



Chapter 4

Overview of Impact Assessment Methods

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

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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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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

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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.

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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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4. OVERVIEW OF IMPACT ASSESSMENT METHODS

4.1. Introduction

This chapter provides an overview of the methods used to assess the environmental, socioeconomic and cultural heritage impacts of the Wafi-Golpu Project (the Project). The environmental impact statement (EIS) uses methods best suited to the individual impact assessment frameworks for environmental, socioeconomic, human health and cultural heritage aspects, rather than adopting a single, generic method. Further detail is provided at the start of chapters 14 to 17, 18, 19 and 20, respectively.

The EIS has been prepared to identify and assess the environmental, socioeconomic and cultural heritage impacts associated with the Project.

The EIS provides the Conservation and Environment Protection Authority (CEPA) with a thorough appraisal of the Project to inform Ministerial decision-making as to whether to grant approval in principle for the Project under the *Environment Act 2000*, and subsequent to that, grant a Level 3 environment permit for the Project.

During the preparation of this EIS, stakeholders including landowners and other communities have, and will continue to be, engaged and provided with information about the Project, which will enhance their understanding of how the Project may be developed. This included stakeholder input in the identification of potential impacts and development of avoidance and management measures to address these potential impacts. Chapter 5, Stakeholder Engagement provides further detail about the stakeholder engagement activities completed up to submission of the EIS and how this engagement has informed Project design.

Each section relating to environmental impacts (chapters 14 to 17), socioeconomic impacts (Chapter 18), human health risks (Chapter 19) and cultural heritage impacts (Chapter 20) is generally structured as follows:

- Approach to impact assessment
- Potential impacts
- Proposed management measures
- Residual impacts
- Monitoring

4.2. Specialist Studies Scopes of Work

Development of the scopes of work for the environmental, socioeconomic and cultural heritage studies is integral to CEPA's environmental impact assessment requirements and is given effect by the preparation of the environmental inception report (EIR). The role of the EIR is to allow CEPA to confirm the adequacy of the scope and content of the specialist studies to be included in the EIS. Development of the scope of work for the human health risk assessment is necessitated by increasing stakeholder interest in this aspect of assessment as part of the EIS process.

Preparation of the scope of work for specialist studies was preceded by consideration of the required time scale, appropriate spatial boundaries, previous Project studies and feedback from stakeholder engagement. The spatial boundaries varied for each study. For example, the deep sea tailings placement (DSTP) impact assessment (presented in Chapter 17, Offshore Marine Environment Impact Assessment) is regional in scale due to the capacity of dilute subsurface tailings plumes to disperse kilometres from the source. By contrast, the cultural heritage assessment focuses on the Project footprint, which is the area in which

physical disturbance of existing features will occur due to Project facilities being built or Project activities being carried out. In the case of the linear infrastructure (pipelines, roads), a 50 metre (m) wide construction right of way (25m either side of the Infrastructure Corridor centreline) buffered either side by a further 50m (for a total width of 150m) has been included in the cultural heritage assessment.

The Wafi-Golpu Joint Venture (the WGJV) submitted an EIR to CEPA on 16 May 2017. On 8 June 2017, CEPA advised the WGJV that it was satisfied the specialist study scopes of works and the study plan nominated in the EIR was appropriate for preparing an EIS for the Project.

The WGJV has used the initial findings of many of the specialist studies to reduce the potential impact of the Project by altering the design or location of various facilities to avoid, or reduce the potential impacts of the Project. This is discussed further in Chapter 7, Assessment of Alternatives.

4.3. Baseline Characterisation

For each specialist study, characterisation of existing conditions was achieved based on desktop studies' results (including review of results of previous fieldwork), field surveys, routine monitoring undertaken by the WGJV under its exploration licences, and the outputs of stakeholder engagement activities. The characterisation of existing conditions before development takes place is a critical reference point for the future regulation of the Project and is often referred to as the baseline characterisation.

The WGJV is implementing a two-staged approach to develop the baseline characterisation for the Project:

- Stage 1: Baseline characterisation as part of the EIS
- Stage 2: Baseline monitoring undertaken after the EIS has been submitted and prior to commencement of construction and/or commissioning of the Project

Stage 1 of the characterisation provides information for the description of existing conditions and assessment of the Project described in the EIS. Stage 1 of the baseline characterisation will be completed prior to submission of the EIS to CEPA.

Stage 2 of the characterisation provides further detail to meet longer term monitoring requirements. Stage 2 is undertaken only if the Project is approved (and the approval conditions are known) but prior to the actual commencement of construction and/or commissioning of the Project. It is expected to augment the existing monitoring program carried out by the WGJV as required by conditions of its current exploration licences and environment permits and as part of EIS investigations. The Stage 2 baseline monitoring will include aspects that are integral to monitoring and validating the predicted impacts described in this EIS in the longer term, but are not necessary to inform the EIS (for example, additional deep slope fish tissue sample collection). Further monitoring may also be required to cover subsequent (post-EIS) Project design refinements.

The separation of baseline characterisation in this manner is consistent with the approach used in other recently-completed major mining development projects in the country.

The findings of the Stage 1, characterisation baseline studies are presented in chapters 8 to 13, and directly inform the impact assessments described in this EIS.

4.4. Impact Assessment

This section provides an overview of the different methods that have been used for the environmental, socioeconomic and cultural heritage impact assessments.

In this EIS, the changes (impacts) that are expected or likely to occur if the Project proceeds may variously be described as direct, indirect and cumulative impacts. The definitions of the different impacts are¹:

- Direct impacts are those effects (whether positive or negative) that are directly caused by Project activities (i.e., there is a direct cause-and-effect relationship between them). These are often within the Project footprint.
- Indirect impacts are those effects (whether positive or negative) that are related to Project activities but are not directly caused by them (i.e., there is not a direct cause-and-effect relationship between them).
- Cumulative impacts are those incremental effects (whether positive or negative) resulting from the interaction of Project activities and non-Project activities occurring simultaneously or subsequently, i.e., the combination of impacts from Project activities and impacts from other activities undertaken either simultaneously or at some anticipated future time (whether or not directly related to the Project). The assessment of cumulative impacts is further described in Section 4.6.

The impact assessment approach focuses on credible impacts, i.e., those that could be reasonably expected during one or more phases of the Project in the context of the existing conditions.

4.4.1. Environmental Impact Assessment

This section provides a description of the framework used to assess the direct and indirect environmental impacts of the Project and, in particular, the use of the significance and compliance standard assessment methods to predict the residual significance of biophysical Project impacts.

The environmental impact assessment approach that has been adopted for the Project involves the following:

- A description of the baseline characterisation of the Project Area and surrounds, including the sensitivity of receptors² which may be affected by changes in baseline conditions as a result of the Project.
- Identification of the potential impacts. Identification is based on knowledge of the baseline conditions, developed from various studies, the Project description, experience with similar operations in similar biophysical environments and issues of concern to stakeholders.
- Identification of proposed management measures, where the measures described in this EIS are technically and economically feasible within the context of the Project.
- Assessment of credible residual impacts, assuming the successful implementation of the proposed management measures.

This framework is consistent with that used in other recently-completed environmental impact assessments for resource development projects in the Independent State of Papua New Guinea (PNG) and elsewhere, and reflects the approach described in the International Finance Corporation Performance Standard 1 'Assessment and Management of Environmental and Social Risks and Impacts' and associated guidelines (IFC, 2012a).

¹ Derived from IFC (2012a) Performance Standard 1 'Assessment and Management of Environmental and Social Risks and Impacts and accompanying IFC (2012b) Guidance Note 1.

² Reference to 'receptors' also includes 'sites', 'environmental values' and/or 'resources'.

Impacts associated with unplanned events (i.e., natural hazards and accidents) are addressed in Chapter 21, Unplanned Events (Natural Hazards and Accident Events). Examples of such events include earthquakes and tsunamis of sufficient size to adversely affect the Project and/or its surrounds.

As noted above, two different methods have been adopted to assess the level of residual environmental impacts of the Project. The methods that have been adopted are dependent on the environmental aspect that is assessed. These are:

- Significance assessment. The significance assessment method has been adopted where a qualitative (or semi-qualitative) assessment is required. This method allows for the development of the most suitable and practical management measures as it focuses on credible impacts with a likelihood of occurring and those of particular concern to stakeholders.
- Compliance standard assessment. The compliance standard assessment method has been adopted where a quantitative assessment is required. The method relies on international, national or good industry practice limits or guidelines to measure an impact. As part of the EIS, the compliance standard assessment method has been adopted for air quality, noise and water quality which can be modelled and compared to established standards.

Chapters 14 to 17 provide further detail on the environmental impact assessment methods.

4.4.2. Socioeconomic Impact Assessment

The socioeconomic impact assessment identified direct and indirect socioeconomic impacts through:

- Analysis of socioeconomic baseline data, and other relevant baseline information including stakeholder feedback
- Consultation with technical experts on the Project design and potential impacts
- Review of the socioeconomic impacts of other mining projects in PNG

Socioeconomic impacts have potential to arise in connection with the construction, operation and closure phases of the Project. The significance of potential impacts was assessed by considering the likelihood and consequences of the impact. An initial assessment assigned a level of significance to each of the socioeconomic impacts identified. This initial assessment did not consider potential management measures which may reduce or mitigate the significance of impacts. Adverse and beneficial impacts were assessed.

Proposed management measures have been identified to avoid or reduce adverse impacts and to assist the realisation of the beneficial outcomes of the Project. As for environmental matters, the management measures described in this EIS are technically and economically feasible within the context of the Project. Measures have been proposed with due consideration to:

- The experience of WGJV and the WGJV Participants, including management strategies currently practiced in the Project Area
- Experience from other mining projects in PNG
- Learnings and outcomes from mining projects elsewhere in the world
- Input provided and views expressed during consultation activities
- Advice from experienced socioeconomic consultants

Assuming the successful implementation of proposed management measures, adverse and beneficial impacts were reassessed. This provides an assessment of the potential effectiveness of the proposed management measures, and illustrates the anticipated impact of the Project.

Chapter 18, Socioeconomic Impact Assessment provides further detail on the socioeconomic impact assessment method.

4.4.3. Cultural Heritage Impact Assessment

To identify cultural heritage impacts, cultural heritage sites within the Project footprint were first identified and recorded through a series of baseline field surveys. Field surveys involved cultural heritage mapping of oral tradition sites in consultation with communities, field inspections of mapped sites to verify their present condition and values, and pedestrian surveys to identify the potential presence of archaeological sites.

The significance of those cultural heritage sites recorded within the Project footprint and associated buffer area was assessed in a manner consistent with the Burra Charter (Australia ICOMOS Burra Charter, 2013) (see Chapter 3, Legal, Policy and Administrative Framework). Significance is derived from a site's aesthetic, historic, scientific, social or spiritual values and involves an assessment of the significance for each value. In the case of historic, social and spiritual values in particular, the cultural significance rating was based on the information which community representatives shared with the consultant in relation to sites.

For the purposes of the impact assessment, where sites have multiple values (e.g., scientific and social) with different cultural significance ratings, the overall cultural significance of a site was determined based on the value (aesthetic, historic, scientific, social and/or spiritual) that received the highest rating.

The impact assessment then involved three steps:

- Identifying the nature of potential impacts to a site, e.g., physical disturbance, damage or destruction, restriction of access to sites, visual modification of the site or surrounding landscape, disruption to intangible characteristics (e.g., *masalai*) or disturbance to ecosystems that could in turn affect cultural heritage sites (e.g., groundwater drawdown associated with mining drying up a spring recorded as holding social or spiritual values).
- Determining the magnitude (high, medium, low or positive) of impacts through an assessment of the severity, geographical extent and duration of the impact.
- Assessing the significance of impacts on cultural heritage sites using a matrix approach. The 'significance of impact' to a site is a function of both the cultural significance of the site and the magnitude of potential impact on the site.

Management measures for avoiding (where possible) or minimising impacts to cultural heritage sites are proposed in this EIS. Proposed measures will be discussed further with relevant communities and the State of PNG National Museum and Art Gallery (NMAG) prior to implementation. These measures will then be contained within an agreed Cultural Heritage Management Plan, the draft of which forms EIS Attachment 5.

To assess residual impacts, the impact significance assessment matrix was used, assuming implementation of proposed management measures.

Chapter 20, Cultural Heritage Impact Assessment provides further detail on the cultural heritage impact assessment method.

4.5. Health Risk Assessment

This section provides a summary of the method used for the health risk assessment (Chapter 19, Health Risk Assessment). In the absence of specific State of PNG guidelines, the risk assessment was conducted in accordance with the Australian National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (NEPC, 2013), referred to as NEPM. The risk assessment approach provided in NEPM is consistent with international guidance such as that provided by the United States Environment Protection Agency (USEPA, 1989) and Canadian Council of Ministries for the Environment (CCME, 2010 and CME, 2012).

A conceptual site model was developed to determine which villages could be exposed to contaminants during construction, operation and closure of the Project. Consideration of the Project design and a literature review of existing data the model identified:

- Presence of substances that may cause harm
- Transport mechanisms that enable a substance to migrate from the source of the substance to a receptor (i.e., a person)
- Presence of a receptor that may be harmed at an exposure point
- Pathways of exposing a receptor to the source of the substance

A pathway must be 'complete' for there to be a potential risk to receptors (i.e., all four of the steps above must be fulfilled for the contaminant to reach the receptor).

Once the conceptual site model was established a two-tiered risk assessment was conducted to:

- Determine the existing baseline or predicted concentrations of contaminants (in air, soil and water) to which receptors (i.e., people within and downstream of the Project Area that could be affected by contaminants) could be exposed to.
- Apply site-specific parameters and assumptions to quantitatively evaluate exposures to receptors, and characterise the potential health risks based on tolerable daily intakes (related to the toxicity and dose of the contaminant) and levels of risk. This quantitative risk assessment also involved calculations to determine which contaminants are potential risks to human health as result of the Project.

Chapter 19, Health Risk Assessment further details the risk assessment method including the calculations used to determine which contaminants are potential risks to human health as result of the Project.

The outcome of the assessment includes management measures proposed to address the risk of exposure to villages.

4.6. Cumulative Impact Assessment

The *Environment Act 2000* and associated guidelines for environmental impact assessment (DEC, 2004) do not explicitly state a need to address cumulative impacts. However, the WGJV Participants deem it important that consideration is given to potential cumulative impacts to environmental, social and cultural heritage aspects for which other existing or reasonably foreseeable future developments may also have environmental and social effects.

The International Finance Corporation provides guidance regarding cumulative impact assessment and management in its Good Practice Handbook: Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets (IFC, 2013). The cumulative impact assessment has been informed by that document.

Chapter 22, Cumulative Impact Assessment provides further detail on the cumulative impact assessment method.

4.7. Reconciliation with State of PNG Guidelines

This EIS has been prepared in accordance with the Guideline for Conduct of Environmental Impact Assessment and Preparation of Environmental Impact Statement (DEC, 2004) and the Papua New Guinea Draft General Guidelines for Deep Sea Tailings Placement (SAMS, 2010). Reconciliation with these guidelines is presented in Attachment 1, Reconciliation with Relevant State of Papua New Guinea Guidelines, to show how each aspect has been addressed in this EIS.

4.8. References

Australia ICOMOS Burra Charter. 2013. The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance. Australia International Council on Monuments and Sites Incorporated. Burwood, Victoria.

CCME. 2010. Federal Contaminated Site Risk Assessment in Canada, Part V: Guidance on Human Health Detailed Quantitative Risk Assessment for Chemicals (DQRACHEM). Canadian Council of Ministries for the Environment (CCME). Canada.

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SAMS. 2010. Draft General Guidelines and Criteria for mining operations in Papua New Guinea (PNG) involving Deep Sea Tailings Placement (DSTP). Prepared by Scottish Association of Marine Science Research Services Limited.

USEPA. 1989. Risk Assessment Guidance for Superfund Volume 1, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response. U.S. Environmental Protection Agency (USEPA). Washington, D.C. United States