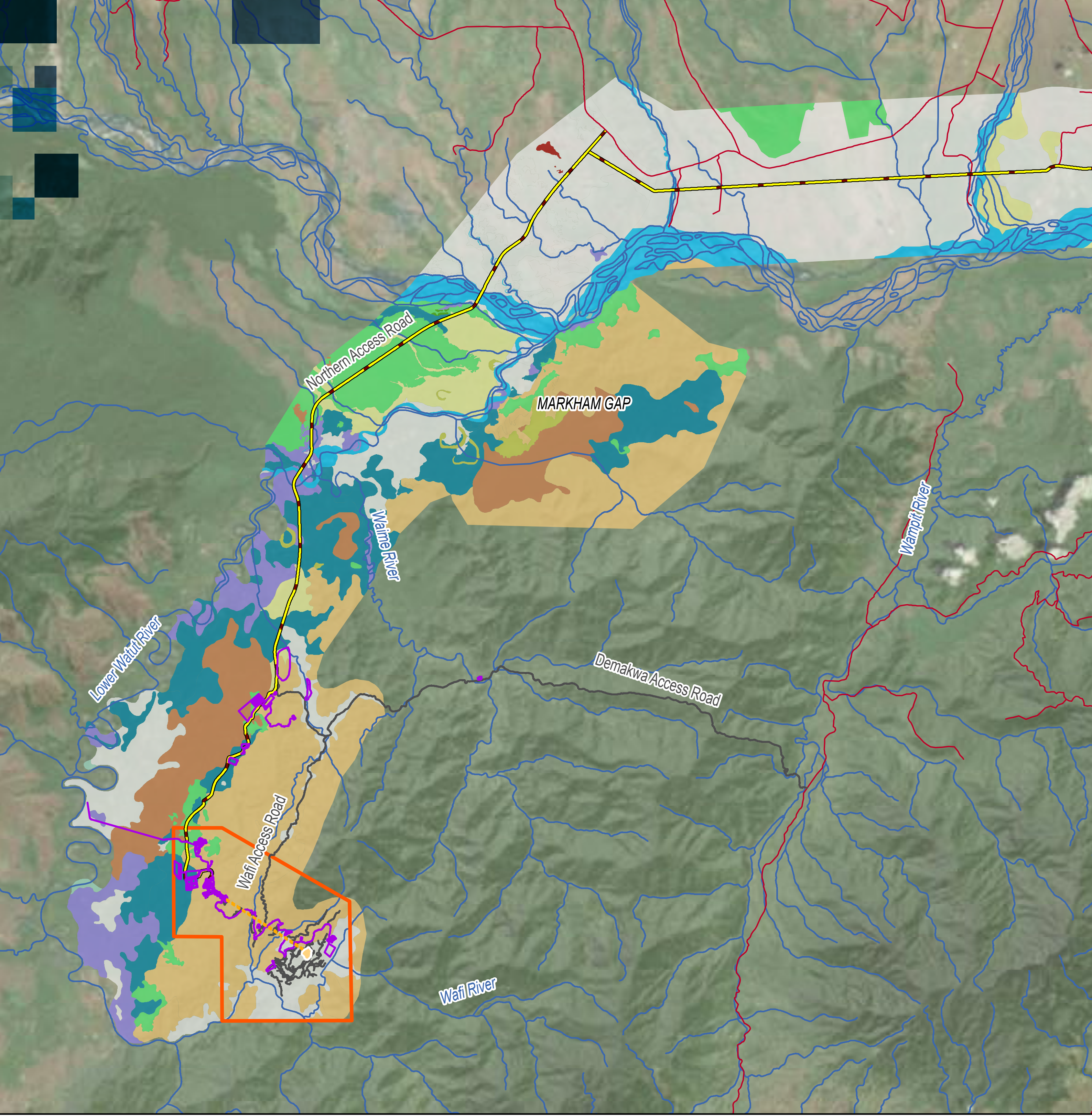


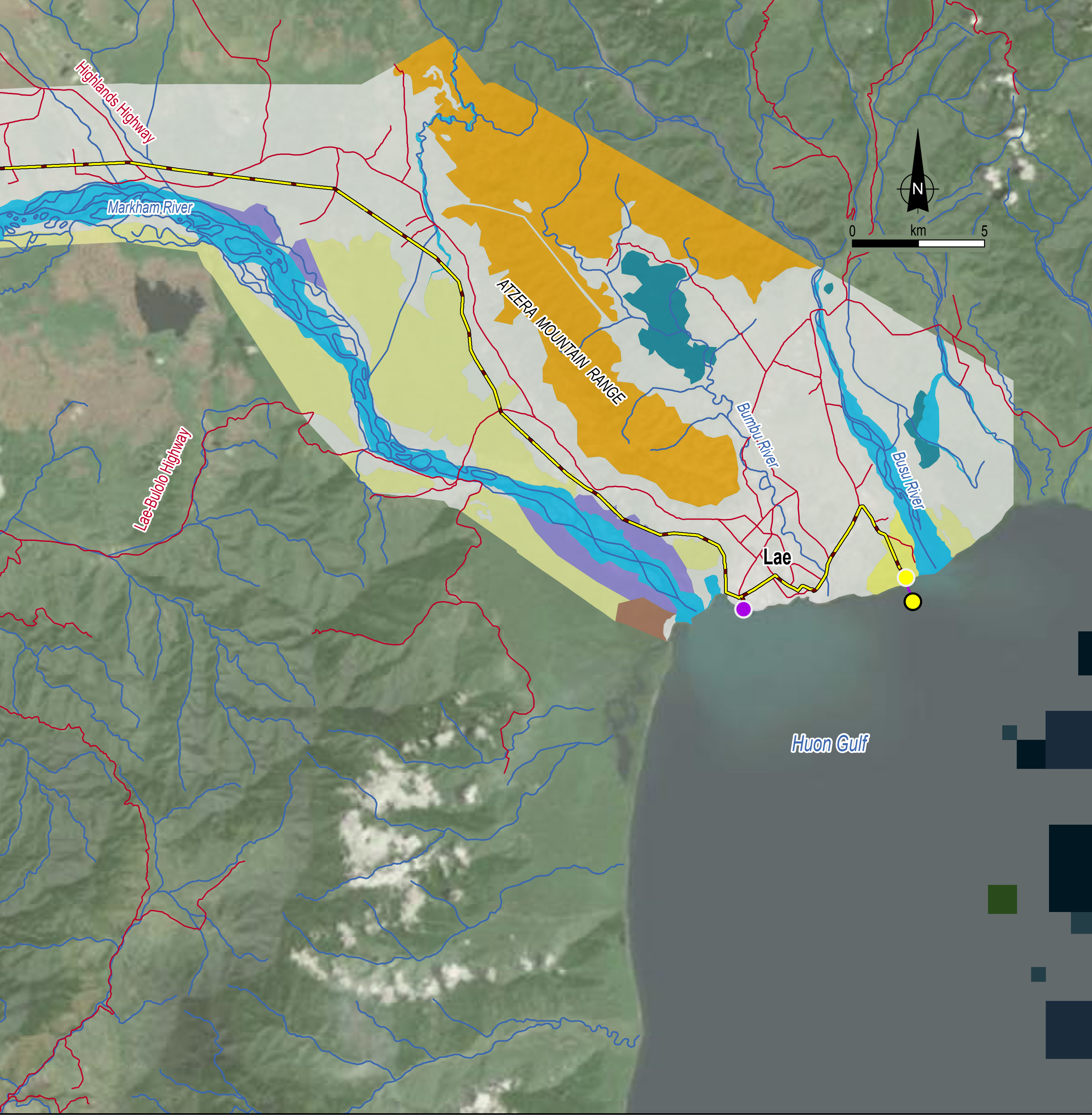
Figure 3.2: Vegetation communities

Terrestrial Ecology

Morobe Province contains a variety of terrestrial habitats and plants and animals. Two distinctive landforms – hills and alluvial plains – influence the number and type of plants and animals each contains.

The majority of the Mine Area is covered by intact and relatively unmodified primary lowland forest. In contrast, the Infrastructure Corridor between the Markham River crossing and the Coastal Area has been mostly cleared by human activity, such as cattle farming (between the Markham River and the Highlands Highway), cropping (along the Highlands Highway from Zifasing to Yalu), installation and maintenance of the PNG Power transmission line corridor and residential development.

Vegetation on steep hills and mountains primarily comprises Small and Medium Crowned Forest. Vegetation on the Lower Watut River floodplain comprises Large to Medium Crowned Forest, Mixed Swamp Forest and Swamp Woodland. Vegetation occurring in the low-lying, permanently swampy areas adjacent to the major watercourses primarily comprises Riverine Mixed Successions and Mixed Swamp Forest. Grasslands are also present in the foothills south of the Lower Watut River floodplain and in the Markham River valley to the north. The distribution of vegetation communities is shown on Figure 3.2.



LEGEND

- Project road
- Road
- Watercourse
- Orebody
- Special Mining Lease (SML) 10 application area

PROPOSED INFRASTRUCTURE

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

VEGETATION TYPE

- Grassland (G)
- Lakes and Larger Rivers (E)
- Large to Medium Crown Forest (Pl)
- Littoral (Beach) Communities (B)
- Mangrove (M)
- Medium Crowned Forest/Small Crowned Forest (Hm/Hs)
- Medium to Large Crowned Forest (Hm/Hl)
- Mixed Swamp Forest (Fsw/FswC)
- Other Non-Forest Areas Dominated by Land-use (O)
- Riverine Mixed Successions (Fri)
- Riverine Successions Dominated by Grass (Gri)
- Scrub (Sc)
- Swamp Grassland (Gsw)
- Swamp Woodland (Wsw)
- Woodland (W)

Figure 3.3: Project Area watercourses and aquatic ecosystems ▶

Plants and Animals

Seven separate surveys were completed between 2010 and 2017 to provide baseline data on the composition, condition and conservation significance of terrestrial plant and animal species, and their habitats.

A total of 885 terrestrial plant species were recorded in the Mine Area and Northern Access Road and 103 species were recorded in the eastern part of the Infrastructure Corridor.

A total of 262 species of terrestrial vertebrate animals were recorded in the Mine Area and Northern Access Road comprising 44 mammal species, 170 bird species, 33 reptile species and 15 amphibian (frog) species. A total of 155 species of terrestrial vertebrate animals were recorded in the eastern part of the Infrastructure Corridor comprising 140 bird species, seven reptile species, six mammal species and two amphibian species.

The assessment of the conservation status of terrestrial plants and animals was based on the classification of the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (2017). Species listed on the *Fauna (Protection and Control) Act 1966* were also considered.

Conservation Significant Terrestrial Plants

Eighteen plant species of conservation significance were recorded during field surveys. These species included:

- Seven threatened species: *Diospyros lolinopsis* and *Halfordia papuana* (Critically Endangered); *Flindersia pimenteliana* (Endangered); and *Aglaia brownii*, Kwila (*Intsia bijuga*), New Guinea Rosewood (*Pterocarpus indicus*) and *Myristica buchneriana* (all classified as Vulnerable).
- Nine plant species listed as Near Threatened: *Aglaia euranthera*, *Aglaia sexipetala*, *Aglaia silvestris*, *Cycas apoa*, *Cycas campestris*, *Cycas scratchleyana*, *Cycas schumanniana*, *Flindersia amboinensis* and *Myristica globosa*.

A further 32 species listed on the IUCN Red List were assessed as either 'likely to occur' (four) or 'possible to occur' (28), based on their respective habitat requirements and geographic distribution. These include one species listed as Critically Endangered, one listed as Endangered, 17 listed as Vulnerable and the remaining 13 either Near Threatened (nine), Data Deficient (two) or Least Concern (two).

Conservation Significant Terrestrial Animals

Field surveys identified five vertebrate animal species of conservation significance. These were:

- The Papuan eagle (*Harpyopsis novaeguineae*) and Pesquet's parrot (*Psittrichas fulgidus*), both listed as Vulnerable.
- Gurney's eagle (*Aquila gurneyi*), listed as Near Threatened.
- The blue-black kingfisher (*Todiramphus nigrocyaneus*) and Papuan hawk-owl (*Uroglaux dimorpha*), both listed as Data Deficient.

Goodfellow's tree kangaroo (*Dendrolagus goodfellowi*; Critically Endangered) and New Guinea pademelon (*Thylogale browni*; Vulnerable) were recorded as captive animals in Madzim village in the Project Area and were not considered to occur locally having been captured from higher elevations in the Upper Watut River valley.

Two other near-threatened species were identified: Doria's goshawk (*Megatriorchis doriae*) and forest bittern (*Zonerodius heliosylus*). Doria's goshawk was identified as being likely to occur in or around the Project Area, and the forest bittern as having the potential to occur. These species were not recorded during surveys for the Project. Similarly, while habitat for the eastern long-beaked echidna (*Zaglossus bartoni*) may occur in lower montane forest at higher elevations outside the terrestrial ecology study area, its mapped extent is within hunting distances (3 to 5km) of the local communities.

A total of 13 species declared as Protected under the *Fauna (Protection and Control) Act 1966* were recorded during surveys. These are primarily conspicuous species including birds-of-paradise, raptors, and waterbirds.

Watercourses and Groundwater

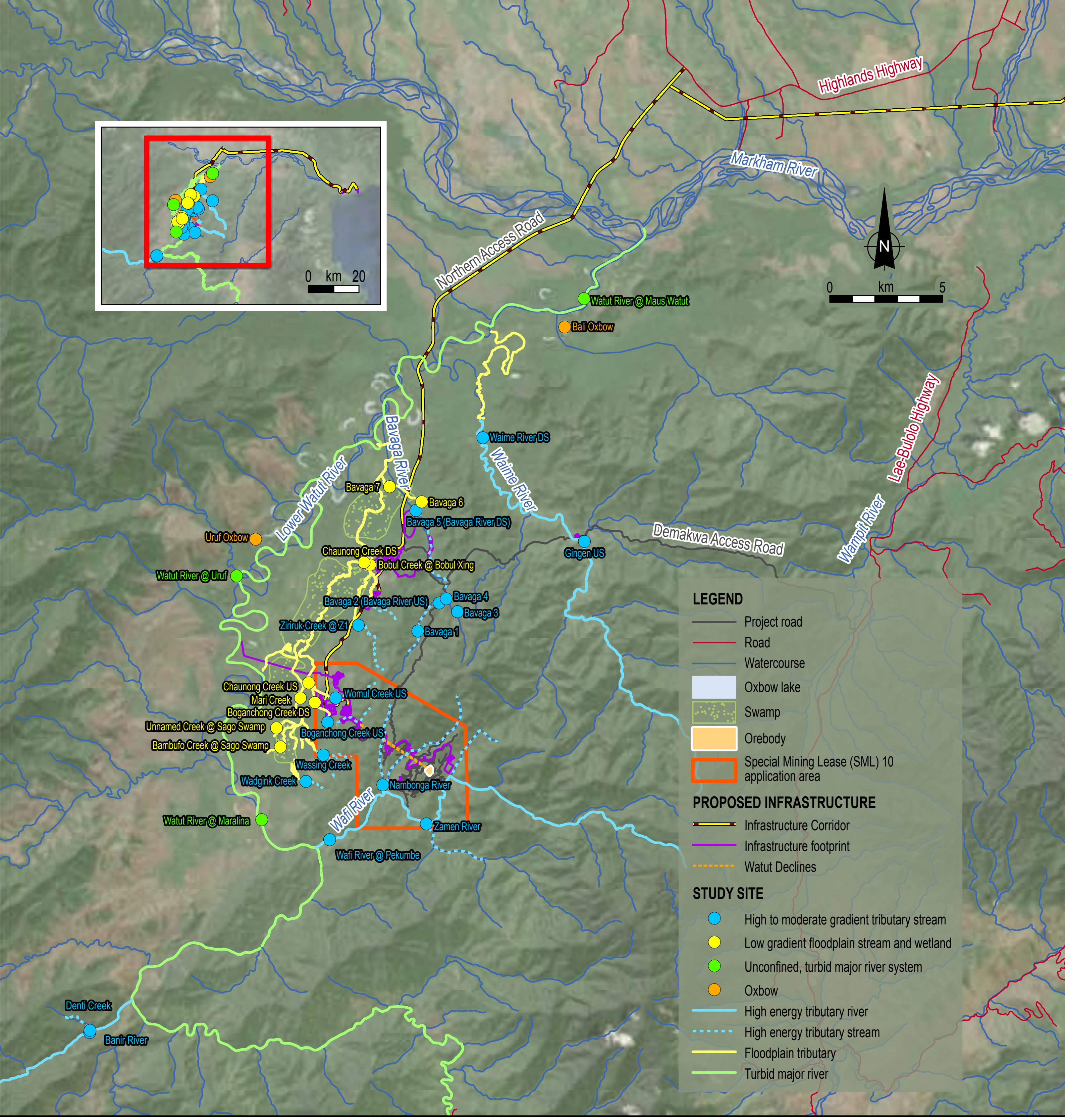
The watercourses in the Project Area range from narrow, tightly confined, fast-flowing streams in the hills, such as the Wafi River and Boganchong and Womul creeks, to broad, sinuous and sediment-laden rivers, such as the Watut and Markham rivers (Figure 3.3). Headwater and small streams in steeper terrain tend to have coarse channel bed material comprised of bedrock, boulders, stones, cobble and gravels, and have good water quality (e.g., low turbidity and high dissolved oxygen concentrations) except during high rainfall events when suspended solids concentrations and turbidity temporarily increase. Within the major rivers, the main aquatic habitats include pools, runs, riffles and backwater areas of the main channels, as well as side tributaries. In the Lower Watut River downstream of the Wafi River confluence, coarse gravel transitions to sand bed and finally to a clay and silt bed near its confluence with the Markham River.

The Markham River floodplain ranges from 3 to 8km wide in the lower catchment and, within it, the river meanders, cutting new channels and reopening former channels following significant flood events. The Lower Markham River floodplain is characterised by a lower terrace within which the current channels are located and an upper terrace occupied by swamp forest and sago palm. The banks and riparian zones of these watercourses have been influenced by access tracks, settlements, gardens and roads.

Heavy rainfall, steep unstable slopes and the catchment geology result in high sediment loads in local watercourses after rainfall, and a constantly shifting main channel of the Lower Watut River and the Markham River. The variable flowrates of these rivers and streams also affect their ability to hold sediment in suspension. As a result, sediment concentrations are highly variable and sediment is frequently being deposited within, or carried to, downstream watercourses.

The water and sediment quality of watercourses in the Project Area is generally consistent with that found in other regions of PNG that share similar catchment geology, rainfall patterns, mineral enrichment and artisanal mining.

Within the Project Area, one fish species of conservation significance, the largetooth sawfish (*Pristis pristis*), which is classified as Critically Endangered on the IUCN Red List, may occur occasionally in the lower reaches of the Markham and Watut rivers. This species was recorded once in the Lower Watut River below the Wafi River junction in 1988 but has



not been recorded in subsequent surveys for the Project between 2007 and 2015. Two freshwater turtle species, Schultze's snapping turtle (*Elseya schultzei*) and New Guinea giant softshell turtle (*Pelochelys signifera*), and two crocodile species, the saltwater crocodile (*Crocodylus porosus*) and New Guinea crocodile (*C. novaeguineae*), classified as Least Concern on the IUCN Red List, are present or expected to occur within the Project Area.

Groundwater systems in the Project Area comprise alluvial aquifers associated with the expansive floodplains of the Lower Watut River and Markham River, and shallow and deep aquifers associated with faults and fracture zones in the weathered and partially weathered bedrock of the Mine Area. Both systems are recharged through ground infiltration following rainfall, with the rivers hydraulically connected to the alluvial aquifers. Faults through Mt Golpu provide preferential pathways for groundwater flow with flow rates decreasing with depth. These aquifers discharge through springs and into watercourses, as baseflow, with artesian conditions on the eastern flanks of Mt Golpu. Groundwater quality is reflective of the low residence time and mineralisation of the host rock. Groundwater-fed springs supply drinking water to a number of villages in proximity to the Mine Area, with watercourses providing a secondary supply.

Marine Environment

From 2016 to 2018, the WGJV completed more than 20 field surveys to investigate the marine environment in the Huon Gulf, with a particular focus on the deep ocean environment. This represents the most comprehensive series of investigations into the marine environment undertaken at the EIS stage for any DSTP project in PNG.

The methods employed during the marine investigations were consistent with PNG and relevant international standards, conventions and guidelines, including the Draft General Guidelines for DSTP in PNG to the maximum practical extent.

Nearshore Marine Environment

The Coastal Area is situated within a highly modified nearshore marine environment, adjacent to Lae, PNG's second largest city and busiest port. The Port Facilities Area is an area of industrial land use within the Port of Lae. The Outfall Area is a beach environment with some human disturbance reflective of its proximity to a large urban centre and surrounding villages and, to a lesser extent, regular traffic of small local transport boats.

Coupled with this, the nearshore marine environment at the Coastal Area is highly influenced by sediment-laden discharge from the Markham, Busu and Bumbu rivers and others. Sensitive benthic habitats such as corals and seagrasses are absent due to the highly turbid conditions, and for this reason fauna such as fish are not as common in the Coastal Area compared to other parts of the Huon Gulf.

According to local people at Wagang, the IUCN-listed critically-endangered west Pacific leatherback turtle nests between Wagang and the Busu River with about three turtles nesting per year. This stretch of beach shows evidence of human influence. No evidence of sea turtles or sea turtle nests was observed at Wagang during field surveys in November 2016, a period that coincided with the early stages of the west Pacific leatherback nesting season in the Huon Gulf. The nearest key nesting areas for the west Pacific leatherback turtle are more than 15km to the south of Lae.

Huon Gulf Physical Environment

The Markham River discharges into the Huon Gulf on the west side of Lae. It is the fourth largest river in PNG. Some 20 smaller rivers drain the Finisterre Range on the Huon Peninsula on the north coast of the gulf. Below sea level,

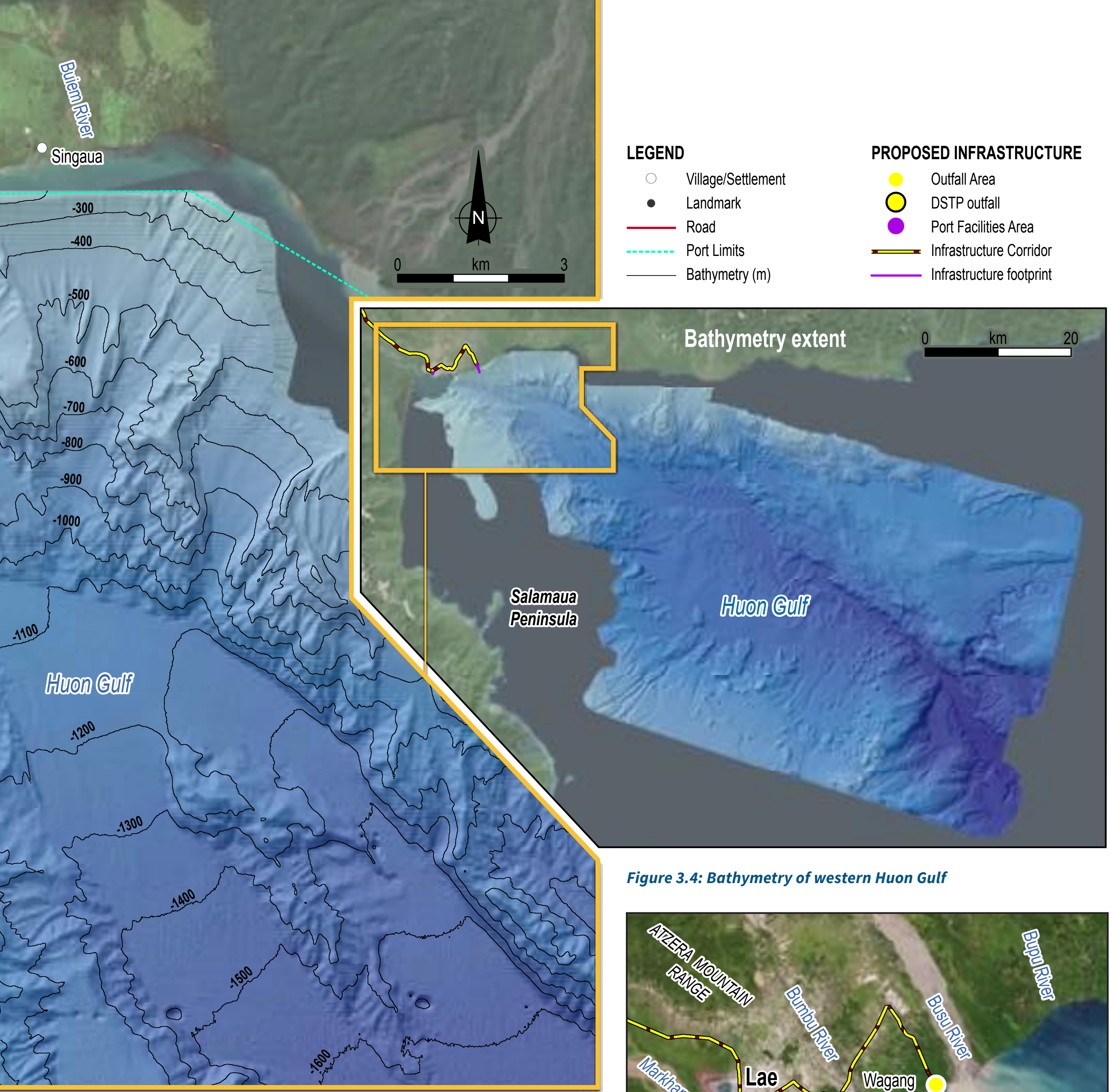


Figure 3.4: Bathymetry of western Huon Gulf

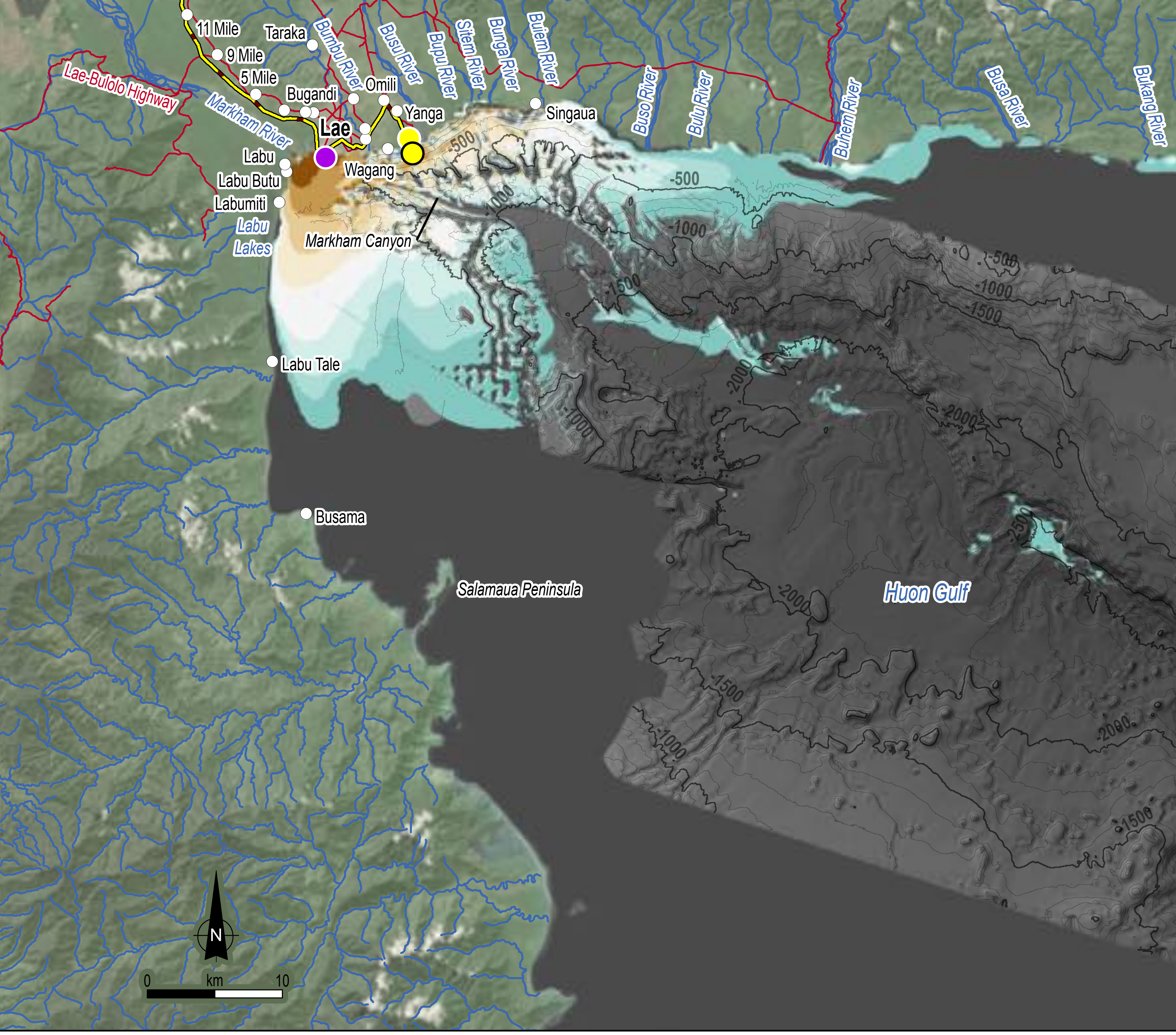
Figure 3.5: Turbid plumes in the Huon Gulf near Lae

seafloor slopes plunge steeply to a submarine canyon known as the Markham Canyon (Figure 3.4). This canyon extends more than 100km from the Huon Gulf to the southeast where it reaches the New Britain Trench at depths over 9,000m.

During high rainfall periods, river discharge causes nearshore waters of the gulf to become estuarine or brackish. Detailed studies for the Project have estimated that around 60 million tonnes (Mt) of river sediment enters the Huon Gulf each year as suspended sediment load, plus an unknown additional quantity of bedload sediment. The turbid plumes in the Huon Gulf from the discharge of the rivers near Lae are shown in Figure 3.5.

Computer modelling completed for the Project predicted that existing natural river sediments settle in nearshore waters along the north coast and extend up to about 20km southwards along the west coast of the Huon Gulf.

Preliminary investigations into the physical Huon Gulf environment were conducted in 2012 and multiple oceanographic and sedimentological investigations (covering at least a year of cumulative data) have been undertaken in the Huon Gulf for the Project between 2016 and 2018. These investigations, measuring processes in the water column and near the side walls and floor of the Markham Canyon, have revealed the presence of a persistent, bottom-attached turbid layer up to about 300m thick within the Markham Canyon. Current flows within the canyon are complex but, nearest the floor, are characterised by mostly down-canyon flows. In addition, episodic but frequent mass movement events occur that cause highly energetic turbidity currents to flow through the canyon at



estimated maximum speeds of between 1 and 8 metres per second (m/s) (2 to 16 knots). These turbidity currents are sufficiently energetic to erode previously deposited natural sediments and transport them down canyon.

Based on multiple lines of investigation, including review of satellite sea surface temperature imagery, year-long upper ocean conductivity-temperature-density profile data, temperature logging data and the year-long ocean vertical current measurements, there is no evidence of coastal upwelling in the vicinity of the proposed DSTP outfall.

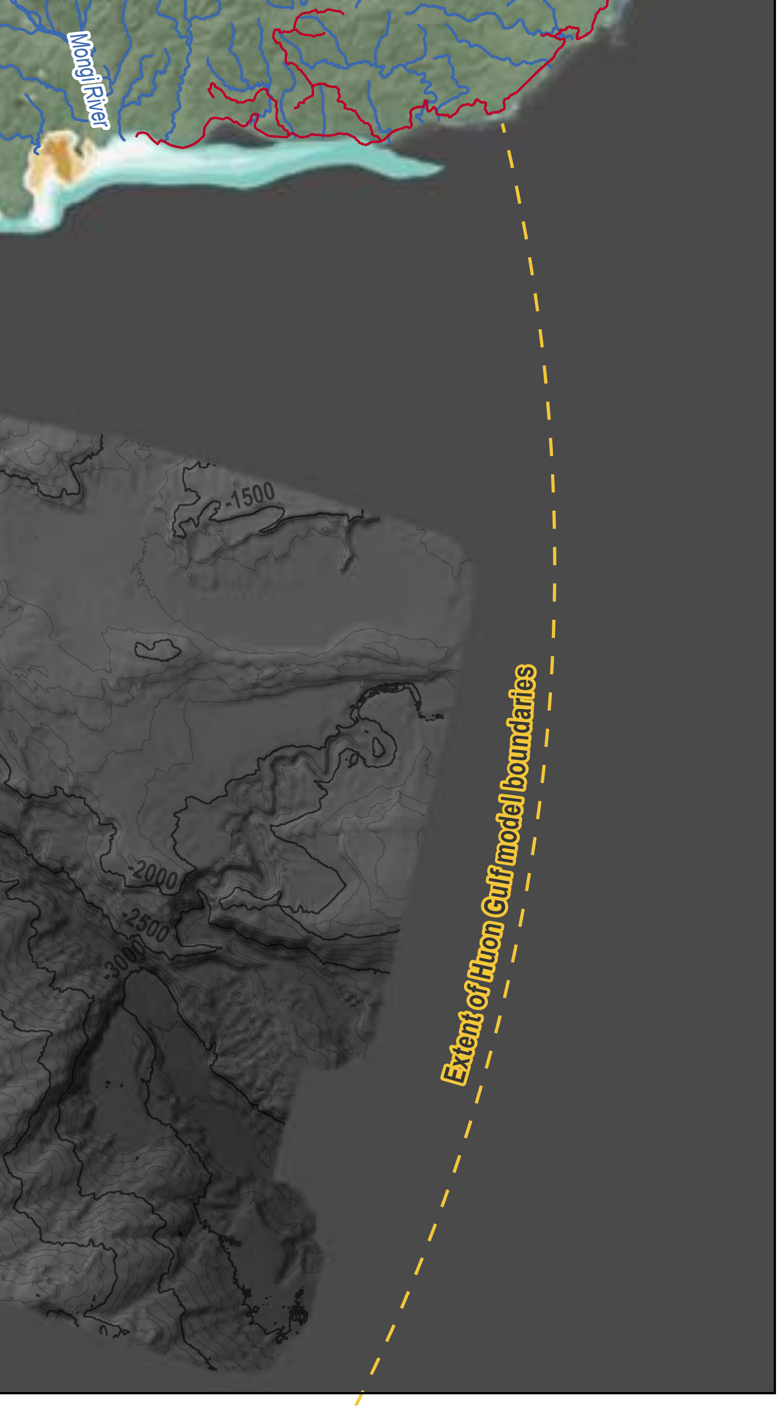
A prediction of long-term deposition of natural sediment in the Huon Gulf is shown in Figure 3.6. The simulation is based on an assumed 27 years[1] of river inflow into the Huon Gulf and includes one simulated mass movement event per year. Figure 3.6 shows the predicted deposition of some 1,620Mt of natural sediment discharged into the Huon Gulf as suspended sediment load from rivers. The modelling predicts thick deposits (5 to 10m) of natural sediment to the south of the Markham River mouth and the absence of deposition on the floor of the Markham Canyon due to the episodic turbidity currents redepositing natural sediment in patches on the canyon floor deeper than 1,000m.

1 This 27 year period was based on an earlier Project Description at the time the modelling commenced, noting the current proposed mine production life is now 28 years. This difference is not expected to have any material effect on the modelling results.

Huon Gulf Chemical and Ecotoxicological Environment

Monitoring of the metal content of suspended sediment in four rivers draining into the Huon Gulf undertaken for the Project shows concentrations of some metals to be elevated compared to average crustal abundance values. When compared to sediment quality guidelines, particulate concentrations of arsenic in the Markham River and copper and nickel in all four rivers monitored, are naturally high enough that ecotoxicological effects may already be occurring prior to any commencement of development of the Project.

Sediment was collected in sediment traps attached to four oceanographic moorings located on the north wall and floor of the Markham Canyon, and also from 15 deep ocean floor samples. These samples showed naturally elevated particulate concentrations of copper and nickel compared to sediment quality guidelines. Toxicity testing of this sediment indicated that ecotoxicological effects may occur naturally.



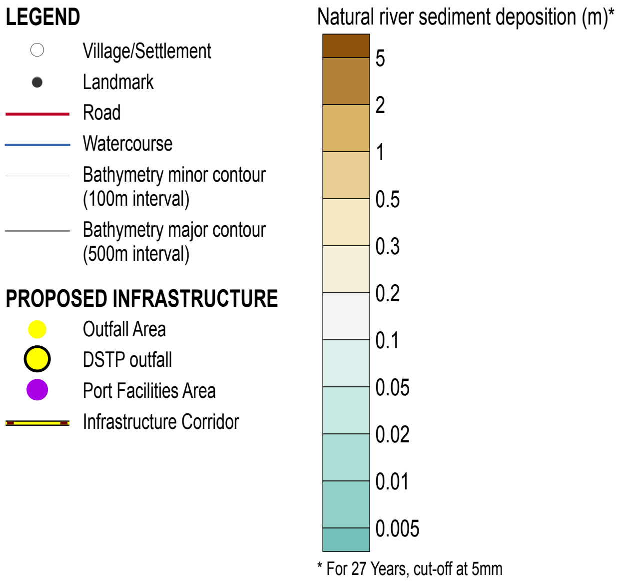


Figure 3.6: Predicted deposition of natural sediment discharged into the Huon Gulf as suspended sediment load from rivers (without DSTP) after 27 years[1]

Figure 3.7: Macrofauna sampled in the Huon Gulf

Figure 3.8: Meiofauna sampled in the Huon Gulf

Huon Gulf Biological Environment

Both the fish catch per unit of effort and the species diversity of deep-slope fish caught between 100 and 800m water depth in the Huon Gulf for Project studies was low, and much lower than recorded during baseline surveys at other DSTP sites elsewhere in PNG, such as Woodlark, Misima, Ramu and Lihir. Sharks comprised 94% of the deep-slope fish catch. No pelagic fish species were captured despite 23 trolling sessions totalling 16.5 hours of fishing during two surveys.

The Project studies also included zooplankton and micronekton sampling, the first time this has been done at the EIS stage for a DSTP project in PNG. Zooplankton abundances were highly variable across sampling sites with no clear relationship between zooplankton abundance and site location, depth, or sampling time. The exception to this was vertical migration of zooplankton from deeper to shallower waters at night. Metal concentrations in zooplankton samples were highest at inshore sites and decreased at the mid-slope and offshore sites, most likely due to the influence of riverine discharges. Concentrations of most metals were noticeably higher in micronekton than in zooplankton samples, suggesting some level of bioaccumulation or biomagnification of these metals is occurring naturally from the zooplankton to micronekton.

Ocean floor samples from the side walls and floor of the Markham Canyon were analysed for macrofauna (Figure 3.7) and meiofauna (Figure 3.8). Macrofauna are small, multicellular animals that inhabit benthic sediments and when sampled are retained on a 500µm sieve. Meiofauna are those sized between 63µm and 500µm. During initial surveys, more than half of the deep-sea infauna (organisms that live in the sediment) samples contained no macrofauna. Further meiofauna sampling after 10 months showed that meiofauna density was generally higher than in earlier sampling, although highly variable temporally and spatially. Meiofauna was again found to be very low on the Markham Canyon floor.

3.2 Socioeconomic

Socioeconomic studies focused on four study areas corresponding to Project components as follows:

- Study Area 1: Mine Area, surrounds and access corridors
- Study Area 2: Infrastructure Corridor from Zifasing to Lae
- Study Area 3: Lae (including the Port Facilities Area and the Infrastructure Corridor within Lae)
- Study Area 4: Wagang and Yanga villages (including the Outfall Area and the Infrastructure Corridor outside and east of the city of Lae)

The socioeconomic context varies considerably across these four study areas. Study Area 1 is the most remote rural location of all the study areas. Study Area 3 is a predominantly urban area. Study Areas 2 and 4 comprise both rural and peri-urban areas.

Study Area 1 comprises 28 villages. The villages closest to the Mine Area are inhabited by people of the Babuaf, Hengambu and Yanta cultural groups. The combined population of these villages is approximately 3,900. Villages on the Lower Watut and Lower Markham rivers (including those along the existing Demakwa Access Road and proposed Northern Access Road) have a combined population of approximately 6,000. These villages are generally occupied by people of the Wampar cultural group.

Study Area 2 covers an approximate linear distance of 50km and traverses villages and settlements along the section of the Infrastructure Corridor between Zifasing and Lae. While also predominantly rural, the proximity of Study Area 2 to the Highlands Highway provides residents of this study area greater connectivity to Lae, Madang and the PNG highlands compared to Study Area 1.

Study Area 3 comprises the city of Lae, the second largest city in PNG. This study area encompasses the Port of Lae and the Malahang area to the east of Lae. The Infrastructure Corridor will traverse the southern and eastern parts of the city of Lae.

Study Area 4 comprises the villages of Wagang and Yanga, which are peri-urban villages east of Lae. The Outfall System, and a portion of the Infrastructure Corridor leading to the Outfall System, will be located on land used by Wagang and Yanga villages.

In Study Areas 1, 2 and 4, land is predominantly under customary tenure and, in some places, ownership is disputed. The majority of land in Lae (Study Area 3) is State land, with some areas of customary land. Land used for residential purposes in Lae includes both formal and informal settlements.

Residents of Study Areas 1 and 2 are generally dependent on the natural environment for food, housing materials, firewood and traditional medicine, which they either grow in gardens or gather from surrounding forests. Houses are predominantly made from local materials with wooden posts and frames, timber or bamboo walls, and sago leaves or grass used for roofs. Most households use kerosene lamps for lighting and open fires for cooking. Ownership of electric generators and solar power systems varies across villages in these study areas. Alluvial mining is undertaken as an income source in Study Area 1.

In Study Areas 1 and 2, drinking water is predominantly sourced from springs and creeks, and, in some villages, from rainwater tanks. A number of villages have gravity-fed piped water systems although the quality of water available from these systems and their reliability varies. Rivers are not a preferred source of drinking water; however, they are regularly used for washing, fishing, transport and recreation.

Residents of Study Area 1 are located in a remote rural area. A widespread system of bush tracks provides access between villages. Villagers also use the Lower Watut River, travelling by raft or canoe, to access markets downstream. The Wafi Access and Demakwa Access roads are used by the public to access Lae and beyond. For residents of Study Area 1, the lack of transport is a barrier to greater participation in commercially-oriented activities, whereas the proximity of the Highlands Highway to Study Area 2 provides better access to commercial opportunities.

Access to education in Study Area 1 is currently limited in some villages due to the distance required to travel to school. Of the Study Area 1 villages surveyed in 2014 and 2015, 31% of boys and 41% of girls aged seven to 14 years of age had no formal education. Most villages in Study Area 1 have access to health facilities, including the Wafi health clinic, Zindaga health sub-centre and Wongkins, Timini and Pokwaluma aid posts – all established or renovated by WGJV. Travel to these facilities can, however, take up to two hours by foot for residents of some villages. Residents in Study Area 2 generally have more convenient access to education and healthcare facilities, although the availability of staff, equipment and supplies varies.

By comparison, Lae (Study Area 3) serves as a major transport hub and a commercial, administrative, residential, industrial and educational centre for both the Morobe Province and PNG. Residents of Study Area 3 are more typically engaged in employment activities compared to those in the other study areas. However, unemployment is high in Lae, particularly among urban youth. Many residents keep gardens for subsistence and for growing produce to sell or barter as part of the informal economy. Nearly half of the land area of Lae comprises informal settlements (i.e., areas occupied by people who have neither formal nor customary right to reside on the land). While Lae is serviced by reticulated water and an electricity grid, informal settlements typically lack these services.

Wagang and Yanga villages (Study Area 4) are peri-urban villages in which the majority of households undertake subsistence agriculture, hunting and fishing, but many also undertake employment or business activities in Lae. Residents of this study area typically have access to electricity from the grid and water is supplied variously from springs, creeks, rainwater tanks and wells.

Results of a human health baseline survey undertaken for the Project in 2013 indicate that people in Study Area 3 are currently exposed to elevated levels of mercury and lead in subsistence foodstuffs. Baseline conditions indicate this is likely due to the presence of mercury and lead in fish and shellfish and the high consumption of these foodstuffs by people in Study Area 3. Elevated levels of arsenic were noted in some villages in Study Area 1 and Study Area 2, which may be related to high levels of arsenic in fish consumed by some villagers.

3.3 Cultural Heritage

Cultural heritage has both tangible and intangible aspects. Tangible heritage includes physical artefacts and objects, whether movable or immovable. Intangible heritage includes oral traditions and history passed down through generations that are reflected in practices, expressions, knowledge and skills that communities identify as part of their cultural heritage. In PNG, cultural heritage can include oral tradition sites (including spiritual and oral history sites of importance to landowners), historic sites (associated with PNG's colonial history and World War II) and archaeological sites (which contain physical evidence of past cultural activity, such as ancient pottery, stone tools and skeletal remains).

There are five cultural groups relevant to the Project. The Babuaf, Hengambu and Yanta are the main cultural groups that live in proximity to the Mine Area. The Infrastructure Corridor crosses land claimed by the Babuaf, Wampar and Ahi people. The Outfall Area is also located within land traditionally inhabited by the Ahi people.

Twelve cultural heritage surveys have been undertaken for the Wafi-Golpu Project since 1996. As a result of these surveys, which included consultation with the Hengambu, Yanta, Babuaf, Wampar and Ahi cultural groups, 351 cultural heritage sites were recorded within, and in the areas broadly surrounding, the Mine Area, Infrastructure Corridor and Outfall Area. These recorded sites include 289 oral tradition sites, 59 archaeological sites and three historical sites. Oral tradition sites include the sites of former settlements, stories, cemeteries, burials, rockshelters and camps.

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Description of the Project

The Golpu copper-gold orebody is one of several copper and gold deposits in the Mine Area. It, together with the nearby Wafi and Nambonga deposits, is the subject of a special mining lease application, plus applications for associated tenements, by the WGJV Participants.

The proposed Project comprises the following facilities and infrastructure:

- The twin Watut Declines from the surface to the Golpu orebody below Mt Golpu
- A single decline at Nambonga
- Underground block cave mine, crushers and conveyors
- Support facilities for the underground mine including refrigeration plants, ventilation shaft and fans
- Support infrastructure including fuel storage, waste rock dumps, wastewater treatment facilities, concrete batch plants and explosives storage areas
- Maintenance workshops, administration buildings and accommodation facilities
- Hard rock borrow pits, quarries and river gravel extraction sites
- The Watut Process Plant, a conventional copper-gold flotation plant
- Electrical infrastructure for power generation facilities and distribution
- An Infrastructure Corridor comprising roads (including the Northern Access Road and Mine Access Road), laydown areas and three buried pipelines to transport concentrate and tailings from the Mine Area to the Port Facilities Area and the Outfall Area respectively, and fuel from the Port of Lae to the Mine Area
- The Port Facilities Area, including the concentrate filtration plant
- The Outfall Area, with DSTP for tailings management

The facilities represent the current optimised design derived from a multi-disciplinary assessment of engineering, economic, environmental, social and cultural heritage factors. The EIS provides a detailed description of the options considered during the design of the Project and the rationale for the current optimised design.

The Wafi-Golpu Joint Venture propose to permit and then develop and operate the Project in the following phases:

- Construction
- Operations
- Closure

4.1 Permitting

The WGJV Participants have applied for a special mining lease over the portion of the Mine Area within Exploration Licence (EL) 440 and EL 1105, under the *Mining Act 1992,* and for ancillary tenements over all Project-related infrastructure across the Project Area. They are also seeking an environment permit under the *Environment Act 2000* for all Project activities.

An indicative timetable for Project development is shown in Table 4.1. The timeframes presented are subject to the completion of statutory processes and securing approvals from the State of PNG and the WGJV Participants. For the purposes of the information included here only, it is assumed that a special mining lease is granted by the State of PNG by June 2019, following its assessment through PNG permitting and regulatory processes.

Table 4.1: Indicative Project timetable

Key Milestones	Timeframe
PERMITTING	
EIS submission	June 2018
Level 3 Environment Permit approval	By June 2019
Special mining lease grant	By June 2019
CONSTRUCTION	
Construction start (decline development)	1 year after special mining lease grant
OPERATIONS	
Operations (including ongoing mine development, ore extraction and processing)	From 5 years after special mining lease grant, continuing for at least 28 years
CLOSURE	
Mine closure (decommissioning)	After completion of all mining activities

4.2 Construction

Construction is expected to take place over approximately five years following grant of a special mining lease, starting with development of the Mine Area in years one to five, and then the Port Facilities Area and Outfall Area in years four and five respectively. Construction of the pipelines will commence in year four, continuing for approximately 1.5 years.

Construction will be undertaken in a carefully managed sequence starting with preparatory works, which will:

- Improve access to the Mine Area and provide accommodation for the construction workforce
- Clear vegetation
- Stabilise the slope above the decline portals and prepare a work area with necessary support facilities

Access to the Golpu orebody will be obtained via declines from both the Watut and Nambonga portals. The declines will be excavated using drill and blast techniques with the waste rock trucked to the surface for disposal in the waste rock dumps.

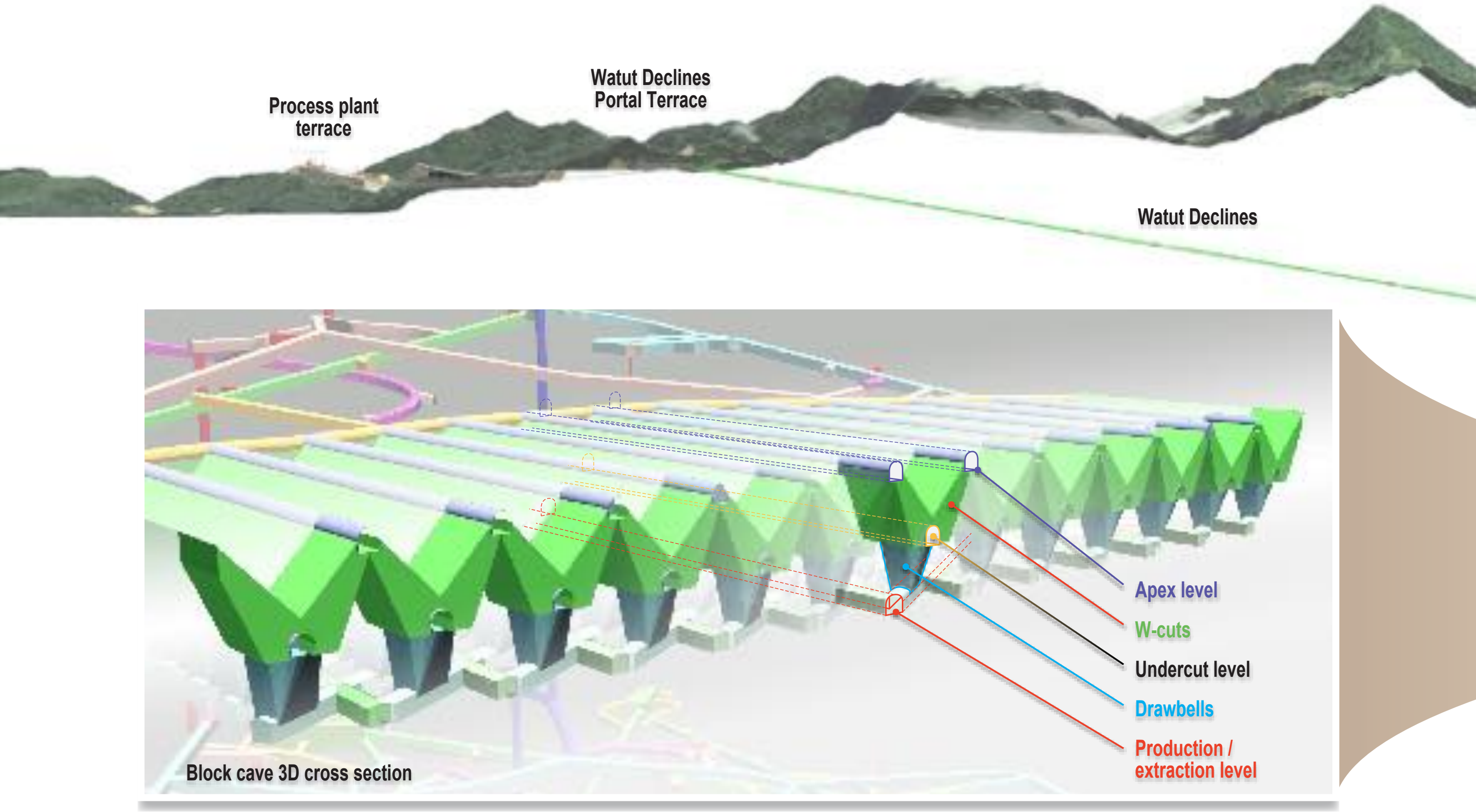
The Golpu orebody is a deep, near-vertical column-like mass that makes it well-suited to mining by block caving. Block caving uses the controlled fracturing and caving of the orebody to break and extract the ore (Figure 4.1) and has the advantage of lower operating costs. Block caving also minimises environmental impacts by having a smaller surface footprint and waste rock dumps compared to open pit methods when applied to the Golpu deposit.

Three block caves, Block Cave (BC) 44, BC 42 and BC 40, located one below the other, will be developed in stages beneath Mt Golpu as shown in Figure 4.1. The production level of the deepest, BC 40, will be 1,740m below Mt Golpu.

A system of access declines, conveyor declines and a return air system will be developed to the base of each successive block cave. The return air system will connect the block caves to a ventilation shaft used to expel air from the mine, with fresh air drawn into the mine from the surface via the declines.

While the Project is designed to minimise physical and economic displacement, some households will likely need to be relocated. The villages of Hekeng, Nambonga and Venembele are within the special mining lease, and are intended to be relocated. The establishment of two roads (Watut Services Road and Resettlement Road, see Figure 1.1) is being investigated to enable community access to the Northern Access Road with the intention to provide persons physically displaced by the Project with equivalent or improved road access. Planning and consultation for resettlement is in progress.

Figure 4.1: Schematic of the declines and block caves

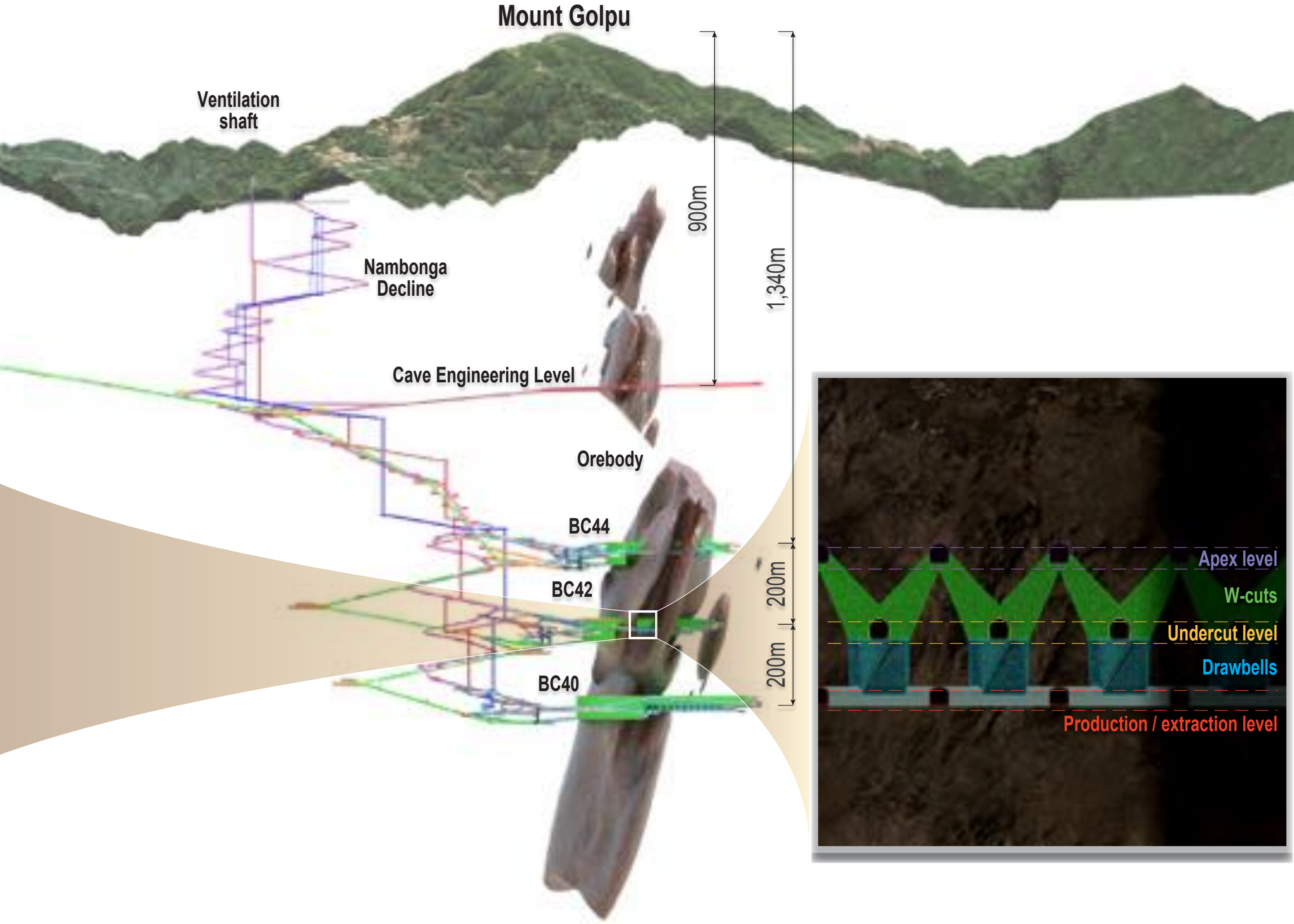


4.3 Operations

Following construction, operations will commence and run for a period of approximately 28 years.

Block Cave 44 is proposed to operate over a seven-year period. Block Cave 42, approximately 200m below BC 44, will commence five years after the first production of BC 44 and will operate for nine years. The longest running block cave, BC 40 will operate for 16 years, with three years' overlap with BC 42.

During mining, loaders will recover broken ore from the base of the block cave and deliver it to an underground crusher. The conveyor decline will contain the ore conveyor and services (such as power and water) and move crushed ore from the block caves to the Watut Process Plant. The Watut access decline will serve as the primary access to move personnel and equipment between the surface and the working areas of the mine.



Once ore production commences, all rock extracted from underground, whether barren or mineralised, will be treated as ore and processed through the Watut Process Plant. No further rock is expected to be emplaced in the waste rock dumps.

Mining will continue 24 hours per day, all year round, with the exception of scheduled shutdowns.

The block cave mining process will result in the gradual subsidence of the surface followed by the breakthrough on the side of Mt Golpu, after approximately 38 months based on numerical modelling, as ore is gradually removed in the block caves below ground. This will result in the formation of a large area of subsidence (i.e., gradual sinking of land).

Figure 4.2: Process plant terrace and associated infrastructure

Ore Processing

The Watut Process Plant will grind the ore extracted from the mine and subject it to a number of physical and chemical processes to separate the valuable minerals from barren rock to produce a copper-gold concentrate, the sole product of the Project. The concentrate will be a black, fine-grained, sand-like material and will be pumped as a slurry to the Port Facilities Area, where it will be dewatered to a low moisture content product and shipped to customers overseas for refining.

The Watut Process Plant will be located on a terrace approximately 6ha in size on a ridge west of the Watut Declines Portal Terrace as shown in Figure 4.2. The plant terrace will also house facilities such as control rooms, offices, laboratories, warehouses, change houses and security.

Aside from scheduled shutdowns for maintenance, the plant is designed to operate 24 hours per day, 365 days per year.

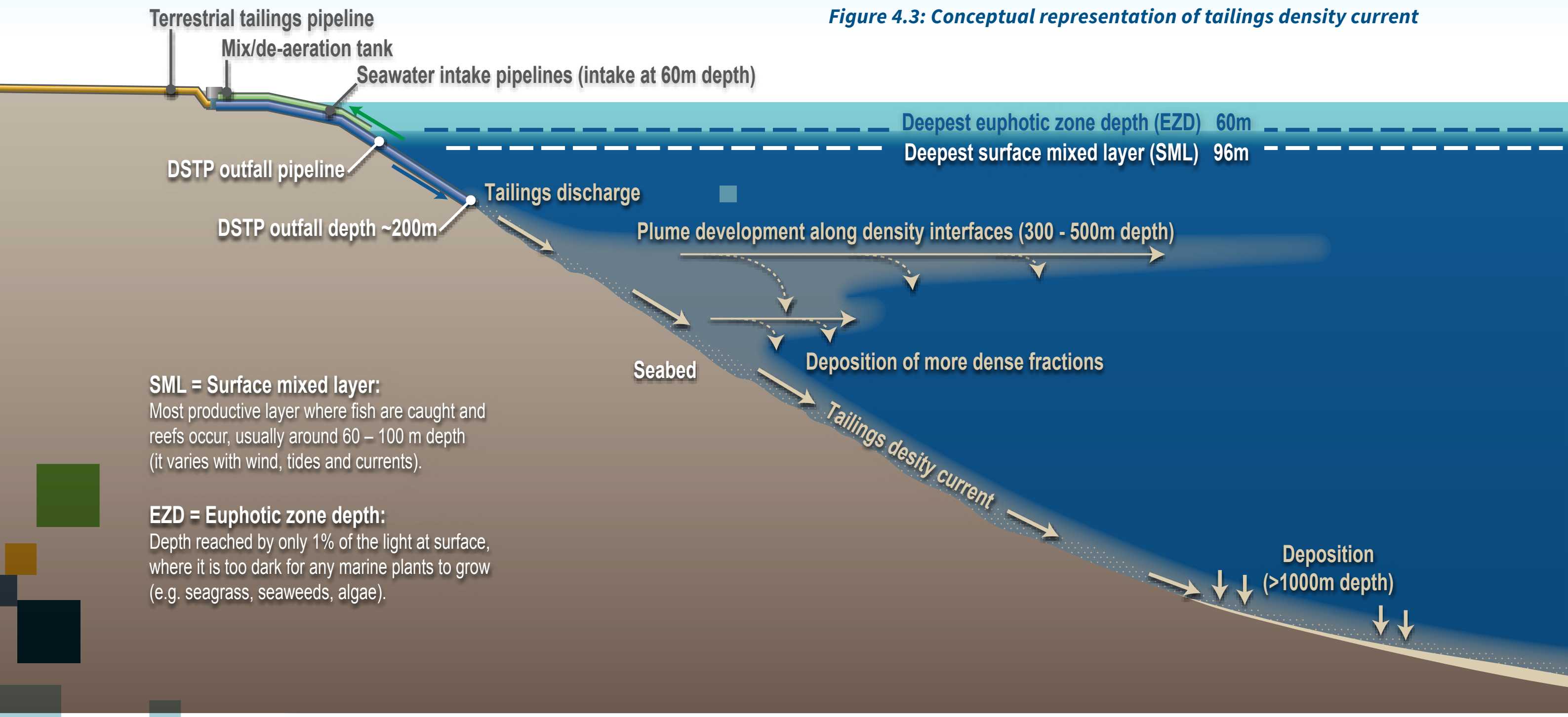


Figure 4.3: Conceptual representation of tailings density current

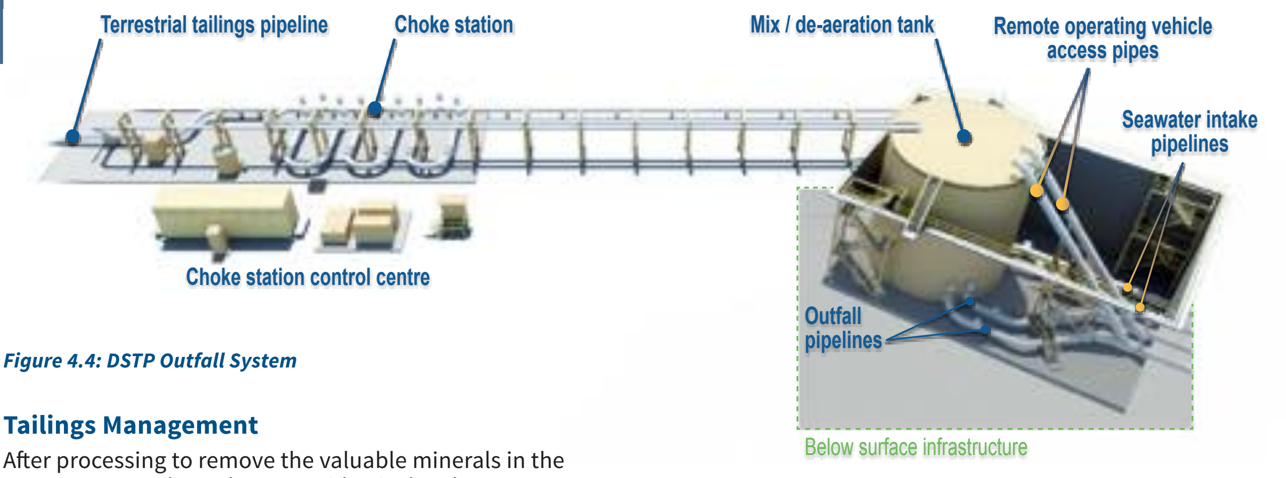


Figure 4.4: DSTP Outfall System

Tailings Management

After processing to remove the valuable minerals in the Watut Process Plant, the ore residue is then known as tailings. The tailings slurry includes process water and will contain residual chemical reagents used in ore processing. Approximately 360Mt of tailings will result from the processing of ore produced from BC 44, BC 42 and BC 40 over a 28 year period.

The WGJV has extensively investigated options, both on-land and utilising DSTP, for life of mine tailings management for the Project. These investigations have identified DSTP as the WGJV's preferred method for the management of tailings, based on consideration of long-term safety, engineering, environmental, social, cultural heritage and economic factors. Tailings management using DSTP involves:

- The transportation of tailings from the mine to an outfall location at the coast via a slurry pipeline.
- The discharge of tailings slurry from an outfall pipeline from land with a terminus located deep below the ocean surface (generally greater than 100m for DSTP operations around the world; proposed at approximately 200m depth for the Project).
- On exiting the outfall pipe, the tailings flow down the sloping seafloor as a density current, with the ultimate deposition of the tailings solids on the deep-ocean floor, nominally at a depth greater than 1,000m. Figure 4.3 provides a conceptual representation of this tailings density current.

Deep sea tailings placement is presently used at six mines in four countries. Other mines in PNG that use DSTP to manage tailings are Misima (now closed), Lihir, Ramu and Simberi. Woodlark is approved to use DSTP but has not yet commenced construction.

In relation to the use of DSTP as the WGJV's preferred method of tailings management, studies to date have confirmed that:

- The Outfall Area is a highly suitable environment for DSTP
- The tailings are expected to mix and co-deposit with naturally occurring riverine sediments from the Markham, Busu and other rivers that are also conveyed via the Markham Canyon into the Huon Gulf
- The pelagic, deep-slope and sea floor receiving environment has a very low biodiversity as a result of the riverine sediment transport, deposition and regular mass movements (underwater landslides)
- The natural riverine sediments are expected to also bury the co-deposited tailings at closure and promote benthic recovery to pre-mine conditions
- Risks to human health from consuming fish caught in the Huon Gulf beyond existing levels are not expected from the use of DSTP.

This is further discussed in Section 6 of this Executive Summary.

Figure 4.5: Port Facilities Area

The Draft General Guidelines for DSTP in PNG have been followed in relation to the siting and design of the Outfall System to the maximum practical extent.

Tailings will be pumped as a slurry to the DSTP Outfall System situated east of Lae (Figure 4.4), from the Watut Process Plant in a buried pipeline within the Infrastructure Corridor. This pipeline will include corrosion prevention and leak detection systems.

The proposed DSTP Outfall System will require construction of seawater intake and tailings outfall pipelines on the seafloor with trenching and scour protection at the shore crossing. The DSTP Outfall System mix/de-aeration tank will remove entrained air from the tailings slurry and add seawater for the hydrodynamic balance of the tank before discharge in two outfall pipelines at a depth of approximately 200m in the Huon Gulf. Data from more than twelve months of oceanographic investigations has confirmed that this outfall depth is well below the bottom of the euphotic zone and surface mixed layer by a distance of much more than fifty per cent, which is a margin of safety (i.e., buffer distance) recommended by the Draft General Guidelines for DSTP in PNG to avoid mixing and upwelling of tailings into the primary production zones of the water column.

Modelling using high-precision swath bathymetry has confirmed that no deposition of tailings solids is predicted near the outfall terminus and so there is virtually no risk of plugging the DSTP outfall. This is an important consideration in the selection of the DSTP outfall location.

Concentrate Pipeline

The copper-gold concentrate will be pumped as a slurry through a buried plastic-lined steel pipeline to the Port Facilities Area (refer to Figure 4.5). The concentrate pipeline will extend approximately 100km between the Watut Process Plant and the concentrate filtration plant in the Port Facilities Area. Where possible, the pipeline will be installed in previously disturbed areas to minimise potential environmental, social and cultural heritage impacts. A number of river and potential road crossings will be required. The concentrate pipeline will include corrosion prevention and leak detection systems.

Port Facilities

The proposed facilities to be constructed for the Project at the Port Facilities Area will include a concentrate filtration plant, ship loading facilities, conveyors and a materials handling and storage facility (Figure 4.5).

The concentrate slurry will be dewatered using a pressure filter and the dewatered concentrate will be stored under cover before being loaded onto ships by covered conveyor for export.

Power Generation

During the construction phase of the Project, power will be provided by on-site diesel generators.

For the operations phase, the WGJV proposes to construct and operate a power generation facility using reciprocating engines to supply power for the mine operations and accommodation facilities. The power generation facilities will be constructed in two stages. The first stage consists of nine 10MW generator sets to meet the initial power demand of 56MW. The second stage consists of an additional five 10MW generator sets to accommodate the Project's peak power demand of 100MW. Power generation using intermediate fuel oil was assessed to be the most economic and reliable way to meet power demand over the life of the Project. The power generation facilities will be located approximately 6.5km north of the Watut Process Plant on an existing cleared pad with power conveyed to the mine and processing plant along the Mine Access Road by two 132kV circuits, one overhead and one buried.

The WGJV will continue to assess the viability of other power supply sources from third parties as permitting and development of the Project progresses.

Water Management

The high rainfall in the Mine Area, combined with the planned ground disturbing activities and the potentially acid-forming characteristics of the rock within Mt Golpu, requires a carefully considered water management strategy. Exposure of potentially acid forming material within the mine underground, ore stockpiles, waste rock dumps and subsidence zone, to water and oxygen is likely to lead to the acidification of contacting water and associated mobilisation of metals, known as acid and metalliferous drainage.

The water management objectives for the Project are to contain fugitive sediments to levels consistent with the existing conditions, limit the generation of acid and metalliferous drainage and to prevent potentially contaminated water reaching downstream watercourses. The WGJV proposes to do this by:

- Installing sediment control structures, such as sedimentation ponds, downstream of key Project infrastructure prior to construction.
- Limiting exposure of potentially acid-forming material to atmospheric conditions.
- Capturing and treating, if necessary, contaminated mine wastewater, including groundwater dewatered from the underground workings, seepage and runoff from stockpiles and waste rock dumps, prior to discharging to the Lower Watut River via the wastewater discharge pipeline. For a period of approximately three years, underground dewatering flows extracted during construction of the Nambonga Decline Portal, and runoff and seepage from the Miapilli Waste Rock Dump, will be captured and treated, if necessary, prior to discharge to Nambonga Creek. Treatment will be undertaken where required to meet ambient water quality criteria at the proposed compliance points (in the Lower Watut River and in Nambonga Creek) at the downstream boundary of the defined mixing zones within each watercourse.

During construction, treated mine water, including treated sewage, will be reused for mine services where possible and excess water will be discharged to the Lower Watut River or Nambonga Creek. For the majority of the operational phase, wastewater will be used to fulfil water demand. Additional site water demands, i.e., those not fulfilled through treated water, will be supplemented using water from the Lower Watut River. Water demand from the Project will be less than 1% of the Lower Watut River flows even in drought years.

4.4 Closure

At the completion of mining and processing, the mine and associated infrastructure will be closed. The closure phase includes progressive rehabilitation, decommissioning, rehabilitation post-closure monitoring and maintenance, and relinquishment.

A Conceptual Closure and Rehabilitation Plan has been developed with the following key post-closure environmental objectives:

- Mitigate generation and release of acidic and suspended solids discharges to the downstream receiving environment
- Rehabilitate the Project Area to self-sustaining, stable landforms
- Develop and meet post-closure land use objectives to be agreed with the regulator in consultation with stakeholders.

Key social objectives of the Conceptual Closure and Rehabilitation Plan include minimising the reliance on the mine by the local communities to enable the transition to sustainable alternative industries and economic activities and to promote alternate employment opportunities.

Post-closure management is further described in Section 6.4 of this EIS Executive Summary.

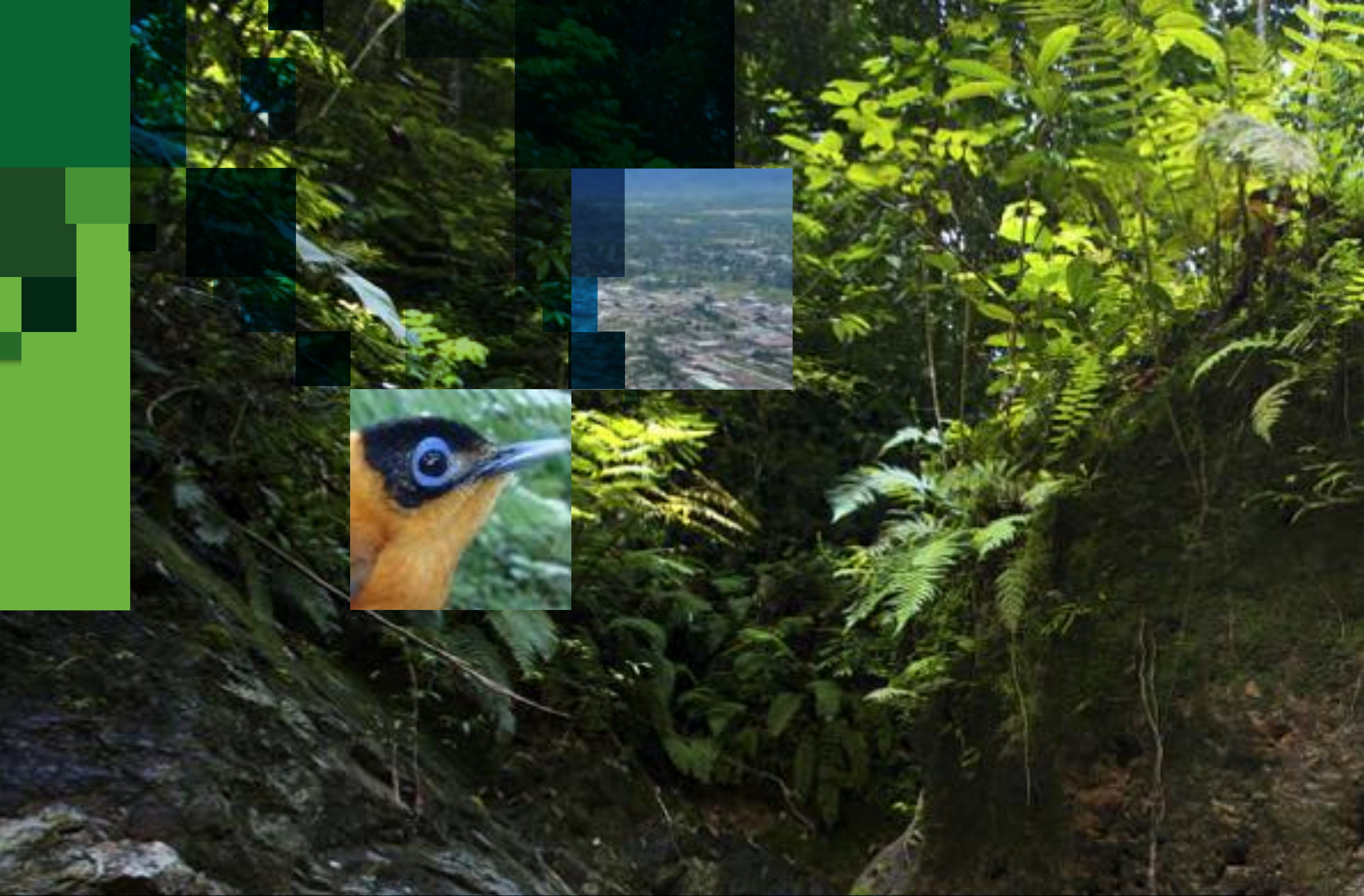


5 Stakeholder Engagement

Transparent and accountable stakeholder engagement has been and remains integral to WGJV's approach to developing and operating the Project. The information collected and feedback received from stakeholders during the long-standing engagement process has informed the scope of the EIS, the conduct of individual studies, the assessment of potential impacts, and the development of management measures to address these impacts. This feedback has also helped to refine the Project design and assists WGJV, on an ongoing basis, to understand and proactively manage community concerns respectfully and transparently. Stakeholder engagement will continue throughout the life of the Project.

Several types of transparent engagement processes have been used to understand and record stakeholders' views and interests in the Project. These include regular meetings with villages near the Mine Area, government and other interested stakeholders, community information sessions, and Project awareness sessions in support of environmental, social and cultural heritage surveys. Input into the scope of environmental, social and cultural heritage studies undertaken for the EIS has also been sought from Project-affected communities.

Many stakeholders, particularly those residing close to the proposed Mine Area, have expressed strong support for the Project to proceed and are of the view that opportunities will arise from which they will benefit. At the same time, concerns have also been raised about potential Project impacts, including environmental damage, an increase in law and order issues, tensions within families, and general social problems related to the perceived deterioration of community cohesion arising from accelerated social change within their villages.



6

Assessment of the Project

6.1 Environment

A comprehensive suite of specialist studies has been carried out since the early 1980s to characterise the Project's environmental setting, how the Project may affect this setting, and identify measures to manage potential impacts, including changes to the Project design where practicable.

The key potential environmental impacts associated with the Project are predicted to relate to terrestrial and aquatic ecology, groundwater and surface waters, noise and air quality and the deep-ocean marine environment. These potential impacts are predicted to arise from:

- Vegetation clearance
- Earthworks (and related erosion and sediment transport)
- Groundwater flow into the declines and underground mine, and the discharge of potentially contaminated groundwater
- Lower groundwater levels due to dewatering the aquifers
- Potential acid and metalliferous drainage from Project-related disturbances
- Altered natural resource use by local communities resulting from increased access from road construction
- The use of DSTP for tailings management.

The EIS also assesses several other environmental aspects, including greenhouse gas emissions, and landforms and soils. A number of environmental impacts (such as air quality and the generation of noise) may also result in impacts to local communities.

The remainder of this section discusses the most significant impacts on the environment predicted to be caused by the Project and provides a brief discussion of the management measures that the WGJV proposes to implement to manage them.

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Air Quality and Noise Impacts

The maintenance of existing air quality and noise level amenity in the Project Area, through compliance with adopted criteria, was predicted at all sensitive receptors, except for Ziriruk (both air and noise emissions), Fly Camp (air emissions), Papas (noise emissions) and Hekeng (noise emissions).

Impacts to air quality are predicted at both Ziriruk and Fly Camp through the generation of combustion emissions (sulphur dioxide) from the power generation facilities during operations.

Noise levels are predicted to exceed the adopted night time criteria during construction under enhanced[2] conditions at Ziriruk, Papas and Hekeng. Enhanced conditions consist of temperature inversions, which while having potential to occur up to 40% of the year at the Mine Area, are typically only during the early morning or evening (i.e., periods where the day time criterion is more applicable) and are not generally present for long periods. Hekeng is also predicted to experience exceedances of the adopted night time criteria under neutral[2] conditions, prior to resettlement.

Throughout operations, noise levels are predicted to exceed adopted night time criteria at Ziriruk, under both neutral and enhanced meteorological conditions. This is due to the predicted noise emissions from the power generation facilities located approximately 800m north of the village.

A range of proposed management measures to reduce the level of air quality and noise impacts on local villages are detailed in the Project Environmental Management Plan. They include:

- For air quality (dust deposition) – Employing dust suppression measures during extended dry periods and limiting vehicle speeds along access roads (particularly near villages).
- For air quality (combustion emissions) – Management measures such as scrubbers on the power generation facilities' stacks or increasing the exhaust gas exit velocity will be implemented as required, with the WGJV committed to achieving compliance with adopted air quality criteria.
- For noise – Minimising works at night, providing advanced notice of works, blasting during daytime only (except for underground workings) and informing nearby villages of the blasting schedule.

Terrestrial Ecology

The Project will cause both direct and indirect impacts to terrestrial plants, animals and habitat. They include:

- Habitat loss from vegetation clearance and earthworks. These impacts may be exacerbated by increased human populations (through in-migration and improved access).
- Habitat degradation from edge effects, barrier effects, deposition of eroded sediments, colonisation by invasive species or from contamination caused by acid and metalliferous drainage or accidental spills of hazardous materials. Degradation may also occur indirectly from increased use of natural resources by the local human population.
- Reduced abundance of plant and animal populations due to: reduced or degraded habitat (i.e., food sources, shelter and nesting or roosting sites); injury, death or displacement from clearing and earthworks; collision with vehicles; predation by exotic species; increased hunting in previously inaccessible areas; and increased disturbance (from Project noise and lighting) disrupting the behaviour of fauna.

The onshore area directly disturbed during the construction phase (including temporary laydown areas) of the Project will be approximately 1,405ha. Over half (862ha; 61%) of all predicted disturbance will affect land which is already highly modified or degraded by cattle farming, gardens or previous clearing.

In terms of direct and indirect Project related impacts, the disturbance to some areas of floodplain forest on alluvial plains is predicted to have the highest residual ecological impact. Compared to the more widely distributed hill forest (and other forest types in the area), these habitats are more productive, are restricted in distribution and are more susceptible to threatening processes (including changes to flood patterns and timber harvesting).

The degree to which plant and animal populations can tolerate habitat loss or degradation, or reduction in population size, varies. Species that are most likely to suffer population declines are those which prefer forest interiors and mature forest (particularly in ecosystems of the mountainous areas).

In terms of impacts to terrestrial plant species, the most significant are predicted to be to *Diospyros lolinopsis*, *Calophyllum morobense*, *Halfordia papuana* and *Helicia subcordata* as a result of impacts to their small populations and Kwila (*Intsia bijuga*), New Guinea rosewood (*Pterocarpus indicus*) and *Mangifera altissima* as a result of creating increased access to harvesting their valuable timbers.

While the Project will not build any facilities in the lower montane forest above 1,000m, the currently-proposed location of the resettlement village sites and the Resettlement Road will provide increased access to the relatively-intact lower montane forest on the southern side of the Wafi River. The montane mammal community here (potentially including Goodfellow's tree kangaroo and the long-beaked echidna) is sensitive owing to the severe restriction of their respective ranges due to overhunting and habitat modification. Predicted direct and indirect impacts to other sensitive fauna were assessed to be of lower significance.

The primary measure to limit impacts on terrestrial ecology values was through assessment of Project alternatives and siting of Project infrastructure. Examples include avoidance of high-value areas, such as the Markham Gap and Lower Watut River floodplain.

2 Enhanced and neutral conditions refer to atmospheric stability classes which describe the tendency of the atmosphere to resist or enhance the propagation of noise emissions. Enhanced conditions, i.e., when the atmosphere is enhancing the propagation of noise, are when temperature inversions are likely to occur, with low wind speeds and clear skies (typically between dusk and dawn). Neutral conditions, i.e., when the atmosphere is neither enhancing nor resisting the propagation of noise, are when temperature inversions are unlikely to occur.

Key proposed management measures detailed in the Project Environmental Management Plan to manage impacts on terrestrial ecology include:

- Minimising vegetation clearance where possible.
- Promoting hydrological connectivity of floodplains.
- Limiting erosion and capturing mobilised sediments.
- Avoiding the introduction and spread of weeds, plant pathogens and pest animals by Project activities.
- Implementing access protocol for Project-related roads.

Surface Waters and Freshwater Ecology

Impacts on surface water and freshwater ecology as a result of construction and operation of the Project are predicted to be low on a regional scale (i.e., the Lower Watut River catchment). There are, however, predicted to be significant local-scale changes to hydrology, sediment transport and water quality (primarily associated with suspended sediment and turbidity) that are expected to have localised effects on aquatic ecology within Project Area watercourses, particularly in the Mine Area.

Most of the Project's predicted residual impacts on aquatic ecology relate to the construction phase, when mobilised sediments from disturbed areas are expected to reach downstream watercourses as a consequence of rainfall-based erosion. Other predicted impacts include the localised direct loss and degradation of aquatic habitats; loss of, or degradation to, aquatic plants, macroinvertebrates and fish; altered hydrology; and altered water quality (including increased suspended solids and turbidity and concentrations of metals and metalloids) in downstream watercourses.

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

These may affect freshwater plants and animals; however, floodplain fish and macroinvertebrates are frequently exposed to natural, short-term high TSS concentrations and turbidity, as well as flooding. These short-term residual impacts on aquatic habitats and biological communities are predicted to occur during the construction period and then persist for a further 18 months to 2 years. They are expected to recover during operations once exposed surfaces are rehabilitated and revegetated.

Construction-derived coarse-grained sediments in Boganchong Creek are unlikely to reach Chaunong Creek or the receiving Bavaga and Lower Watut river main channels. Construction-derived sediments are expected to settle on the outer backplain of the Lower Watut River's eastern floodplain between Chaunong Creek and the escarpment due to reduced water velocities and the trapping efficiency of vegetation.

Potentially acid-forming waste rock is proposed to be buried in purpose-built cells within the waste rock dumps to limit the generation of acid and metalliferous drainage due to exposure of sulphidic material to atmospheric conditions. During construction and operations, potentially contaminated drainage from Project infrastructure (including water from the underground workings) will be intercepted and treated, if required, such that metals and metalloids in the wastewater discharge to the Lower Watut River (near Wongkins Village) will comply with PNG Environment (Water Quality Criteria) Regulation 2002 and/or ANZECC/ARMCANZ (2000) ambient water quality guidelines at the end of a mixing zone. This will thereby protect aquatic plants and animals downstream of this point.

During the post-closure period, the block caves will be filled with water. Modelling predicts that over time a lake will form in the subsidence zone and contain poor quality water (i.e., low pH and elevated concentrations of sulphate, metals and metalloids). This subsidence zone lake will require careful management. Seeps via groundwater springs and any flows from the lake spill point(s) may require interception and treatment after closure in order to meet discharge water quality criteria. Further modelling of the subsidence zone lake properties and management options is required following data acquisition during the operational phase of the Project to refine proposed post-closure management measures.

The residual impacts of treated seepage and/or subsidence zone lake overtopping, after several decades of rainwater infiltration, and discharging to the Wafi River system are predicted to be low on the basis that WGJV proposes that water treatment would be applied where required to meet permitted water quality discharge criteria prior to discharge to the environment until such time that closure objectives are met.

A range of measures detailed in the Project Environmental Management Plan are proposed to manage impacts on surface water and freshwater ecology. The key measures include:

- Implementing management measures in the Project Erosion and Sediment Control Plan.
- Revegetating disturbed areas not required during the operations phase.
- Capturing potentially contaminated mine waste water and, if required to meet environment permit criteria, treating this prior to discharge.
- Managing potentially acid-forming materials and runoff from storage areas.

Groundwater

Groundwater will flow into the declines, shafts and block caves through pathways such as faults and fracture zones. Development of the block caves will increase groundwater flow into the mine as more faults and fracture zones are intercepted by the growing block caves and the ultimate collapse of the ground surface above them to form the subsidence zone.

Dewatering of the rock by installation of surface dewatering bores and horizontal drains, and collection and disposal of groundwater inflows to the declines, shafts and block caves will cause drawdown in the groundwater systems connected to Mt Golpu, with a groundwater cone of depression around the block caves and declines. Maximum drawdown is predicted at the end of mining but does not vary significantly over the last decade of operations. At the end of mining, maximum drawdown along the declines is predicted to be 40m and to extend up to 150m laterally. Maximum drawdown around the block caves is predicted to be 500m and extend radially up to 1,400m.

The predicted drawdown will affect groundwater flow to groundwater-fed springs and groundwater baseflow to adjacent rivers and streams. Baseflow in the Buvu and Nambonga catchments is predicted to reduce by 34% and 26% respectively. The impact of reduced baseflow on groundwater dependent ecosystems and beneficial uses will be particularly evident in dry years when river and stream flows are naturally low. Flows to groundwater-fed springs are expected to cease during mining and for up to 80-years post mining. If the springs reactivate, flow rates may return to pre-mining conditions.

It is predicted that groundwater percolating through the block caves and associated fracture zone will become acidic as the potentially acid-forming rock oxidises. Generated acid and metalliferous drainage will be collected and treated, if required, prior to discharge to comply with environment permit criteria. The generation of acid and metalliferous drainage is likely to slow when the subsidence zone and block caves are saturated, which is predicted to be approximately four years following cessation of operations assuming inundation is accelerated by pumping surface water into the voids. Further detailed investigation will refine the modelling and assess the feasibility of water treatment options, including investigating the potential opportunities to limit acid generation in the subsidence zone.

A range of measures detailed in the Project Environmental Management Plan are proposed to manage impacts on groundwater. The key measures include:

- Implementing a risk-based spill prevention and response plan.
- Intercepting, capturing and, if required, treating potentially contaminated groundwater prior to discharge to meet environment permit criteria.
- Intercepting, capturing and, if required, treating seepage and/or leachate from waste rock dumps, ore stockpiles, landfills, acid sulphate soils treatment pads, effluent ponds and contaminated water ponds prior to discharge to meet environment permit criteria.

Nearshore Marine Environment

Project activities are predicted to have little impact on the nearshore marine environment.

Construction of the Outfall Area is predicted to result in temporary disturbance to a short length of the beach near Wagang, a temporary increase of suspended sediment in nearshore waters, and intermittent and short-term emissions of noise. At the Outfall Area, impacts to nearshore marine fauna and habitats will be short term (i.e., in most cases limited to several days but over a construction period of 19 months) with the environment likely to return to its original condition following construction. Potential disturbance to the critically-endangered west Pacific leatherback turtle will need to be managed during trenching across the beach at the Outfall Area. Although these turtles prefer to nest on the beaches more than 15km to the south of Lae, small numbers may nest near the Outfall Area during the construction period. Management measures such as regular inspections for the presence of turtles so they can be avoided, fencing off any nests that are identified and noise and light management procedures will minimise the impact to any leatherback turtles that may be in the Outfall Area during construction.

During operations at the Port Facilities Area, the Project will discharge treated filtrate from the concentrate filtration plant into the marine environment adjacent to the Port Facilities Area (i.e., at Berth 6 of the Port of Lae). The predicted low concentrations of contaminants in the treated filtrate means that dilution should not be required to comply with PNG ambient water quality criteria and that a regulatory compliance mixing zone is currently not proposed by WGJV. Additionally, suspended solids concentrations in the treated filtrate are predicted to be within background ranges in the receiving seawater.

Project vessel movements at the Port Facility Area have the potential to introduce invasive marine species; however, this is considered unlikely with the implementation of normal quarantine management measures. Given the long-running use of the Port of Lae by international vessels and the potential exposure to invasive species that this brings, the lack of known significant impacts resulting from these activities to date suggests current quarantine practices are working and/or invasive species have not been able to become established in the area.

A range of measures detailed in the Project Environmental Management Plan are proposed to manage impacts on the nearshore marine environment. The key measures include:

- During construction of the DSTP Outfall System, reinstating trenched areas as soon as practicable after completion of trenching.
- Installing fences around any turtle nests between Wagang and Busu River during construction within the nesting season (i.e., November to March).
- Employing noise and light management procedures during construction in the nearshore marine zone so as to minimise startling nearby turtles or other marine fauna.
- Fully covering the concentrate storage area and ship loading conveyors at the Port Facilities Area in order to contain concentrate dust and equip conveyors with rain/dust covers and suitable drip/spillage trays to contain concentrate from becoming entrained in surface runoff.

Offshore Marine Environment

Physical Behaviour and Effects of DSTP

The Wafi-Golpu Project tailings solids will be fine grained and mostly comprise silt-sized particles. Prior to discharge at the DSTP outfall, the tailings slurry will enter a mix/de-aeration tank where it will be de-aerated to allow trapped air bubbles to escape and mixed with seawater at a ratio of one part tailings slurry and four parts seawater (by volume). The de-aerated tailings slurry will then be discharged at the proposed DSTP outfall at a depth of approximately 200m, located 800m west of the Busu River mouth on the steeply sloping north wall of the Markham Canyon.

The higher relative density of the tailings and seawater mixture means that it will sink when it exits the outfall pipeline and flow down the seafloor under the influence of gravity. At the point of discharge, the tailings exiting the DSTP outfall pipelines will form a turbulent jet and, as the jet slows down, it will gradually change into a density current that will entrain more and more seawater as it moves further downslope. Computer modelling predicts that subsurface tailings plumes will start to shear off the descending density current about 300m below the surface but that these plumes will be very dilute and will be transported laterally by ocean currents while the tailings particles continue to settle towards the ocean floor. Modelling predicts that the tailings density current will continue to flow down the canyon wall until it reaches the floor of the Markham Canyon, where it will then mix with a persistent near-bottom turbidity current from the natural river sediments from the Markham River, and continue further downslope to the east where tailings solids and natural sediments will temporarily settle.

The presence of episodic, but frequent, mass movement events identified during characterisation surveys are predicted to continue to occur throughout the operating life of the DSTP Outfall System. These mass movement events cause highly energetic turbidity currents to flow through the canyon with sufficient energy to erode previously deposited natural sediments and transport them down canyon. These events are expected to mix tailings solids and natural river sediment moving down the canyon and periodically rework the deposited tailings and flush the tailings further down-canyon.

Computer modelling has simulated the combined deposition over an assumed 27 years[3] from natural sediments, the tailings density current, and subsurface tailings plumes and also simulated the effect of one (ten-minute) mass movement event per year which would mobilise an estimated 408,000m^3 of natural sediment by a slope failure on the opposite canyon wall to the DSTP outfall.

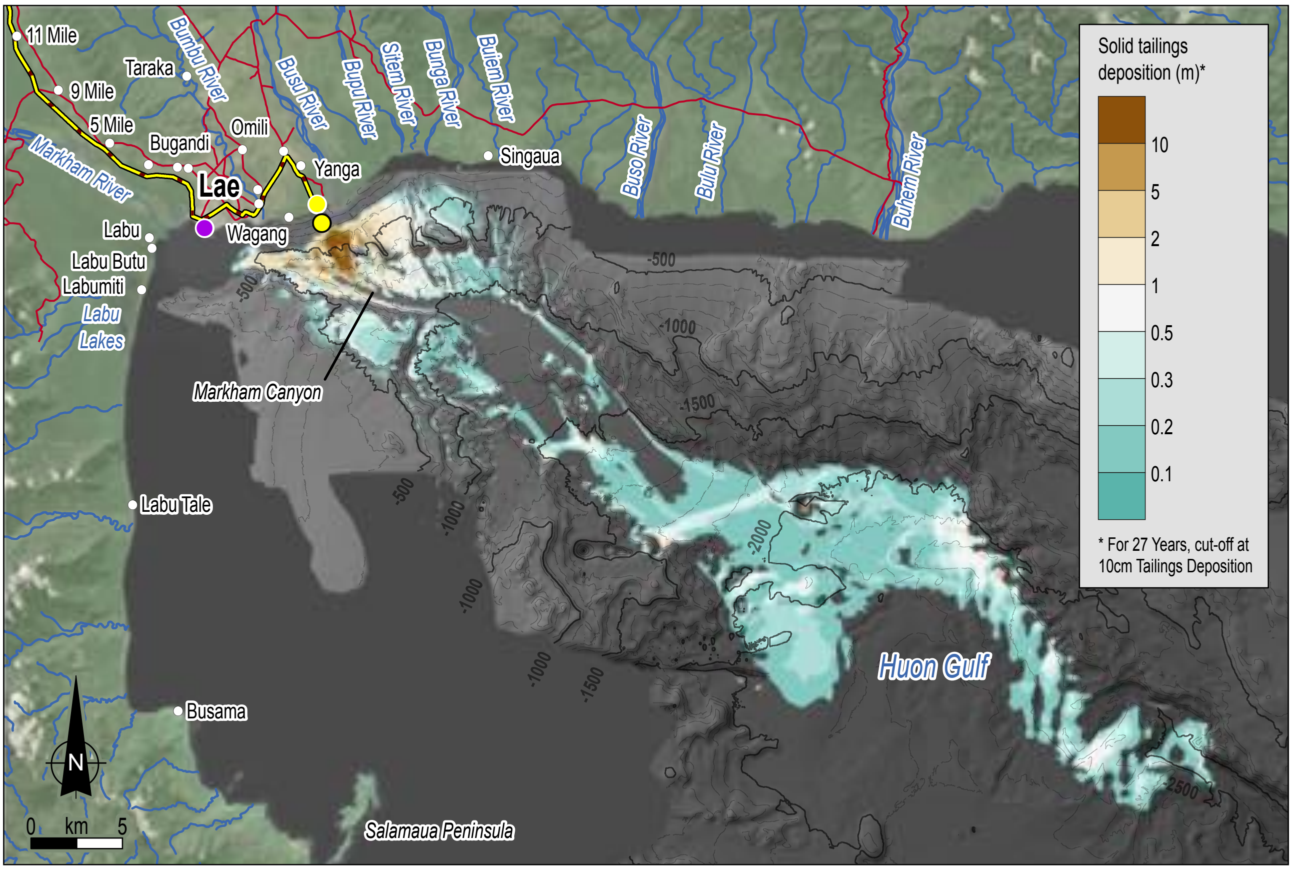
The simulated depositional footprint after 27 years from the discharge of 361Mt of tailing solids, assuming one mass movement event per year, is shown in Figure 6.1 and reveals that the thickest predicted deposits of tailings solids (more than 10m) occur between the DSTP outfall and the bottom of the north wall of the Markham Canyon. Deposition of 10m of tailings on the canyon wall is a conservative model result as it does not account for episodic slumping and downslope migration of natural sediments in this section of the canyon, which are expected to redistribute the tailings to deeper depths. Figure 6.1 shows that the thick deposition of tailings solids on the canyon floor over the duration of DSTP operation is predicted to be eroded and transported through the canyon to be redeposited mostly in thin deposits on the canyon floor at depths of between 1,500m and 2,500m. However, oceanographic observations and modelling indicate that tailings deposited within the Markham Canyon are likely to be conveyed down-canyon towards the New Britain Trench over time as a result of persistent downslope turbidity currents as well as the episodic mass events of natural sediments through the canyon.

Modelling has also simulated deposition from natural sedimentation over 27 years (see Figure 3.6) to place the depositional footprint from tailings into perspective.

To appreciate the incremental deposition that the proposed discharge of tailings solids will bring to the Huon Gulf, the ratio of tailings deposition to existing natural deposition has been modelled and is shown in Figure 6.2. Figure 6.2 displays the ratio of tailings solids deposition to natural sediment deposition: a brown colour indicates that more tailings solids than natural sediment have deposited, whereas a green colour indicates that more natural sediment deposited than tailings solids have deposited.

After closure of the mine, natural river sediment and the mass movement events in the Markham Canyon will continue to occur and are expected to rework the tailings deposits and eventually bury the deposits. The mass movement events are expected to erode and convey the tailings and sediments into deeper water to the east, leaving the canyon floor clear of accumulations of tailings (and fresh natural sediment), as is evident in the existing bathymetric maps. This is consistent with field measurements of turbidity currents occurring in succession at ADCP moorings in the Markham Canyon and then in the deeper basin, indicating that the mass movement events transport material through the canyon into deeper waters toward the New Britain Trench. Figure 6.3 shows the predicted annual rate of natural sedimentation after tailings discharge ceases with no mass movement events. The natural sedimentation is predicted to be fairly rapid down the flow-path of the tailings density current between the DSTP outfall and the Markham Canyon floor, being in the range of 10 to 100 mm/year. Burial is predicted to occur more slowly (less than 1mm per year) in deep water below about 1,000m, but this does not account for the ongoing transport of natural sediments into deep water via the mass movement events.

3 While the nominal DSTP discharge is 360Mt over 28 years, the modelling of the fate and behaviour of tailings discharged by DSTP was undertaken assuming 361Mt of tailings discharged over a 27-year period. This difference is expected to have an immaterial and unmeasurable effect on the modelling results.



▲ ***Figure 6.1: Simulated depositional footprint after 27 years of discharge of tailings solids***

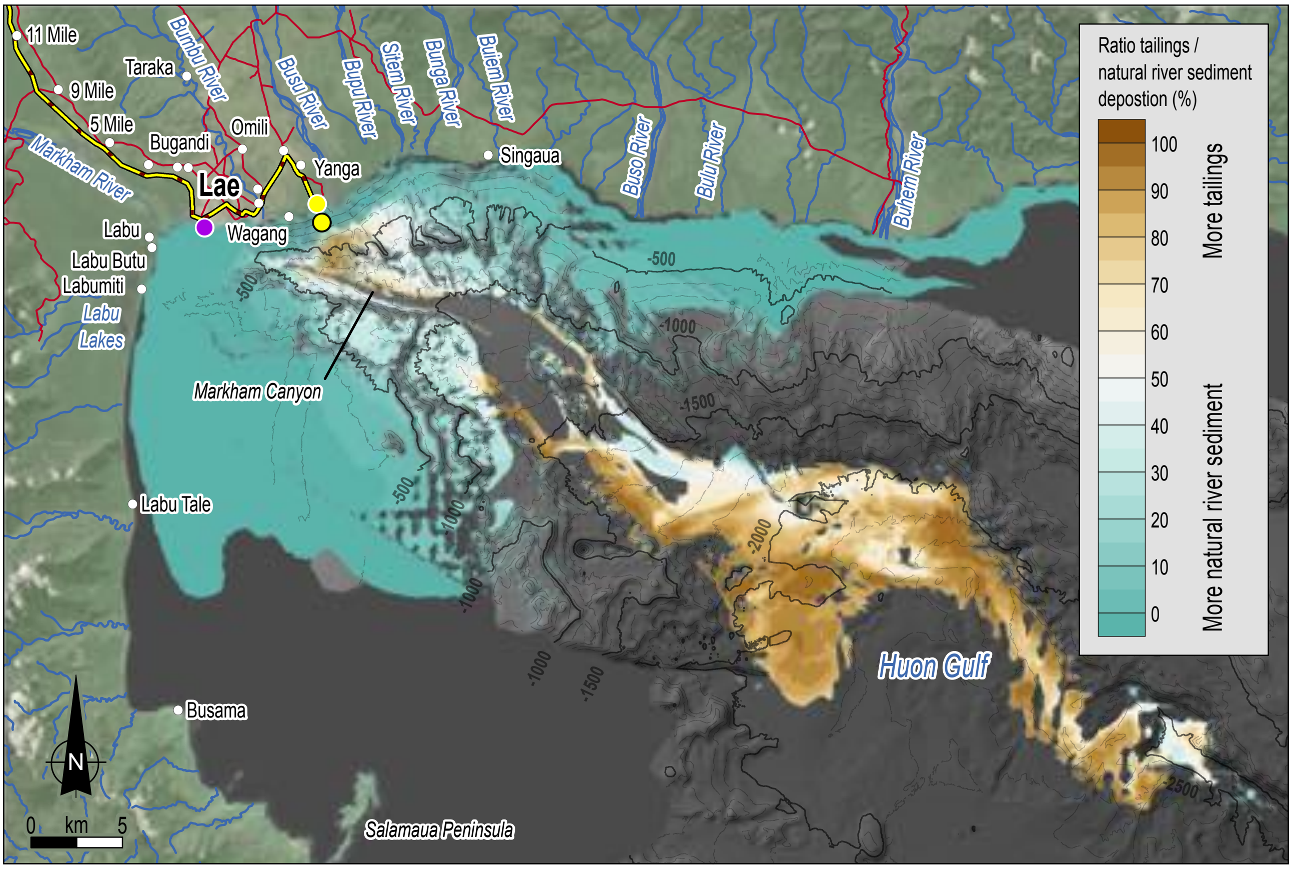
▼ ***Figure 6.2: Ratio of tailings solids to natural sediments***

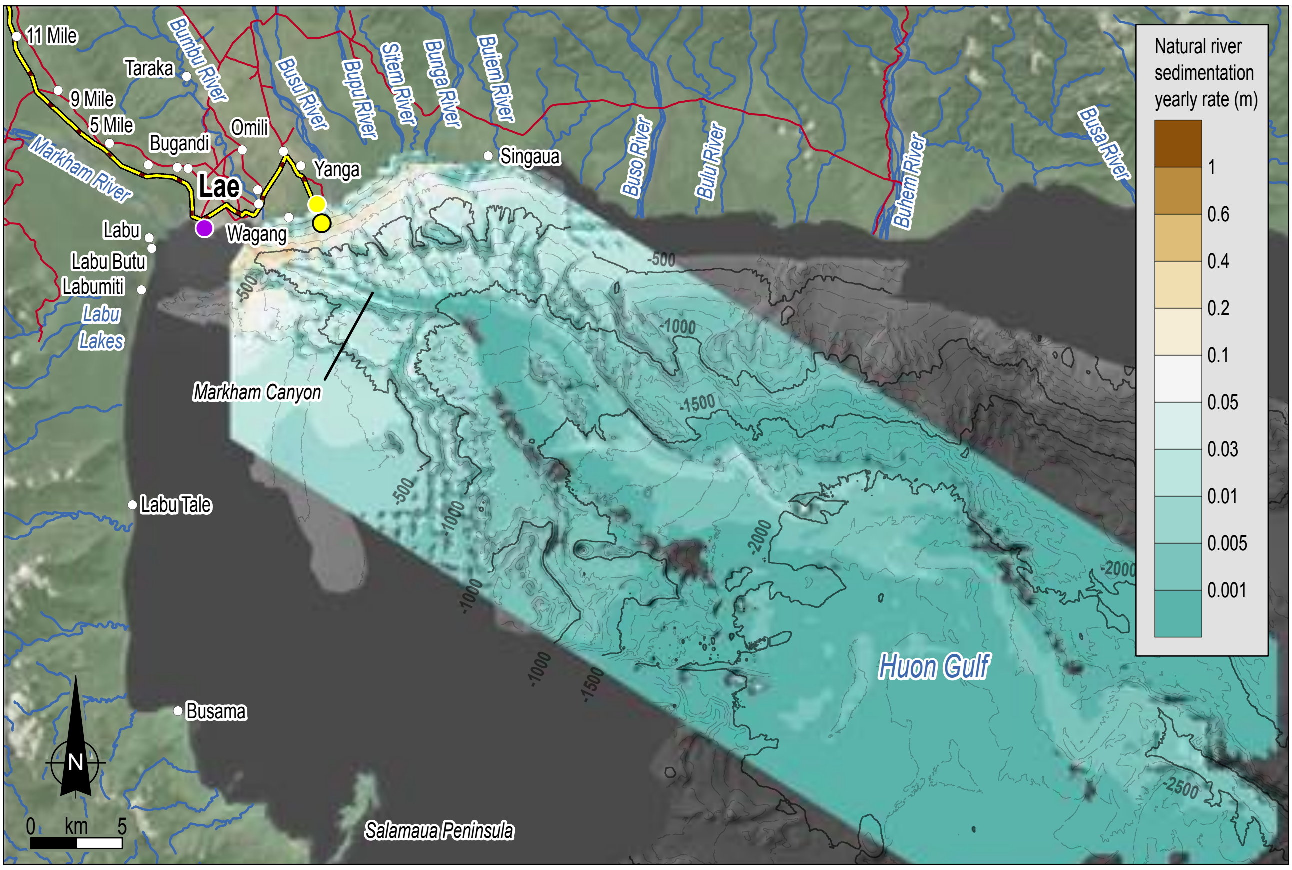
LEGEND

- Village/Settlement
- Landmark
- Road
- Watercourse
- Bathymetry minor contour (100m interval)
- Bathymetry major contour (500m interval)

PROPOSED INFRASTRUCTURE

- Outfall Area
- DSTP outfall
- Port Facilities Area
- Infrastructure Corridor





▲ ***Figure 6.3: Predicted annual rate of natural sedimentation post closure***

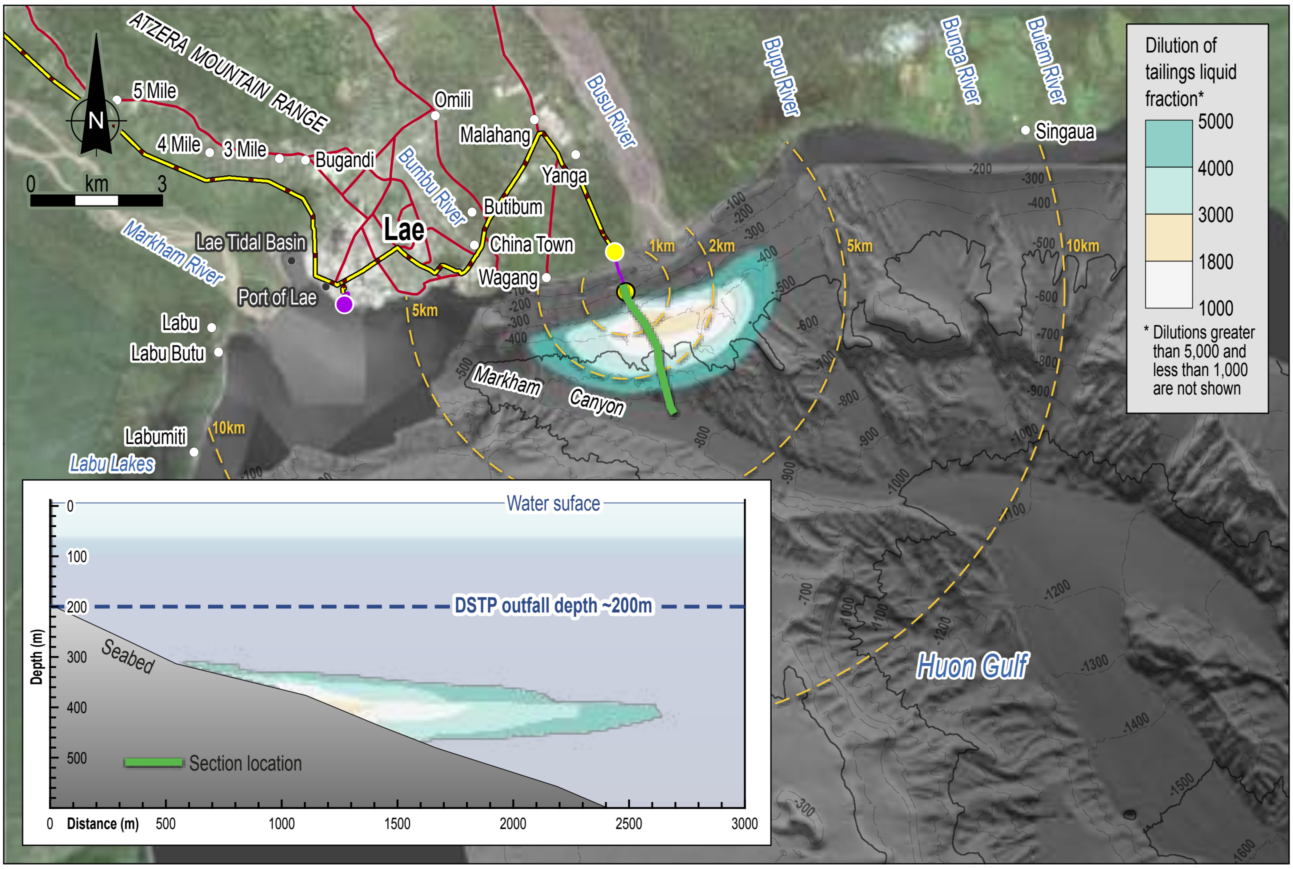
▼ ***Figure 6.4: Modelled extent of the liquid fraction of tailings subsurface plumes***

LEGEND

- Village/Settlement
- Landmark
- Road
- Watercourse
- Bathymetry minor contour (100m interval)
- Bathymetry major contour (500m interval)

PROPOSED INFRASTRUCTURE

- Outfall Area
- DSTP outfall
- Port Facilities Area
- Infrastructure Corridor



Chemical and Ecotoxicological Effects of DSTP

The CSIRO study into the chemical and ecotoxicological characteristics of the tailings is in two parts:

1. Initial, bench-scale, short-term characterisation from two tailings samples that represent the likely range of tailings composition expected over the Life of Mine. The tailings samples were prepared from aged core samples with up to 12 months between receipt of the first tailings sample and commencement of test work.
2. Long-term testing under conditions that better simulated the open ocean environment using freshly prepared tailings samples. This testwork is continuing to expand on and refine the results reported below.

Based on the results of the initial bench-scale CSIRO study, the dissolved metal requiring the highest number of dilutions to meet PNG ambient marine water quality criteria is cobalt, which requires 1,800 dilutions, i.e., one part tailings to 1,799 parts seawater. In comparison, copper requires 27 dilutions, nickel requires 1.2 dilutions and zinc requires 1.6 dilutions. This dilution factor is based on a conservative measurement of metals concentrations released from the tailings into seawater. It is therefore expected that a regulatory mixing zone based on the dilution factor for cobalt will also be conservative. Preliminary results suggest that the aged core samples release into solution greater amounts of some metals and, although this has yet to be definitively confirmed, samples in the initial study of aged core are likely to have had greater reactivity than if fresh core samples had been used. Therefore, the results from this initial bench-scale testwork are likely to be conservative (i.e., overestimate impact).

Figure 6.4 shows the modelled extent of the liquid fraction of tailings subsurface plumes as a snapshot in time. Dispersion modelling has shown that 1,800 dilutions of the tailings subsurface plumes (liquid fraction) will be achieved 2,174m from the DSTP outfall 95% of the time. It is therefore suggested that the 95th percentile distance, 2,174m, be used as a basis to set the regulatory mixing zone. For simplicity, it is recommended that the distance be set as 2,200m.

An ecotoxicological characterisation of the tailings liquor (i.e., after filtration removal of solids through a 0.45µm membrane) was undertaken by CSIRO using eight toxicity tests, which included tropical and sub-tropical species. Test species for this study were selected by CSIRO based on their known sensitivity to contaminants (in particular metals), their availability for use in testing throughout the duration of the project, their known reproducibility as surrogate test species (and test endpoints) for assessing contaminated waters in marine environments and the availability of standard test protocols. Coral species were not included in this study because coral reefs are absent within 20km of the DSTP outfall site due to the natural turbidity.

Based on the ecotoxicological test results, a total of 1,053 dilutions will be the median required for the tailings to achieve 95% protection of marine species. This number of dilutions is lower than the 1,800 dilutions as determined by comparison of tailings contaminants to PNG ambient marine water quality criteria, due to the low criterion for cobalt.

The toxicity of the tailings solids and potential bioaccumulation of trace metals from the solids was assessed by preparing mixtures of tailings and sediments using natural sediment collected from the Huon Gulf. The results from the initial short-term bench-scale characterisation study showed that tailings may cause adverse effects on amphipod and copepod reproductive output when at concentrations of more than 10% (for Tailings 1; 90% porphyry to 10% metasediments) and more than 1% (for Tailings 2; 25% porphyry to 75% metasediments). (Note: Long term studies that better simulated the open ocean environment showed reduced impacts on amphipod reproduction as described in the sections below).

Bioaccumulation test work from the initial short-term bench-scale characterisation study showed that high tailings/sediment concentrations of Tailings 1 and Tailings 2 samples (e.g. 60% and greater compared to natural sediment) were lethal to the bivalve test species tested. Dissolved copper and zinc in the waters released from the tailings were high enough to account for the observed toxicity and bioaccumulation in tissue could not be measured during this study. In contrast, the long term studies summarised below showed lower levels of toxicity.

The long-term testing by CSIRO conducted under conditions that better simulated the open ocean environment and better represented potential interactions between contaminants from the deposited tailings solids with benthic biota. The testwork was also conducted using fresher tailings samples compared to the short-term testwork; i.e., the analysis commenced immediately after the sample collection. These tests were conducted over 17 weeks (at the time of reporting) and assessed the release of copper and zinc from tailings into overlying seawater. These two metals were identified as potentially being the most toxic to marine biota based on their noted exceedance of ANZECC/ARMCANZ water quality guidelines in preliminary work.

The work to date assessed mixtures of 20% tailings to 80% Huon Gulf sediment. Testwork using an 80% tailings to 20% Huon Gulf mixture is ongoing.

The results for the mixture of 20% tailings to 80% Huon Gulf sediment had been concluded (at the time of EIS publication) and showed that while the release of copper to overlying waters exceeded the ANZECC/ARMCANZ marine water quality guideline, this did not translate into toxicity to, and bioaccumulation in, test species known to be sensitive to copper. The assessment found, after exposure of test organisms to a mixture of 20% tailings in sediment, there was:

- No acute (survival) or chronic (reproductive) toxicity to amphipods (small shrimps) over a 10-day standard test period.
- No acute toxicity to bivalves (mussels) and also no bioaccumulation of metals over the 30-day standard exposure test period.

The assessment also showed some variability of the composition of the tailings in the long-term study compared to the tailings used in the short-term study. The key differences were that copper and zinc concentrations were significantly lower in the tailings used in the long-term study compared to the short-term study, possibly reflecting differences in the geology of master composite used to generate the tailings. This indicates that the tailings samples used in the short-term testwork, along with the ecotoxicity results, were conservative.

Biological Effects of DSTP

Marine biological impacts are summarised overleaf in two parts: pelagic (i.e., ocean water column) ecology and benthic (i.e., ocean floor) ecology.

Pelagic Ecology

The principal stressors on deep-water pelagic ecology during DSTP operation relate mainly to changes in water quality and include:

- Increased tailings suspended solids concentrations and associated turbidity in subsurface and bottom-attached tailings plumes and potential physical effects on pelagic organisms
- Increased concentrations of trace metals in tailings liquor within the descending density current and within tailings subsurface plumes and potential toxicity to pelagic fauna
- Potential for trace metal bioaccumulation within marine pelagic organisms
- Potential for biomagnification in the pelagic food web

The predicted residual impact of tailings subsurface plumes on zooplankton and micronekton, and epipelagic species within the inner Huon Gulf that are capable of swimming downwards to depths between 200m and 400m where subsurface plumes are predicted to form, are low. This is because they will only have transient or short-term exposure to low average TSS concentrations, and the species that may be affected are common and widespread.

Between 300m and 450m water depth, where the bulk of subsurface tailings liquor/turbidity plumes are predicted to shear off from the descending tailings density current and will be transported in the direction of ambient currents, the tailings liquor may have residual chronic toxicity effects on marine organisms under continuous exposure conditions. This is a conservative assessment, as continual exposure is highly unlikely. The principal marine organisms likely to be exposed to elevated dissolved trace metal concentrations at less than 1,800 dilutions (and therefore may be exposed to potential toxicity) are zooplankton and micronekton. However, the vertical passage of these fauna through the subsurface liquor/turbidity plumes is expected to be transient with short-duration exposure (typically less than one hour) to those species that undertake diel vertical migrations. In the case of those zooplankton or weak-swimming micronekton being brought in with ambient currents, if they are trapped within the subsurface liquor/turbidity plumes, their exposure to dissolved trace metal concentrations will reduce with time of travel as dilution increases at distance from the shearing-off point from the descending density current.

The residual impacts from mixtures of dissolved trace metals in tailings liquor potentially inducing chronic toxicity to exposed zooplankton and micronekton will be confined to a small and localised segment of the ocean water column and mostly within the proposed mixing zone. The species that will be affected are common and widespread zooplankton and micronekton assemblages. No residual toxicity impacts are predicted for the larger more mobile fauna such as fish, sea turtles or marine mammals.

There are predicted to be no impacts from DSTP to commercial tuna fisheries because these fisheries are not located within the Huon Gulf and, as described above, residual impacts to pelagic ecology are predicted to be confined to the proposed mixing zone.

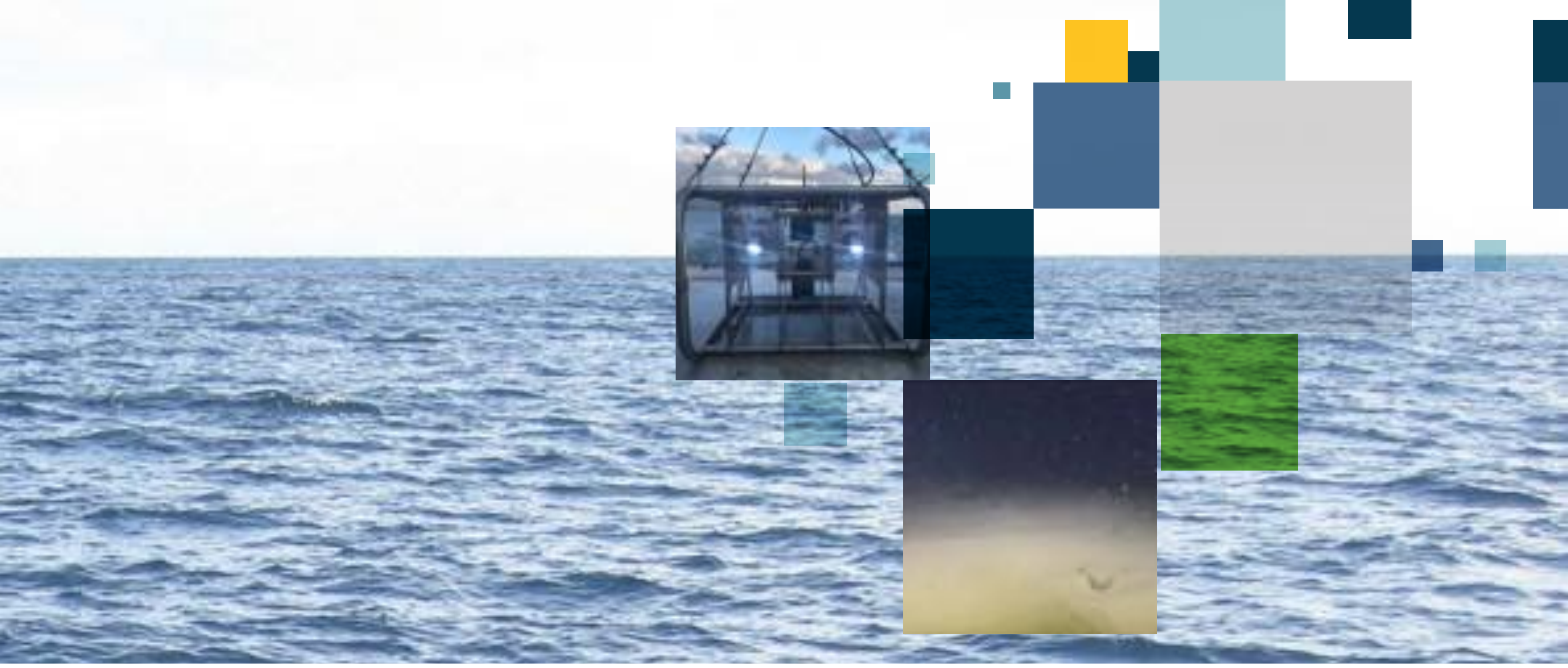
Bioaccumulation is predicted to be largely confined to lower trophic food organisms and trace metals are expected to diminish in higher trophic levels (i.e., fish). There is not predicted to be significant residual impacts from DSTP-derived trace metal bioaccumulation or biomagnification up the food chain to leatherback turtles because these turtles have large foraging areas outside the inner Huon Gulf and there is low predicted trace metal exposure to jellyfish, which are the key prey of the leatherback turtle. Similarly, bioaccumulation (to concentrations significantly above observed background ranges) up the food chain to large fish consumed by people, such as tuna, is not predicted. Metals concentrations are predicted to not exceed food standards in fish tissue as a result of DSTP.

Benthic Ecology

The potential stressors arising from the proposed DSTP operation on the deep-slope and seafloor benthic habitats and biological communities (benthic ecology) are:

- Loss of benthic habitat by smothering by the tailings density current and eventual settling of the subsurface plumes
- Deterioration of benthic habitat structural diversity due to changes in particle size distribution caused by tailings deposition
- Reduction in species composition/abundance and biodiversity of benthic marine communities resulting from the abovementioned physico-chemical effects
- Potential for bioaccumulation or biomagnification of trace metals in the benthic food web

The continuous discharge of tailings solids is expected to cause impacts on the deep slope benthic habitats and biological communities below the DSTP outfall and on those of the receiving Markham Canyon and deep seafloor and basin of the Huon Gulf. These impacts are expected to be incremental to the existing naturally high sedimentation in the Huon Gulf. Three zones of impact are expected from tailings solids deposition and sedimentation: the obliterative zone (characterised by rapid settling of the coarser fraction of



tailings solids); the semi-obliterative zone (characterised by slower settling of coarser fractions of tailings solids peripheral to the descending density current) and the non-obliterative zone (characterised by the delayed settlement of fine tailings solids present in subsurface plumes and transported laterally in the direction of ambient deep-water currents).

Within the obliterative impact zone, benthic habitats and biological communities will be blanketed by a deep layer of tailings solids resulting in the burial and mortality of most of the meiofauna and macroinvertebrate (i.e., those with no backbone) infauna. The more mobile macroinvertebrates, as well as benthic and epibenthic fish will be able to move away from areas of high sedimentation, whereas sessile macroinvertebrates or macroinvertebrates of low mobility are likely to be buried and not survive. In areas of light tailings solids deposition (i.e., semi-obliterative zone on the periphery of the tailings density current), benthic habitats and biological communities will be covered by the slower settling of the coarser fraction of tailings solids. In this zone, some fauna are expected to perish due to the smothering of tailings solids and they may also experience toxicity effects from contaminants in the tailings.

Those opportunistic macroinvertebrates and meiofauna that do colonise and establish populations on or in areas of the tailings solids deposits may bioaccumulate trace metals from both ingestion of tailings particles and exposure to elevated trace metal concentrations within the deposit pore waters. However, given the very low diversity and abundance of benthic, epibenthic or demersal fish in the Markham Canyon where DSTP discharge is proposed and where the main depositional area of tailings is predicted, and the weak bentho-pelagic coupling within the Markham Canyon, bioaccumulation or biomagnification in the benthos is unlikely to be a significant source for the higher trophic levels in the water column.

In general, the diversity of benthic macroinvertebrate and meiofauna is expected to increase progressively to natural background levels as tailings solids sedimentation rates decrease with distance from the tailings density current and the main downslope and lateral zones of tailings deposition. This general pattern of decreasing biological impact with decreasing tailings solids deposition has been recorded for other coastal mines with DSTP systems. A similar scenario is predicted for the benthic impact of tailings solids deposition on the submarine deep slopes in the inner Huon Gulf and the Markham Canyon.

Benthic ecology impacted by DSTP is predicted to progressively recover once tailings discharge ceases and natural sedimentation and mass movement events dilute and bury deposited tailings. This recovery is likely to be most rapid in the areas of greatest predicted annual natural sediment deposition post closure (see Figure 6.3). Recent studies for the Project by CSIRO have examined the effects of natural sediment covers over tailings and sediment mixtures. The study concluded that even covers as thin as 5mm over 100% tailings significantly reduces copper mobility. These and related CSIRO studies have shown that copper release is dependent on dissolved oxygen (oxidation) and that the exclusion of oxygen by both mixing and burial by natural sediments to depths of more than 20mm will mitigate potential benthic (sea floor) impacts.

A range of measures detailed in the Project Environmental Management Plan are proposed to reduce the potential impacts of DSTP and include:

- Selecting a DSTP outfall site on a sufficiently steep submarine slope, such that the tailings solids will flow as a bottom-attached density current to the deep sea and will not accumulate or plug the DSTP outfall pipelines.
- Selecting the DSTP outfall at a depth that is below the:
  - Deepest measured base of the biologically productive surface mixed layer[4] that includes the euphotic zone[5] where light penetration from the surface allows photosynthesis in phytoplankton to take place
  - Depth of any upwelling (noting that none has been identified)
- Providing adequate de-aeration of the tailings slurry prior to discharge to avoid air being entrained into the DSTP outfall pipelines.
- Ensuring that the tailings slurry has a higher density than the receiving ocean water so that a density current will form and flow by gravity down the submarine slope.
- Locating the DSTP outfall pipelines so that the tailings solids will co-deposit with natural riverine sediments in the receiving canyon system that has existing low biodiversity due to high rates of natural background sediment deposition and transport.
- Taking advantage of the natural submarine slope failures and resultant turbidity current events that will re-suspend both tailings and natural seafloor sediments and transport them further down the Markham Canyon before redepositing them in deeper water as mixed deposits.
- Compliance with receiving water quality criteria applied at the regulatory mixing zone boundary.

4 The uppermost part of the ocean water column that is kept well mixed by the turbulent action of wind and waves.

5 The layer close to the surface that receives enough light for photosynthesis to occur.

6.2 Socioeconomic

The proposed Project will be one of the largest mines in PNG and has the potential to generate significant and long-term benefits at the local, provincial and national levels if developed.

During the peak construction period, up to 2,500 people will be employed (although not necessarily at the same time), while at its full production rate, the mine will employ approximately 850 people.

The socioeconomic studies that have informed this EIS show that there is potential for the Project to result in both beneficial and adverse impacts.

Potential Benefits

The Project is predicted to directly benefit the PNG economy in multiple ways, including:

- Direct financial benefits, such as:
  - Taxes paid to the State of PNG by the WGJV Participants.
  - Royalties paid to the State of PNG. The distribution of royalties by the State of PNG will be discussed at the Development Forum, which the Minister for Mining will convene.
  - Special support grants allocated by the State of PNG to Morobe Province as budget support for infrastructure development.
- Procurement of equipment and materials from within Morobe Province and elsewhere in PNG, where practicable. This will be supported by WGJV's National Content Plan, which aims to support, as far as practicable, the establishment of local businesses that are sustainable in the longer term.
- Employment and training to maximise the proportion of PNG workers over time. Recruitment preference will, where possible, be given to the landowners affected by the Project and will include strategies for education, training and female workforce participation.
- Wages paid to employees of WGJV and contractors.
- Contributions to national mineral export revenue, total export revenue and gross domestic product.
- Contributions by the WGJV for provincial and local community development projects across the health, education, sustainable livelihoods, environment and other program areas.

The progressive development of the Project means that substantial capital expenditure is expected over an extended period. The level of expenditure during construction and operations has the potential to provide business entities within Morobe Province with a long-term opportunity to supply equipment and materials, and provide long-term employment opportunities for local and Morobe Province residents. It will potentially also strengthen the status of Lae as a key service centre for PNG's mining industry.

The National, Provincial and Local Level governments have important responsibilities for the fair, transparent and equitable distribution of Project royalties, and the development of programs and policies that help translate the direct positive impacts of the Project into sustainable social outcomes.

Potential Adverse Impacts

Potential adverse impacts resulting from the Project have been assessed for each of the four study areas. Impacts identified across all study areas include:

- In-migration – An influx of in-migrants seeking mine employment and business opportunities, in turn leading to increased pressure on the availability of subsistence and natural resources, potential pressure on education and health services, and potential law and order problems.
- Road safety – Project and non-Project (i.e., 'third-party') use of roads and access tracks, with the potential for an increase in traffic and pedestrian accidents.
- Community health and community safety – Potential increase in high-risk behaviour arising from higher levels of disposable income, increased mobility and/or in-migration; or communicable diseases linked with higher population density.
- Physical and economic displacement as a result of Project-related land acquisition and/or restrictions on land use – Includes loss of houses and loss of livelihood assets.

- Law and order – Potential for disputes over landownership due to the importance attached to clan boundaries in determining entitlement to compensation and allocation of project benefits. There is also potential for excessive consumption of alcohol or illicit use of drugs, afforded by increased incomes that could lead to stealing, fighting or domestic violence. Conflict may also arise within or between community members due to in-migration or changed social circumstances associated with mine development.

Study Area 1 is anticipated to experience the greatest level of impact due to the concentration of activity around the Mine Area. Within Study Area 1, the villages of Hekeng, Nambonga and Venembele are within the special mining lease, and are intended to be relocated.

Risks to human health were assessed in a Human Health Risk Assessment. The risk assessment evaluated both existing baseline risks to human health and human health risks should the Project proceed. Based on the available data, the exposure modelling and parameters adopted, the risk assessment identified the following existing human health risks prior to any development of the Project (i.e., not related to the Project):

- The contaminants of concern associated with exposure from all pathways evaluated for each study area primarily relate to the ingestion of local terrestrial and aquatic biota, particularly arsenic and mercury in fish.
- Young children in all study areas may ingest elevated levels of mercury (conservatively assumed to be present in the form of methylmercury which is the more toxic organic form of mercury) and zinc in locally obtained terrestrial and aquatic foods under baseline conditions.
- Adults in coastal study areas may already ingest elevated levels of mercury (assumed to be present in the form of methylmercury) in locally obtained terrestrial and aquatic foods.
- Mercury ingestion from locally sourced fish was the largest contributor associated with exposures to both young children and adults in all study areas.

Following the evaluation of baseline conditions in the selected study areas, the potential human health risks resulting from Project related discharges were assessed. The following summarises the findings:

- Predicted concentrations of contaminants of concern in receiving waterways were below the adopted screening criteria.
- An assessment of metal bioaccumulation and a review of several studies of projects with similar DSTP systems indicate that the predicted levels of mercury and arsenic are not expected to make a discernible contribution to fish tissue metal concentrations beyond existing baseline levels, and fish tissue metal concentrations that are currently below food safety guidelines are likely to remain so with DSTP in the Huon Gulf. Therefore, DSTP is not predicted to pose an additional human health risk to the coastal study areas. The concentration of manganese is predicted to double the observed background range as a result of DSTP; however, the predicted concentration is relatively low compared to amounts of manganese required in the human diet and will not cause detrimental human health impacts.
- After mine closure, water levels within the block cave and subsidence zone will rise eventually forming a lake. Modelling has predicted the water quality of this lake to be poor (low pH and elevated metals and sulphate concentrations) and therefore represents a potential source of long-term impact to receiving surface waters. Based on these predictions, treatment of water discharging from the lake may be required to minimise the risk to human health and to meet closure objectives.
- The power station is predicted to produce sulphur dioxide emissions during operations which exceed the Project adopted criterion at two villages, Ziriruk and Fly Camp. The WGJV will implement management measures as required to achieve compliance with the adopted air quality criteria.

Management of Socioeconomic Impacts

For each socioeconomic impact identified, management measures are proposed to manage adverse impacts and to enhance positive impacts where possible. These management measures are included in the Project Social Management Plan. The objectives of the Project Social Management Plan are to define a clear approach to the management of socioeconomic impacts, and to outline the action plans required to achieve effective socioeconomic impact management. The Project Social Management Plan encompasses three action plans which target socioeconomic impacts relating to in-migration, resettlement, and community health, safety and security.

In addition to the Project Social Management Plan, a number of related management plans will contribute to the management of potential socioeconomic impacts, including the Project Environmental Management Plan, Cultural Heritage Management Plan, Stakeholder Engagement Management Plan, and National Content Plan (which sets out the WGJV's approach to employing PNG citizens, to engaging PNG suppliers of goods and services, and to investment in programs that promote community development).

6.3 Cultural Heritage

Cultural heritage studies undertaken between 1996 and 2017 recorded 351 cultural heritage sites associated with the Hengambu, Yanta, Babuaf, Wampar and Ahi cultural groups. Of these, 60 cultural heritage sites (41 oral tradition sites and 19 archaeological sites) were identified as having potential to be impacted by Project activities.

Implementation of the Project Cultural Heritage Management Plan during the construction and operation of the Project aims to avoid impacts to 15 sites and to reduce the significance of impacts to the remaining 45 sites, which comprise 32 oral tradition sites and 13 archaeological sites. This is proposed to be achieved through a suite of standard management measures for undertaking Project activities and site-specific management measures to be implemented for individual sites.

Proposed management measures include:

- Cultural awareness training for Project employees and contractors
- Maintaining a register of all sites identified and obtaining the advice, as required, of a suitably qualified archaeologist and/or anthropologist on the management of known oral tradition, historic and archaeological cultural heritage sites.
- Ongoing liaison with local communities regarding cultural heritage issues, including addressing any complaints received through the Concerns, Complaints and Grievance Procedure.
- Routinely inspecting recorded archaeological and other cultural heritage sites in the Project Area to confirm they are managed as agreed.
- Prohibiting vehicle movement into fenced or flagged areas.

For potentially impacted cultural heritage sites, site-specific management measures may include one or more of the following, depending on the site type and type of impact:

- Identifying the site boundary and erecting a protective barrier and/or implementing other protective measures such as briefing staff and contractors on site protection requirements and circulating maps with GPS references to relevant personnel during daily toolbox meetings.
- Recording of oral traditions by a qualified anthropologist in accordance with any community preferences regarding public disclosure.
- Confirming a site's boundary and salvage collection if required of an agreed portion of the site by a qualified archaeologist.
- Culturally and legally sanctioned exhumation and relocation of skeletal remains.
- Assisting relevant clans or village communities with culturally appropriate ceremonies as required prior to construction.

These site-specific management measures will be finalised following consultation with relevant communities and the PNG National Museum and Art Gallery.

Potential exists to locate further cultural heritage material (referred to as 'chance finds') during Project development, particularly during construction activities. The WGJV Cultural Heritage Chance Find Procedure contained in the WGJV Cultural Heritage Management Plan sets out the process for reporting, investigating and managing chance finds of cultural heritage.

6.4 Post-closure Management

Final mine closure will be managed through implementation of the Closure and Rehabilitation Plan. At this point in time, the plan is at a conceptual level and will be further developed as the Project progresses. A detailed Rehabilitation and Mine Closure Plan will be prepared at least five years prior to closure.

The general sequence of the closure phase will be:

- Complete operations, including processing of last ore
- Make equipment safe
- Decontaminate equipment
- Dismantle and remove or bury equipment
- Transfer infrastructure to third parties (as applicable)
- Repurpose infrastructure for alternate use (as applicable)
- Stabilise landforms (geotechnically and geochemically)
- Re-shape and revegetate landforms
- Install necessary water management infrastructure
- Carry out monitoring and amelioration, as required

Stakeholder engagement will be ongoing throughout the life of the Project, with increasing focus on closure planning in the years leading up to closure.

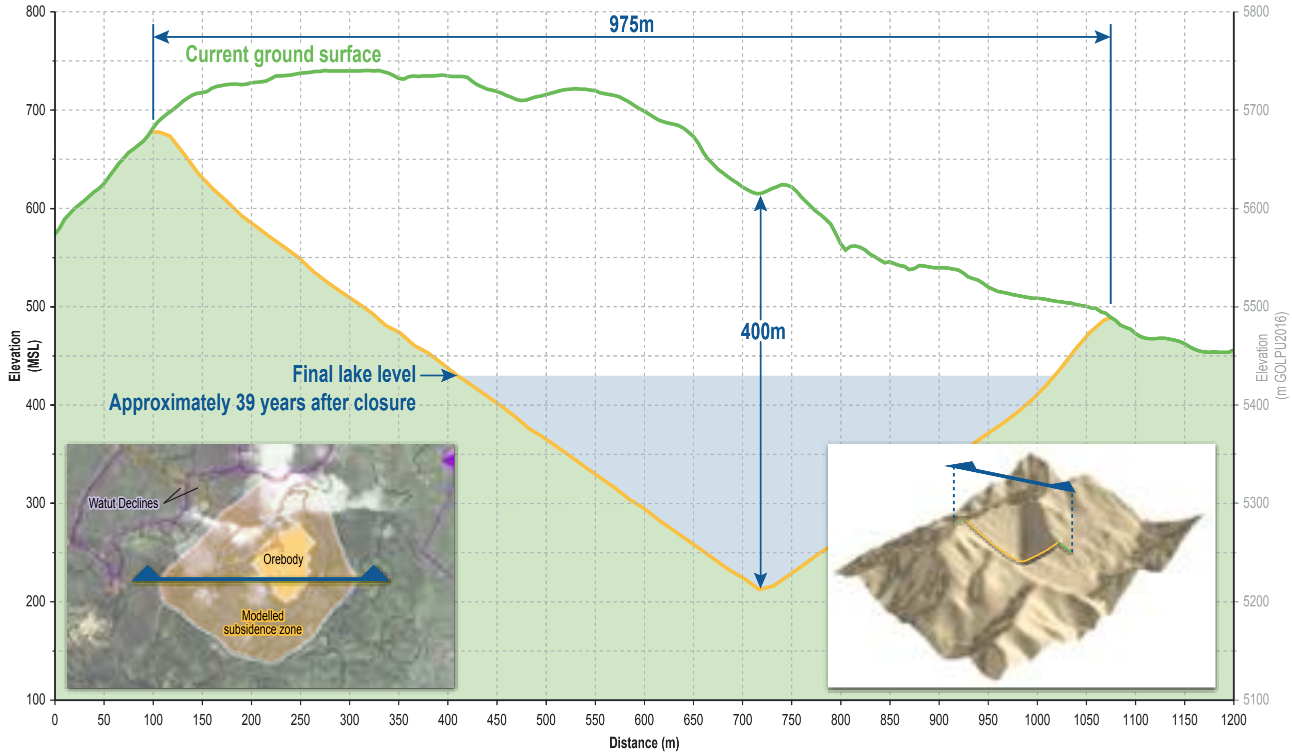


Figure 6.5: Modelled final subsidence zone and final lake

Rehabilitation

Rehabilitation is the process of restoring the land to an agreed state following disturbance. Rehabilitation generally consists of landform design and reconstruction of a stable land surface, and revegetation (or the development of an alternative land use) on the reconstructed landform. Rehabilitation is proposed to be undertaken progressively throughout the life of the Project within the constraints of maintaining unrestricted mine operations.

The Conceptual Closure and Rehabilitation Plan contains an inventory of Project infrastructure that will need to be decommissioned, removed and/or rehabilitated for planned and unplanned closure of the mine. Prior to closure, and as part of its ongoing consultation program, WGJV will engage with key stakeholders to determine which facilities (if any) may be transferred to the State or the community for ongoing use.

Subsidence Zone Lake and Discharge

Subsidence above the block cave is predicted to occur approximately 38 months, based on numerical modelling, after mining commences. By the end of mining, the surface subsidence zone is predicted to be 400m deep and 975m in diameter at its widest extent. Figure 6.5 shows the predicted maximum extent of the subsidence zone as well as the current topography of Mt Golpu.

Following the cessation of mining and mine dewatering, hydraulic plugs are proposed to be installed at the Watut Declines and Nambonga Decline portals to prevent water from the full block caves perpetually spilling from the portal entrances. Groundwater levels within the block cave and subsidence zone will begin to rise, augmented by active pumping to bring forward inundation of the block cave and the overlying subsidence zone and thereby, minimise the potential for further generation of acid and metalliferous drainage.

Modelling predicts that the lake in the subsidence zone will contain poor quality water (i.e., low pH and elevated concentrations of sulphate, metals and metalloids) and the subsidence zone lake will require careful management. Following the cessation of production, the subsidence zone lake is predicted to reach surface level after approximately 40 years of rainwater infiltration. Seeps via groundwater springs and any flows from the subsidence lake spill point may require some interception and treatment after closure in order to meet closure objectives. Further modelling of the lake properties and management options is required following data acquisition during the operational phase of the Project. Water treatment would be applied where required until such time that closure objectives are met.

An exclusion zone will be established around the subsidence zone and lake area to protect public safety.

Social Impacts of Closure

Regulation and policy in PNG, in particular the draft Mine Closure Policy and Guidelines (2005), place strong emphasis on social and economic benefits extending into the post-mining period.

Social and economic closure outcomes after final mine closure are planned to focus on the transition from mining to opportunities in other sectors. Planning and implementation of measures to support a successful transition is planned to commence well before the cessation of mining, and will take place in consultation with National, Provincial and Local Level governments, Project-affected communities and other stakeholders. This is expected to include activity at all levels, from village to Provincial to National Government, aimed at workforce training and redeployment, industry and business development, and revenue management.

7

Further Information and Submissions

Hard copies of the EIS will be on public display at the following locations:

- Conservation and Environment Protection Authority (CEPA), Port Moresby
- Mineral Resources Authority (MRA), Port Moresby
- Morobe Provincial Government, Lae

As part of its assessment of the EIS, the State of PNG will invite members of the public to make written submissions to the Conservation and Environment Protection Authority (CEPA) about their views on the EIS. Guidance on how to do this can be obtained from:

Managing Director

Conservation and Environment Project Authority
Stratos Avenue, Savannah Heights
PO Box 6601
Waigani, National Capital District
Papua New Guinea

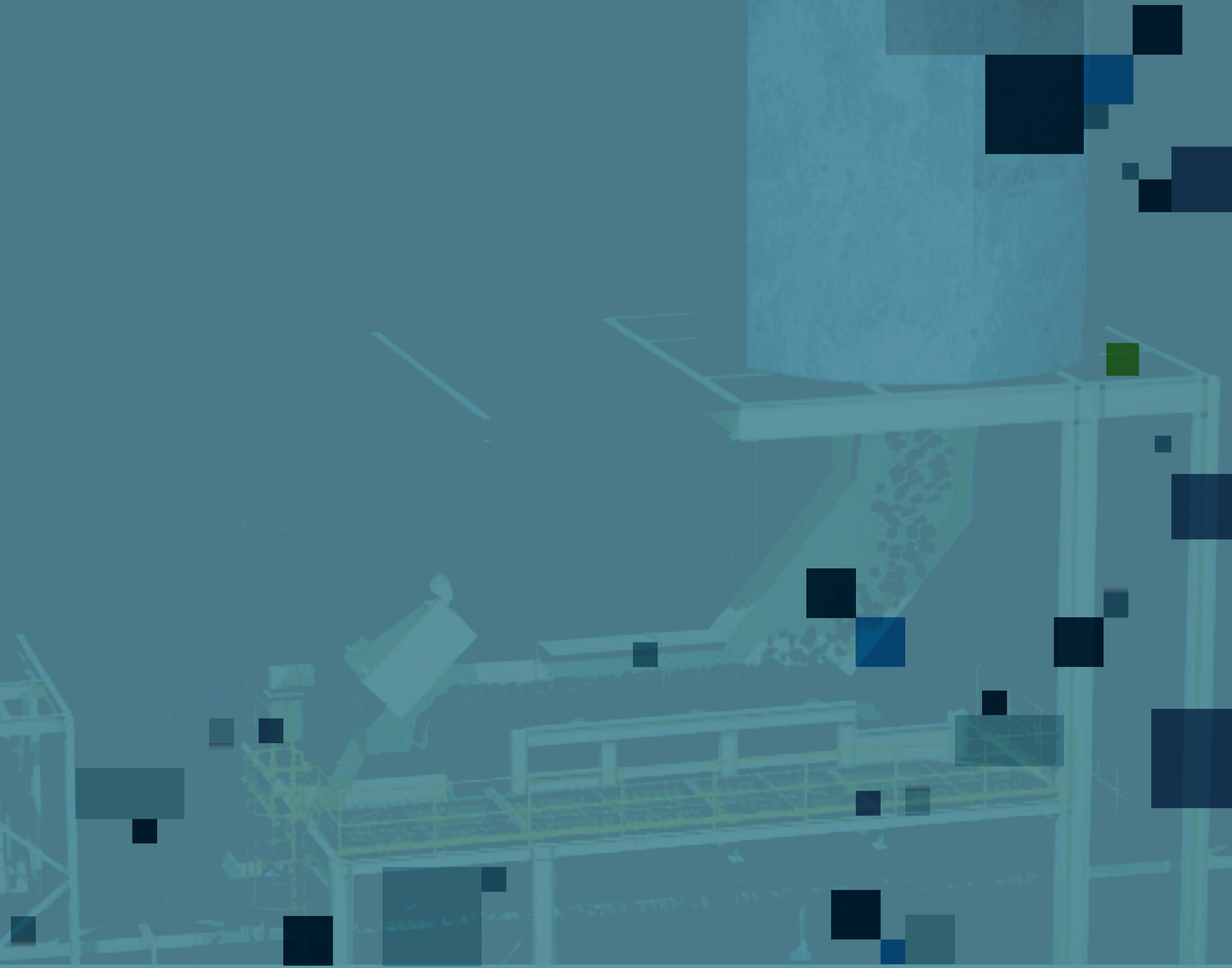
Subject to the consent and approval of its release by the Conservation and Environmental Protection Authority (CEPA), the WGJV will make the entire EIS available:

- in hardcopy, for review by members of the public, at the offices of WGJV in Lae.
- for download, from the Wafi-Golpu Joint Venture website at http://www.wafigolpujv.com.

If you would like further information from the WGJV about the Project, please contact:

Wafi-Golpu Joint Venture

EISquestions@wafigolpujv.com



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