



Chapter 22

Cumulative Impact Assessment

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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.

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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.

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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.

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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.

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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.

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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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22. CUMULATIVE IMPACT ASSESSMENT

As set out in Chapter 4, Overview of Impact Assessment Methods, in the absence of guidelines for cumulative impact assessment under the *Environment Act 2000*, WGJV has adopted a method for cumulative impact assessment informed by the International Finance Corporation Good Practice Handbook: Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets (IFC, 2013).

IFC (2013) defines cumulative impacts as:

... those that result from the successive, incremental, and/or combined effects of an action, project, or activity when added to other existing, planned, and/or reasonably anticipated future ones.

Cumulative impact assessment involves identifying those external projects within Morobe Province and Papua New Guinea, along with the Project, that might contribute to cumulative effects on the valued environmental, social and cultural components where, what may appear to be minor impacts from the Project at a local level, may take on a greater significance when placed in a wider context. This is achieved through (IFC, 2013):

- Identifying the valued environmental, social and cultural components
- Understanding whether other projects are credible
- Understanding whether the Project's activities overlap or connect in space with those of the other projects, i.e., there is a spatial relationship
- Understanding whether the Project's activities overlap in time with those of the other projects, i.e., there is a temporal relationship
- Assessing the cumulative impacts and their significance
- Proposing mitigation strategies

This chapter identifies credible external projects that could contribute to a cumulative impact on the valued environmental, social and cultural components and then assesses their spatial and temporal relationships to the Project to determine if cumulative impacts are possible and, if possible, significant. Management strategies are proposed where the Project could contribute to a significant cumulative impact. Importantly, a cumulative impact on a valued environmental, social or cultural component is only possible when all three aspects – a credible project and spatial and temporal relationship – exist.

22.1. Valued Environmental, Social and Cultural Heritage Components

The valued environmental, social and cultural components are described in chapters 14 to 18, and 20 of this environmental impact statement (EIS). The components most at risk of cumulative impacts from Project activities are:

- Terrestrial ecosystems and species habitat from incremental clearing of intact forest
- Freshwater ecosystems and species habitat from incremental increase in sediment loads and pollutants
- Social and economic components (livelihoods, cohesive communities) from an influx of people seeking work or business opportunities
- Safe roads from increased traffic and wear and tear on road pavements
- Efficient transport systems from competition for access to ports and berths, and timely distribution of cargoes
- Human health and wellbeing from air pollution where adjacent projects increase the amount of pollutants in the atmosphere

Cumulative impacts on the marine environment may arise from discharges combining to affect:

- Nearshore ecosystems and species
- Offshore ecosystems and species

These components form the basis for identifying and evaluating cumulative impacts that may arise from the Project and other projects.

22.2. Criteria for Identifying Credible Projects

The criteria used to determine projects that could contribute to a cumulative impact are explained in this section.

22.2.1. Credible Projects

Existing external projects and their impacts have been considered in the environmental, social and cultural heritage baseline characterisations described in chapters 8 to 13. These projects will only be considered in the cumulative impact assessment if their operations are expected to change during the life of this Project.

Credible projects are those that are:

- In operation and seeking approvals for expansion; for example, an existing mine that has lodged an application with the PNG Government to expand operation or increase production.
- Under construction or being commissioned; for example, a power station, industrial facility or mine.
- Approved and awaiting Final Investment Decision (FID); for example, a project that has received approval by the PNG Government and is awaiting a board decision on whether the company intends to proceed with the investment or not.
- Approved and in Front End Engineering Design (FEED); for example, a project that has received approval by the PNG Government and is currently in FEED.
- In an approvals process and likely to proceed if approval is obtained; for example, a project for which an Environmental Inception Report (EIR) has been lodged, and the company has established a presence in PNG and expressed a desire to proceed with the project if approved.

In all instances, for a project to be eligible for consideration in the cumulative impact assessment the valued environmental, social and cultural heritage components need to have been described in an EIS or sufficiently described in an EIR or permit amendment to enable the project's contributions to a cumulative impact to be assessed.

The cumulative impact assessment cannot assess projects which are speculative and for which there is no verified publicly-available information relating to the design, construction and operation of the project.

22.2.2. Spatial Relationship

Projects geographically connected (e.g., via a river or road) or proximate to each other (e.g., in the same catchment) may contribute to a cumulative impact. An example of this would be air pollutants from several fuel combustion facilities in proximity to one another combining to increase the amount of pollutants in the atmosphere, or sediment runoff from several projects combining to cause changes in river form and behaviour.

Projects within the same catchment or connected via a transport corridor may contribute to cumulative impacts through incremental clearing of intact forest or stressing community, health and education infrastructure and services within the area serviced by the road.

The Project is located in the Watut River catchment, Lower Markham River catchment and lower Busu and Bumbu rivers catchments. Proposed projects in these catchments could contribute to a cumulative impact within these catchments or in the Huon Gulf where the Markham, Bumbu and Busu rivers discharge.

The Mine Area will be connected to the Highlands Highway via the Northern Access Road, a new road to be constructed along the Lower Watut River valley from Zifasing (Figure 22.1). Two new roads are proposed to provide access to villages in the Lower Watut River valley and potential resettlement areas (Figure 22.1). Projects that could benefit from these roads have the potential to contribute to cumulative impacts in these areas on the valued environmental, social and cultural components.

Projects that involve clearing of intact forest in the same catchments and bioregion as the Project could contribute to a cumulative impact on those forest types and the associated ecosystems.

Downstream impacts may be exacerbated by incremental contributions of sediment to rivers that collectively may result in changed hydrology and impacts on land use and aquatic and marine ecosystems.

22.2.3. Temporal Relationship

A project's construction, operation and decommissioning activities must overlap with the life of the Project for a cumulative impact to occur. The timing of projects determines their eligibility to be considered in this cumulative impact assessment.

22.3. Identification of Credible Projects

Projects spatially and temporarily connected to the Project are listed in Table 22.1 along with an evaluation of whether they meet the criteria for a credible project. The projects are shown in Figure 22.1 and Figure 22.2.

Four projects have been identified as credible projects for the purposes of this cumulative impact assessment. They are:

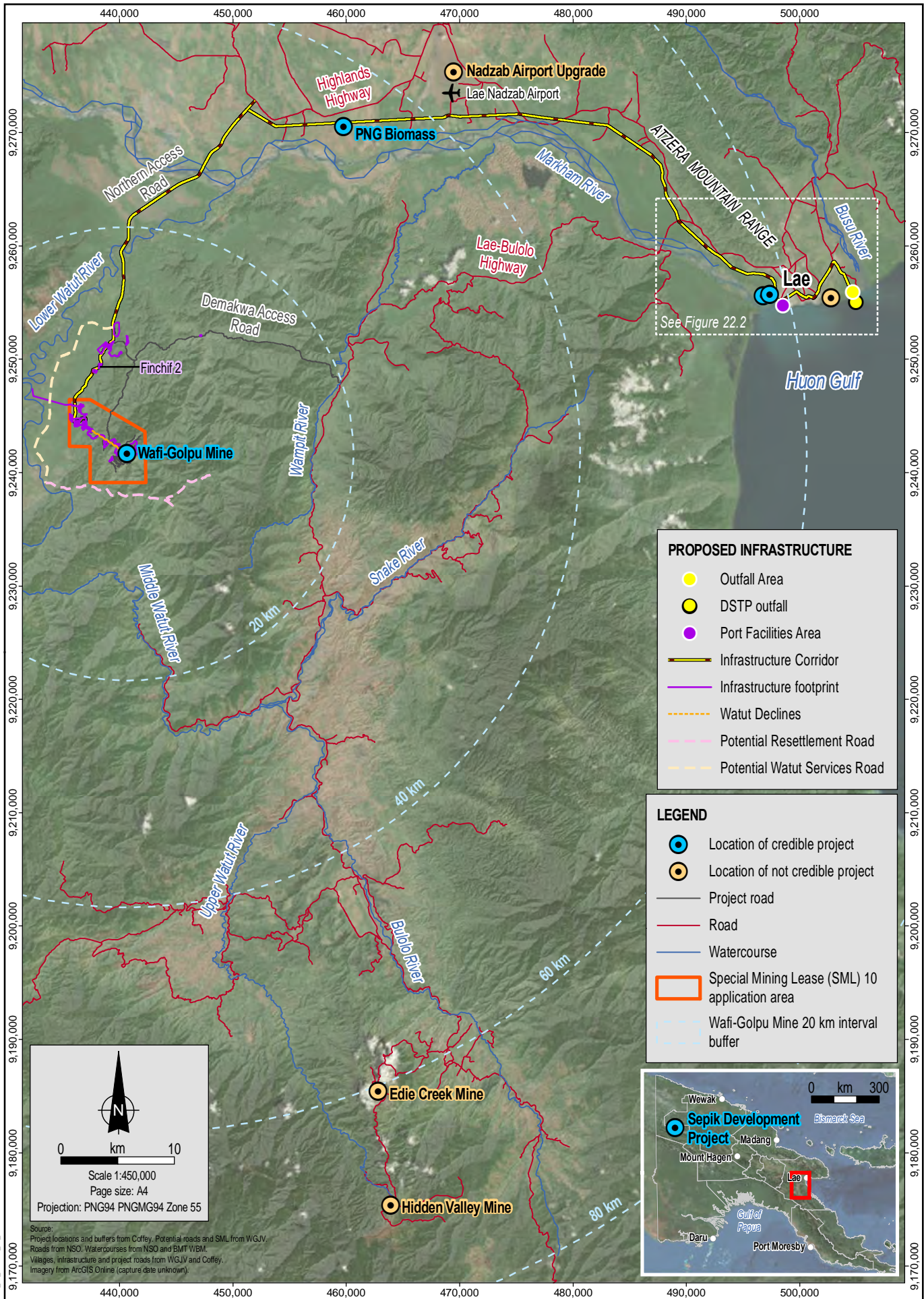
- Lae Power Project
- PNG Biomass
- Lae Tidal Basin
- Sepik Development Project (formerly the Frieda River Copper-Gold Project)

Table 22.1: Evaluation of potential credible projects

Project	Spatial relationship	Temporal relationship	Eligibility
<p>Hidden Valley Mine is a gold and silver mine located in the Watut River catchment. Production commenced in 2009 and is expected to continue to 2024. There are opportunities for expansion.</p>	<p>The mine is located in the Watut River catchment approximately 120km upstream (river distance) of the Project.</p>	<p>The Project is expected to commence construction within the life of the Hidden Valley Mine.</p>	<p>Impacts from the Hidden Valley Mine have been addressed in the Project's baseline described in this EIS. There are no announcements regarding expansion or extension of the current mining operations. This is not a credible project for the purposes of this cumulative impact assessment.</p>
<p>Edie Creek Mine is a small gold and silver mine located close to the Hidden Valley Mine in the Bulolo River catchment, a subcatchment of the Watut River catchment. Production recommenced in 2014 following an exploration program to better define the resource. The mining lease expires in 2022.</p>	<p>The mine is located in the Bulolo River catchment (and Watut River catchment) 100km upstream (river distance) of the Project.</p>	<p>The Project is expected to commence construction within the life of the Edie Creek Mine.</p>	<p>Impacts from Edie Creek mine have been addressed in the Project's baseline described in this EIS. There are no announcements regarding expansion or extension of the current mining operations beyond 2022. This is not a credible project for the purposes of this cumulative impact assessment.</p>
<p>Lae Power Project is a proposed multi-fuel power station to be located adjacent to the Lae Tidal Basin. The initial proposed development is 52 megawatt (MW) expanding to up to 200MW. Mayur Resources has environmental approval and is seeking development partners and financing for the project.</p>	<p>The project is located west of Port of Lae and 2km northwest of the proposed site of the Project's concentrate filtration plant.</p>	<p>The development may overlap with the Project which has a five-year construction schedule and 27 year production schedule.</p>	<p>This is a credible project for the purposes of this cumulative impact assessment.</p>
<p>PNG Biomass is a renewable energy project in Morobe Province comprising plantations and a 30MW biomass power station.</p>	<p>The project is located in the Lower Markham River valley. Plantations have been established near Zifasing. The power station is proposed in the vicinity of the plantations, between Zifasing and Lae Nadzab Airport, north of the Infrastructure Corridor.</p>	<p>FEED was completed in 2017 with construction of the power station planned to enable electricity production in 2020. PNG Biomass has signed a 25-year power purchase agreement with PNG Power Limited.</p>	<p>This is a credible project for the purposes of this cumulative impact assessment.</p>

Project	Spatial relationship	Temporal relationship	Eligibility
<p>Wagang Fisheries Development Centre is a concept proposal to establish a harbour, tuna cannery and mixed commercial/residential development between Wagang Village and the Bumbu River. The project is identified in the Lae-Nadzab Urban Development Plan in Papua New Guinea (JICA, 2017).</p>	<p>The conceptual development may be located 1.7km west of the Outfall Area on the small estuary between the Busu River and Bumbu River. Development of the harbour may involve dredging the estuary.</p>	<p>The project is a concept in the Lae-Nadzab Urban Development Plan. No proponent or timeframe for the conceptual development have been confirmed.</p>	<p>Despite this concept proposal being of concern to local communities, there is no detailed information about its footprint, the scale of the development, construction and operation philosophy, workforce, fishing fleet, vessel movements and timing. It has not commenced an approval process. Therefore, this concept proposal is not a credible project for the purposes of this cumulative impact assessment.</p>
<p>Lae Tidal Basin was established to expand capacity at the Port of Lae. Capital dredging has been completed and wharf facilities established on the east side of the basin. Suitable dredge material was used in the construction of the wharf areas. Unsuitable material was disposed offshore of the mouth of the Markham River. Backwash from the Markham River discharge is causing sedimentation of the basin. The need and program for maintenance dredging is unknown.</p>	<p>The Lae Tidal Basin is located at the head of the Markham Canyon in the northwest corner of the Huon Gulf. The location for disposal of dredge spoil could overlap with the area of influence of the deep sea tailings placement (DSTP) outfall.</p>	<p>There is no information on planned or proposed maintenance dredging of the Lae Tidal Basin. However, it could be expected in the life of the Project.</p>	<p>This is a credible project for the purposes of this cumulative impact assessment.</p>
<p>Nadzab Airport Upgrade is a conceptual development in the Lae-Nadzab Urban Development Plan in Papua New Guinea (JICA, 2017). The concept includes aviation, commercial, industrial and retail precincts between Nadzab Airport and Highlands Highway.</p>	<p>The project is located on the Highlands Highway which will be used to transport personnel and materials to the Mine Area.</p>	<p>The project is a concept in the Lae-Nadzab Urban Development Plan. No proponent or timeframe for the conceptual development have been identified.</p>	<p>This is not a credible project for the purposes of this cumulative impact assessment.</p>

Project	Spatial relationship	Temporal relationship	Eligibility
<p>Sepik Development Project is proposed to comprise:</p> <ul style="list-style-type: none"> • A copper-gold mine in the headwaters of the Sepik River • A hydroelectric power facility in the headwaters of the Sepik River • An infrastructure corridor from Frieda River to Vanimo, and an upgrade of the existing Vanimo port • An electricity distribution network in Sandaun Province <p>A feasibility study completed in 2016 for the mine is currently being updated and will address the other aspects of the development. An environmental approvals process is in progress with construction potentially commencing in 2019 and production potentially commencing in 2024-2025.</p>	<p>Internationally-sourced and supplied mining equipment and construction materials for the project will be imported through Madang or Lae ports. The Project will use the Port of Lae during construction and until the existing Vanimo port is upgraded.</p>	<p>The Sepik Development Project is likely to overlap with the Project. The proposed life of the Sepik Development Project copper-gold mine is at least 30 years.</p>	<p>This is a credible project for the purposes of this cumulative impact assessment.</p>



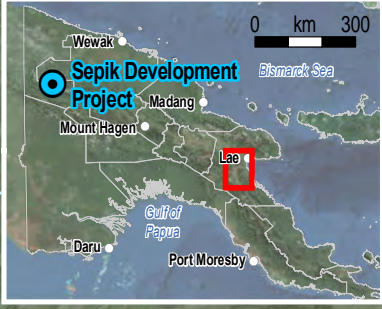
PROPOSED INFRASTRUCTURE

- Outfall Area
- DSTP outfall
- Port Facilities Area
- Infrastructure Corridor
- Infrastructure footprint
- - - Watut Declines
- - - Potential Resettlement Road
- - - Potential Watut Services Road

LEGEND

- Location of credible project
- Location of not credible project
- Project road
- Road
- Watercourse
- ▭ Special Mining Lease (SML) 10 application area
- Wafi-Golpu Mine 20 km interval buffer

Scale 1:450,000
Page size: A4
Projection: PNG94 PNGMG94 Zone 55



Source:
Project locations and buffers from Coffey. Potential roads and SML from WGJV.
Roads from NSO. Watercourses from NSO and BMT WBM.
Villages, infrastructure and project roads from WGJV and Coffey.
Imagery from ArcGIS Online (capture date unknown).

MAD Reference: 0520DD_10_GIS01_v0.8



LEGEND

- Location of credible project
- Location of not credible project
- Village/Settlement
- Landmark
- Road
- Watercourse
- Port Facilities Area 5 km interval buffer

PROPOSED INFRASTRUCTURE

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

MXD Reference: 0520DD_10_GIS062_v01_5

Source:
 Project locations and buffers from Coffey.
 Villages/Settlements, landmarks and infrastructure from WGVJ and Coffey.
 Roads and watercourses from NSO.
 Imagery from WGVJ (capture date 2016) and ArcGIS Online (capture date unknown).

coffey
 A TETRA TECH COMPANY

Date: 13.06.2018
 Project: 754-ENAUABTF100520DD
 File Name: 0520DD_10_F22.02_GIS

WAFI-GOLPU
 JOINT VENTURE

Wafi-Golpu Project

Credible and not credible projects –
 Lae

Figure No:
22.2

These projects were evaluated for their potential to cause further change to the valued environmental, social and cultural components already predicted to be affected by the Project.

22.4. Cumulative Impact Assessment

Potential cumulative impacts are discussed in the following sections, along with proposed mitigation strategies for the potentially significant cumulative impacts. The impacts are discussed under each of the causes of cumulative impact that could arise from the credible projects identified in Table 22.1.

22.4.1. Traffic and Transport

Construction of the Lae Power Project, PNG Biomass power generation facility and Sepik Development Project will involve the importation of plant, equipment and construction materials through the Port of Lae. There is potential for congestion at the port and its access roads, including the Highlands Highway, if the construction timeframes for these projects and the Project coincide or overlap.

The socioeconomic impact assessment for the Project (Chapter 18, Socioeconomic Impact Assessment) assessed the impacts of increased traffic and congestion in Lae due to Project-related activities. The assessment concluded that traffic and congestion in the port area and its access roads could be managed with appropriate traffic management and community awareness programs. The Project will not cause congestion at the Port of Lae with proposed shipping movements integrated with current usage.

Traffic and shipping congestion would be expected if one or more of the identified credible projects occurred in a similar timeframe. Coordination of shipping movements (including berthing and loading and unloading requirements) is the key strategy for managing this cumulative impact, as successfully happened during the construction of the PNG LNG Project. This will involve projects communicating their needs to PNG Ports Corporation Limited who will work with the project proponents to coordinate access to the port and logistics through the port.

22.4.2. Construction Workforce

Skilled and unskilled workers will be required to construct these credible projects, each of which is estimated to take between two and five years to construct. Experience from other large-scale development projects in Papua New Guinea demonstrates that in-migration is expected from within Morobe Province and Papua New Guinea more broadly, as people seek employment opportunities in these workforces. The most significant impacts will occur where project construction timeframes coincide or overlap, as there is a limited pool of suitably qualified and skilled workers in PNG to construct large-scale projects such as these. Sequential timing provides an opportunity for suitably qualified and skilled construction workers to transfer between projects, but this rarely provides sequential employment opportunities for unskilled workers.

In-migration and its associated residual impacts are assessed as low to moderate significance in Chapter 18, Socioeconomic Impact Assessment. The effects of an influx of people seeking work and an influx of skilled workers will be managed in consultation with the Morobe Provincial Government and include consideration of impacts on community health, education and support services.

The strategies and measures proposed by WGJV to manage in-migration will need to be periodically reviewed to ensure they remain effective in dealing with the Project's contribution to the cumulative impact caused by in-migration. This will necessitate WGJV

working with the Morobe Provincial Government to review the effectiveness of the strategies and the government's priorities for managing a growing population and economy.

22.4.3. Air Emissions

The proposed PNG Biomass power station and Lae Power Project power station will emit combustion gases containing air pollutants, the composition of which will depend on the fuel type used.

The Project's concentrate filtration plant at the Port Facilities Area is 2 kilometres (km) southeast of the nominal location of the Lae Power Project power station. There may be minor fugitive dust emissions from the shed and ship loading facilities at the filtration plant. The Project will not contribute to a cumulative impact from air emissions from the proposed Lae Power Project power station, as no combustion gases will be emitted by the filtration plant.

The Project's mine and process plant facilities will be supplied with electricity from a power generating facility located at Finchif 2 in the Mine Area (see Figure 22.1), approximately 30km south-southwest of the conceptual location of the proposed PNG Biomass power station. The Project will not contribute to a cumulative impact from air emissions from the proposed PNG Biomass power station, as the distance between the power station and Project generating plant will enable adequate dispersion of air pollutants.

22.4.4. Physical Disturbance (Vegetation Clearing)

Potential cumulative impacts on intact forest arise from multiple projects clearing vegetation to develop a resource, construct infrastructure, establish gardens or harvest forest products. Opportunistic and commercial logging pose the greatest risk of cumulative impacts on intact forest, particularly the previously inaccessible alluvial forest of the Lower Watut River valley. Potential impacts to terrestrial ecology from logging this forest are assessed in Chapter 14, Physical and Biological Environment Impact Assessment. Development of the Lae Power Project and maintenance dredging of Lae Tidal Basin do not involve vegetation clearing. The Sepik Development Project is located in the Sepik River catchment over 350km to the northwest of the Project Area. PNG Biomass is located in the Lower Markham River catchment near the confluence of the Lower Watut River.

PNG Biomass has established Eucalyptus plantations in the vicinity of Zifasing to provide feedstock to the proposed 30MW biomass power station. The plantations have and are being developed on degraded kunai grassland, the ecosystem resulting from conversion of intact forest to secondary forest to grassland through successive clearing and burning regimes. This project will not contribute to a cumulative impact on intact forest to be cleared for the Project.

22.4.5. Physical Disturbance (Sedimentation)

The environmental and social impact assessment for development of the Lae Tidal Basin (PNGPCL, 2007) concluded that disposal of dredge spoil offshore of the mouth of the Markham River at the head of the Markham Canyon was the most effective option for reducing impacts on the Labu estuary, nearshore and offshore environments. Development of the basin involved the dredging and offshore disposal of approximately 3.4 million cubic metres of unsuitable material. The conditions resulting from this project have been considered in the baseline studies for the Project and described in this EIS.

Maintenance dredging is not addressed in the Lae Port Development Project EIS but is likely to be required in the future, possibly within the life of the Project. Maintenance dredging is likely to involve significantly less volume of material (for the purposes of this

assessment, assumed to be approximately 10% of original volume depending on deposition rate and maintenance dredging interval based on review of maintenance dredging management plans for various ports) and it is assumed a similar disposal site and method would be adopted. The location of the disposal site at the mouth of the Markham River, which has a highly turbid discharge, and the DSTP outfall being at approximately 200m depth, approximately 6.5 km east of the Port Facilities Area and well below the euphotic zone and surface mixed layer will reduce the potential for cumulative impacts.

The Markham River discharges approximately 12Mtpa of terrigenous material into the Markham Canyon (see Chapter 11, Offshore Marine Environment Characterisation). For the purposes of this assessment, maintenance dredging for the Lae Tidal Basin has been assumed to require disposal of up to 10% of the original volume, which was approximately 3.4 million cubic metres, i.e., 340,000 cubic metres. Disposal of maintenance dredging spoil offshore of the mouth of the river is expected to be within the natural variability of the system. Based on the nearshore and offshore impact assessments for the Project presented in Chapter 16 - Nearshore Marine Environment Impact Assessment and Chapter 17- Offshore Marine Environment Impact Assessment, the DSTP discharge is not predicted to contribute to a cumulative impact, as the proposed DSTP outfall at approximately 200m water depth is below the euphotic zone and surface mixed layer and there is not predicted to be a turbidity plume at the surface that could combine with the dredge spoil turbidity plume in the upper part of the water column.

22.5. Conclusion

Eight projects that could contribute to cumulative impacts have been identified and assessed for their eligibility as credible projects, having regard to their spatial and temporal relationship to the Project. Four credible projects have been identified and their contribution to cumulative effects assessed. Potential cumulative impacts arising from the following aspects were considered:

- Traffic and transport
- Construction workforce
- Air emissions
- Vegetation clearance
- Sedimentation

No cumulative impacts are predicted from air emissions, vegetation clearance and sedimentation. Cumulative impacts from traffic and transport and construction workforces are possible depending on the actual timing of construction activities for the applicable credible projects. Strategies for mitigating the potential cumulative effects have been proposed. They involve reviewing Project mitigation strategies and programs with those of other projects, where possible. This will enable the strategies to account for changing conditions and to incorporate, where appropriate, Morobe Provincial Government initiatives and priorities for managing a growing population and economy.

Proposed strategies for management of cumulative impacts include:

- Implementing appropriate traffic management and community awareness programs to minimise cumulative impacts on local and regional traffic
- Liaising with PNG Ports Corporation to coordinate shipping movements between multiple projects
- Manage, in consultation with Morobe Provincial Government, the effects of the influx of skilled workers on community health, education and support services
- Placing the DSTP outfall at a depth well below the euphotic zone (i.e., approximately 200m) so that cumulative impacts to the productive zone of the ocean are avoided

22.6. References

JICA. 2017. The Project for the study on Lae-Nadzab Urban Development Plan in Papua New Guinea. Final Report. February 2017. Report prepared by Japan International Cooperation Agency, Yachiyo Engineering Co. Ltd. and Kokusai Kogyu Co. Ltd. for Morobe Provincial Administration, Lae Urban Local Level Government.

PNGPCL. 2007. Papua New Guinea: Lae Port Development Project. Summary Environmental Impact Assessment. Prepared by PNG Ports Corporation Limited for the Asian Development Bank. August 2007. 58pp.