OSINO

RESOURCES

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REPORT:

TWIN HILLS GOLD PROJECT – FINAL ESIA REPORT

PROJECT NUMBER: ECC-103-332-REP-02-A

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EXECUTIVE SUMMARY

Environmental Compliance Consultancy (ECC) has been contracted by Osino Gold Exploration and Mining (Pty) Ltd. (OGEM), a Namibian company and subsidiary of Osino Resources Corp., to undertake an environmental and social impact assessment (ESIA). OGEM manages operations in Namibia as a wholly owned subsidiary of Osino Namibia Holdings (Pty) Ltd. which is in turn a subsidiary of Osino Resources Corp. ECC is conducting an ESIA for the proposed mining of precious metals on Mining Licence 238 (ML 238), located near the town of Karibib, Erongo Region, Namibia.

OGEM is the proponent for the proposed Project, referred to as "the Proponent". The proposed Project will be a conventional open pit mine with a gold extraction process similar to those in existing gold mines in Namibia, such as the Otjikoto and Navachab mines. The proposed Project will be referred to as the "Twin Hills Gold Project" or the "Project" herein.

The proposed Project covers an area of approximately 8 000ha, excluding linear power and water supply infrastructure. The site is accessed from the C33 road in central Namibia, between the towns of Karibib and Omaruru.

In terms of the Namibian Environmental Management Act, 2007 and its regulations, the Ministry of Mines and Energy (MME) is the competent authority for the proposed Project. Mining operations trigger listed activities in terms of the Act, and as such, requires an environmental clearance certificate.

SCREENING PHASE

A high-level ESIA formed part of the company's recently published preliminary economic assessment (PEA) and was incorporated into the screening phase. Alternative locations for key infrastructure, such as the processing plant and tailings storage facility (TSF), as well as potential road and river diversions, with possible mitigation measures, were considered.

The screening phase determined that the most likely potential environmental and social impacts could include:

- Surface and groundwater impacts
- Social impacts during construction, operations, and post-closure
- Habitat alteration and impacts on biodiversity
- Visual impacts affecting the sense of place
- Impacts to air quality
- Impacts on road and land users associated with the road diversion
- Impacts associated with the Okawayo river diversion.

SCOPING PHASE

The objective of the scoping phase was to obtain a thorough understanding of the biophysical and socioeconomic environment in which the Project is located, often using baseline and specialist studies. It also provided an opportunity for the public to have input into the scope of the assessment. The technical inputs combined with the inputs from the I&APs led to the development of the Terms of Reference (ToR) for the assessment phase. The following was considered during the preparation of the scoping report:

- Desktop and literature research
- Site visits by ECC and specialists
- Environmental monitoring data
- Specialist baseline studies, including:
    - Soil sampling and analysis
    - Acid-base accounting (ongoing study)
    - Surface and groundwater studies
    - Biodiversity study
    - Noise
    - Air quality
    - Road traffic study
    - Visual impacts on sense of place
    - Socioeconomic baseline
    - Heritage and archaeology study.

TERMS OF REFERENCE

The ToR within the scoping report was proposed for the assessment phase and covered the following:

- Soil impact assessment
- Acid mine drainage impact assessment
- Surface and groundwater impact assessment
- Biodiversity impact assessment
- Noise impact assessment
- Air quality impact assessment
- Traffic impact assessment
- Visual impact assessment
- Socioeconomic impact assessment
- Heritage impact assessment
- Blast and vibration assessment.

The methodology used for assessing impacts was described in the scoping report and is included in chapter 6 of this report. A hierarchical decision-making process is followed, to prevent or eliminate, prevent, reduce or offset, mitigate or manage potential impacts. The draft scoping report and draft environmental management plan (EMP) was provided to the

public for review (1 – 21 December 2021) prior to submission to the competent authority, including MME and ultimately MEFT on 22 December 2021.

The next stage of this assessment was to conduct the impact assessment. All I&AP comments, if any, were responded to, either through providing an explanation or further information in the response table, or by signposting where information exists, or where new information has been included in the ESIA report or appendices.

The draft ESIA report and appendices were made available for government and public review from the 23rd February – 8th March 2022. This is the final ESIA report provided for a record of decision on the project.

The ESIA report and appendices will be formally submitted to the competent authority, first the MME and then to the MEFT as part of the application for an environmental clearance certificate for the Twin Hills Gold Project. The phases of the ESIA are provided in Figure 1.

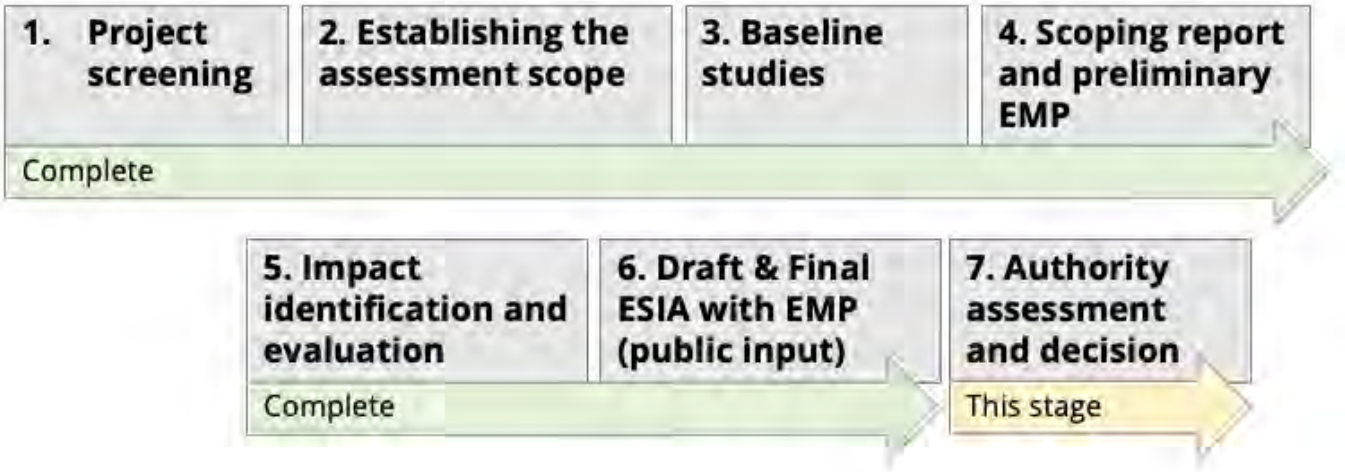

Figure 1 – Simplified Namibian ESIA process noting Twin Hills progress

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TERMS AND ABBREVIATIONS

TERM OR ABBREVIATION	DESCRIPTION
%S	percentage sulphur
ADMS	air dispersion modelling system
Ag	silver
AMD	acid mine drainage
ANC	acid neutralising capacity
Au	gold
BFS	Bankable feasibility study
CAN	Central area of Namibia
CC	Close Corporation
CEO	Chief Executive Officer
CIA	cumulative impact assessment
CIL	carbon-in-leach
CO	carbon monoxide
COD	Cone of Drawdown
CO2	carbon dioxide
Competent Authority	Government Ministry that assists the MEFT in assessing a project and issuing a record of decision
Corp.	corporation
COVID	Coronavirus
COVID-19	Coronavirus 2019
CSA	CSA Global - mining industry consultants
dBA	decibels
DEA	Directorate of Environmental Assessment
DWA	Department of Water Affairs
E	endemic
EAP	environmental assessment practitioner
ECC	Environmental Compliance Consultancy
ECC	environmental clearance certificate
EHS	environmental health and safety
EIA	environmental impact assessment
EMA	Environmental Management Act
EMP	environmental management plan
EPLs	exclusive prospecting licences
ESIA	environmental and social impact assessment
g/t	grams per tonne
GDP	gross domestic product
GG	government gazette
GN	government notice
GROWAS	groundwater survey
ha	hectares
HIV/AIDS	human immunodeficiency virus / acquired immunodeficiency syndrome
I&APs	interested and affected parties
IFC	International Finance Corporation

TERM OR ABBREVIATION	DESCRIPTION
ITS	ITS Global - traffic engineering consultants
KFZ	Karibib fault zone
kg H2SO4/t	kilograms of sulphuric acid per tonne
kg/ha	kilograms per hectare
km	kilometres
km/h	kilometres per hour
km2	kilometres squared
KP	Knight Piesold (Pty) Ltd.
kV	kilovolts
kW	kilowatts
kWh/t	kilowatt hour/tonne
LAN	limestone ammonium nitrate
LOM	life of mine
Ltd.	Limited
m	metre
m/s	metre per second
m3	cubic metres
m3/day	cubic metres per day
Ma	million years ago
masl	metres above sea level
MAWLR	Ministry of Agriculture, Water and Land Reform
MEFT	Ministry of Environment, Forestry and Tourism
mg/m2/day	milligrams per metres squared per day
ML	mining licence
mm	millimetre
Mm3	million cubic metres
MME	Ministry of Mines and Energy
MWT	Ministry of Works and Transport
MPA	maximum potential acidity
Mt	million tonnes
Mtpa	million tonnes per annum
MVA	megavolt ampere
MW	million watts
N$	Namibian dollar
Na	sodium
NAF	excess ANC, unaltered rock and low sulphur content
NAPP	net acid producing potential
NDP	national development plan
NHC	National Heritage Council
NOx	nitrogen oxides
NPI	national pollutant inventory
NSR	noise sensitive receptor
NT	near-threatened
OGEM	Osino Gold Exploration and Mining (Pty) Ltd.
Osino	Osino Resources Corp. / Osino Namibia Holdings (Pty) Ltd.

TERM OR ABBREVIATION	DESCRIPTION
PAF	low to moderate ANC, altered rock and elevated sulphur content
PEA	preliminary economic assessment
pH	acidity alkalinity unit
PM	particulate matter
PM10	particulate matter with an aerodynamic diameter of less than 2.5µm (thoracic particles)
PM2.5	particulate matter with an aerodynamic diameter of less than 10µm (respirable particles)
Project	Twin Hills Gold Project
Proponent	Osino Gold Exploration and Mining (Pty) Ltd.
Pty	proprietary
Reg	registration
RGS	RGS Mine Waste and Management Consultants
ROM	run of mine
SAR	sodium absorption ratio
SGS	mining consultancy
SLR	SLR Global Environmental Solutions
SO2	sulphur dioxide
STRM	shuttle radar topography mission
t	tonnes
TB	tuberculosis
ToR	terms of reference
TSF	tailings storage facility
TSP	total suspended particulates
UK	United Kingdom
US EPA	United States Environmental Protection Agency
USGS	United States geological survey
V	vulnerable
WHO	World Health Organisation
WRD	waste rock dump
Zn	zinc
µS/cm	microsieverts per cm

1 INTRODUCTION

1.1 COMPANY BACKGROUND

Environmental Compliance Consultancy (ECC) has been contracted to conduct an ESIA by Osino Gold Exploration and Mining (Pty) Ltd. (OGEM), a Namibian company and subsidiary of Osino Resources Corp. Osino Resources Corp. manages operations in Namibia through its wholly owned subsidiary, Osino Namibia Holdings (Pty) Ltd., the parent company of OGEM. ECC is conducting an ESIA for the proposed mining of precious metals on Mining Licence 238 (ML 238), located near the town of Karibib, Erongo Region, Namibia, see Figure 2.

The Proponent has focused on the acquisition and development of potential gold projects in Namibia through extensive exploration programmes. The advanced and successful exploration programme near Karibib has resulted in the development of the Twin Hills Gold Project, or Project. The proposed Project will be a conventional open pit mine with a gold extraction process similar to existing gold mines in Namibia, for example the Otjikoto and Navachab mines.

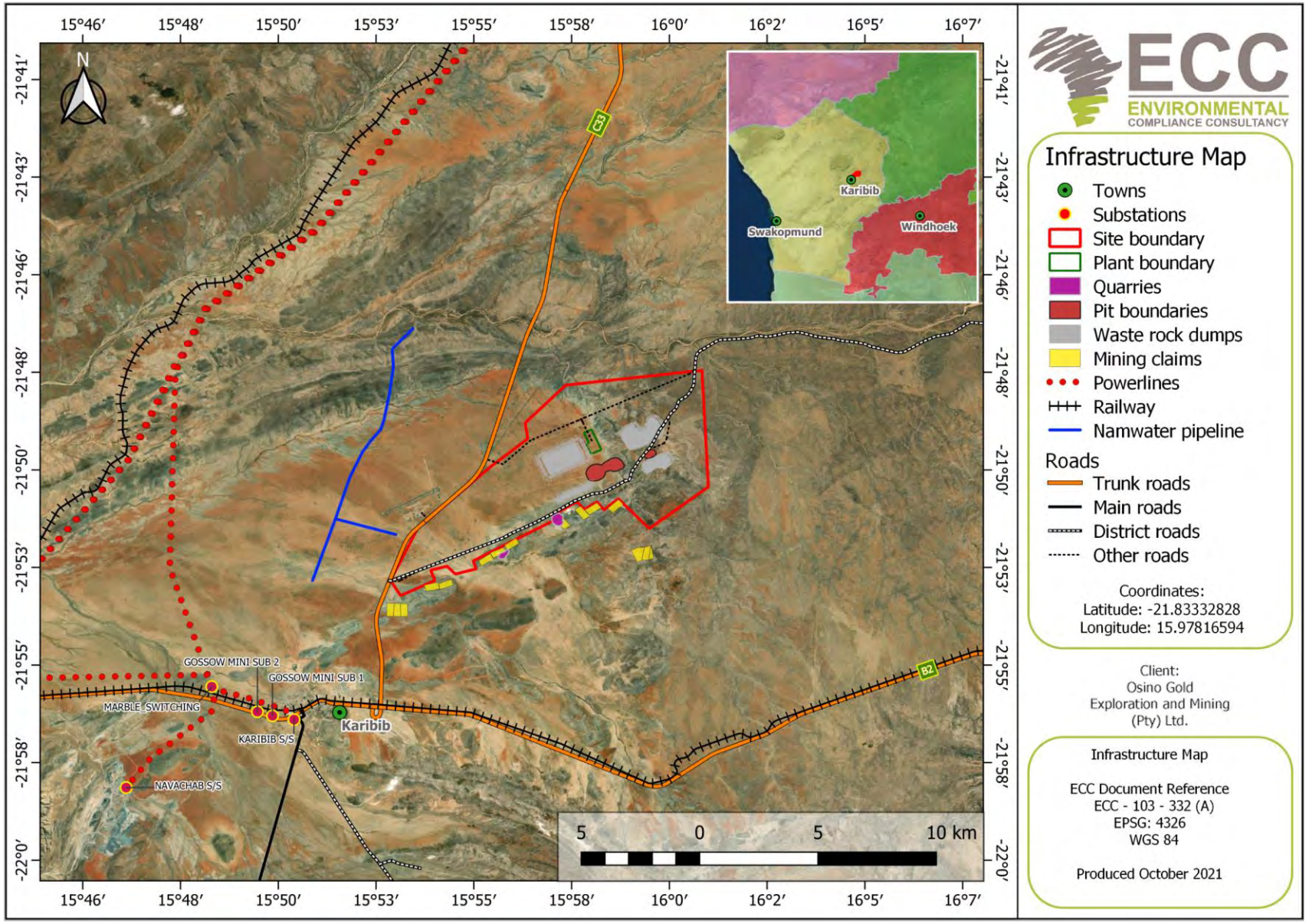

Figure 2 – Project location and regions

1.2 PURPOSE OF THE SCOPING REPORT

An environmental and social impact assessment (ESIA) has been conducted in compliance with the Namibian Environmental Management Act, 2007 and its regulations. This report presents the findings of the ESIA process. In addition to describing the prescribed ESIA process, the report describes the baseline biophysical and socioeconomic environments, provides a project description, findings from the assessment phase, and presents a preliminary environmental and social management plan (ESMP). The scope of the assessment was determined through undertaking a preliminary assessment of the proposed Project against the receiving environment, obtained through a desktop review, available site-specific literature, monitoring data, and site reports.

The scoping report and appendices was submitted to the public for review (1-21 December 2021) and input on the impacts and the related ESIA terms of reference. After the public review period the final scoping report with public input was submitted to the Ministry of Mines and Energy (MME) as the competent authority for the Project, and to the Ministry of Environment, Forestry and Tourism (MEFT) - Directorate of Environmental Affairs (DEA) for a record of decision. A draft ESIA and ESMP was then produced and issued for public and government review, during the period of 23 February to 8 March 2022. Upon completion of the public review period of the draft ESIA and ESMP the final ESIA and ESMP was prepared for Government review and a record of decision.

Chapter 1 of the report is an introduction to the proposed project and ESIA. Chapter 2 provides detail about the ESIA approach, including the roles of the public and specialists. Chapter 3 provides additional detail on the legal environment and requirements. Chapter 4 provides sufficient detail on the project to identify and assess potential impacts. Chapter 5 provides an overview of the screening and scoping results and related baseline information identifying all relevant biophysical and social aspects. Chapter 6 provides an overview of the methodology for identifying and evaluation impacts. Chapter 7 provides the findings of the impact assessment. Chapter 8 and 9 covers the conclusion and bibliography, respectively.

1.3 THE PROPONENT OF THE PROPOSED PROJECT

Osino Gold Exploration and Mining (Pty) Ltd. is the Proponent for the proposed Project. The Proponent holds the rights to several exclusive prospecting licences (EPLs) located within the central and northern zones of Namibia's Damara gold belt, in proximity to and along strike of the operating Navachab and Otjikoto gold mines.

The Proponent has a head office in Namibia's capital, Windhoek, and a regional office based in Omaruru. The Proponents' details are provided in

Table 1.

Table 1 – Proponent's details

Company Representative:	Contact Details:
Mr Heye Daun Osino's co-founder with Alan Friedman President and CEO	Osino Resources (Pty) Ltd.: PO Box 3489, Windhoek info@osinoresources.com +264 (61) 246 533

1.4 ENVIRONMENTAL AND SOCIAL ASSESSMENT PRACTITIONER

Environmental Compliance Consultancy (ECC) (Reg. No. CC 2013/11401) has prepared this report and the ESMP on behalf of the Proponent.

This report has been authored by employees of ECC, who have no material interest in the outcome of this report, nor do any of the ECC team have any interest that could be reasonably regarded as being capable of affecting their independence in the preparation of this report. ECC is independent from the Proponent and has no vested or financial interest in the Project, except for fair remuneration for professional fees rendered which are based upon agreed commercial rates. Payment of these fees is in no way contingent on the results of this report or the assessment, or a record of decision issued by Government. No member or employee of ECC is, or is intending to be, a director, officer, or any other direct employee of Osino. No member or employee of ECC has, or has had, any shareholding in Osino.

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1.5 ENVIRONMENTAL REQUIREMENTS

The Environmental Management Act, 2007, and its regulations, stipulates that an environmental clearance certificate is required before undertaking any of the listed activities that are identified in the Act and its regulations. Potential listed activities triggered by the Project are provided in Table 2.

Table 2 – Activities potentially triggered by the Twin Hills Gold Project

Source: Environmental Management Act, 2007, and its regulations

Listed activity	As defined by the regulations of Act	Relevance to the project
Energy generation, transmission, and storage activities	The construction of facilities for: (1a) The generation of electricity. (1b) The transmission and supply of electricity.	– The Twin Hills Gold Project will need to generate and or transmit electricity for its operations. – It is very likely that the mine will connect to the national power grid supplied by Nampower. – There is a possibility that a renewable energy plant (i.e. solar) will be constructed for the generation of supplementary power. – Power generated will be used to supply the mine operations, and potential surplus could be redirected into the national grid. (Section 4.7.1 Power supply)
Waste management, treatment, handling, and disposal activities	2.1 The construction of facilities for waste sites, and the treatment and disposal of waste. 2.2 Any activity entailing a scheduled process referred to in the Atmospheric Pollution Prevention Ordinance Act, 1976. 2.3 The importing, processing, use and recycling, temporary storage, transit, or exporting, of waste.	– The Project will require waste sites for the disposal of mineralised and non-mineralised waste. Hazardous waste may be generated by the operation. – Facilities for the disposal of waste will need to be constructed. – In terms of the Atmospheric Pollution Prevention Ordinance Act, the bulk storage and handling of mineralised or metallic ore on waste dumps designed to hold 100 000 metric tonnes or more, is defined as a scheduled process. (Section 4.8 Mineral and non-mineralised waste)

Listed activity	As defined by the regulations of Act	Relevance to the project
Mining and quarrying activities	3.1 The construction of facilities for any process or activities that require a license, right or other form of authorisation, and the renewal of a licence, right or other form of authorisation, in terms of the Minerals (Prospecting and Mining) Act, 1992. 3.2 Other forms of mining or extraction of any natural resources, whether regulated by law or not. 3.3 Resource extraction, manipulation, conservation, and related activities.	– This listed activity infers the provisions of the Minerals (Prospecting and Mining) Act 33 of 1992. The very nature of the Project is mining, which therefore triggers this listed activity. (Section 4.6 Mining infrastructure and services)
Forestry activities	4. The clearance of forest areas, deforestation, afforestation, timber harvesting, or any other related activity that requires authorisation in terms of the Forest Act, 2001 (No. 12 of 2001) or any other law.	– Vegetation clearing will be required for site construction and infrastructure establishment. – During operations, vegetation clearing will be required as the Project develops. (Sections 4.9.1 Mine layout and 5.15 Biodiversity)
Water resource developments	8.1 The abstraction of ground or surface water for industrial or commercial purposes. 8.2 The abstraction of groundwater at a volume exceeding the threshold authorised in terms of the law relating to water resources. 8.4 Construction of canals and channels, including the diversion of the normal flow of water in a riverbed, and water transfer schemes between water catchments and impoundments.	– Ground and surface water may be abstracted to support the operation. – The sourced groundwater may likely exceed the threshold authorised in terms of the Water Act, and therefore permits for abstraction must be sourced. – The mining area is within a catchment area, and an ephemeral river runs through a section of the planned open-pit. – A dam may be constructed to provide water for the process plant.

Listed activity	As defined by the regulations of Act	Relevance to the project
	8.5 Construction of dams, reservoirs, levees, and weirs. 8.6 Construction of industrial and domestic wastewater treatment plants and related pipeline systems. 8.8 Construction and other activities in watercourses within flood lines. 8.9 Construction and other activities within a catchment area.	– Pipeline systems will be used to transport water or slurry within the site. (Sections 4.7.2 Water supply; 4.9 Alternatives considered and 5.14.1.2 Mine water supply and preliminary studies).
Hazardous substance treatment, handling, and storage	9.1 The manufacturing, storage, handling, or processing of hazardous substance defined in the Hazardous Substances Ordinance, 1974. 9.2 Any process or activity that requires a permit, licence, or other form of authorisation, or the modification of, or changes to, existing facilities for any process or activity that requires amendment of an existing permit, licence or authorisation, or which requires a new permit, licence or authorisation in terms of governing the generation or release of emissions, pollution, effluent, or waste. 9.4 The storage and handling of dangerous goods, including petrol, diesel, liquid petroleum, gas, or paraffin, in containers with the combined capacity of more than 30 cubic meters at one location.	– The mining operations and proposed process plant triggers this activity, as both fuel and hazardous substances are required for mining and processing. – Bulk fuel may be required for onsite generation of electricity, and for refuelling the mining fleet. – Consumer installation certificates are required for bulk fuel storage and dispensing. – Hazardous reagents will be used within the gold extraction and processing plant.

Listed activity	As defined by the regulations of Act	Relevance to the project
	9.5 Construction of filling stations or any other facility for the underground and above ground storage of dangerous goods, including petrol, diesel, liquid, petroleum, gas, or paraffin.	
Infrastructure	10.1 The construction of: (b) public roads. (j) masts of any material or type, and of any height, including those used for telecommunication broadcasting and radio transmission.	– Powerlines and telemetry for water and tailings pumping will be required. – Radio and telecommunication towers will be required for the site. – Diversion of gravel road D1941.

2 APPROACH TO THE ASSESSMENT

2.1 PURPOSE AND SCOPE OF THE ASSESSMENT

The aim of this assessment is to determine which impacts are likely to be significant; to scope the available data and identify any gaps that need to be filled; to determine the spatial and temporal scope; and to identify the assessment methodology.

2.2 THE ASSESSMENT PROCESS

The ESIA methodology applied to this assessment has been developed using the International Finance Corporation (IFC) standards and models, in particular Performance Standard 1: 'Assessment and management of environmental and social risks and impacts' (International Finance Corporation, 2012 and 2017); Namibian Draft Procedures and Guidance for EIA and EMP (Republic of Namibia, 2008); international and national best practice guidelines; and ECC's combined relevant ESIA experience.

Furthermore, this assessment was undertaken for the Proponent in accordance with Namibian legal requirements.

This assessment is a formal process. The potential effects that the Project will have on the biophysical, social, and economic environments are identified, assessed, and reported so that the significance of potential impacts can be taken into account when considering a record of decision for the proposed Project.

Final mitigation measures and recommendations are based on the cumulative experience of the consulting team and the client, taking into consideration the potential environmental and social impacts. The process followed, through the assessment, is illustrated in Figure 3**,** and is detailed further in the following sections.

It is important to note at this juncture, that the assessment has been carried out in accordance with the indicative plans received from the proponent. Subsequent to completing the assessment, some aspects of the proponent's plans may need to change in order to comply with the stated recommended mitigations.

1. Project screening

Complete

The first stages in the ESIA process are to undertake a screening exercise to determine whether the Project triggers listed activities under the Environmental Management Act, 2007, and its regulations. The screening phase of the Project is a preliminary analysis, in order to determine ways in which the Project might interact with the biophysical, social, and economic environments.

The outcome of the screening phase was that the mine layout and position of some of the mine infrastructure needed to change to fit within the current scope and extent. The ephemeral pans needed avoiding as well as the biodiverse limestone hills. Thus, the waste rock dumps, plant and tailings facility had to be relocated. The boundary of the mining licence needed to change due to the existing quarries that operate along the ridge. Alternatives were considered for water supply, river diversion routes and options, as well as the road access.

Stakeholder engagement:
- Registration of the project
- Preparation of the BID

2. Establishing the assessment scope

Complete

Where an ESIA is required, the second stage is to scope the assessment. The main aim of this stage is to determine which impacts are likely to be significant; to scope the available data and any gaps that need to be filled; to determine the spatial and temporal scope; and to identify the assessment methodology.

The scope of this assessment was determined through undertaking a preliminary assessment of the proposed Project against the receiving environment. Feedback from consultation with the public and the Proponent informs this process. The following environmental and social topics were scoped into the assessment, as there was the potential for significant impacts to occur. Impacts that are identified as potentially significant during the screening and scoping phase are taken forward for further assessment in the ESIA process. These are:

SOCIOECONOMIC ENVIRONMENT
- Employment
- Local businesses
- Visual impacts on sense of place

BIOPHYSICAL ENVIRONMENT
- Noise and air quality, including dust emissions
- Surface and ground water
- Heritage and culture
- Biodiversity
- Road traffic
- Soils and
- Mine waste characterisation

The following topics were scoped out of the ESIA, and they are therefore not discussed further in this report.
- An assessment of safety impacts or risks associated with developing the mine are not included within the scope of this assessment, and will be addressed by the Proponent in a site-specific safety management plan.

3. Baseline studies

Complete

A robust baseline is required, in order to provide a reference point against which any future changes associated with a Project can be assessed, and to allow suitable mitigation and monitoring to be identified.

The region and general area have been studied for various projects and assessments. This literature was available to be referenced. The Project site-specific area has been studied as part of the ESIA process, and the following has been conducted as part of this assessment:
- Field surveys
- Desktop studies
- Consultation with stakeholders
- Specialist field visits, monitoring, and ongoing studies

The environmental and social baselines are provided in the scoping study.

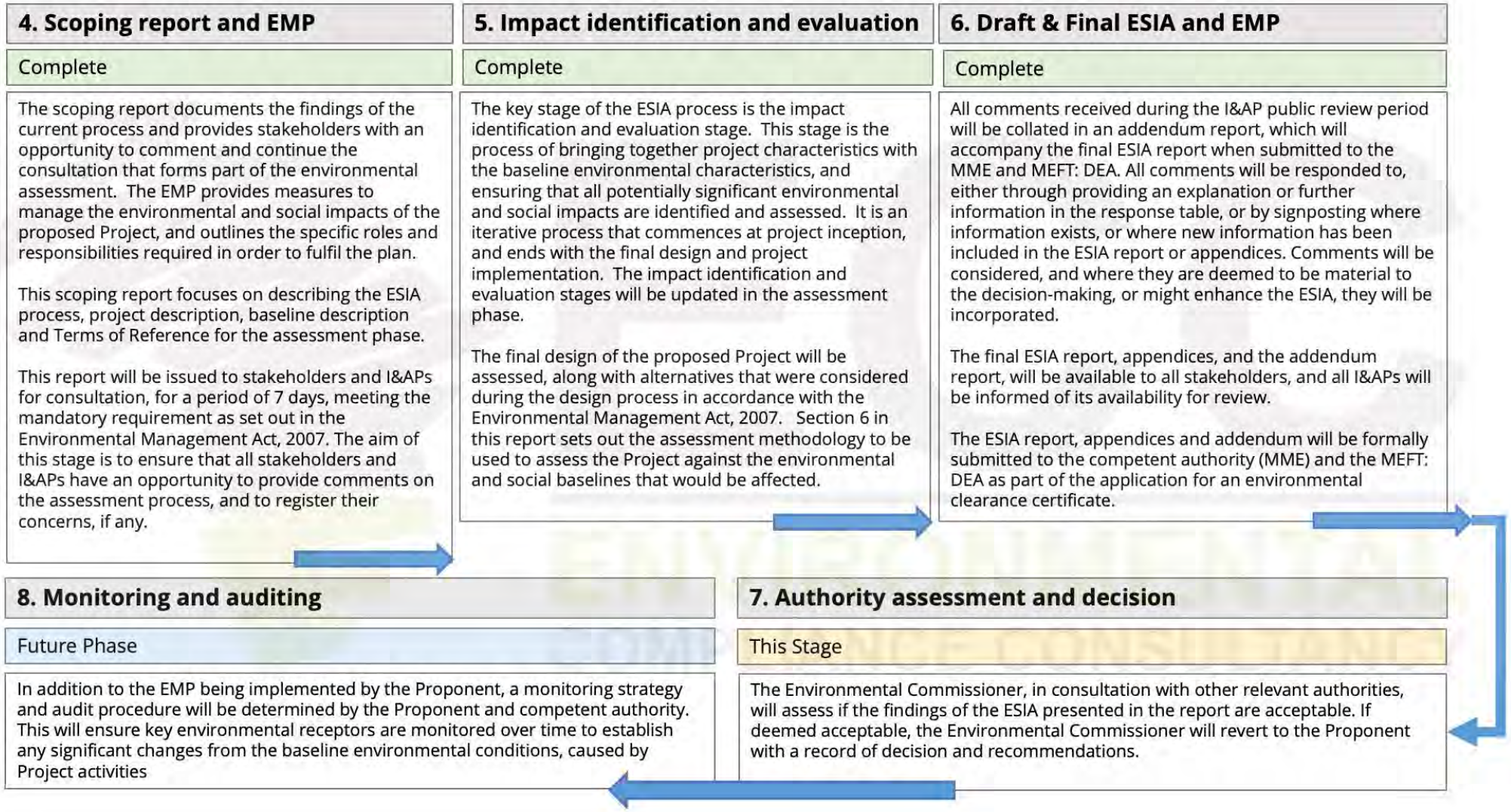


Figure 3 – ESIA process and stages complete

2.3 STUDY AREA

This ESIA study area has been defined according to the geographic scope of the receiving environment and potential impacts that could arise because of the proposed Project within that area. The receiving environment is a summary term for the biophysical and socioeconomic environment that is described in the baseline chapter. The study area is presented in Figure 4. The study area extends beyond the mining licence boundary and includes the nearby receptors such farmsteads and Karibib town.

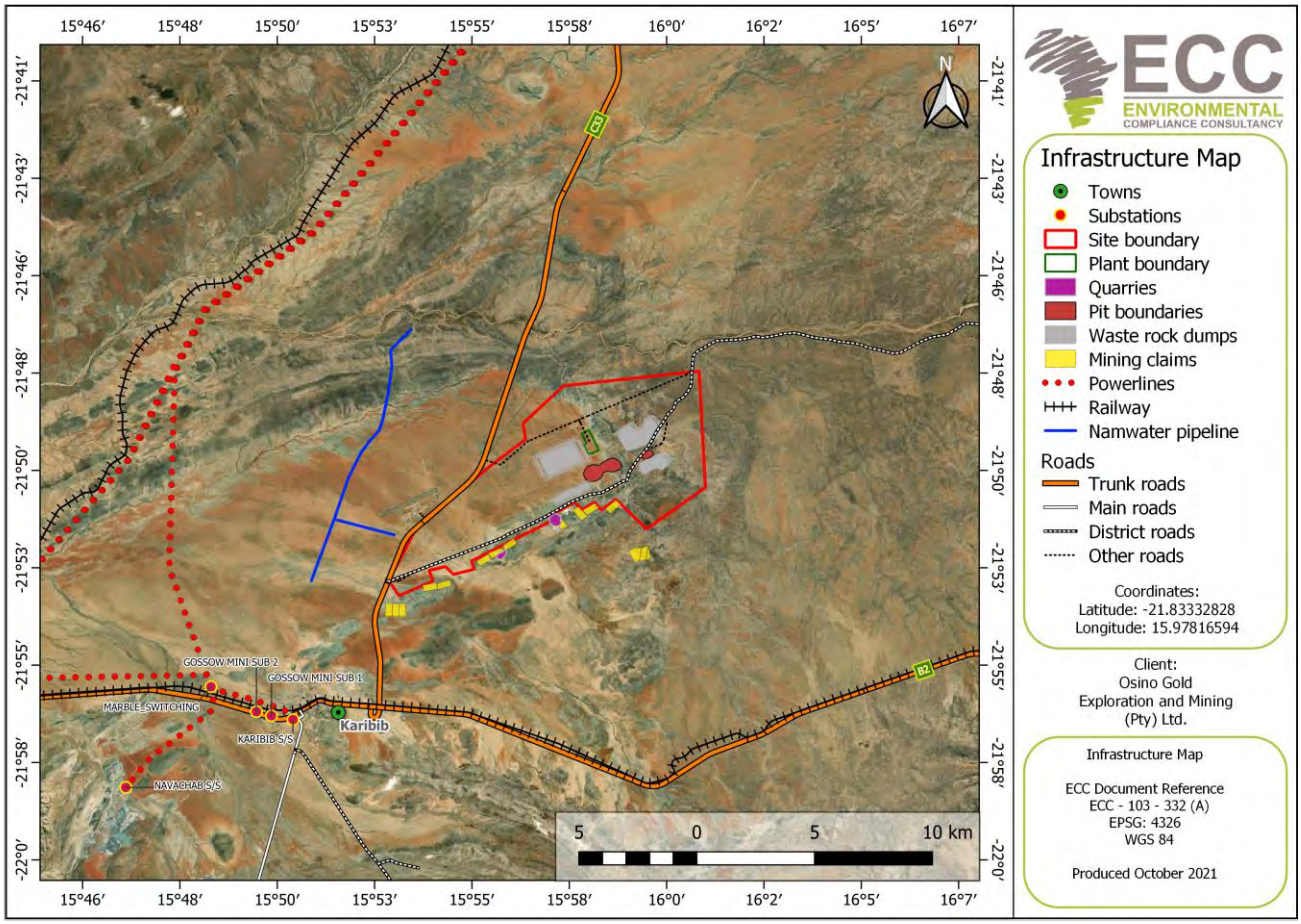


Figure 4 – ESIA study area, infrastructure, and surrounds

2.4 PUBLIC CONSULTATION

Public participation and consultation are a requirement stipulated in Section 21 of the Environmental Management Act, 2007 and its regulations, for a project that requires an environmental clearance certificate. Consultation is a compulsory and critical component of the ESIA process for achieving transparent decision-making and can provide many benefits. Consultation is ongoing during the ESIA process. The objectives of the public participation and consultation process are to:

- Provide information on the Project, and introduce the overall Project concept and plan in the form of a background information document (BID) (Appendix B)
- Determine the relevant government, regional and local regulating authorities
- Listen to and understand community issues, record concerns, and questions
- Explain the process of the ESIA and timeframes involved
- Establish a platform for ongoing consultation.

2.4.1 IDENTIFICATION OF KEY STAKEHOLDERS AND INTERESTED OR AFFECTED PARTIES

A stakeholder mapping exercise see Figure 5, was undertaken to identify individual or groups of stakeholders, and the method in which they will be engaged during the ESIA process. Stakeholders were approached through direct communication (letters and phone calls), the national press, site notices, or directly by email. The list of stakeholders is included in Appendix B. A summarised list of stakeholders that were engaged during the public consultation process is given below:

- Directly and indirectly affected landholders
- The general public with an interest in the Project
- Ministry of Environment, Forestry and Tourism (MEFT)
- Ministry of Agriculture, Water and Land Reform (MAWLR)
- Ministry of Mines and Energy (MME)
- National Heritage Council (NHC)
- Ministry of Works and Transport (MWT) and the Roads Authority
- Erongo Regional Council
- Karibib and Omaruru Town Councils
- Town residents and business owners
- NamWater and NamPower
- Cellular network providers
- Quarry and mineral claims holders adjacent to the Project
- Khan River water users downstream of the Project
- Namibian Air Force, Karibib Air Base, and the Civil Aviation Authority.

Appendix B provides a list of interested and affected parties, evidence of consultation, including notices of advertisements in national newspapers, minutes of public meetings, and a summary of the comments or questions raised by the public. A summary of the key concerns raised during the consultation process is provided in section 2.4.2.

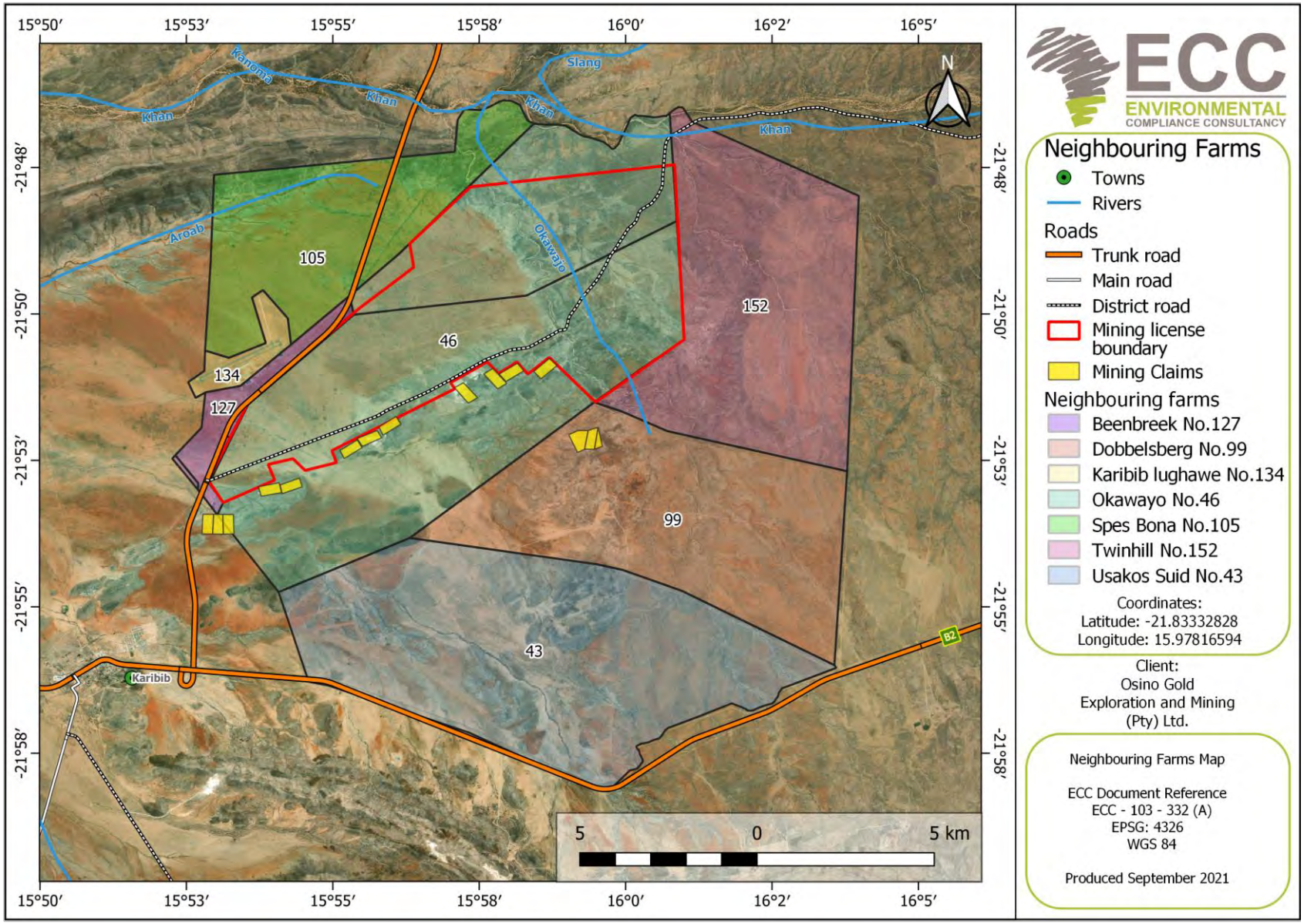


Figure 5 – Neighbouring farms to the mining licence area

2.4.2 SUMMARY OF ISSUES RAISED

During the compilation of the ESIA, several stakeholders were engaged for input and feedback into potential issues or concerns regarding the proposed Project. Overall, the proposed Project received significant positive feedback, and was well received by the public. The records of the consultation meetings are provided in Appendix B of this scoping report.

The matters raised at the public meetings and via email could be considered typical concerns for this scale of Project, and these are summarised as follows:

- Heritage impacts
- Power and water supply
- Waste management
- Waste resource management
- Visual impacts
- Biodiversity impacts
- Socioeconomic and social impacts, such as job creation, staff housing and accommodation, and the lack of amenities in Karibib
- Potential pollution impacts
- Mine closure.

To ensure that interested and affected parties can comment and provide feedback on the scoping report, the completed scoping report was circulated to potentially interested and or affected parties, and stakeholders of the Project for a 21-day review period.

3 REVIEW OF THE LEGAL ENVIRONMENT

This chapter outlines the regulatory framework applicable to the proposed Project. As stated in Section 1, an environmental clearance is required for any activity listed in the Government Notice No. 29 of 2012 of the EMA. The Proponent holds several current and valid environmental clearance certificates for the exploration phase of the Project.

The Project area is located outside of any national parks, heritage listed areas, or areas of significance. The Project area is not located within a groundwater-controlled area, as regulated under the Water Management Act of 1956.

A thorough review of relevant legislation has been conducted for the proposed Project. Table 3 below identifies relevant legal requirements specific to the Project. Table 4 provides the national policies and plan and Table 5 lists specific permits for the Project.

3.1 NATIONAL REGULATORY FRAMEWORK

Table 3 – Details of the regulatory framework as it applied to the Twin Hills Gold Project

National regulatory framework	Summary	Applicability to the project
Constitution of the Republic of Namibia (1990)	The constitution defines the country's position in relation to sustainable development and environmental management. The constitution refers that the state shall actively promote and maintain the welfare of the people by adopting policies aimed at the following: "Maintenance of ecosystems, essential ecological processes and biological diversity of Namibia, and the utilisation of living, natural resources on a sustainable basis for the benefit of all Namibians, both present, and future."	The Twin Hills Gold Project is committed to the sustainable use of the environment, and has aligned its corporate mission, vision, and objectives within the ambit of the Constitution of the Republic of Namibia (1990).
Minerals (Prospecting and Mining) Act No. 33 of 1992	The Act provides for the granting of various licences related to mining and exploration. Section 50 (i) requires: "An environmental impact assessment indicating the extent of any pollution of the environment before any prospecting operations or mining operations are being carried out, and an estimate of any pollution, if any, likely to be caused by such prospecting operations or mining operations." The Act sets out the requirements associated with licence terms and conditions, such that the holder of a mineral licence shall comply with.	The proposed mining activity requires an ESIA to be carried out, as it triggers listed activities in the Environmental Management Act's regulations. Mining activities shall not commence until all conditions in the Act are met, which includes an agreement with the landowners and conditions of compensation, if applicable. The Project shall be compliant with Section 76 of the Act with regard to records, maps, plans and

National regulatory framework	Summary	Applicability to the project
	The Act also contains relevant provisions for pollution control related to mining activities and land access agreements and provides provisions that mineral licence holders are liable for any damage to land, water, plant, or animal life, caused by spilling or pollution, and must take all such steps as may be necessary to remedy such spilling, pollution, loss, or damage, at its own costs.	financial statements, information, reports, and returns submitted. As the Proponent may need to access privately owned land, the Proponent will ensure Sections 50 and 52 are complied with.
Environmental Management Act, 2007 (Act No. 7 of 2007) and its regulations, including the Environmental Impact Assessment Regulation, 2007 (No. 30 of 2011)	The Act aims to promote sustainable management of the environment and use of natural resources. The Act requires certain activities to obtain an environmental clearance certificate prior to Project development. The Act states that an EIA should be undertaken and submitted as part of the environmental clearance certificate application process. The MEFT is responsible for the protection and management of Namibia's natural environment. The Department of Environmental Affairs, under the MEFT, is responsible for the administration of the EIA process.	This environmental scoping report documents the findings of the scoping phase of the environmental assessment undertaken for the proposed Project. The process has been undertaken in line with the requirements under the Act and its regulations.
Water Act, 1956 (Act No. 54 of 1956)	Although the Water Resources Management Act (No. 11 of 2013), has been billed, but not promulgated, it cannot be enacted, as the regulations have not been passed – therefore the Water Act of 1956 remains the current piece of legislation relating to water management in Namibia.	The Act stipulates obligations to prevent the pollution of water. Measures to minimise potential surface and groundwater pollution are contained in the EMP. The Project is obliged to have all permits relevant to its operations under this Act.

National regulatory framework	Summary	Applicability to the project
	This Act provides for the control, conservation and use of water for domestic, agricultural, urban, and industrial purposes; and to make provision for the control of certain activities on or in water. The Department of Water Affairs, within the Ministry of Agriculture, Water and Land Reform (MAWLR), is responsible for the administration of the Act.	Abstraction of water from boreholes requires an abstraction permit to be obtained from the Ministry of Agriculture, Water and Land Reform. The diversion of the Okawayo river, the location and placement of mining infrastructure, such as the tailings storage facility, and the location of industrial effluent storage ponds, require consideration in terms of the Water Act. This will be considered in the assessment phase of the ESIA.
Soil Conservation Act, No. 76 of 1969	This Act makes provision for the prevention and control of soil erosion, and for the protection, improvement, and conservation of soil and vegetation.	Land clearing is an unavoidable necessity for the proposed Project, as large areas will be cleared for mining infrastructure. Measures will be included in the EMP to conserve soil and vegetation that will be used as part of the rehabilitation phase of the Project.
The Forestry Act, No. 12 of 2001 as amended by the Forest Amendment Act, No. 13 of 2005	Section 22 deals with the protection of natural vegetation that is not part of the surveyed erven of a local authority area as defined. Section 21 states that no person shall cut, destroy, or remove vegetation that is growing within 100 metres of a river, stream, or watercourse.	The Project activities will require vegetation clearing. The Proponent will ensure that all required permits are in place before vegetation removal commences.

National regulatory framework	Summary	Applicability to the project
	Section 23 requires a permit from the Director for the clearance of vegetation on more than 15ha on any piece of land or several pieces of land situated in the same locality as that which has predominantly woody vegetation; or cut or remove more than 500 cubic metres of forest produce from any piece of land in a period of one year.	
National Heritage Act, No. 27 of 2004.	The Act provides provision for the protection and conservation of places and objects with heritage significance. Section 55 compels mining companies to report any archaeological findings to the National Heritage Council. Subsection 9 allows the NHC to issue a consent, subject to any conditions that the Council deems necessary.	There is the potential for heritage related objects to be found in the mining licence area. Therefore, the relevant stipulations in the Act will be taken into consideration and incorporated into the EMP. In cases where heritage sites are discovered, the 'chance find procedure' will be used.
Labour Act, No. 11 of 2007	The Labour Act, No. 11 of 2007 (Regulations relating to the Occupational Health & Safety provisions of Employees at Work, promulgated in terms of Section 101 of the Labour Act, No. 6 of 1992 - GN156, GG 1617 of 1 August 1997)	The Project shall adhere to all labour provisions and guidelines, as enshrined in the Labour Act. The Project shall also develop and implement a comprehensive occupational health and safety plan to ensure adequate protection for its personnel throughout the Project lifecycle.
Road Traffic and Transport Act, No. 22 of 1999	This Act makes provision for the control of traffic on public roads, the licensing of drivers, the registration and licensing of vehicles, and the control and regulation of road transport users across Namibia.	The Project will involve transportation activities in support of mining activities. The employees and support business shall adhere to national road regulations on public roads.

National regulatory framework	Summary	Applicability to the project
		The Proponent will ensure that the diversion of the D1491 road will be conducted in compliance with the Act.
Hazardous Substances Ordinance, No. 14 of 1974	This Ordinance provides for the control of toxic substances and can be applied in conjunction with the Atmospheric Pollution Prevention Ordinance, No. 11 of 1976. This applies to the manufacture, sale, use, disposal, and dumping of hazardous substances, as well as their import and export.	The planned Project will involve the handling and storage of hazardous substances such as fuels, reagents, and industrial chemicals. The Proponent shall ensure safe handling, transfer, storage, and disposal protocols are developed, implemented, and audited throughout its operations. The Proponent is obliged to ensure that all permits under this Ordinance are obtained prior to Project commencement.
Civil Aviation Act, No. 6 of 2016	Section 55 of the regulations relates to safety and security protocols near aerodromes.	The Project is located in proximity to the military air base, and as such, the Proponent will ensure that all regulations regarding safety and security near aerodromes is complied with.
The Atmospheric Pollution Prevention Ordinance, No. 11 of 1976	The Ordinance pertains to the prevention of air pollution, with particular focus on public health, and contains detailed provisions on air pollution matters, including the control of noxious or offensive gases, atmospheric pollution by smoke, dust control, motor vehicle emissions, and other general provisions.	The nature of mining activities generates dust. Activities within the mining operations and processing plant will generate gases, odours, and air pollution. The Proponent will ensure that all measures reasonably practicable will be implemented to reduce and mitigate impacts to air quality, and this will be included in the EMP.

3.2 NATIONAL POLICES AND PLANS

Table 4 – Namibian national polices and plans applicable to the Twin Hills Gold Project

Policy or plan	Description	Relevance to the Project
Vision 2030	Vision 2030 sets out the nation's development targets and strategies to achieve its national objectives. Vision 2030 states that the overall goal is to improve the quality of life of the Namibian people aligned with the developed world.	The proposed Project shall aim to meet the objectives of Vision 2030 and shall contribute to the overall development of the country through continued employment opportunities and ongoing contributions to the gross domestic product (GDP).
Fifth National Development Plan (NDP5)	The NDP5 is the fifth in a series of seven five-year national development plans that outline the objectives and aspiration of Namibia's long-term vision. The NDP5 pillars are economic progression, social transformation, environmental sustainability, and good governance.	The planned Project supports meeting the objectives of the NDP5 through creating opportunities for continued employment.
The Harambee Prosperity Plan ii (2021 – 2025)	Second Pillar: Economic advancement – ensuring increasing productivity of priority key sectors (including mining) and the development of additional engines of growth, such as new employment opportunities.	The Project will contribute to the continued advancement of the mining industry and create an additional employment generation engine within the regional and national landscape.
Minerals Policy	The Minerals Policy was adopted in 2002 and sets guiding principles and direction for the development of the Namibian mining sector, while communicating the values of the Namibian people. The policy strives to create an enabling environment for local and foreign investments in the mining sector and seeks to	The planned Project conforms to the Policy, which has been considered through the ESIA process and the production of this report. The Proponent intends to continue to support local spending and procurement.

Policy or plan	Description	Relevance to the Project
	maximise the benefits for the Namibian people from the mining sector, while encouraging local participation. The objectives of the Minerals Policy are in line with the objectives of the Fifth National Development Plan that include reduction of poverty, employment creation, and economic empowerment in Namibia.	The Project will comply with the general guidelines of the Policy through the adoption of various legal mechanisms to manage all aspects of the environment effectively and sustainably from the start. The ESIA is one such mechanism to ensure environmental integrity throughout the planned Project's lifecycle.

Table 5 – Specific permits and licence requirements for the Twin Hills Gold Project

Permit or licence	Act / Regulation	Related activities requiring permits	Relevant authority
Environmental clearance certificate	Environmental Management Act, No. 7 of 2007	Required for all listed activities shown in Table 2.	Ministry of Environment, Forestry and Tourism (MEFT)
Mining licence	Section 90 (2) (A) of the Minerals Act, No. 33 of 1992	Written permission from the mining commissioner.	Ministry of Mines and Energy (MME)
Surface rights agreements (mine, infrastructure corridors)	Section 52(1)(A) of the Minerals Act, No. 33 of 1992	Included in the mining license application. Also required in the permit application for accessory works areas.	Ministry of Mines and Energy (MME)
Exclusive prospecting licences	Section 68 (2) (A) of the Minerals Act, No. 33 of 1992	Written permission from the mining commissioner before prospecting can commence.	Ministry of Mines and Energy (MME)
Accessory work permit	Section 90(3) of the Minerals Act, No. 33 of 1992	Written permission from the mining commissioner before accessory works can be erected on an EMP or mining licence area.	Ministry of Mines and Energy (MME)

Permit or licence	Act / Regulation	Related activities requiring permits	Relevant authority
Permit for boreholes (exploration and water boreholes)	A permit is issued under the Water Act, No. 54 Of 1956 (enforced)	Required before the drilling of boreholes for exploration and the abstraction of water.	Ministry of Agriculture, Water and Land Reform (MAWLR)
Tailings waste disposal permit	A permit is issued under the Water Act, No. 54 of 1956 (enforced)	Required for the disposal of tailings.	Ministry of Agriculture, Water and Land Reform (MAWLR)
Wastewater discharge permit	A permit is issued under the Water Act, No. 54 Of 1956 (enforced) but form types that fall under the Water Act, No. 24 of 2004 are used.	Required for discharge of sewage and/or excess industrial or mine wastewater.	Ministry of Agriculture, Water and Land Reform (MAWLR)
Permit for construction of river diversion	A permit is issued under the Water Act, No. 54 Of 1956 (enforced) and The Water Resources Management Act, No. 11 of 2013 (not enacted).	Construction of canals and channels, including the diversion of the normal flow of water in a riverbed, and water transfer schemes between water catchments and impoundments.	Ministry of Agriculture, Water and Land Reform (MAWLR)
Permit for the clearing of land	The Forest Act, 2001 (Act No. 12 of 2001)	This Act governs the removal of vegetation within 100 m of a water course, or removal of more than 15ha of woody vegetation, or the removal of any protected plant species.	Ministry of Agriculture, Water and Land Reform (MAWLR)
Permit for the destruction of heritage objects and artefacts	The Heritage Act, No. 27 of 2004.	This Act relates to interference with heritage artefacts during the Project life. Heritage sites could potentially be located within the proposed mining licence footprint, or along proposed pipeline or powerline routes.	National Heritage Council (NHC)

Permit or licence	Act / Regulation	Related activities requiring permits	Relevant authority
Consumer installation certificate for bulk fuel storage	Petroleum Products Regulations	A consumer installation certificate is required for bulk fuel storage and dispensing.	Ministry of Mines and Energy (MME)
Licence for explosives magazine	Minerals (Prospecting and Mining) Act, No. 33 of 1992; Mine Safety Regulations	This is also covered under the accessory works application.	Ministry of Mines and Energy (MME)
Permit for the storage and use of explosives, and the burning of packaging	Minerals (Prospecting and Mining) Act, No. 33 of 1992; Mine Safety Regulations	Part x (10), explosives and blasting.	Ministry of Mines and Energy (MME)
Emissions stack(s) and towers	Civil Aviation Act, No. 6 of 2016	Section 55 of the regulations relates to safety and security protocols near aerodromes.	Civil Aviation Authority
Aviation	Civil Aviation Act, No. 6 of 2016; Section 90(3) of the Minerals Act, No. 33 of 1992	This is also covered under the accessory works application.	Civil Aviation Authority

4 PROJECT DESCRIPTION

4.1 NEED FOR THE PROJECT

New mining activities could contribute to the national and local economies and may have a positive impact on the country's economy. Namibia's economy depends largely on mining. Should the Twin Hills Gold Project prove economically viable, the Namibian economy can expect benefits from revenues during the construction phase, royalties and taxes during the life of mine (LoM), and a positive contribution towards employment. Based on current mine plans, between 1000 and 1500 people will be employed during construction, and approximately 450 for the operational phase, providing jobs and livelihoods for them, and their families, for a minimum of 16.5 years.

4.2 EMPLOYMENT

The labour requirement for a typical gold mine the size and scale of the proposed project is expected to be approximately 1000 people during the construction phase, and approximately 750 – 850 during the operational phase. During operations it is expected that the split for the labour requirement will be; processing plant approximately 120 people, administration and management 235, mining approximately 450 people. A detailed labour plan covering all components of the operation will be developed as the project evolves. The labour compliment for the mining component at this stage comprises of the following:

- Management team
- Mine technical service team
- Mine support services team
- Production crew – drill and blast
- Production crew – load and haul
- Mine maintenance crew.

The labour requirement for mining operations over the LoM ranges from 268 to 416 people at maximum production and is illustrated in Figure 6 (Source Qubeka, 2021).

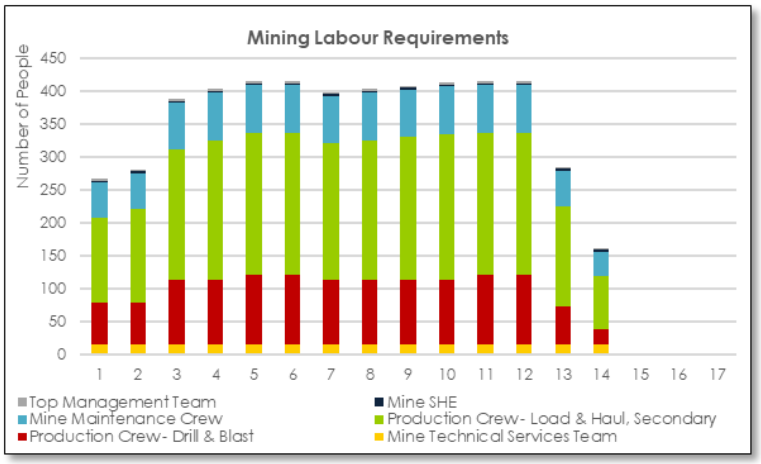


Figure 6 - A generalised graph showing employment levels of operations over the life of mine (Source Qubeka, 2021)

4.3 BACKGROUND OF THE PROJECT AND EXPLORATION HISTORY

The Twin Hills Gold Project is located in central Namibia near the regional towns and settlements of Karibib, Omaruru, Wilhelmstal, and Usakos in the Erongo Region of Namibia (see Figure 7).

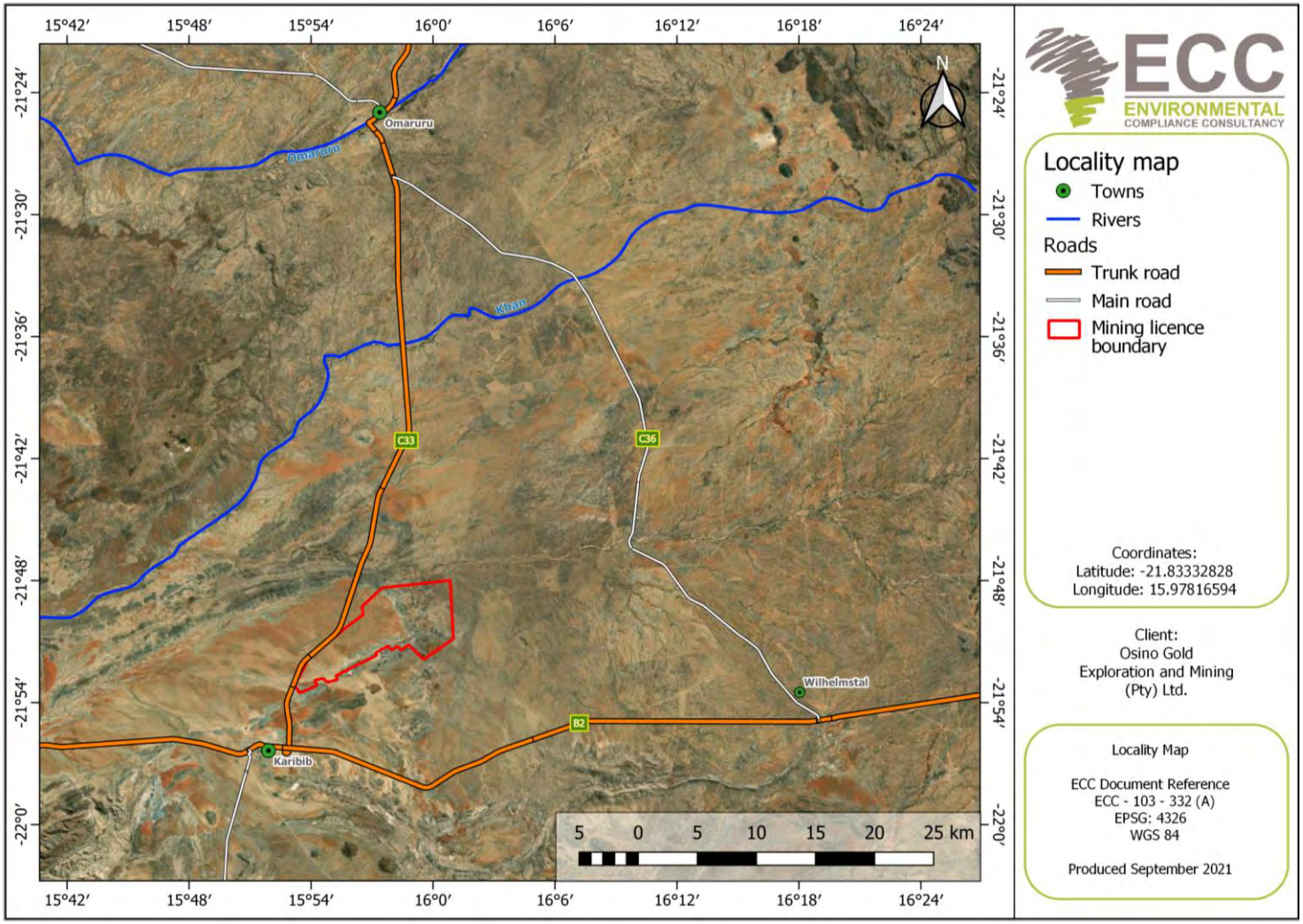


Figure 7 - Project location in proximity to towns and roads.

Osino, through various locally held and majority-owned subsidiaries, holds 16 EPLs in central Namibia. The EPLs relevant to the Twin Hills Gold Project and the mining licence area are shown in Figure 8.

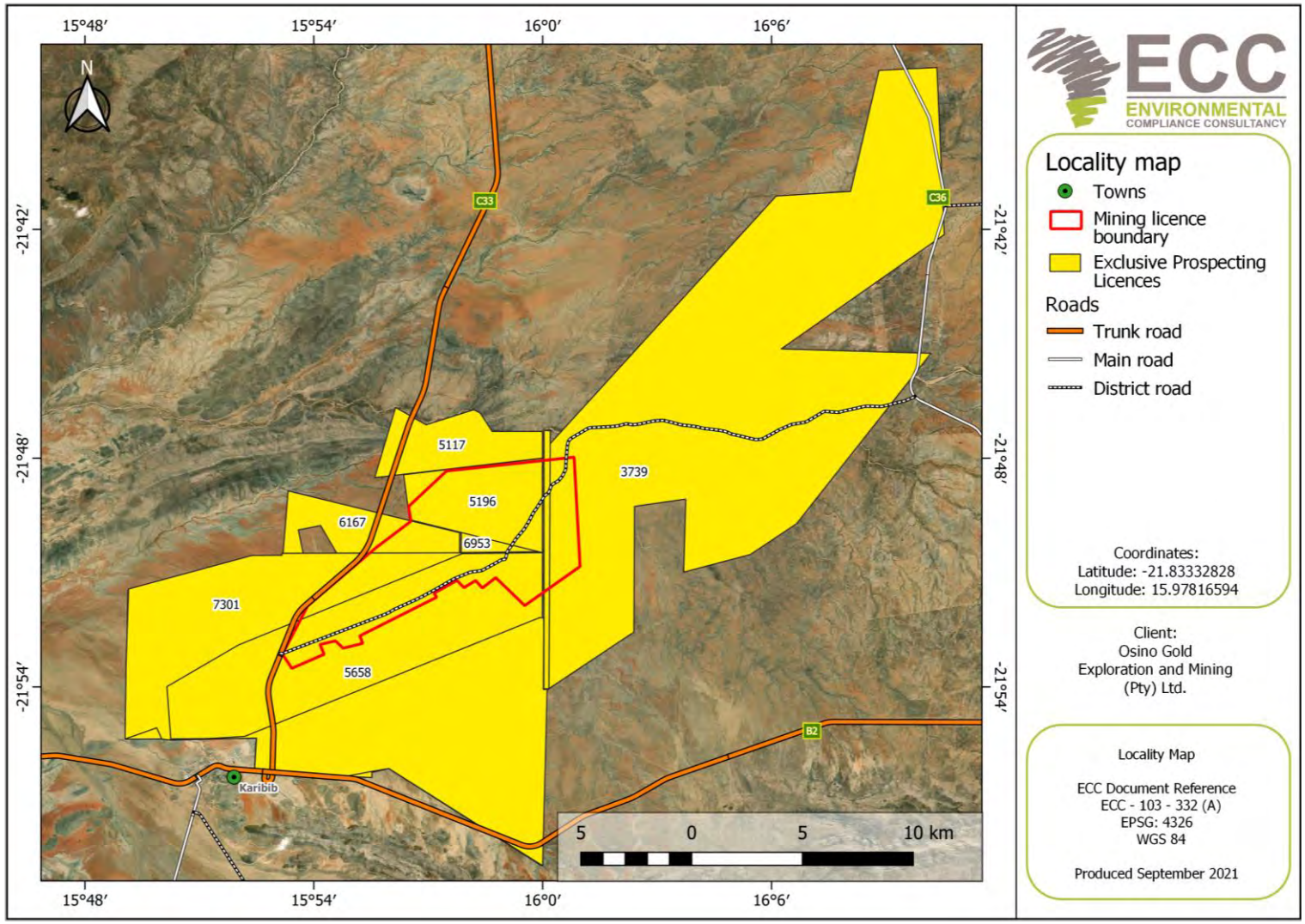


Figure 8 – Tenement boundaries showing mining licence and EPLs

Parts of the Project area were explored historically by Anglo American and Bafex Exploration as of 2008, prior to Osino. Osino has actively and systematically explored the Project area since 2016, using a variety of exploration methodologies, including, but not limited to, geochemical surveys, soil sampling, limited trenching, and drilling (RAB, RC and diamond drilling) techniques. (CSA Global, 2021).

Osino has used government regional aeromagnetic data, and carried out a detailed ground magnetic survey, as part of the exploration programme to define the Project and numerous other targets along the Karibib fault zone and related structures.

The mineral resource estimated for the Twin Hills Gold Project includes three sub-areas, namely Bulge, Twin Hills Central, and Clouds. The mineral resource has an economically viable cut-off grade of 0.3 g/t Au (gold), as demonstrated in the company's published PEA.

The Proponent has rapidly advanced the technical viability of the proposed Project through accelerated exploration drilling and fast-tracked development studies. The Proponent has drilled more than 85,000 drill meters with assays from the drilling that were used to support the maiden mineral resource, effective 1 April 2021.

4.4 GEOLOGY AND MINERALISATION

The Proponent has completed numerous in-depth studies in relation to the geology and mineralisation of the Twin Hills Gold Project. The CSA Global NI 43-101 Technical Report dated 21 May 2021 describes the geology and mineralisation in depth. Those descriptions are summarised in this section to provide a concise technical overview of the geology and mineralisation of the Twin Hills Gold Project. For more fulsome and technical descriptions, please find the CSA Global NI 43-101 Technical Report, 2021 on the Osino website, or as filed on SEDAR under the company's' profile at www.sedar.com.

The Project is located in an area of known gold deposits hosted within the inland arm of the Pan-African Neoproterozoic Damara Belt, a northeast-striking Neoproterozoic fold, thrust, and metamorphic belt. It reflects a Neoproterozoic rifting-accretionary event between the Congo Craton to the north and the Kalahari Craton to the south. Peak deformation within the Damara Belt occurred between 500Ma and 530Ma.

The Damara Belt comprises a gently folded Northern Zone, a Central Zone, and a Southern Zone. The Central Zone consists predominantly of calcareous and pelitic sediments that were deposited in a back-arc environment. The Southern Zone is considered to represent the suture zone and was intensely deformed, at high pressures and low temperatures, by a series of southeast verging thrusts. A range of syntectonic and post-tectonic intrusions are present, and these range from mafic to acid (i.e. gabbros to granites). Of these, the early syntectonic to late tectonic I-type Salem granites are the most abundant. These were followed by post-tectonic I-type granites. A much later Jurassic to Cretaceous event led to the emplacement of various alkaline ring complexes and granitic batholiths, as well as flood basalt provinces.

Geologically, the Project lies in the Southern Central Zone of the Damara Belt, lying to the south of a prominent regional scale lineament (the Omaruru lineament) and 20km to 55km east-northeast of the Navachab gold mine. The north-eastern part of the Project area is largely underlain by undifferentiated syntectonic Salem-type granite. The balance of the Project area is underlain by meta-sedimentary rocks of the Swakop Group. This group comprises the Arandis Formation (biotite schist, minor quartz schist calc-silicate rock and amphibolite), the Karibib Formation (dominantly dolomitic and calcitic marbles), and the overlying Kuiseb Formation (schistose, quartz, feldspar, mica, metagreywacke, and metapelite).

The sediments underwent polyphase deformation and metamorphism during the Damara Orogen. The larger, earlier folds have northeast-southwest striking axial planes, parallel to the Omaruru lineament. These were subsequently deformed into open basin and dome structures about fold axes with northwest-southeast orientations. Later crosscutting lineaments are also evident in the area. The Swakop Group sediments were intruded by a series of syntectonic, late-syntectonic, and post-tectonic granite and pegmatite bodies. Both generations of folds are recognised in drill core. Later, during the Damara Orogen, the crustal scale Karibib Fault Zone (KFZ) on the southern margin of the Karibib Basin was reactivated as a dextral fault with associated secondary and tertiary structures.

The structural geology of the Project area is dominated by features typical of the Southern Central Zone of the Damara Belt, namely: basement and/or basal Damara metasedimentary rocks in the cores of dome and anticlinal structures, and regional synclinal structures with thick packages of Kuiseb Formation schists “filling” these synclines.

The geology of the Goldkuppe prospect, 20km northeast of the Twin Hills deposit, is dominated by a series of interbedded marble and dolomite units belonging to the Karibib Formation. The marbles are folded into a first-order overturned anticline, which plunges gently to the northeast and verges towards the northwest. Small, medium and large-scale, tight to isoclinal reclined folds and sheath folds, with steep to sub-vertical fold axes and fold axial planes, dominate the structure in the Goldkuppe target area.

Osino has made a series of gold discoveries along the Karibib Fault Zone, which was originally interpreted from regional magnetic data to have a strike length of over 100km. Osino’s licences cover more than 70km of this strike extent. The Karibib Fault Zone is manifested as a belt of very high strain, intense silicification, and partial remelting. The calcrete covered central portion of the Karibib Fault Zone has been the most prospective to date, and is where the Twin Hills deposit is located. Twin Hills is a cluster of gold mineralised zones associated with schists of the Kuiseb Formation.

Gold mineralisation is closely associated with arsenopyrite and pyrrhotite, and the deposits and occurrences are classified as orogenic. Orogenic gold deposits are generally hosted by volcanic

and turbiditic sequences that have been metamorphosed to greenschist or, less commonly, amphibolite facies. (CSA Global, 2021).

The deposits are generally interpreted to form late in the orogenic cycle from mid- to lower-crustal metamorphic fluids. Gold mineralisation develops syn-kinematically, with at least one stage of major deformation of the country rocks, and they inevitably have a strong structural control involving faults or shear zones, folds, and other areas of competency contrasts. Mineralisation along the Karibib Fault Zone has been located, by Osino, for over 20km of strike to date, with the main target area at Twin Hills being associated with a structural jog along the Karibib Fault Zone. At a deposit scale, mineralisation is associated with shearing in the greywacke/turbidite sequence, parallel to the axial planes of isoclinal folds, and occurs in millimetre-scale veinlets as well as in more disseminated forms.

At Goldkuppe, 3km of mineralised strike has been defined, with mineralisation occurring in several discontinuous plunging shoots located predominantly within a dolomitic marble horizon. Mineralisation is typically associated with secondary fold noses, small-scale saddle reefs, and limb faults, and occurs in association with massive or semi-massive sulphides (chalcopyrite-pyrite and subordinate pyrrhotite). Low-grade mineralisation is also associated with pervasive skarn alteration adjacent to intrusive bodies.[1]

Osino used an orogenic gold, mineral systems approach to select and prioritise its regional exploration targets, with the Karibib Fault Zone considered the priority regional structure.

4.5 SITE LAYOUT

An optimal site layout is based on designing the site around critical landform features such as topography and sensitive areas, while considering the efficiencies required for the mining operation. The proposed site layout is provided in Figure 9.

As mentioned, it is important to note that the assessment has been carried out in accordance with indicative plans received from the proponent. After completing the assessment, some aspects of the proponent's plans may need to change in order to comply with the stated recommended mitigations.

[1] Reference: CSA Global Twin Hills Gold Project, Namibia NI 43 -101 Technical Report 21 May 2021.

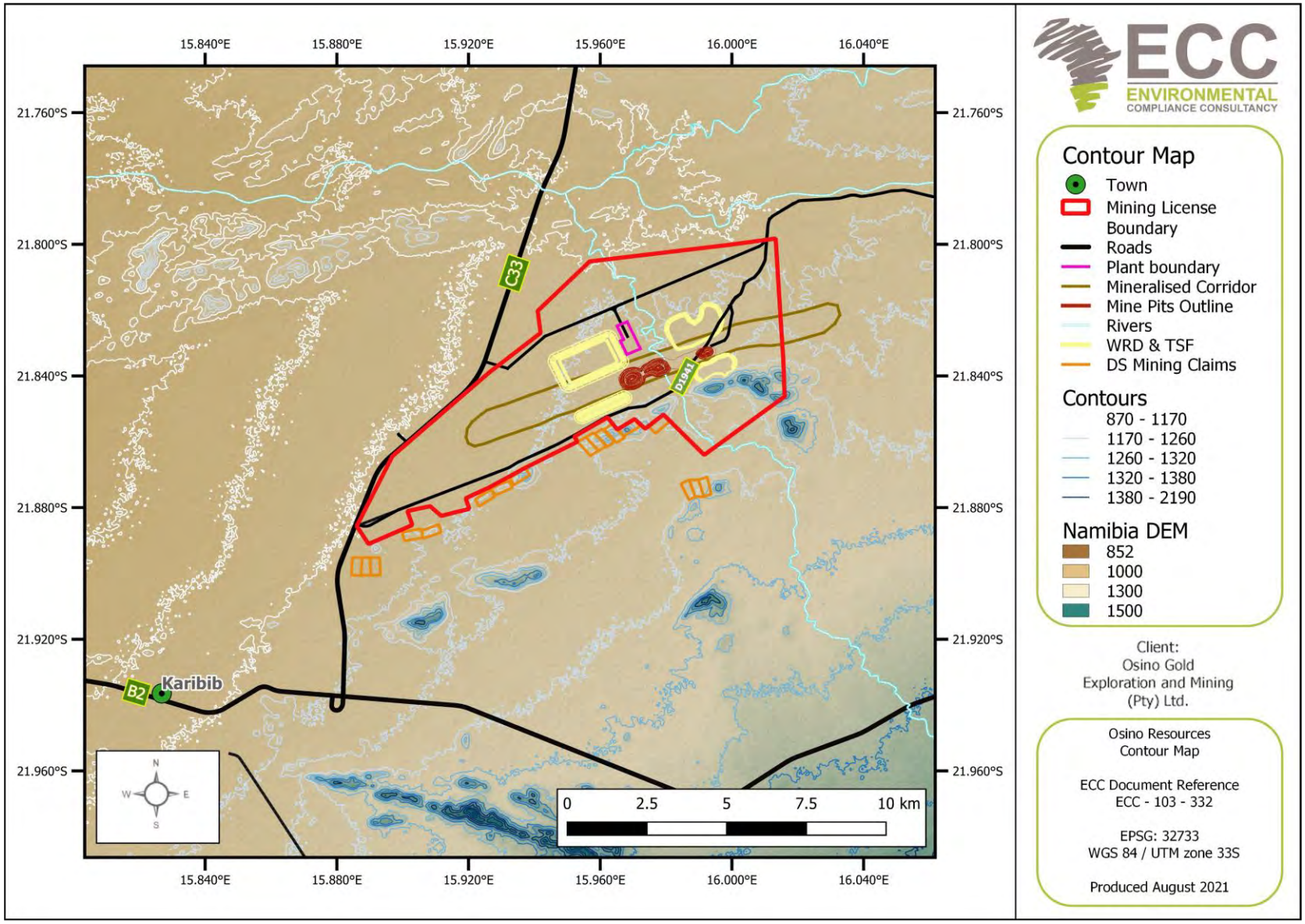


Figure 9 - Contour map showing the Project layout

The area surrounding the Twin Hills Central and Clouds open pits has relatively flat topography to the east and west of the Okawayo River course.

Potential waste rock dump (WRD) locations exist in the footwall and hanging wall of both pits, providing a flexible waste rock dumping strategy through the course of the mine life.

A potential plant site location is situated to the north of the Twin Hills Central open pit in an area of flat ground covered by Kalahari sands. The open area designated for the plant site is situated optimally for the transportation of most of the ore tonnes to be mined from the Twin Hills Central open pit.

The tailings storage facility (TSF) will comprise a downstream-type facility, constructed from the waste rock excavated from the open pit. It is envisaged that the tailings facility will accommodate filtered tailings inside the waste rock embankments, with the transportation of tailings undertaken by either haulage or conveyors. A detailed map of the proposed site layout is provided in Figure 10.

4.6 MINING INFRASTRUCTURE AND SERVICES

Qubeka Mining Consultants (2021) conducted a mining study as part of the PEA. The following components are taken from their study, namely: orebody description, mining method, mine pit design, mining infrastructure, equipment and utilities, and staffing.

4.6.1 OREBODY

Sulfide-hosted gold mineralisation was interpreted and modelled from a combination of structural and assay data for each of the Twin Hills mineral resource areas (Bulge, Twin Hills Central, and Clouds) as indicated in Figure 11. The mineralisation, hosted in metagreywacke, dips between 60° and 80° and ranges from a few metres to 200m thick.

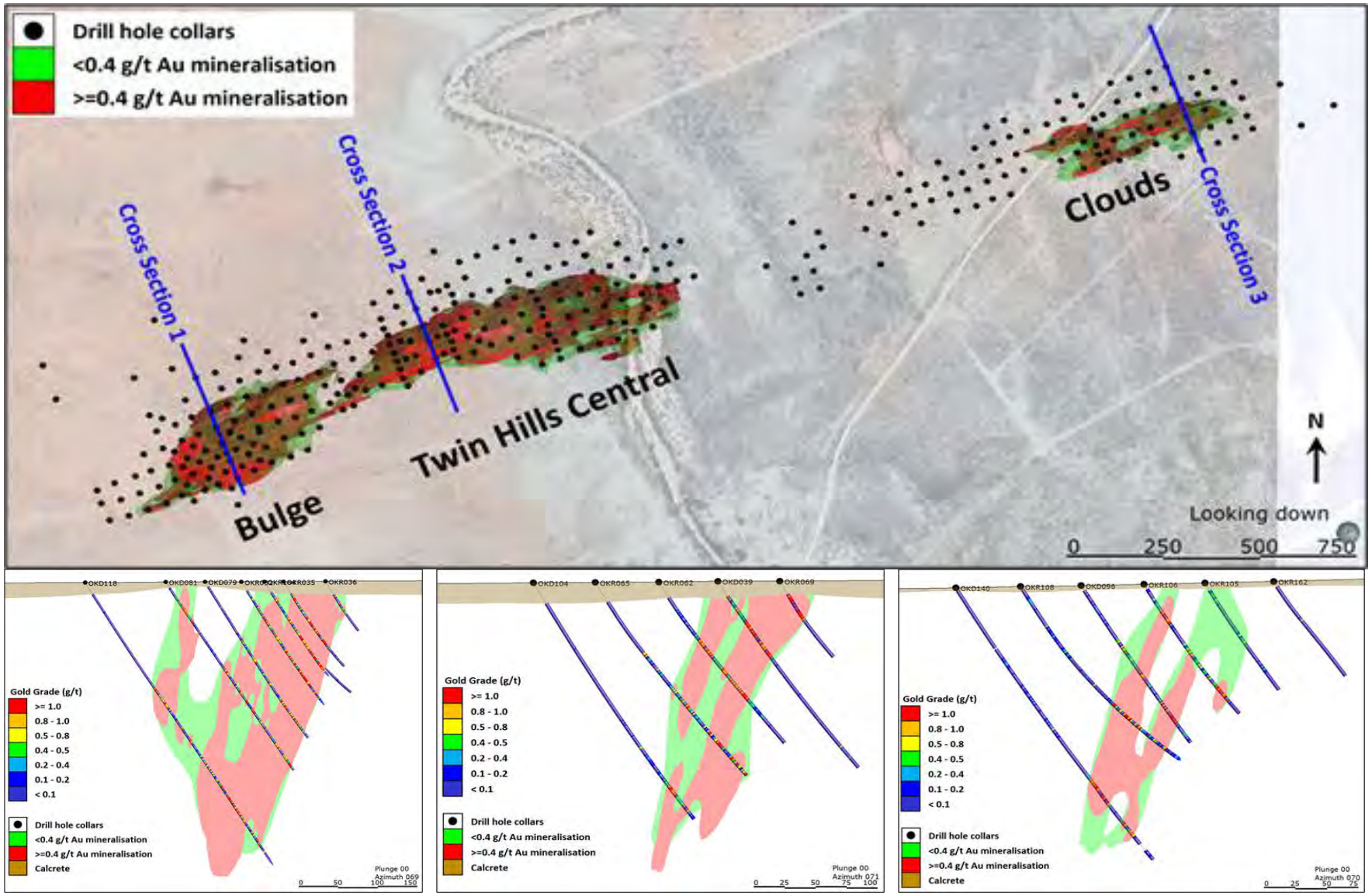


Figure 11 – Gold mineralisation and pit design (Source Qubeka, 2021)

The degree of stability for slopes in an open pit mine is critically important, in order to minimise the risks related to the safety of operating personnel and equipment, as well as the economic risk to the reserve. Ore recovery must be maximised, and waste stripping kept to a minimum throughout the productive life of the operation. The resulting compromise is typically a balance between formulating designs that can be safely and practically implemented in the operating environment and establishing slope angles that are as steep as possible and consistent with the ore body geometry and rock conditions.

4.6.2 MINING METHOD AND EQUIPMENT

The Twin Hills Gold Project will make use of conventional open pit mining methods, with the ore zone and waste zone being drilled and blasted at 10m benches, and ore material being loaded selectively. Ore and waste will be loaded with hydraulic excavators and hauled by diesel-powered trucks to the primary crusher, ROM pad stockpile, low-grade stockpile, or waste dump. At this stage it is assumed that the whole mining operation, except for the mine technical services function, will be outsourced to a reputable mining contractor company. All other mine technical services that include management, planning and grade control will be the responsibility of the Proponent.

The Project is planned as a multi-pit mining operation with nine pushbacks in the main Twin Hills / Bulge pit design, and one satellite pit, called the Clouds pit, to be mined in different phases throughout the life of mine (LoM). No equipment size trade-offs were performed during the PEA, and it is assumed that a contractor mining model will be deployed with 100-tonne class haul trucks and suitably sized loading equipment. The medium-sized equipment gives increased flexibility and allows better loading selectivity, which will limit dilution. The primary equipment will be supported by an array of secondary and support equipment.

The initial management team will include a globally experienced contingent, to ensure that operation start-up is safe and efficient, and that ramp-up targets are met. An approved localisation plan will be established to train and equip the local workforce sufficiently, to enable and ensure a seamless transition of responsibilities over time. The bulk of the equipment operators are expected to be unskilled (approximately 80%) and will require training from a basic level. The start-up strategy for mining operations takes account of this requirement.

The mine will operate 361 days per annum (allowing for lost days for public holidays and weather delays) on a 24-hour basis with three shifts rotating on an 8-hour duration.

4.6.2.1 Blast operations

Rock fragmentation will be undertaken by drilling and blasting, with the weathered zones requiring blasting with lower powder factors. Blasting will be a core component of the mining operation, impacting all downstream mining and comminution (crushing) processes, and also extending into the plant by way of ore recovery and dilution factors.

Blasting can substantially modify and control material flow within the mining operation, including the feed size to the primary crusher. Blast performance must be assessed in terms of the following outcomes:

- Fragmentation, relating to the feed size supplied to the primary crusher, as well as oversize material and the requirement for rehandling of material, and secondary breakage
- Shovel productivity, including wear and maintenance costs
- Use of track dozers to condition the bench floor and rip high bottoms
- Grade control
- Primary crusher power consumption, throughput, and maintenance costs
- Disruption to material flow during digging and crushing that affects truck efficiency.

The pit configuration bench height is expected to be 5m for ore and selective waste benches, and 10m for bulk waste benches. The material type at the Project is suitable for a drill rig capable of drilling holes with a diameter of up to 171mm. Drill burden, spacing and sub-drill design will be functions of the selected powder factor, which is based on the unconfined compressive strength measurement results from the geotechnical study.

A lower relative energy factor was assigned to the waste rock because the waste material needs to be efficiently and economically excavated, hauled and placed on the waste rock dump. On the other hand, with the ore material's higher relative energy factor, any finer fragmentation could benefit the downstream crushing and milling costs of the Project.

In areas where mining slopes remain intact for extended periods, it is good practice to minimise the fracturing of the high walls during blasting. In such identified areas, wall control blasting, also known as pre-splitting, can be considered. Pre-splitting was provided within the final pit boundary along the high wall, to create safe working conditions in the lower areas.

4.6.2.2 Drilling

Drilling is the first operation performed at most open pit mining operations. Rotary drills are predominantly used, although for smaller holes (<171mm) down, the hole hammer drills have often been employed, and would be well suited for smaller surface operations. For this Project, a 260kW (1800rpm) diesel crawler down hole hammer drill rig has been selected for the production holes, for ore and waste benches, and the wall control blasting holes.

4.6.2.3 Load and haul operations

The overall scale of mining envisaged for the Project is a medium to large-sized mine with total material movements of approximately 25Mtpa. As a result of the limited extent of mineralisation, selective mining practices have been incorporated into the ore mining methodology.

Waste and ore mining operations will utilise medium-sized backhoe excavators – 200t bulk mining to 120t selective mining class range, combined with a fleet of 100t rigid dump trucks, has been selected. The hydraulic face shovel, wheel loader and hydraulic excavator can fit into primary loading functions, as shown in Figure 12. Multi-face loading or secondary functions do not favour

hydraulic shovels or excavators, but certainly favour wheel loaders, due to speed and flexibility. Rigid frame and articulated diesel trucks have been used in the mining of small to large open pits for many years, and their mechanical capabilities are well respected. It is for this reason that diesel-powered rigid haul trucks have been selected for the Project.

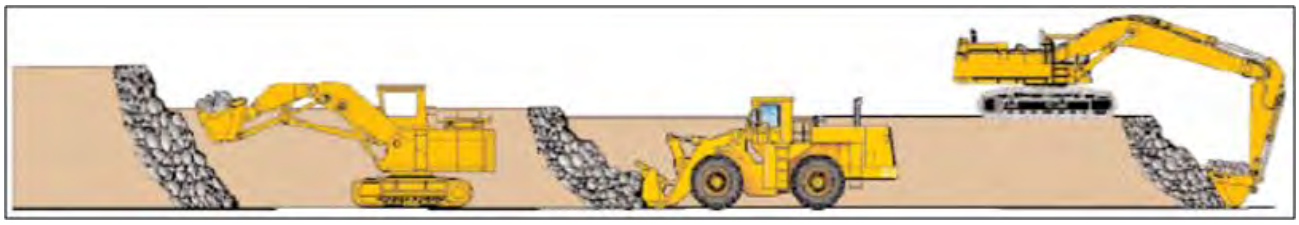


Figure 12 – Examples of equipment to be used on the Project (Source Qubeka, 2021)

4.6.2.4 Ancillary equipment

Ancillary equipment that is required for functions that fall outside of the primary production equipment's scope, is also necessary for mining operations. Primary production costs are directly impacted by a number of aspects related to ancillary equipment. Support equipment is the lifeline of reliable and cost-effective mine production, and is required for the following functions or activities:

- Keeping the loading, tipping and haul road areas clean, thus prolonging tyre life and making the operation safe
- Contributing to the mitigation and reduction of mobile equipment noise (via good road maintenance)
- Maintaining haul road conditions, thus prolonging tyre life and making the operation safe
- Suppressing dust emissions from health, safety, environmental, and financial perspectives
- Supporting the full equipment maintenance and diesel requirements for remote, track-propelled equipment, and breakdowns
- Bench preparation and levelling
- Fuelling of track-mounted equipment, and dump trucks
- Rehabilitation.

The tertiary support equipment fleet consists of units that assist in tasks that are required, in order to make primary and secondary fleets' work easier and safer. Other functions they complete are not production-related and have no direct impact on production. The tertiary equipment fleet consists of:

- Small trucks used for maintenance activities
- Light delivery vehicles used to transport management, technical services, and maintenance personnel around the mine
- Buses used to transport operators from the change houses to the equipment in the field, and back
- Lighting plant to increase visibility around the excavators during night-time
- Pumping equipment for pit dewatering.

4.6.2.5 Other mining activities or infrastructure

Most surface haul roads, dumps and stockpiles required for the LoM will have to be constructed during the first year of mining. The waste dump will progress by the haul truck tipping on the top elevation of the dump, with the dozer pushing the waste down. These actions will cause the waste dump to progress horizontally over time. Waste dumps should be progressively rehabilitated with suitable rehabilitation materials, subsoil, and topsoil where possible. Rehabilitation must be performed as soon as possible on the external faces of the waste dump, to reduce visual and air quality impacts. Ore stockpile dumps will be constructed in close vicinity to the primary crusher tipping point, in order to minimise the reclamation costs and meet the environmental management requirements.

Waste rock will be required for the construction of mine infrastructure such as run of mine (RoM) pad and tailings storage dam walls. During normal operations, the ore feed will be achieved by a combination of ore tipped directly into the RoM bin by the haul trucks from the pit with the RoM loader adding other appropriate ore material from RoM grade control stockpiles. The assumption is that 65% of direct ex-pit ore sent to the RoM pad would be stockpiled and rehandled due to ore blending and scheduling requirements, which affects mine materials handling and possibly environmental impacts and mitigation.

In-pit water management will mainly consist of run-off control around the pit perimeter and temporary sumps at the lowest elevation in the pit. Pit dewatering pumps will pump excess water to a suitable holding dam ready for use as dust suppression and plant make up water.

Haul road dust suppression is considered for the Project and will be handled through a comprehensive dust management system. A bitumen-based product may be applied during haul road construction and maintained on a customised maintenance programme.

4.6.3 PIT AND HAULAGE DESIGN

The pit design was developed from the pit optimisation study to produce a practical pit with ramps, bench and berm configurations. The ramp positioning within the overall pit design is an integral component of mine design because it influences the stripping ratio of the overall design, the performance of the equipment, as well as the operating costs. The exit positions of the ramps were determined taking into consideration the current position of the primary crusher and the waste rock dumps. Typical pit design and terminology components are rendered in Figure 13.

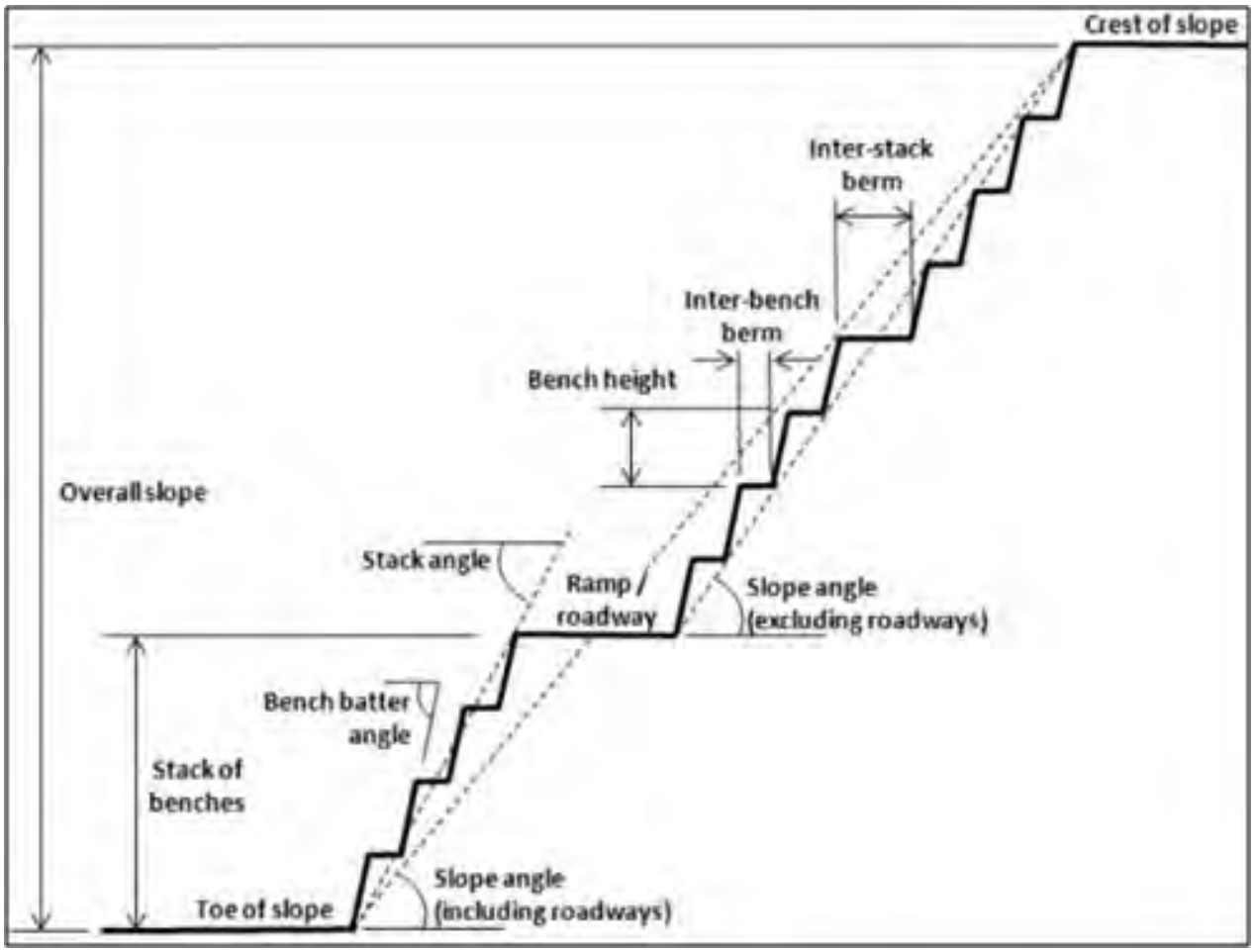


Figure 13 – Pit design and terminology (Source Qubeka, 2021)

Sufficient room for manoeuvring is required to promote safety and maintain continuity in the haulage cycle. The width criterion for a haul segment is based on the widest vehicle in use, which is the Komatsu 785-7 100 tonne rigid dump truck, with an operating truck width of 6.9m. To design for anything less than this dimension would create a safety hazard due to a lack of adequate clearance. In addition, narrow lanes often create an uncomfortable and unsafe driving environment, resulting in slower traffic, and thereby impeding production.

The haul road design parameters were established taking into consideration the type and size of hauling equipment that will be used during operations. The dimensions of the haul road were based on a Komatsu 785-7 rigid truck using global standards of good practice.

A haul road gradient of 1:10 (10% or 5.71°) was selected for the Project. The selection of the haul road gradient was based on the world best practice for the type of trucks that will be utilised. A haul road gradient of 1:8 (12% or 7.1°) was selected for the single lane ramp system utilised in the lower four benches of each pushback. The practical design width for the dual ramps will be 25m and for the single ramps will be 18m.

The design, construction and maintenance of haul roads have a considerable impact on haulage cost, which makes up a greater percentage of the total mining cost. It is therefore important that

appropriate, detailed sets of designs for haul road construction are compiled for the site. Haulage is the largest mining cost, and the design, construction and maintenance of haul roads has a major impact on the haulage costs.

The benefits of an improved haul road design are: efficiency of haulage by reduction in cycle time, reduced fuel burn, and reduced truck component wear. It is therefore desirable to generate a minimum site-wide construction standard for both new and existing haul roads. The minimum bench operating width for the pit is limited by the size of the equipment. The pit design parameters are summarised in Table 6.

Table 6 – Pit design parameters (Source Qubeka, 2021)

Parameter	Unit	Value
Minimum mining width (20m + Single Ramp Width)	(m)	35.0
Minimum pushback width	(m)	60.0
Dual ramp width	(m)	25.0
Single ramp width	(m)	18.0
Minimum turning circle	(m)	10.0
Ramp gradient (short ramps < 400m)	(1:#)	8.0
Ramp gradient (short ramps < 400m)	(%)	12.0
Ramp gradient (short ramps < 400m)	(deg)	7.1
Ramp gradient (long ramps > 400m)	(1:#)	10.0
Ramp gradient (long ramps > 400m)	(%)	10.0
Ramp gradient (long ramps > 400m)	(deg)	5.7

Ramp positioning within the pit design is an integral component of mine design. It influences the stripping ratio of the overall design, the performance of the equipment, as well as the operating costs. The exit positions of the ramps were determined taking into consideration the proposed position of the primary crusher and the waste rock dumps.

Figure 14 and Figure 15 show the Twin Hills, Bulge, and Clouds pit design and dimensions.

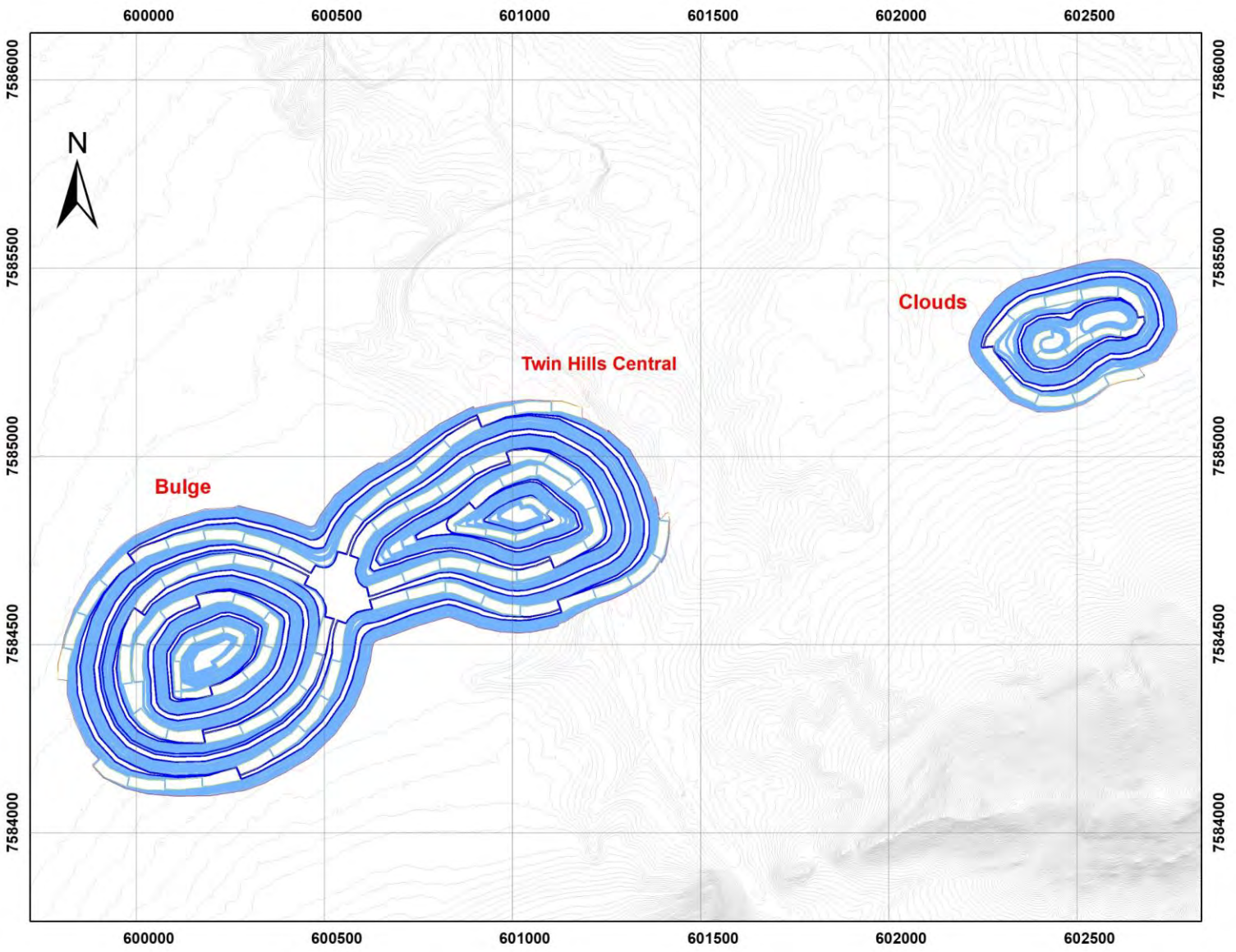


Figure 14 – Twin Hills, Bulge, and Clouds pit design (Source Osino, 2021)

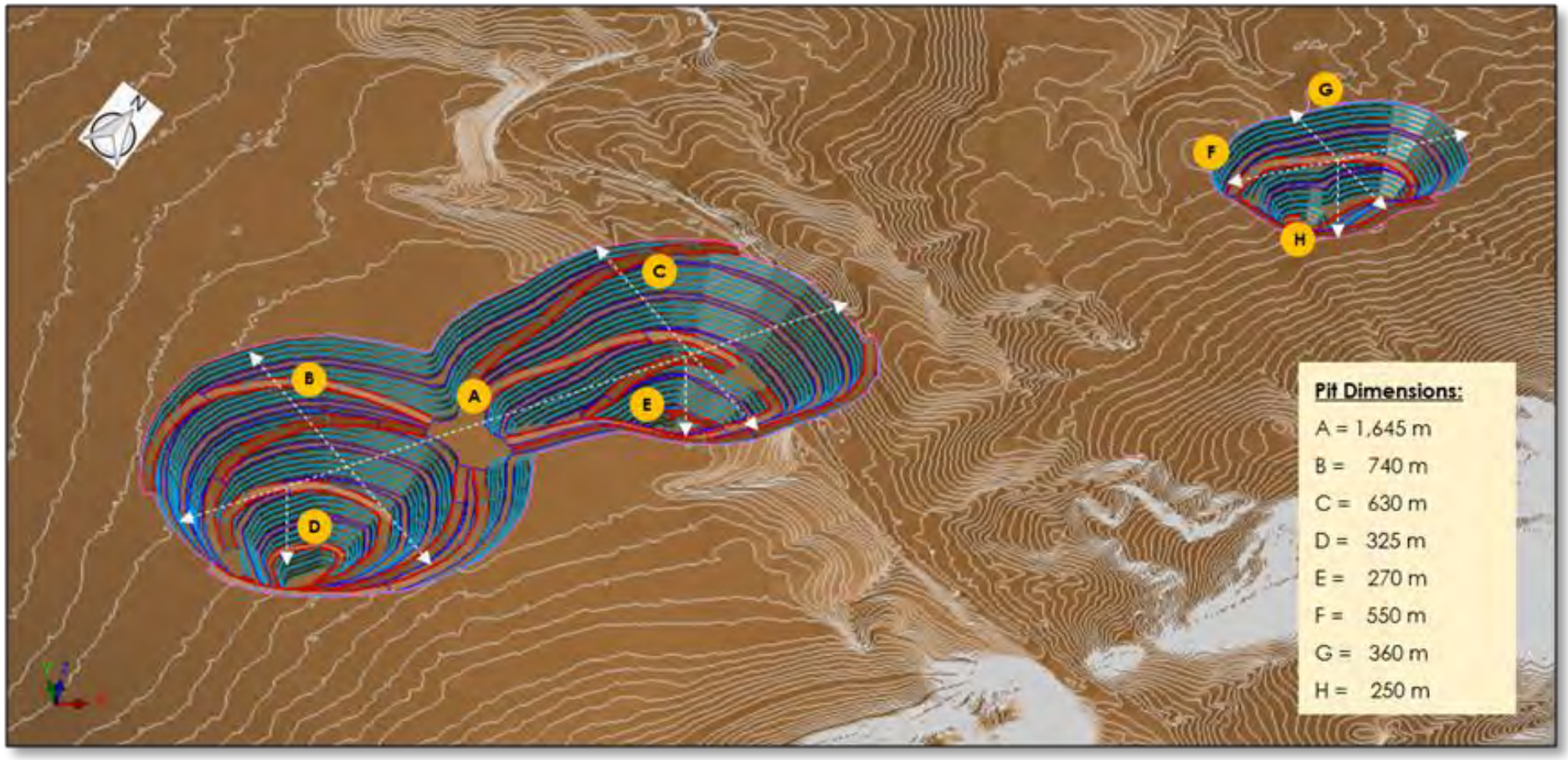


Figure 15 – Twin Hills, Bulge, and Clouds pit dimensions (Source Qubeka, 2021)

4.6.4 METALLURGY AND PROCESSING

Gold recovery will be achieved using a conventional crushing, milling, gravity, pre-oxidation and carbon-in-leach (CIL) processing plant, as depicted in Figure 11. The process plant design is based on a robust metallurgical flowsheet developed for optimum recovery, while minimising initial capital expenditure and operating costs. The metallurgical flowsheet is based on unit operations proven in the industry, as shown in Figure 16.

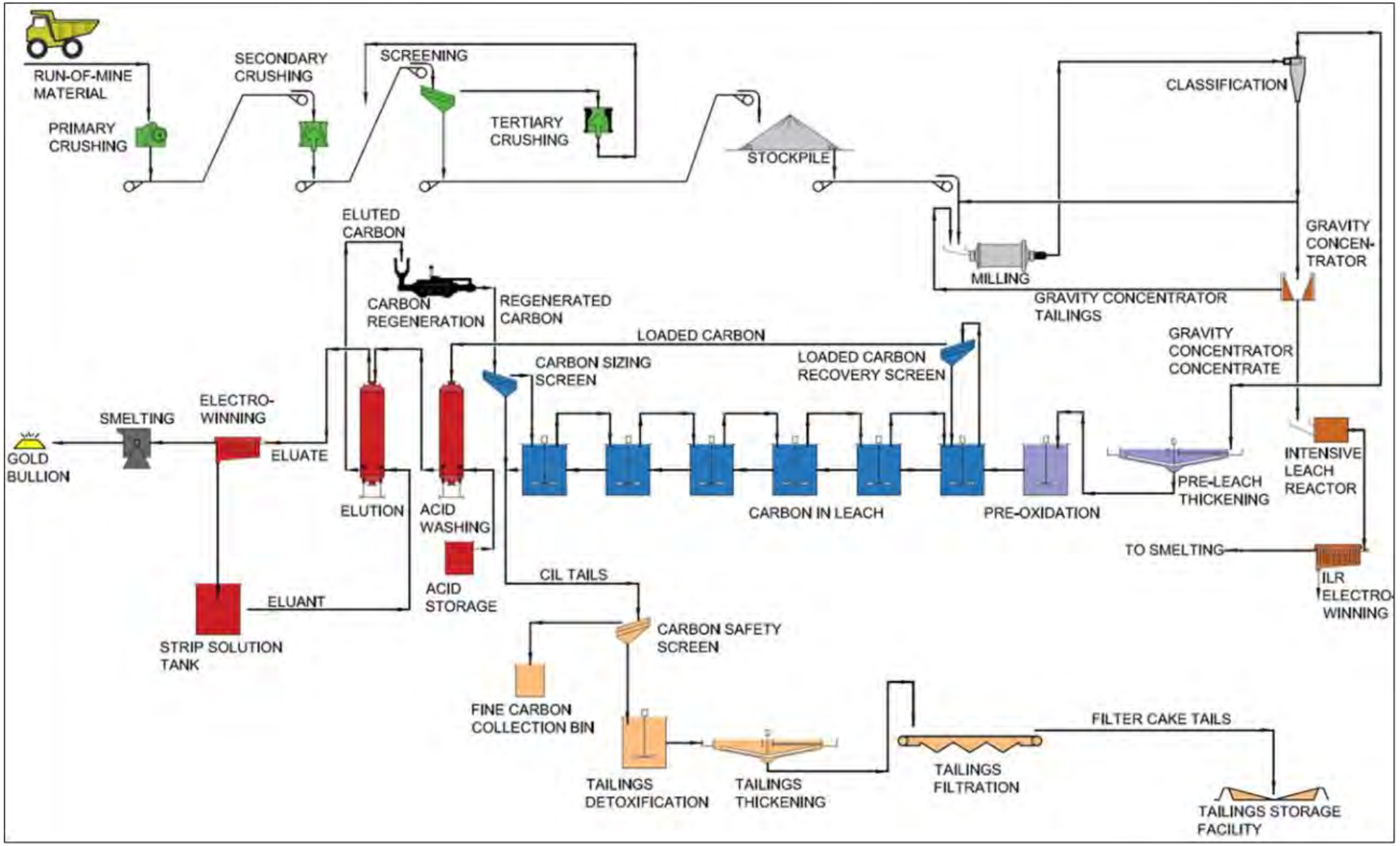


Figure 16 – Metallurgical process flow (Source Lycopodium, 2021)

As stated in the PEA (2020), initial metallurgical test work was carried out by SGS (2020), with the objective of determining gold dissolution via cyanidation. The work showed average gold dissolution of 89% at an average grind of 93% passing 75 micron, but also indicated significant variability in gold dissolution.

The test work showed that the samples had an average head grade of 1.19g/t Au and 0.58g/t Ag, with a low concentration of base metals, carbonaceous material, sulphates, and carbonates. Several samples contained appreciable amounts of arsenic. Mineralogy was found to be reasonably consistent across the deposit, and relatively high concentrations of pyrrhotite were noted in the fresh west and east sample material.

A standard set of crushing, milling, and abrasion tests was carried out. This concluded that three stages of crushing, followed by ball milling, were likely to be the optimal configuration to achieve 80% passing 75µm in mill cyclone overflow.

Mineralised material is considered “medium to hard” in comparison with similar material from other deposits, with average comminution circuit power consumption estimated to be 14.9kWh/t at this grind size. Optimisation test work is ongoing.

The mill cyclone overflow product stream will be processed via a CIL circuit, carbon elution, electrowinning, and a gold room. CIL tails will be treated to achieve cyanide destruction before being pumped to the tailing’s thickener, with the underflow being filtered. Filter cake will be conveyed and disposed of as tails in the tailings storage facility. Tailings will either be disposed of in a lined TSF or it will be co-disposed with waste rock.

4.6.5 SUPPORT INFRASTRUCTURE AND SERVICES

4.6.5.1 Mining office block

The mining office block will be a modular structure installed on a mesh reinforced concrete slab. The building will provide office space to the mining personnel, including the mine manager and the technical services manager, geology personnel, surveyors, maintenance engineers, and mining support staff.

It is likely that the building will have offices, one main boardroom, two meeting rooms, male and female ablutions, a kitchen, a pit control room, a first aid room, and an open quadrant for landscaping.

4.6.5.2 Geological core shed

The geological core shed building will be a sheeted steel portal structure. The core shed will be used by the geology section to assess and store core and geological samples. Operations will include night shift, internal ablution facilities have been provided in the building.

4.6.5.3 Mining changehouse

The mining changehouse will provide ablution facilities to all mining employees, and production and maintenance crews, including foremen. All employees who use the changehouse will clock in through the changehouse turnstiles when they enter or exit the mining complex. A single tier locker will be allocated to each employee, either on shift or off shift, for personal belongings and clean overalls. Washing facilities will be included in the mining changehouse for washing overalls and clothing.

4.6.5.4 Warehouse

The mining warehouse (or stores) will be a sheeted steel portal structure. The warehouse shall be used for the storage of all critical and operational spares, as well as office and other consumables. Goods will be received by the store's personnel in fenced receiving bays prior to storage in the main building. Access to the stores building is limited to stores personnel, and dispatch will either take place over a goods issue counter or through a fenced dispatch bay. Stores yards external to the warehouse will be used for pipes, large equipment, and tyres, etc. Acetylene gas, oil, paint, and other flammable materials will be stored in separate areas and designed accordingly if storing dangerous goods.

4.6.5.5 Heavy mobile equipment workshop

The heavy equipment workshop is the main shop for maintenance and rebuilds of mining equipment. The building design is capable of handling maintenance work for 60t ADT trucks and support equipment as per the maintenance plan. The structure will be sheeted steel portal supported on concrete plinths, with double storey offices in brickwork. The workshop will be bunded with an internal drainage system into a suitable hydrocarbon collection and treatment facility. Wash bays will be required for equipment, before, during and after maintenance, and therefore settling dams/ponds will be required as part of the wastewater treatment system in the wash bay.

4.6.5.6 Light vehicle workshop

The light vehicle workshop will be used for maintenance of all mine light vehicles, including those operating in the processing plant areas. The structure will be sheeted steel portal supported on concrete plinths. Similar wash bay facilities and arrangements for the heavy equipment workshop will be required for the light vehicle workshop and will need to be designed accordingly.

4.6.5.7 Fuel facility

Diesel for mine operations will be delivered by trucks to a designated and designed site fuel facility. A site-based service provider will erect infrastructure and facilities for the storage and handling of fuel. The service provider will also be responsible for the supply, delivery, and management of stock for the life of mine. The Proponent will ensure the facility has the required installation certificates prior to commissioning the fuel facility.

A hard stand pad for minor maintenance will be provided for the servicing of mining equipment outside the pit perimeter. The hard stand will be 30m x 30m and will also be used for refuelling equipment from a fuel bowser.

4.6.5.8 Explosive magazine and bulk emulsion storage facility

The number and capacity of magazines are determined based on the defined mine production schedule and on rock mass conditions in terms of strength and moisture. A total of two explosive magazines have been determined:

- One magazine holding 200 cases of accessories
- One magazine holding 200 cases of high explosives

The designs are based on an explosive supplier's recommendation and addresses all legal requirements. There is also provision for an emulsion storage silo of 42 tonne capacity.

An appointed contractor will be based on-site, and will provide explosives and blasting services to the mine. The contractor will establish and be responsible for the explosive magazine infrastructure, office, and workshop infrastructure. Space provision has been made for both sites, and the siting of the explosive magazine will be in conformance with the requirements of the Namibian Labour Act, Namibian Mining Legislation, and Regional Explosives Standards or regulations.

The location of the explosive magazines is southeast of the main offices, is more than 700m in radius away from any other infrastructure and is approximately 1km away from the open pit.

4.6.5.9 Communication

Radio, telephone, and internet connections will be required for the mining operation. Infrastructure, including communication masts, will be installed, and provisions will be made with the relevant service providers.

4.7 UTILITIES

4.7.1 POWER SUPPLY

The Project's power requirement is estimated to be approximately 15MW, and the current strategy is to source power for the Project from the national grid. Electrical power is readily available in the area from the national power utility, NamPower.

The nearby Navachab gold mine is linked to the national grid by a 66kV transmission at Karibib. To link the proposed Project site into the national grid requires a 19km transmission line from Karibib. Further studies will assess the viability of solar power options to be integrated into a potential hybrid system.

4.7.2 WATER SUPPLY

The current mine design indicates a daily requirement of 4 100m^3/day (1.5 million m^3/annum) for the estimated 3.5 million tons per annum (mtpa) ore throughput, to sustain mining operations and related activities. Water supply options that were also addressed in the SLR (2020) Report were as follows:

- Three potential local dam sites on the Khan River, with catchment areas ranging from approximately 2 100km^2 to 2 400km^2 (See Figure 17)
- Obtaining a water use license from the existing NamWater Swakoppoort to Karibib Pipeline, provided that there is sufficient capacity for mining activity
- A planned desalination pipeline, which will primarily be used to support the Central Area of Namibia (CAN). According to the CAN Surface Water Augmentation Report, the desalination pipeline will supply water, at the earliest, in 10 years
- Groundwater supply from boreholes.

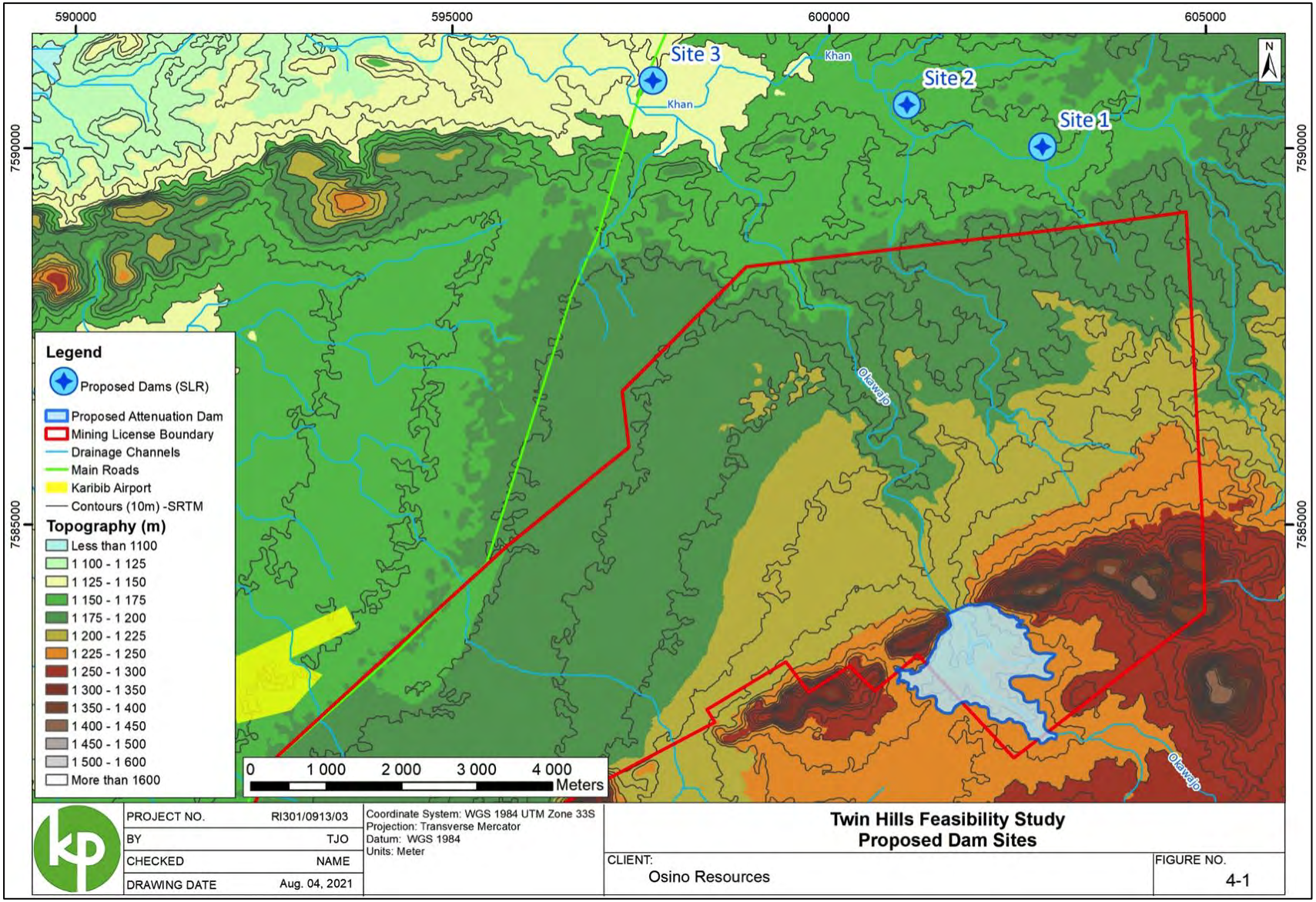


Figure 17 – Proposed dam construction by SLR (2020) for surface water supply (source KP, 2021)

Long drought periods of up to seven years, typically referred to as critical periods, are common to the Namibian climate. During a long critical period, the groundwater table drops significantly due to limited recharge, causing some boreholes to dry up. Similarly, surface water sources, which are already stressed, might not be able to support priority users, resulting in water restrictions being enforced to prevent the failure of the water resource. Local dam options are typically developed over a long timeframe, in excess of 5 to 10 years, due to land acquisition, environmental and social studies, and full design and construction cycles. Developing water resources is also very costly due to the aforementioned factors (Knight-Piesold, 2021).

The pipeline route for the desalination support to the CAN will follow the B2 Road from Swakopmund to Okahandja, adjacent to the mining operation. Water supply from the desalination pipeline will be costly due to the high pumping costs and the expensive desalination process itself. The desalination plant and pipeline are planned to be implemented in 2031, and it is estimated that one cubic meter of water is going to cost more than N$ 45 at 2020 infrastructure costs. The official reports have not yet been made publicly available. The unit cost is likely going to increase significantly, due to the inflation of electricity and general costs (Knight-Piesold, 2021).

Water supply is proposed from a combination of surface and groundwater sources and supply optimisation studies are ongoing.

4.8 MINERAL AND NON-MINERALISED WASTE

4.8.1 WASTE ROCK

Waste rock dumps will be designed as close to the pit exits as possible, in order to optimise productivity and minimise waste mining costs. Rehabilitation requirements are considered in dump location and design, and all dumping areas will undergo an ore sterilisation campaign prior to waste dumping. The waste rock dumping strategy is to reduce the hauling distance and similarly enable progressive rehabilitation of the waste dumps wherever possible. In-pit dumping will also be deployed where possible.

4.8.2 TAILINGS

The final design of the tailing storage facility will be based on a set of specific and detailed studies associated with international best practices for tailings storage facility design. The initial conceptual design comprises a downstream type of facility, constructed from the waste rock excavated from the open pit. The tailings facility will accommodate a total of 50Mt of filtered tailings inside the waste rock embankments over the 14-year life of mine.

The Project site layout and landforms surrounding the proposed open pit were assessed, and three sites or areas were identified for the TSF. Preliminary calculations demonstrate that each of the sites would need to comprise a footprint of approximately 185ha, which is considered to be sufficient to accommodate the storage of 50 million tonnes of tailings, including the associated waste rock embankments. The sites are described as follows:

- **Option 1** is located to the north of the open pit, and east of the Okawayo Stream, over an area with undulating topography, outcrops of calcrete and sparse vegetation
- **Option 2** is positioned north of the open pit, to the west of the Okawayo Stream, and is characterised by gently sloping topography, covered by red Aeolian Kalahari Sand and sparse vegetation. The sand layer is estimated to be 500mm thick (on average) and is underlain by a hardpan calcrete layer
- **Option 3** is positioned on an area to the south of the open pit, and south of the marble ridge that runs parallel with the open pit. This site is approximately 40m higher in elevation relative to the open pit area, with a gently sloping to flat topographic profile.

As a result of the arid climate of the Project area and the expected shortage of water, it is assumed that the selected method of processing will include the filtration of thickened tailings, to produce a "dry" filtered tailings material with a typical target moisture content ranging from 15% to 20%. The transport of filtered tailings is usually undertaken by haulage or conveyors.

The mining activities will also produce waste rock hauled from the open pit, which will be stored on the surface. The preliminary design of the TSF is based on the co-deposition of the tailings and selected waste rock, such that the tailings material is stored within a fully contained facility constructed from the waste rock. Table 7 summarises the key design criteria for the permanent storage of the tailings material.

Table 7 – TSF design criteria (Source Prime Resources, 2021)

Description	Specification	Source
LoM	14 years	Lycopodium
Production rate	3.5 Mt	Lycopodium
Tailings product type	Filtered	Lycopodium
Tailings dry density	1.8 t/m3 (assumed)	Prime Resources
Waste rock bulk density	1.8 t/m3 (assumed)	Prime Resources
Tailings total production	50 Mt	Lycopodium
Tailings volume requirement	27.8 Mm3	Prime Resources
Tailings deposition method	Haul, dump and spread	Prime Resources
Waste rock deposition method	Haul, dump, spread and compact	Prime Resources

This proposed type of facility comprises waste rock containment walls behind which the dry filtered tailings material is deposited. The bulk of the embankments are typically comprised of coarse material, with the upstream face zone constructed from selected finer material. The finer material allows for the installation of a geomembrane which reduces the risk of a puncture. The containment walls are sequentially raised in a downstream direction and may be developed in any number of phases or lifts, as shown in Figure 18.

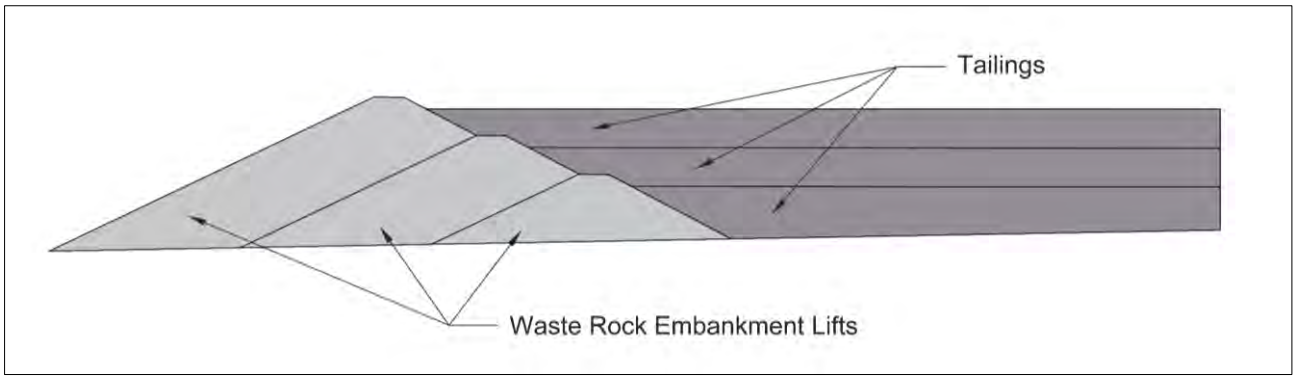


Figure 18 – Downstream development of a TSF (source Prime Resources, 2021)

The phased construction of the TSF allows for the deferral of capital expenditure and takes into account the possible limited availability of waste rock for the construction of the embankments. The embankments will be constructed continually, but the installation of the barrier will be undertaken in phases. The following summarises the proposed phasing of the TSF, a critical element of environmental and closure management to address during the LoM:

- **Phase 1:** Construction of a cell with a 10m high waste rock embankment and an internal footprint of 52.5ha. The basin and internal side slopes will be lined. This phase will have a tailings capacity of 4.35Mm^3, deposited over a period of 2 years
- **Phase 2:** This phase will involve the construction a similar sized cell as in Phase 1, which will be constructed adjacent to Phase 1, such that the two phases share an embankment
- **Phase 3:** This phase includes the raising of the TSF embankments to a height of 18m. The internal embankment side slopes will also be lined. Phase 3 will accommodate tailings with a further volume of 9.35Mm^3, deposited over a period of 4.8 years
- **Phase 4:** The final raise of the TSF embankments to a height of 26m. This phase will accommodate 9.8Mm^3 of tailings over a period of 5 years. As per the previous phase, the internal embankment faces will likely be lined.

Each phase will allow for a minimum freeboard of 2m. The TSF can still potentially be developed beyond the proposed height and provide additional storage capacity. The volumes of tailings and waste rock for each phase is summarised in Table 8 below.

Table 8 – Waste rock and tailings volumes and tonnages (Source Prime Resources, 2021)

Phase	Waste rock		Tailings	
	Volume (m^3)	Tonnage (t)	Volume (m^3)	Tonnage (t)
1	1 004 833	1 808 699	4 345 736	7 822 325
2	753 625	1 356 525	4 345 736	7 822 325
3	2 464 859	4 436 746	9 350 847	16 831 525
4	3 660 792	6 589 426	9 795 326	17 631 587
Total	7 884 109	14 191 396	27 837 645	50 107 761

4.8.3 GENERAL WASTE

Waste will be separated at source, stored in a manner that there can be no discharge of contamination to the environment, and either recycled or reused where possible. On-site facilities will be provided at a dedicated waste storage facility for sorting and temporary storage prior to removal and disposal to appropriate recycling or disposal facilities off-site (Karibib for general waste and Walvis Bay for hazardous waste).

Industrial waste will be sorted on-site and disposed of at appropriate facilities. Hazardous waste includes, but is not limited to, the following: fuels, chemicals, lubricating oils, hydraulic and brake fluid, paints, solvents, acids, detergents, resins, brine, solids from sewage, and sludge. The waste types as set out in Table 9 will be generated by the project, a dedicated waste management and recycling facility will need to be built on site that specifically manages these waste types and this will include an incinerator.

Table 9 – Waste specification, storage and end use

Waste type	Waste specifics (example of waste types)	Storage facility	End use
Non-hazardous solid waste (non-mineralised)	Wooden crates, pallets, cable drums, scrap metal, general domestic waste such as food and packaging.	Dust bins in relevant work areas will be provided for different waste types. A waste management contractor will remove dust bins regularly to a dedicated waste handling and storage area.	Waste will be sorted further at a dedicated waste handling and storage area on site. Recyclable waste will be sent to a reputable recycling company. Some items may be distributed directly to the community if possible. The remainder of the waste will be transported by the waste management contractor to a permitted landfill facility which may be constructed on site for example within the WRD.
	Building rubble and waste concrete	Designated rubble collection points will be determined to which contractors will take rubble and concrete.	The waste management contractor will regularly remove the waste from the designated collection points to the footprint of the waste rock dump.
Hazardous contaminated solid waste	Treated timber crates, printer cartridges,	Hazardous waste will be separated at source and stored in designated	Hazardous waste will be disposed of at the permitted hazardous disposal site (for

Waste type	Waste specifics (example of waste types)	Storage facility	End use
(non-mineralised).	batteries, fluorescent bulbs, paint, solvents, tar, empty hazardous material containers etc.	containers in bunded work areas. The waste management contractor will remove these drums regularly to a dedicated waste handling and storage area.	example in Walvis Bay) by the waste management contractor.
	Hydrocarbons (oils, grease)	Used oil and grease will be stored in drums in bunded areas at key points in work areas. The waste management contractor will remove these drums regularly to a dedicated waste handling and storage area. The yard will have a dedicated used oil storage area which will include a concrete slab, proper bunding and an oil sump. The appointed bulk fuel supplier will collect used oil for recycling.	Used oil will be sent to a reputable recycling company for recycling.
	Sewage	Sewage will be collected and stored in a septic tank on site.	Sewage will be collected on a regular basis and transported for treatment to a dedicated sewage treatment facility which may be constructed on site.
Laboratory waste	Mineral samples, mineral assay samples, chemical fluids, glass, gloves and general	Mineral waste samples that are not required to be kept will be disposed of at the tailing storage facility and at an approved mineral disposal landfill. A mineral waste	Hazardous laboratory waste will be collected regularly and transported to a hazardous disposal treatment facility (for example in Walvis Bay). Non- hazardous waste will be disposed of at an appropriate landfill which may be on site.

Waste type	Waste specifics (example of waste types)	Storage facility	End use
	laboratory waste samples	management contractor will remove the waste on a regular basis to a waste handling and storage area.	
Medical waste	Syringes, material with blood stains, bandages, etc.	Medical waste will be stored in sealed containers. A waste management contractor will remove these drums regularly to a dedicated waste handling and storage area.	Medical waste will be transported by the waste management contractor to a permitted medical waste treatment facility.

4.8.4 EFFLUENT AND WASTEWATER

Sewage will be collected and will use gravity reticulation via buried sewer pipes to be transported to the treatment facility. Sewage will be treated in a purpose-built sewage treatment plant. The plant will have the capacity to treat the sewage generated on-site per day. The water output from the plant will be suitable for use in dust suppression, vehicle washing, irrigation, fire water, and process water. The wastewater treatment plant will also produce a small quantity of sludge, which will be dried in a sludge-drying bed located at a point lower than the plant. Dried sludge can be used as fertiliser for rehabilitation of mining landforms.

4.9 ALTERNATIVES CONSIDERED

The primary alternatives to be assessed, in addition to the mining landform positions, will be the proposed diversion of a tributary of the Okawayo river and the district road, D1491, both of which traverse the planned open pit.

Alternative mine designs, processing plant options, and the types of tailing disposal methods are all considered during the pre-feasibility and feasibility study stages of the Project. The availability of water, potential for acid mine drainage, long-term slope stability, safety, and climate change, etc. will all be considered when assessing the economic, technical, and environmental suitability of an alternative. For every alternative option there is a trade-off or an impact on another aspect of the Project. The detailed baseline environmental studies in the appendices, and summarised in the environmental baseline chapter, provide further information to the decision-making process.

4.9.1 MINE LAYOUT

Several site layout alternatives will be considered during the assessment phase. Layout options are currently constrained by the EPL boundaries, national roads, and the dimension stone

prospecting claims held over the marble ridge. In addition, there are constraints with respect to the strike of the ore body, blue sky (possible future economic ore), a 500m blast zone around the pits, the volumes of waste rock, and the tailings to be disposed of. Details of the alternatives for the positions, placements and designs for the waste rock dump and tailings storage facility are detailed in the assessment chapter.

4.9.2 ROAD DIVERSION

The D1941 currently provides access to the dimension stone quarries to the south of the mining licence area. The road passes through the mining licence area and across the future mine pit area. This same road continues and joins another district road. The alternative that is proposed, is the truncation of the D1941 at the Okawayo farmstead and the construction of a new section of the D1941 that will join the C33 road north of the mining area, thereby allowing access to the mine from the north and thoroughfare for district road users. Access to the dimension stone quarries would remain in place.

4.9.3 WATER SUPPLY

The alternatives for water supply are discussed in the utilities section above, and in more detail in the environmental baseline chapter of this report. The alternatives for water supply are as follows:

- NamWater supply from the Swakoppoort Dam
- NamWater supply from the Spesbona wellfield
- Surface water dammed in the Khan River
- Groundwater boreholes within the mining licence area
- Dammed water behind the proposed weir / dam wall that would divert the Okawayo river around the mine pit.

Water supply optimisation strategies are in progress and continuing, current findings are included in the assessment chapter.

4.9.4 RIVER DIVERSION OPTION

Knight-Piesold (2021) have proposed options to prevent the flooding of the mine pit and thereby halt mining. Two options for diverting the Okawayo River can be considered. The environmental baseline chapter describes these two options for diverting the Okawayo River and at the same time providing surface water storage options subsequent to flow events. Another alternative is not to divert the river and allow seasonal flow (if any) to flow into the open pit, and pump this water out and back into the river downstream of the open pit, this option will be influenced by geotechnical pit stability and water quality from the open pit.

4.10 REHABILITATION AND CLOSURE

The Proponent will commit to establishing a rehabilitation plan as part of the mine closure plan. An environmental consultant, in conjunction with the Proponent and the specialist consultants working on the mine design, and those undertaking the environmental impact assessment, will prepare a conceptual mine closure plan as part of the EMP requirements.

5 ENVIRONMENTAL AND SOCIAL BASELINE

5.1 BASELINE DATA COLLECTION

Initial desktop baseline studies relevant to the Project formed part of the initial environmental assessments conducted for the exclusive prospecting licences on which the Project is situated. As part of this assessment, the baseline was studied in detail, with inputs from specialist studies commissioned as part of the environmental and social impact assessment process.

5.1.1 DESKTOP AND FIELD SURVEYS

Initial desktop baseline studies were completed between 2018 and 2020 for the EPL assessments. Additional desktop and field-based baseline studies were conducted between February and September 2021. These build on the dataset of site environmental monitoring data being collected since 2010.

This section sets out the biophysical and socioeconomic environments in which the Project is situated. It is an important part of the scoping component of the assessment, as it determines if there are any knowledge gaps that require additional information prior to the assessment phase being completed.

5.1.2 SPECIALIST STUDIES

The following specialist studies as outlined in Table 10 were commissioned and completed, to determine the current state of the baseline environments:

Table 10 - Specialist studies conducted for the ESIA

Study area	Purpose	Specialists
Terrestrial ecology	– Biodiversity and habitat – Identification of species of concern and sensitive areas – Impacts of mining construction and operations on habitats and biodiversity	– Peter Cunningham
Hydrology	– Water supply – Storm protection and river diversion – Impact on heritage aspects – Clean and dirty water management systems	– SLR – Knight-Piesold
Groundwater	– Assess the potential for contamination of aquifers from TSF & WRD – Provide a model to determine impacts of drawdown and plume mobility – Assess the sustainability of boreholes for water supply	– SLR – Knight-Piesold
Air quality	– Provide emission standards and dust suppression requirements	– Airshed

Study area	Purpose	Specialists
	– Assess prevailing wind directions and possible effects of emissions on the process and/or personnel – Model potential air quality impacts	
Noise and sense of place	– Identification of possible receptors, and assess levels of noise to which they may be exposed during construction and operations	– Airshed – ECC
Soils and land use	– Assess existing land use, and potential impacts on surrounding land users – A soil study informs the quality and quantity of material available for rehabilitation to a similar state on closure	– ECC
Traffic	– The traffic impact assessment will study the potential traffic impacts and loading on routes associated with the mining activities – Assessing the capacity of infrastructure and safety aspects of the mine entrance – Assessing the need for an intersection upgrade at the mine entrance, and providing a concept layout plan if necessary	– ITS Global
Heritage and culture	– A heritage assessment is required, in order to comply with Namibian national legislature	– Dr John Kinahan
Visual and tourism	– Assessing the potential visual impacts of a proposed Project on the receiving environment	– ECC
Social and economic	– Includes the assessment of various recreational activities in Karibib / Omaruru / Usakos	– Deon Wessels
Geochemical sampling and analysis	– The geochemical analysis of waste rock, tailings, and overburden will be undertaken to assess the mineralogical composition, acid mine drainage potential, and metal concentration of the leachate of waste rock and tailings	– ECC:RGS - Mine Waste and Management Consultants
Blast vibration impact	– Assessing the impact of blasting on receptors in the area	– Blast Management and Consulting

5.2 LOCATION

The Twin Hills Gold Project is located approximately 180km inland from the Atlantic coastline. The site is in a triangular area bounded by the towns of Omaruru, Karibib, and Wilhelmstal. The Project area is shown in Figure 19, and is located northeast of Karibib. The Khan River is north of the Project. The site is accessed from Karibib along the C33 that runs northeast to Omaruru. The B2 runs parallel to the Project area and is separated by a marble mountain ridge. Omaruru is 45km north of the Project site. Karibib is the closest town ~15km to the southwest.

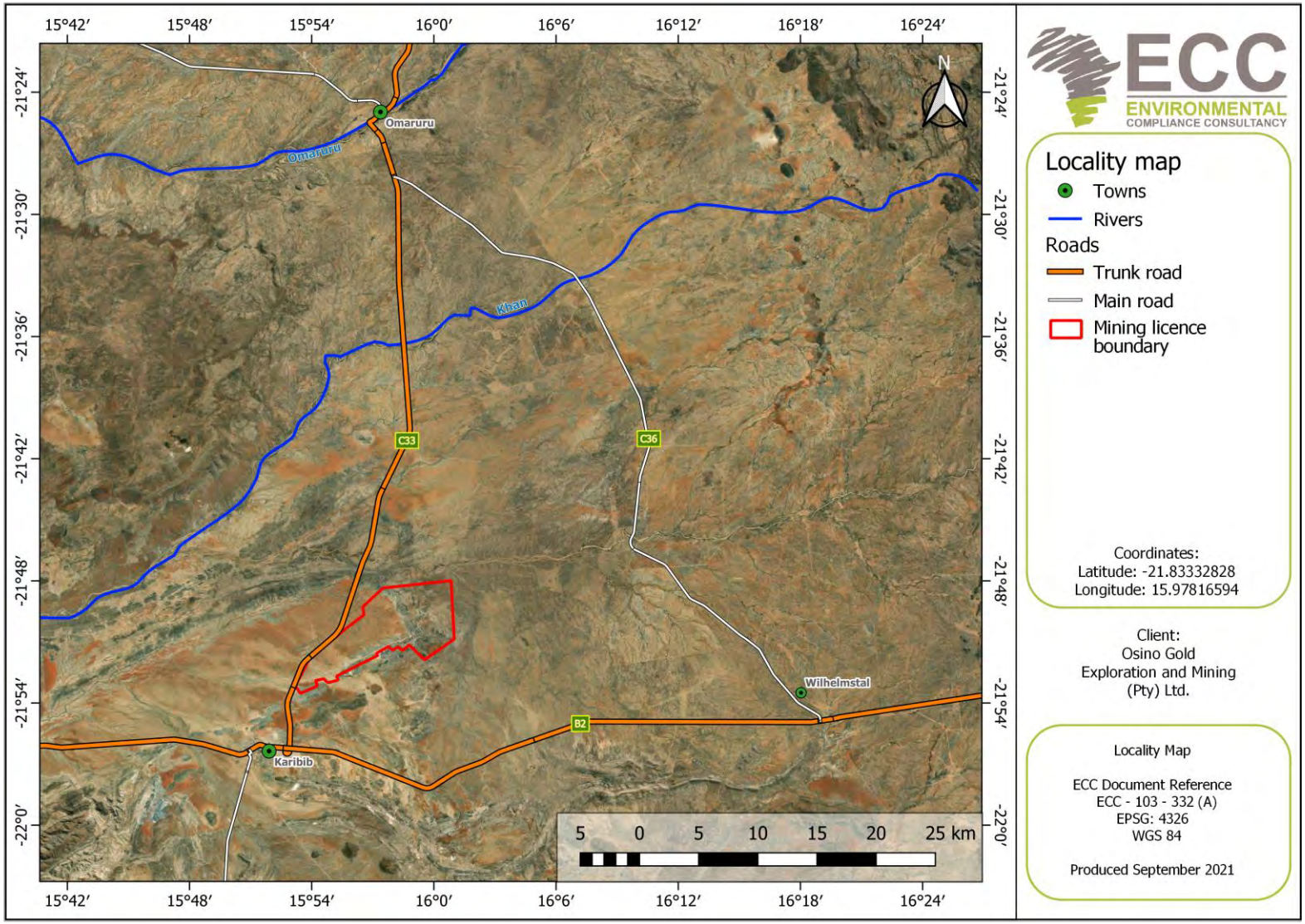


Figure 19 - Project location in proximity to towns and roads

5.3 LAND USE

The Project is situated in a commercial agricultural region and the land use is dominated by cattle, game and small stock farming. Figure 2 outlines the proposed mining licence area map with surrounding farms. A spatial review identified that one farm has a remnant orchard, but no large-scale irrigation farming was identified. The Okawayo farm has been described as a wildlife and hunting farm. Portions of the directly impacted farms will no longer be available for farming, as the area will form part of the mining operational footprint. Farming activities on surrounding properties will be able to continue relatively undisturbed by the proposed Project.

Dimension stone quarries are located on the marble ridge that occurs on the Okawayo farm, and several mining claims are held along portions of this ridge, as shown in Figure 20.

The Project area is not part of a communal conservancy. The closest is ǂGaingu, which is located in the Spitzkoppe area to the west of Karibib. The Project area is not situated within a freehold conservancy (Mendelsohn *et al*. 2002).

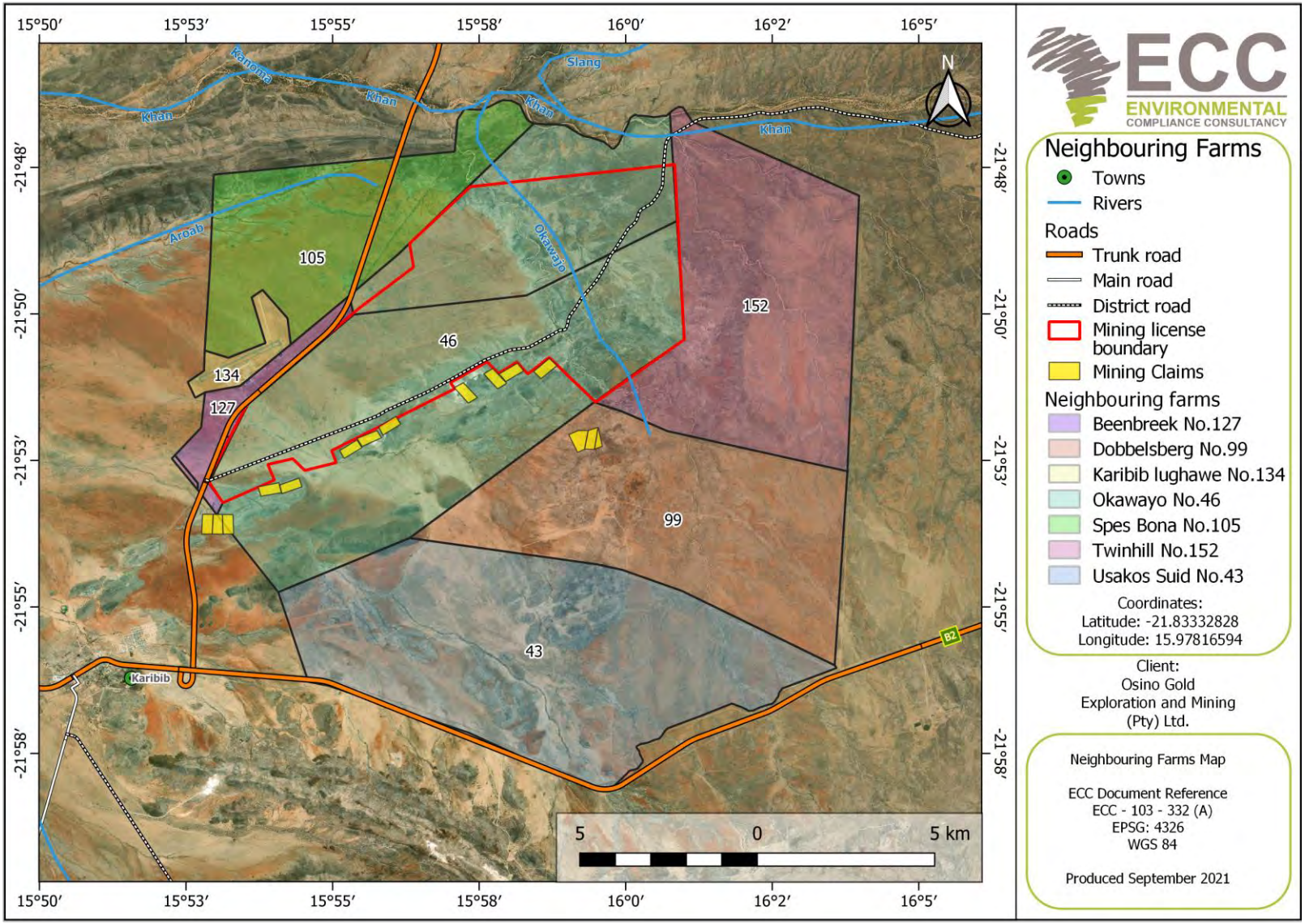


Figure 20 - Project location in proximity to farms and mining claims

5.4 GEOLOGICAL SETTING

The local geology is summarised from a collection of reports compiled by the Proponent during exploration activities and is provided in detail in the Project description chapter of this report. The Twin Hills Gold Project is situated within the Southern Central Zone of the Damara Supergroup. It comprises continental margin carbonates and silts that grade into turbidite sequences representing continental shelf and basin deposits. The regional mapping and reinterpretation of the available aeromagnetic data undertaken by the Proponent resulted in the identification of a large deep regional structure, the Karibib Fault, which strikes east northeast and has several 'splays' associated with it.

The Twin Hills deposit lies in the Kuiseb Formation, which is the uppermost portion of the Swakop Group, a sequence of turbiditic marine sediments several kilometres thick, which was folded during the Neoproterozoic Damaran orogen. The gold mineralisation is hosted within a metagreywacke unit, which has been tightly folded into an overturned syncline, underlain by biotite schist and cordierite schist. The host rocks are overlain by red Kalahari sands and calcretes between 2m and 25m thick. Faults and lithological contacts between the marble and the greywacke/schist are considered potential targets for groundwater supply investigations. The geological setting is shown in Figure 21.

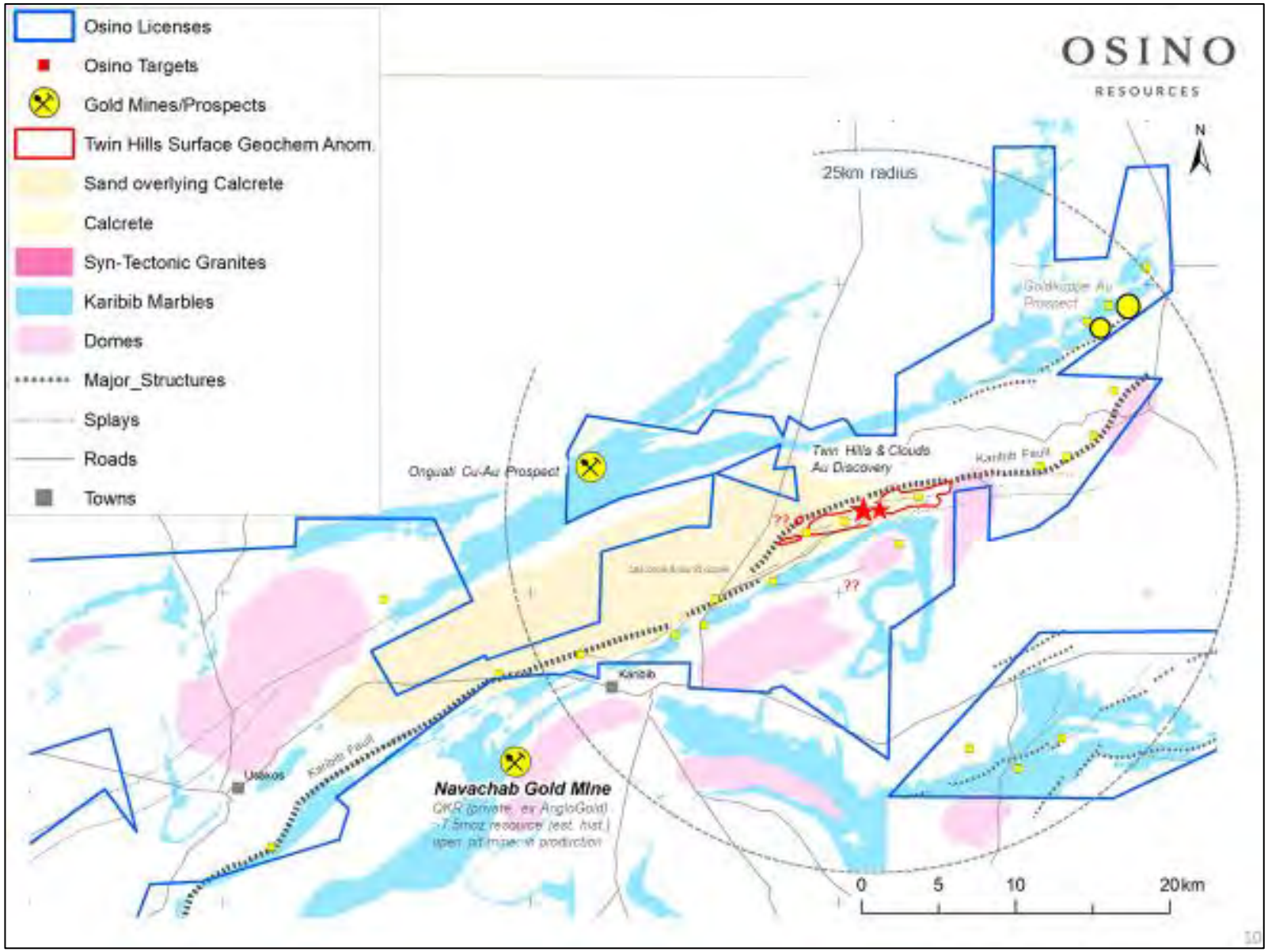


Figure 21 - Geological setting of the Project

5.5 TOPOGRAPHY

The land in the Project area is dominated by calcisols, (commonly called calcretes), regisols, and rocky outcrops (Figure 3). The eastern portion of the Project area is moderately rough, with steep hill slopes. Conversely, the western portion of the Project area is relatively flat, covered by reddish sands, and slopes gently towards the northwest.

The southern half of the Project area is traversed by a marble ridge that tends northeast southwest across the property. North of the marble ridge, the topography slopes towards the Khan River, approximately 8km away. Figure 22 shows an image of the calcrete plain below the marble ridge. This flat plain area is where the open pits will be situated.

The marble ridge is bisected by the ephemeral Okawayo minor river, which drains northwards across the proposed open pit to the Khan River. This water course will need to be diverted before mining can commence, and is discussed in further detail within the water section of this baseline chapter.

Figure 22 – An image taken from the marble ridge overlooking the proposed Project area, with a view of the Erongo mountains

5.6 BUILT ENVIRONMENT AND INFRASTRUCTURE

5.6.1 INFRASTRUCTURE AND BULK SERVICES

The wide tarred B2 road south of the Project area, also known as the Trans-Kalahari Highway, carries large traffic volumes between Windhoek and Walvis Bay, and is considered the regional trade route. The tarred C33 road running north from Karibib to Omaruru is likely to be the primary access route to the site.

The D1941 gravel road traverses the proposed mine site, across the proposed open pit area. This road will have to be diverted, probably to the north of the mine. On the southwest of the site, the D1941 is used to access the marble quarries and other mining claims along the marble ridge.

The TransNamib Railway line parallels the B2 in the south, with a line branching north-eastwards (at Krazenberg, west of Karibib) towards Omaruru, Otjiwarongo, and on to Tsumeb. A 66kW powerline runs loosely parallel to this railway line, but not in the same corridor (Figure 23).

NamWater currently has an unused wellfield in the Khan River, with an associated pumpstation to the northwest of the proposed Project. A pipeline runs south-south-westwards from there towards Karibib.

Bulk water to Karibib is pumped by NamWater from the Swakoppoort reservoir to a treatment plant in Karibib.

The town is supplied by a 66kV overhead powerline by ErongoRED, terminating at the Karibib 66/11kV, 2.5 MVA substation. The power supply for the proposed Project has not yet been determined, but renewable and grid power will be considered. If future powerlines are required, then the line routes will require an assessment, as linear infrastructure is not included within the scope of this assessment. The Karibib Air Base, approximately 7km southwest of the proposed Project, is supplied by a 33kV line from Karibib.

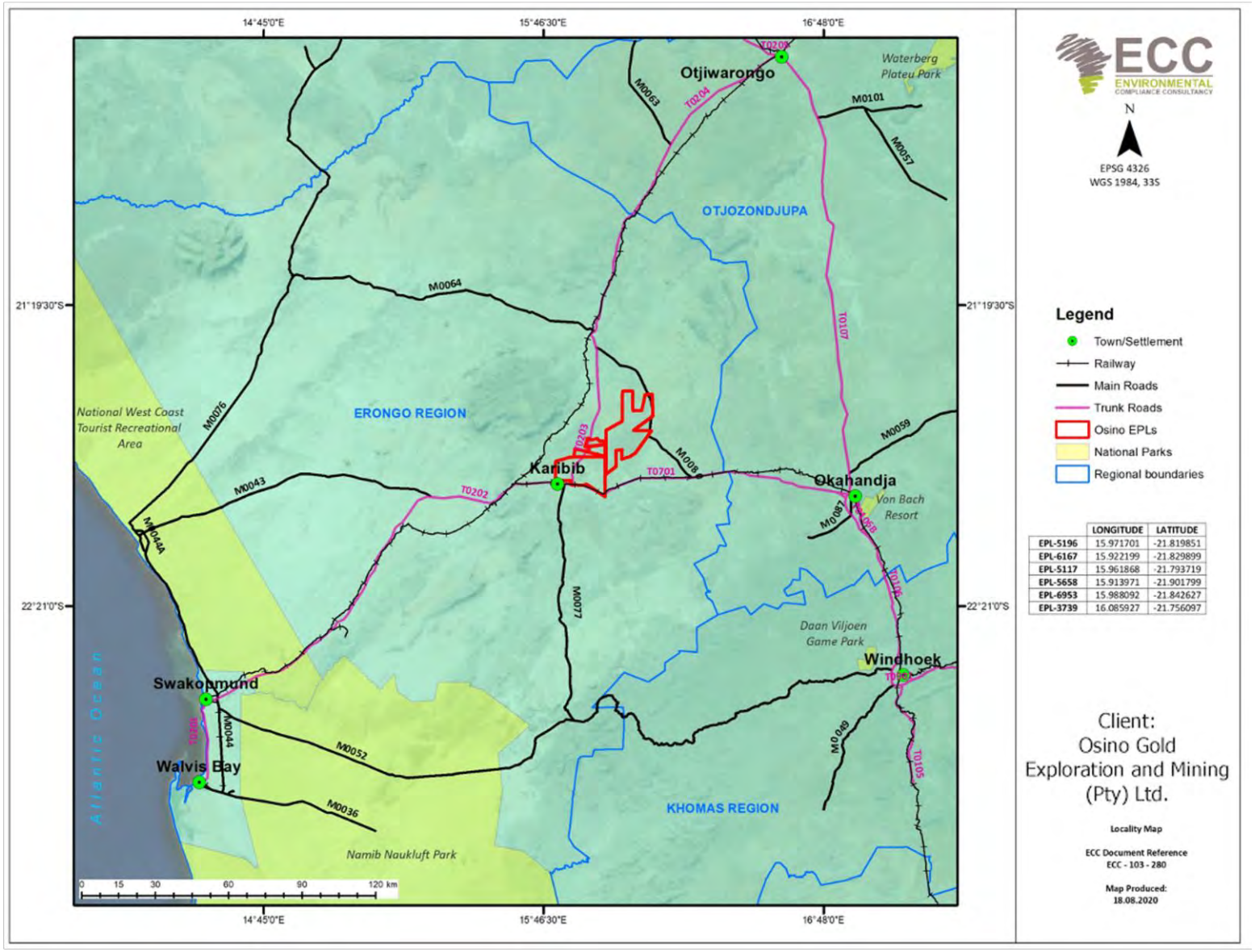


Figure 23 – Road and rail infrastructure

5.6.2 TRAFFIC AND TRANSPORT

Innovative Transport Solutions (ITS Global) was commissioned by ECC to assess the road traffic baseline. The traffic study was completed in September 2021, at a time when there were no COVID-related travel restrictions or lockdowns, which would have affected the accuracy of the baseline study. The traffic baseline study can be found in Appendix H. It must be noted that this study presents the current baseline conditions of the road network in proximity to the Project. Details of how the Project could impact these roads is provided in the impact assessment chapter.

The current conditions of the roads and intersections in terms of traffic volumes, lane configuration, and traffic controls, are provided in Figure 24.

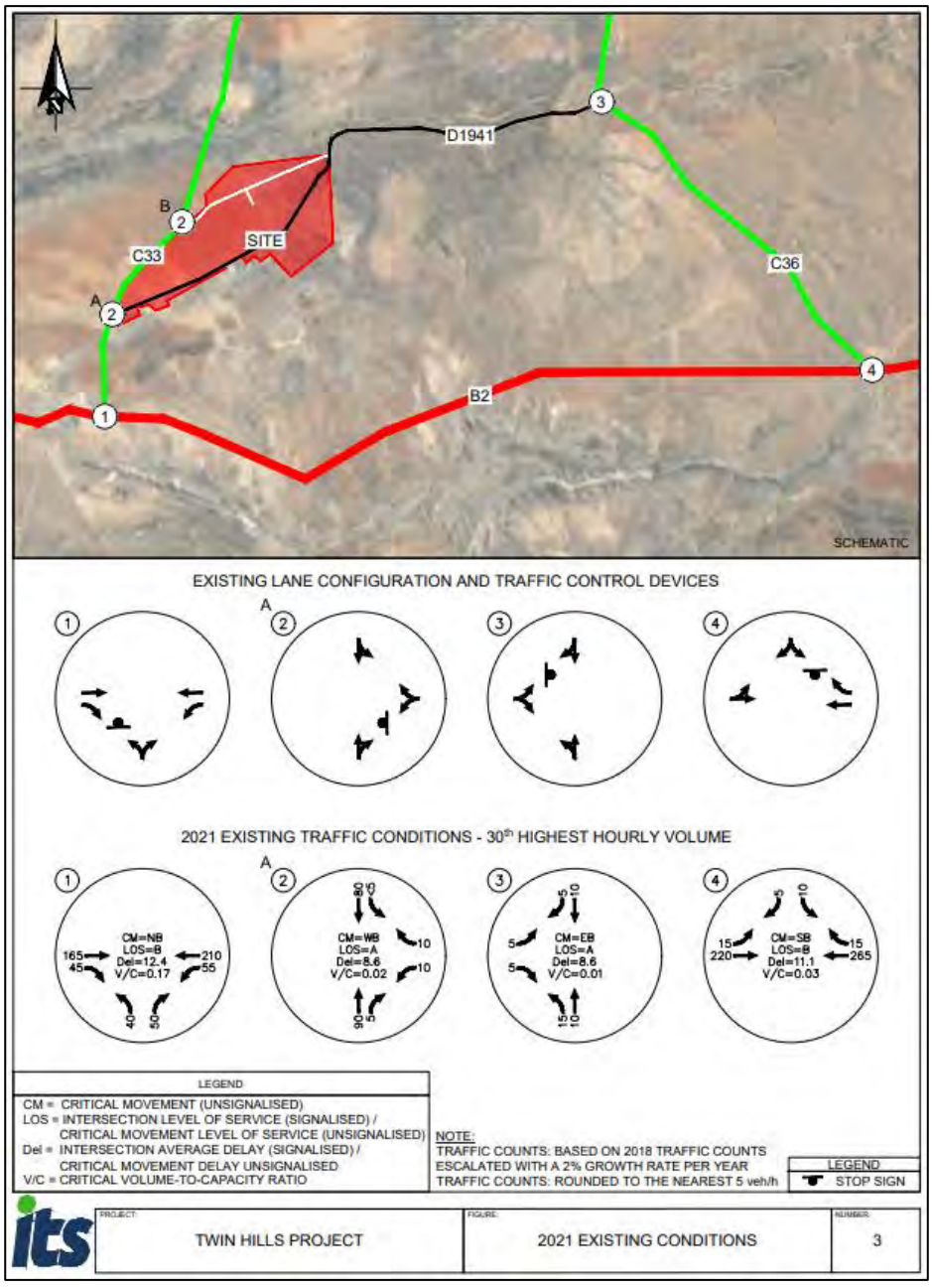


Figure 24 – Baseline conditions for intersection hourly traffic volumes

ITS Global (2021) engineers determined that all the intersections currently operate with a good level of service and have spare capacity. No upgrades are required. This preliminary statement shows that the introduction of more traffic associated with the Project would be possible.

The major existing roadways in proximity to the Project area include:

- B2 Road (T0106) – Class 1 principal arterial, with a surfaced lane (approx. 3,7 meters wide) per direction. Speed limit of 120km/h
- C33 Road (T0203) – Class 2 major arterial, with a surfaced lane (approx. 3,5 meters wide) per direction. Gravel shoulders and a speed limit of 120km/h
- C36 Road (M0080) – Class 3 minor arterial, with a gravel lane per direction. Speed limit of 100km/h
- D1941 Road – Class 4 distributor, with a gravel lane per direction.

5.6.2.1 Additional traffic volumes associated with the Project

ITS Global utilised available information associated with the Project to determine the additional traffic volumes that will be added to the road infrastructure due to the proposed Project.

The trip generation for the Project was based on the number of trips required to transport the expected number of personnel, equipment, and supplies to site during construction and operations.

5.6.2.2 Site access

The current district road (D1941) runs through the Project area and will intersect the planned open pits. It will therefore need to be relocated. The proposed relocation of the D1941 will require the road to be moved northwards to a point within the Okawayo farm.

The proposed realignment of D1941 would be off the C33 Road just north of Karibib Air Force Base, as shown in Figure 10, and will need to meet the safety requirements set out by the Roads Authority of Namibia.

The current site access road from the C33 is surfaced (with asphalt) for approximately 17m and is gravel thereafter. The width of the existing asphalt road is 3m and it is recommended that the road width be increased to at least 7m, as part of the Project ramp up.

Based on the current capacity analysis, a separate right turn lane along the C33 Road onto the minor road is not warranted at this stage. However, it would be recommended that a separate righthand turning lane be installed for safety.

The current speed limit along the C33 is 120km/h. It is recommended that the speed along the C33 Road be reduced to 80km/h near the site access area (1.5km radius) for safety.

5.7 SOCIOECONOMIC BASELINE

5.7.1 GOVERNANCE

Namibia was established in 1990 and is led by a democratically elected and stable government. The country ranked fifth out of 54 African countries in the Ibrahim Index of African Governance in 2015 for indicators that include: the quality of governance and the government's ability to support human development, sustainable economic opportunity, rule of law, and human rights (National Planning Commission, 2017).

As a result of sound governance and stable macroeconomic management, Namibia has experienced rapid socioeconomic development. Namibia has achieved the level of 'medium human development' and ranks 125th on the Human Development Index out of 188 countries (National Planning Commission, 2017).

Namibia is divided into 14 regions, subdivided by 121 constituencies. The Erongo Region is divided into seven constituencies. The proposed Project is in the Karibib constituency of the Erongo Region. The Erongo Regional Council is responsible for the planning and development of the region in a sustainable manner for the benefit of its inhabitants by establishing, managing, and controlling settlement areas and focusing on core services. The council is accountable for an area of 63,586km^2, which is about 7.7% of the total area of Namibia (Erongo Regional Council, 2017).

5.7.2 DEMOGRAPHIC PROFILE

Namibia is one of the least densely populated countries in the world (2.8 persons per km^2). Vast areas of Namibia are without people, in contrast to areas of dense concentrations, such as the central-north and along the Kavango River. Windhoek, the capital, is not only the main urban area with the largest population, but the concentration of private and public head offices attracts Namibians from all parts of the country in search for a better life.

The national population growth rate is estimated at less than 2%, which is lower than that of most African countries. Namibia's population is young – although 57% falls into the age group 15 to 59, 37% of the total population is younger than 15 (Namibia Statistics Agency, 2017). Since 2005, there has been a steady improvement in life expectancy, which is currently estimated at 65 years. In 2018, it was estimated that 50% of all Namibians are urbanised, i.e. living in an urban settlement (retrieved from www.worldpopulationreview.com). The last national census was conducted in 2011, and counted 2.1 million Namibians (Namibia Statistics Agency, 2011). An inter-censal demographic survey was conducted in 2016 and estimated the total population at 2.3 million (Namibia Statistics Agency, 2017).

It is predicted that urbanisation will continue, with an increase from 43% of the population living in urban areas in 2011, to 67% in 2041. The populations of the Khomas and Erongo regions are projected to increase the most, with over a third of Namibia's population expected to live in these two regions (Namibia Statistics Agency, 2011).

The proposed Project is in the Karibib constituency, and borders the Omaruru constituency. In this region, the gender split between males and females is almost equal, the unemployment rate is estimated to be 30%, and the average age of the population is 26 years. Figure 25 provides a pictorial representation of the baseline in relation to the Project area.

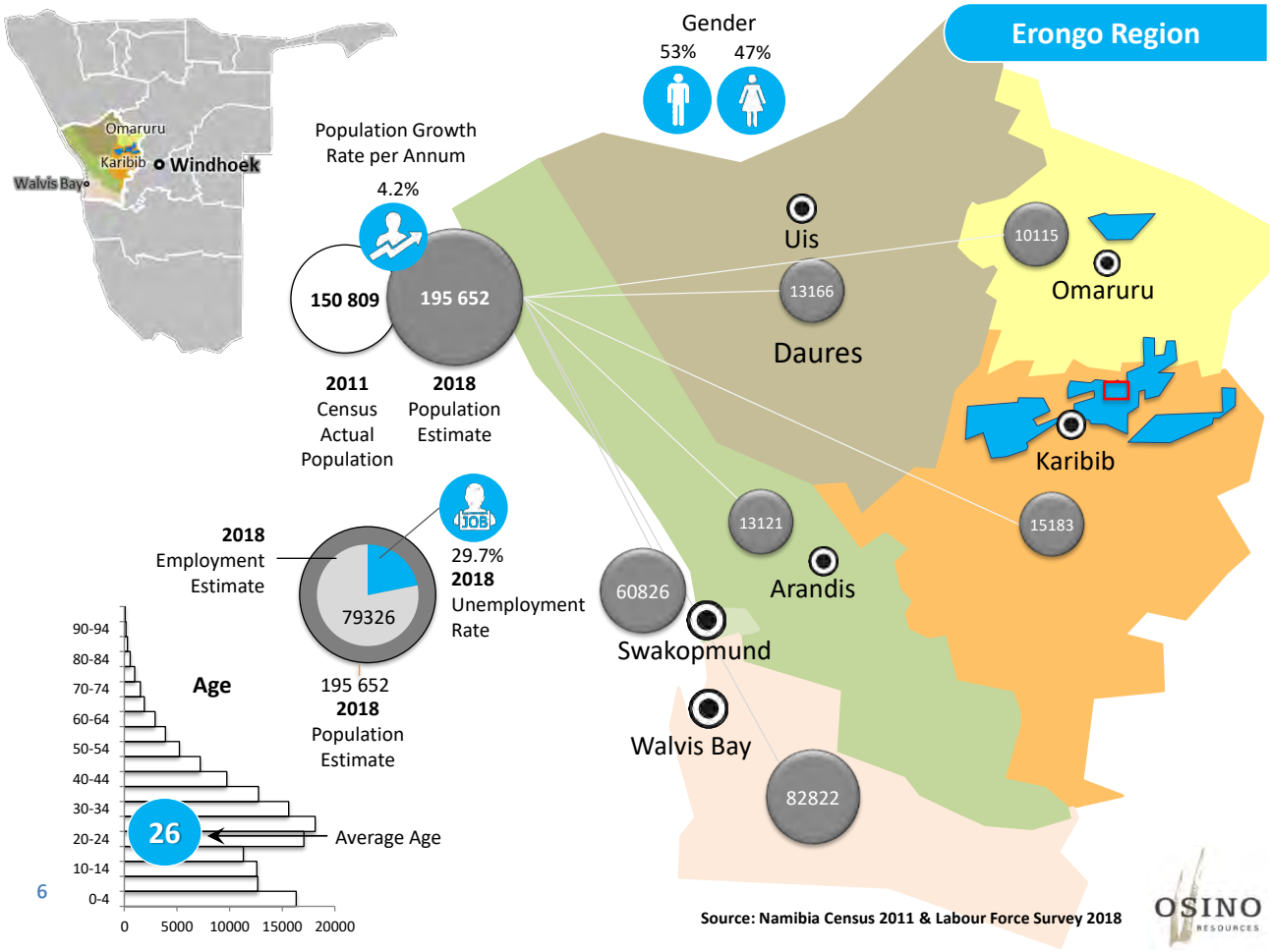


Figure 25 – An infographic showing the Erongo Region demographic profile (Source Wessels, May 2020)

The socioeconomic baseline study has collated information from a variety of resources, including the 2011 Census, Labour Force surveys, and the Namibian demographic health survey, amongst others – the study is provided in Appendix I. An overview of the two towns closest to the proposed Project is presented in Table 11.

Table 11 – Socioeconomic baseline study summary of key indictors

Indictor	Erongo Region	Omaruru	Karibib
Population estimate 2018	195 652	10 115	15 183
Gender ratio	53% male, 47% female	52% male, 45% female	48% male, 52% female
Average age	26	25	24
Number of households	57 000	2 400	3 500
Formal houses	65%	70%	67%
Informal houses	33%	28%	31%
Schools	19	Six schools: 2 Gvt secondary and boarding 3 Gvt primary 1 private primary	Five schools: 2 Gvt secondary 2 Gvt primary 1 Pvt primary and secondary
Health facilities	4 hospitals 2 health centres 18 clinics	1 district hospital 2 private healthcare facilities	1 district hospital 3 clinics

Karibib is approximately 20km by road from the mine, whereas Omaruru is 52km by road. Despite the further distance, the Proponent has indicated a preference for mine employees to be housed in Omaruru, with its well-established stores, banks and restaurants. Karibib is known for the Navachab Gold Mine, and over 750 employees live in the town, contributing to Karibib's economy. Figure 26 renders the Erongo population with projections in relation to access to infrastructure and services.

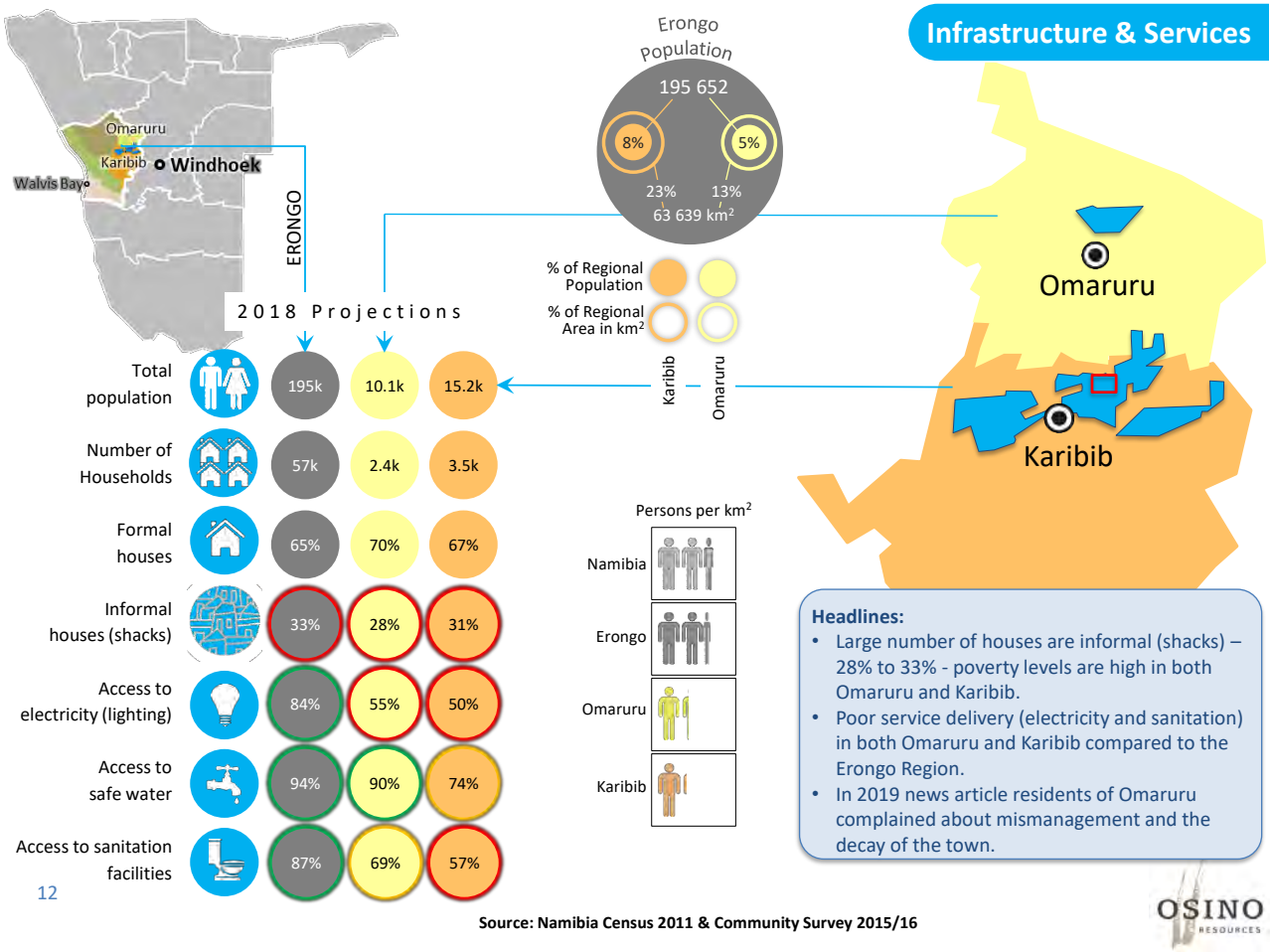


Figure 26 – An infographic showing infrastructure and services (Source Wessels, May 2020)

5.7.3 HEALTH

Since independence in 1990, the health status of Namibia has increased steadily, with a remarkable improvement in access to primary health facilities and medical infrastructure. In 2015, the World Health Organisation (WHO) recommended strategic priorities for the health system in Namibia, which entailed improved governance, an improved health information system, emergency preparedness, risk reduction and response, preventative healthcare, and the combating of HIV/AIDS and TB (WHO, 2016).

According to the website of the Ministry of Health and Social Services (MHSS), the Erongo Region has a total of 18 primary healthcare facilities, including two health centres, and four district hospitals. There are also private hospitals in Swakopmund and Walvis Bay. Figure 27 shows an overview of the health facilities in the two towns and region.

As with elsewhere in Namibia, HIV/AIDS remains a major reason for low life expectancy and is one of the leading causes of death in the region. HIV/AIDS remains the leading cause of death and premature mortality for all ages, killing up to half of all males and females aged 40 to 44 years in 2013 (IHME, 2016).

Tuberculosis (TB) is a leading killer of people infected by HIV/AIDS, and Namibia had a high burden in 2018 – 35% of people with TB were infected with HIV. The country is included among the top 30 high-burden TB countries in the world, with an estimated incidence rate of 423 per 100,000 people, and 60 fatalities per 100,000 people in 2018 (retrieved from www.mhss.gov.na).

As at the beginning of 2020, the coronavirus (COVID-19), caused illness in humans at a pandemic scale, and has resulted in an increasing number of deaths worldwide. The viral outbreak has adversely affected various socioeconomic activities globally, and with reports of a continually increasing number of people testing positive, it is anticipated that this may have significant impacts on the operations of various economic sectors in Namibia too. The disease caused many countries to enter a state of emergency, which included various levels of lockdown restrictions that had dire economic consequences. In addition, these measures have had a detrimental effect on tourism, and Namibia is, in both cases, no exception.

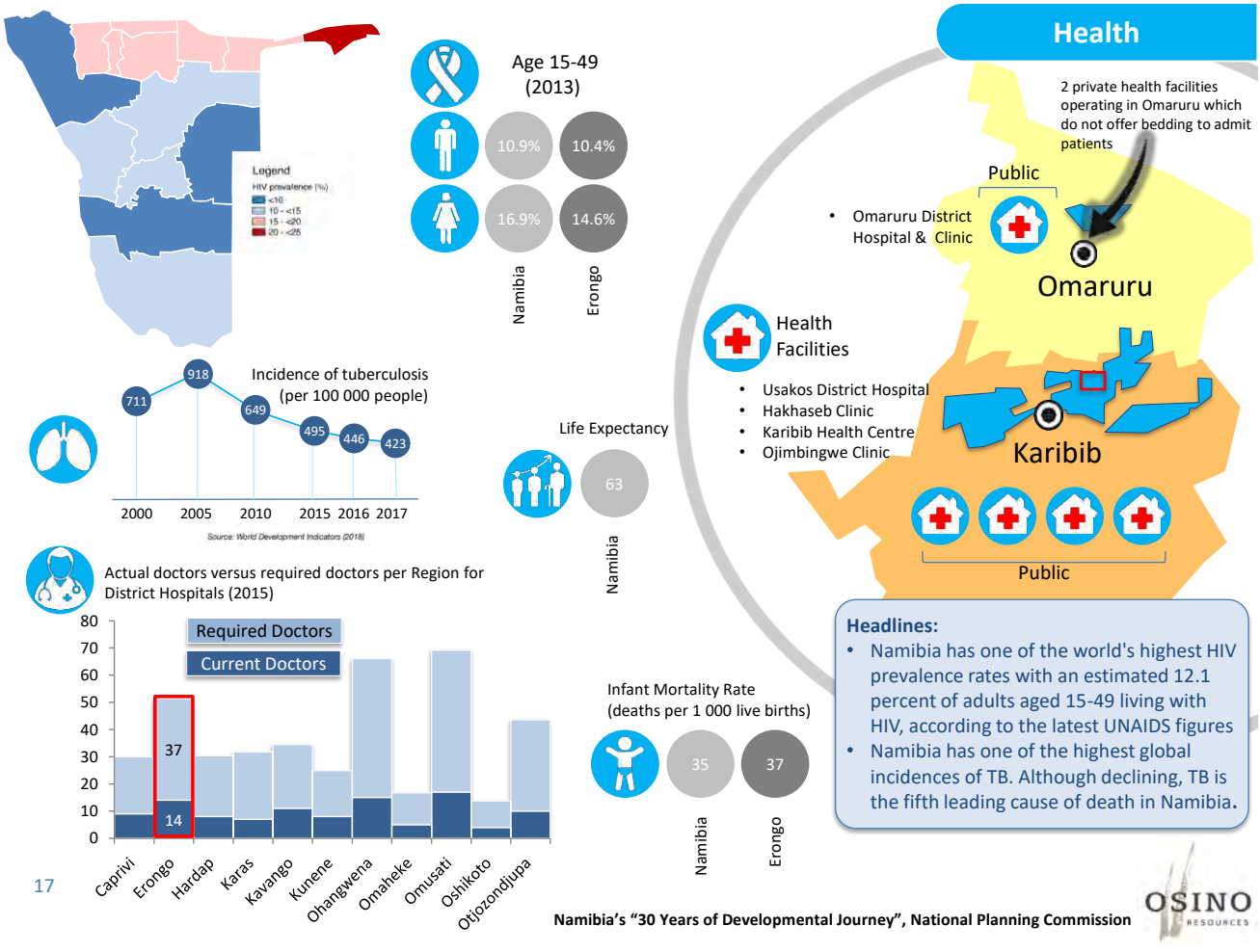


Figure 27 – An infographic showing the health profile (Source Wessels, May 2020)

5.7.4 EMPLOYMENT

The Erongo Region is one of the most affluent regions in Namibia, with the second highest per capita income in Namibia at N$16,819 per annum (Environ Dynamics, 2010). In Walvis Bay, most employment is through the harbour, fishing industry, and the processing of sea salt (Walvis Bay Municipality, 2008).

The labour force participation rate is the proportion of the economically active population, given as a percentage of the working age portion of the population (i.e. older than 15 years of age). The rate of labour force participation for the Erongo Region was 80.9% compared to the average of 71.2% for Namibia in 2018 (Namibian Statistics Agency, 2019).

In 2018, 53.4% of all working Namibians were employed in the private sector, and 21.5% by the state. State-owned enterprises employ a further 7.6%, and private individuals 16.6%. Agriculture (combined with forestry and fishing) is the economic sector with the most employees – 23% of all employed persons in Namibia work in this sector. Wages and salaries represented the main income source of 47.4% of households in Namibia (Namibian Statistics Agency, 2019).

Low education levels affect employability and prevent many households from earning a decent income. Of all employed people in Namibia, 63.5% do not have more than a junior secondary level qualification (Grade 10 and lower), and 11.8% of all employed people have no formal education. In total, 29.1% of all employed people fall into the category of “elementary occupation”, and 15.2% into the category of “skilled agriculture”.

Overall, the rate of unemployment is estimated at 33.4% for Namibia, using the broad definition of unemployment. The unemployment rate in rural and urban areas is almost the same – 33.4% in urban areas and 33.5% in rural areas. The highest unemployment rates are found amongst persons with education levels lower than junior secondary. The unemployment rate of persons with no formal education is 28.6%, with primary education at 34.6%, and junior secondary education at 32.7% (Namibian Statistics Agency, 2019).

According to the Namibian Chamber of Mines 2020 annual review, the mining industry employs over 9,000 people directly in the industry – 800 temporary employees and over 6,500 contractors. The mining industry spent almost 2 million Namibian dollars on skills expenditure, including operating mines, and exploration and development companies such as Osino. Figure 28 shows the employment profile of the two towns and the region.

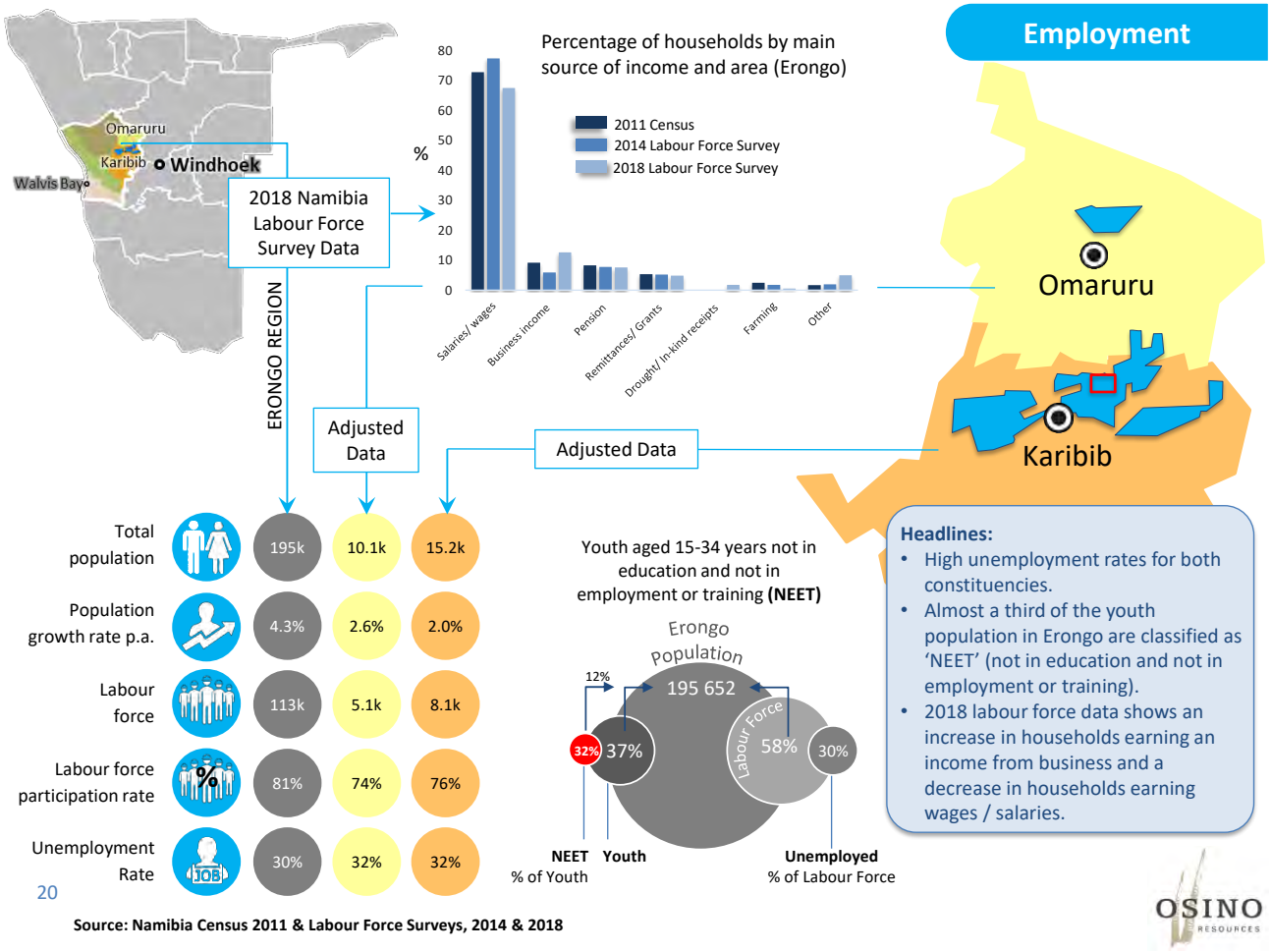


Figure 28 – An infographic showing the employment profile (Source Wessels, May 2020)

5.7.5 CRIME

Namibia's crime rate has been on the decline, in general and in the Erongo Region, since 2011. Namibia's crime index is 65.49 as at October 2021. The town of Omaruru has a police station with 41 police officers, and compared with other towns, it is classified as having a below average rate of crime as shown in Figure 29. Anecdotally, a rising trend of substance abuse in Karibib has been reported during public consultation. The reason for this increasing trend is associated with the limited recreational and entertainment facilities in the Karibib area and is fuelled by the increase in disposal income from those working in the mining and quarrying industry in the area.

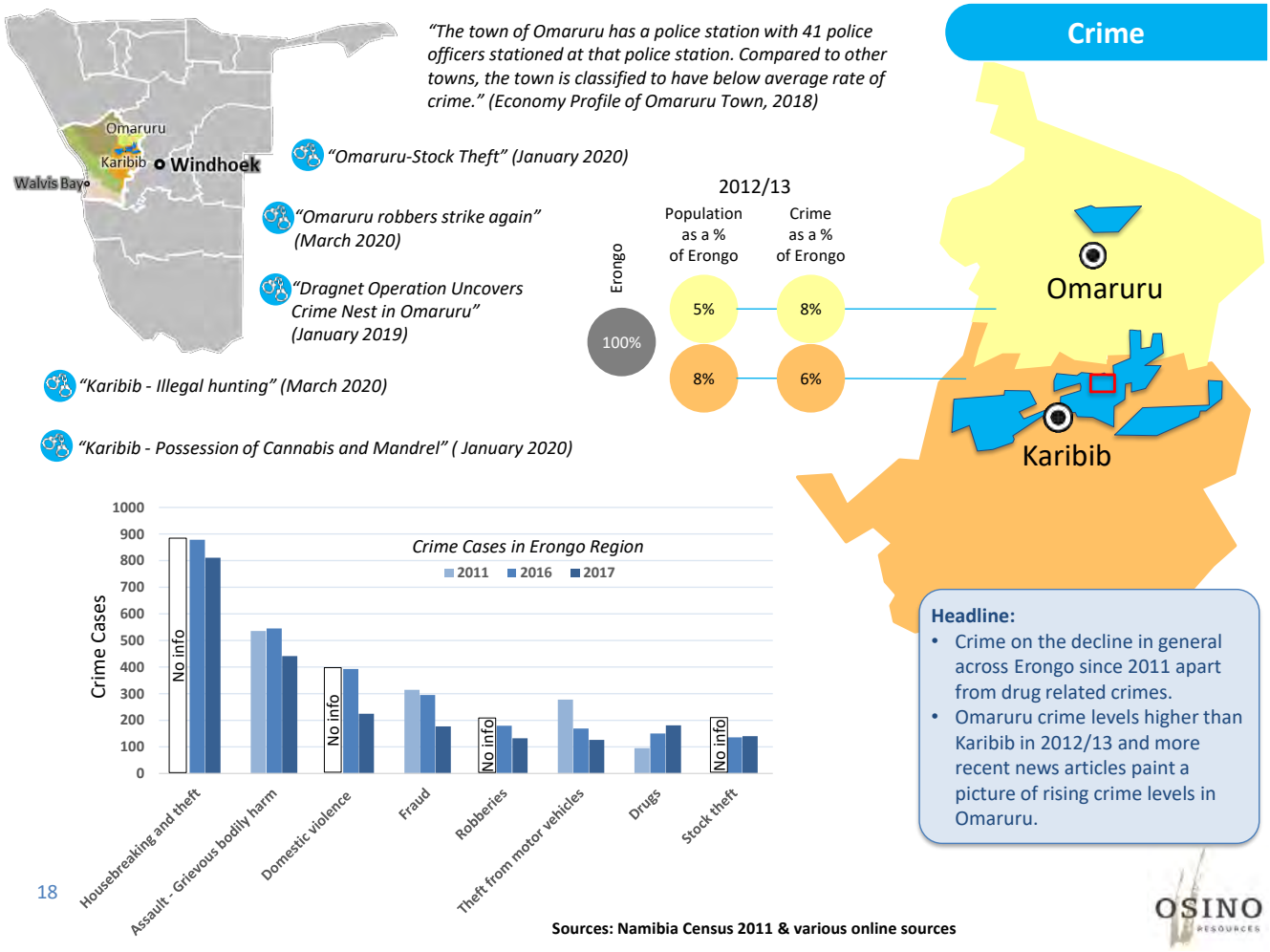


Figure 29 – An infographic showing the crime profile (Source Wessels, May 2020)

5.7.6 ECONOMIC AND BUSINESS ACTIVITIES

Key economic activities of the Erongo Region include agriculture, forestry and fishing, mining and quarrying, manufacturing, tourism, and retail as shown in Figure 30.

Mining plays a pivotal role in the economy of Namibia. Since independence, it has consistently been the biggest contributor to Namibia's economy in terms of revenue, and accounts for 25% of the country's income. Mining is one of the main contributors to GDP, and one of the largest economic sectors of Namibia. Mining is a pronounced industry in the Erongo Region, and the main commodities are uranium, gold, salt, and dimension stones.

In addition to the sectors mentioned, the economy of the Erongo Region is dominated by the local economies of Swakopmund and Walvis Bay. In the rural parts of the region, extensive livestock farming is a common activity, but intensive farming is also practiced along the lower part of the Swakop River, and at Omaruru. Several fresh crops are produced, mainly for local consumption.

In the Erongo Region, 67.5% of all households depend on salaries and wages as the main income (Namibian Statistics Agency, 2019). Exact figures do not exist, but this high percentage can be ascribed to the dominance of the mining, fishing, and manufacturing and processing sectors,

together with the prominence of state departments and the administrative sectors in the Erongo Region. A total of 12.6% of households receive their income from business activities (Namibian Statistics Agency, 2019).

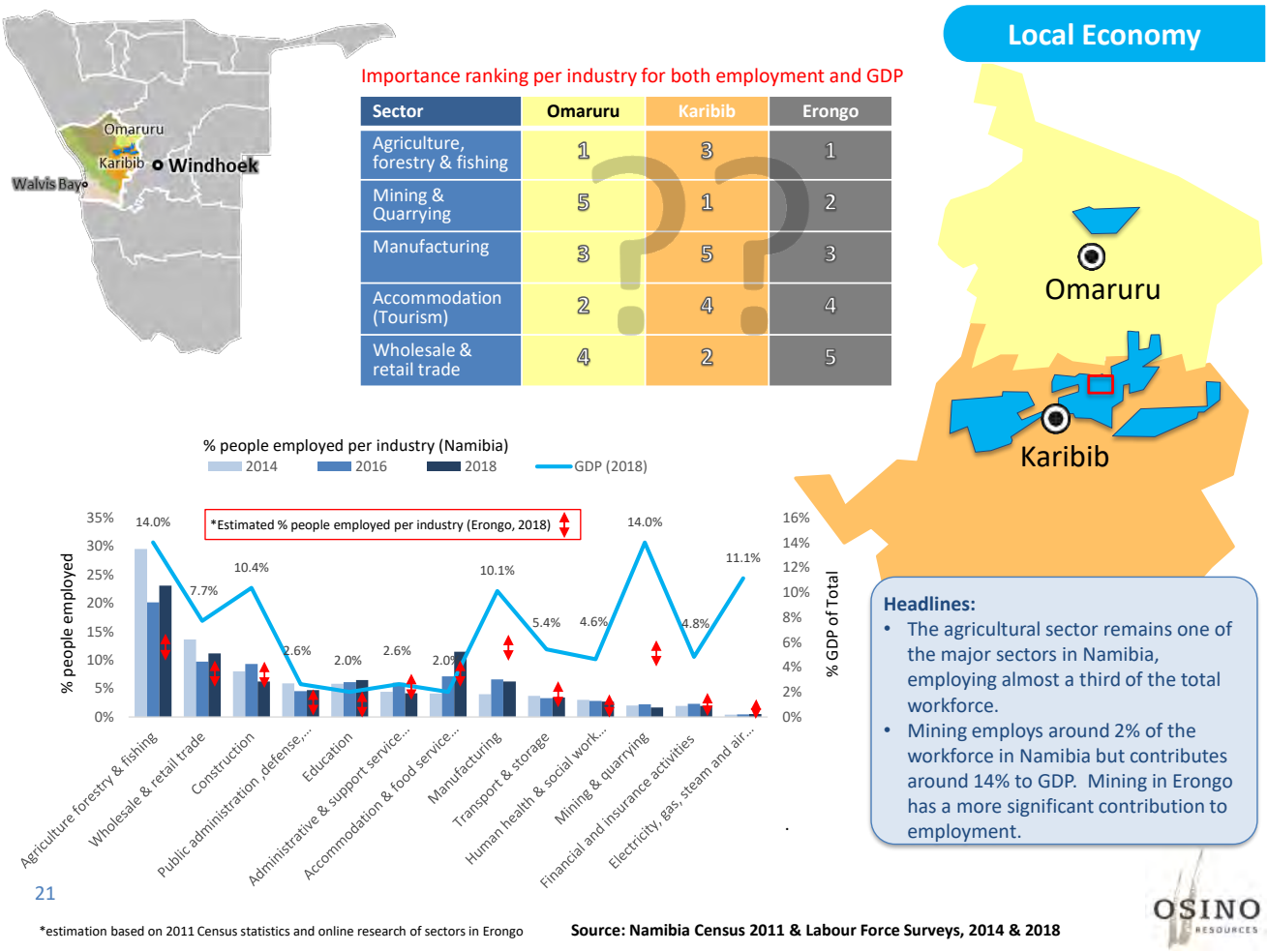


Figure 30 – An infographic showing the local economic profile (Source Wessels, May 2020)

5.8 HERITAGE AND CULTURE

The archaeological field survey and assessment was carried out on the proposed Twin Hills Gold Project site in early February 2021. Several minor archaeological sites were located see Figure 31, and colonial era structures (as shown in Figure 32) that might merit protection under the National Heritage Act (27 of 2004) were assessed by Dr John Kinahan (2021). The heritage assessment report is provided in Appendix G.

The ruined colonial farm building appears to be vulnerable, as is the well-constructed Okawayo farmstead, which was established in the late 19th century and is in relatively good condition. Both may potentially be affected by vibrations from mine blasting that will take place nearby. Further research from the national archives is required to determine the history of these buildings and is presented in the assessment chapter.

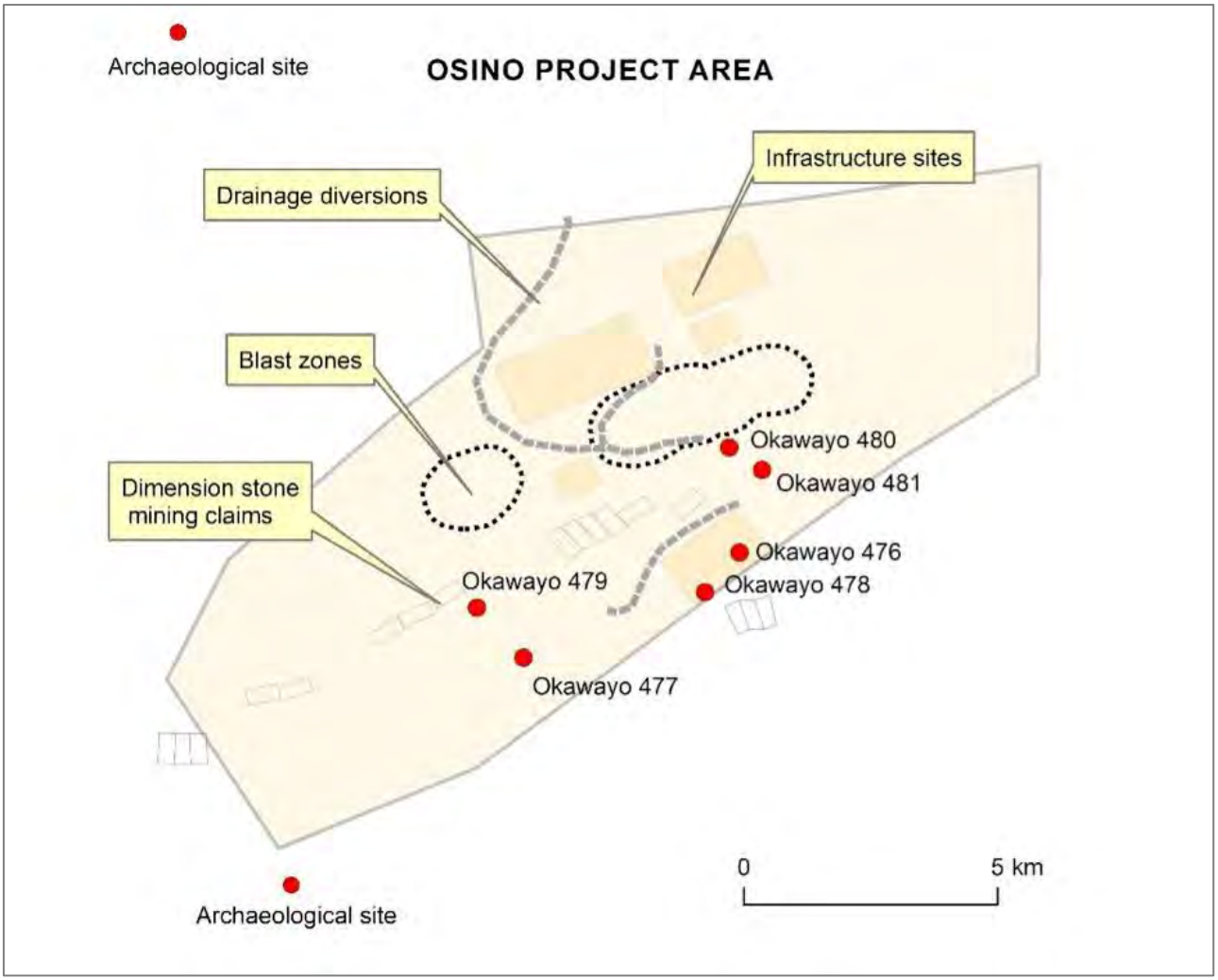


Figure 31 – A map showing the location of archaeological sites

Figure 32 – A photo of the 19th Century German buildings on the Okawayo farm

Archaeology has been studied in the areas surrounding the Erongo mountains, 20km to the northwest of the site, but no previous work has been completed at Okawayo itself. The field survey discovered several precolonial sites resembling historical Ovaherero settlements on the south side of the marble ridge, outside of the proposed Project area, but in proximity to the current dimension stone quarrying activities.

The archaeological report indicates that the Project area is considered moderately archaeologically sensitive. The scoping assessment determined that a blast vibration assessment would be required, in order to determine the effects of mining activities on these buildings. This is presented in the assessment chapter.

5.9 NOISE AND VIBRATION

Noise is generally defined as unwanted sound transmitted through a compressible medium such as air. Sound, in turn, is defined as any pressure variation that the ear can detect. Human response to noise is complex and highly variable, as it is subjective rather than objective. The IFC General Environmental Health and Safety Guidelines on noise addresses the impacts of noise beyond the property boundary of the facility under consideration and provides noise level guidelines. The IFC states that noise impacts should not exceed levels or result in a maximum increase above background levels of 3 dBA at the nearest receptor location off-site (IFC, 2007). For a person with average hearing acuity, an increase of less than 3 dBA in the general ambient noise level is not detectable. 3 dBA is, therefore, a useful significance indicator for a noise impact.

A noise baseline survey was conducted on the 7th to 8th of April 2021, at designated points as shown in Figure 33 for the Twin Hills Gold Project site. Airshed Planning Professionals (Pty) Ltd., a firm that specialises in all aspects of air quality, ranging from neighbourhood concerns to regional air pollution impacts, was appointed to conduct the modelling and assessment process. Airshed identified sites to be monitored for day and night-time noise level measurements, for the noise baseline report. Survey sites were selected after careful consideration of future activities, accessibility, potential noise sensitive receptors, and safety restrictions. A total of seven survey sites were selected.

These sites were chosen based on the sensitivity of the areas in terms of proximity to properties within the Project site. Noise sensitive receptors (NSRs) generally include private residences, community buildings such as schools and hospitals, and any publicly accessible areas. The ability of the environment to attenuate noise as it travels through the air was studied by considering land use and terrain. The same map shows the sensitive receptors near and at the proposed Project site.

The baseline acoustic environment was described in terms of the location of NSRs, that is, the ability of the environment to attenuate noise over long distances, as well as existing background and baseline noise levels.

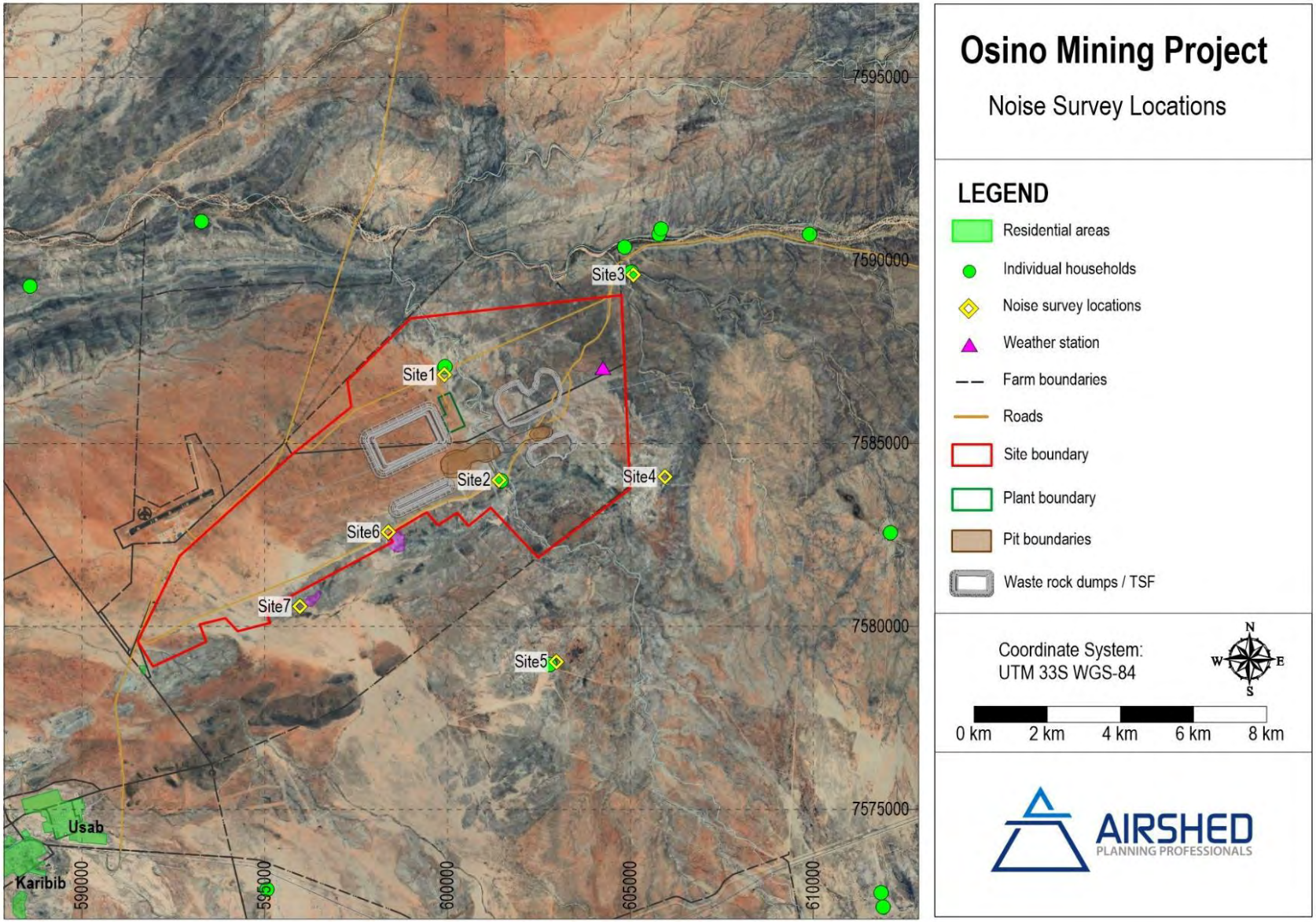


Figure 33 – Baseline noise survey and sensitive receptors

The noise sources of the proposed Project are typical of opencast mining and ore processing facilities. Sources of noise at the Project site will include the following:

- Drilling
- Blasting – although not assessed as part of this study, the character of noise generated by blasting is mentioned. Blasting can cause noise and vibration, which can have an impact upon neighbouring noise receptors. Blasting usually results in both ground and airborne vibration
- Ore and waste handling (loading, unloading, dozing) in open pits, on waste dumps, and in crusher/plant areas
- Crushing and screening of ore
- Haul truck traffic
- Diesel mobile equipment use (including reverse warnings)
- Ore processing activities such as crushing, screening and milling.

5.9.1 ATMOSPHERIC ABSORPTION AND METEOROLOGY

Meteorological data from an on-site station, for the period 23 July 2020 to 22 July 2021, was used for the baseline study. The measured data set indicates wind flow primarily from the southwest. At night, the predominant wind direction shifts to the southeast. On average, noise impacts are expected to be more notable to the northwest and northeast of the Project activities.

Temperature gradients in the atmosphere create effects that are uniform in all directions from a source. On a sunny day with no wind, temperature decreases with altitude and creates a 'shadowing' effect for sounds. On a clear night, temperatures may increase with altitude, thereby 'focusing' sound on the ground surface. Noise impacts are therefore generally more notable during the night.

5.9.2 TERRAIN, GROUND ABSORPTION AND REFLECTION

Noise reduction caused by a barrier (i.e. natural terrain, installed acoustic barriers, buildings) feature depends on two factors, namely: the path difference of a sound wave as it travels over the barrier compared with direct transmission to the receiver, and the frequency content of the noise (Brüel & Kjær Sound and Vibration Measurement A/S, 2000). Readily available terrain data was obtained from the United States Geological Survey (USGS) website (https://earthexplorer.usgs.gov/) accessed in July 2021. A study was made of Shuttle Radar Topography Mission (STRM) 1 arc-sec data.

Sound reflected by the ground interferes with the directly propagated sound. The effect of the ground is different for acoustically hard (e.g. concrete or water), soft (e.g. grass, trees or vegetation), and mixed surfaces. Ground attenuation is often calculated in frequency bands, to take into account the frequency content of the noise source and the type of ground between the source and the receiver (AirShed, 2021a). Based on observations, ground cover was found to be acoustically hard.

The main findings from the baseline study were as follows:

- The flow field is dominated by winds from the southwest (daytime) and southeast (night-time)
- Sensitive receptors in the study area consist of industrial sites, individual households, and residential areas (i.e. Usab and Karibib)
- The baseline noise levels (LAeq) for the area surrounding the Project range between 28.6dBA to 54.8dBA for daytime, and 29.4dBA to 50.2dBA for night-time, as shown in Figure 34 and Figure 35.

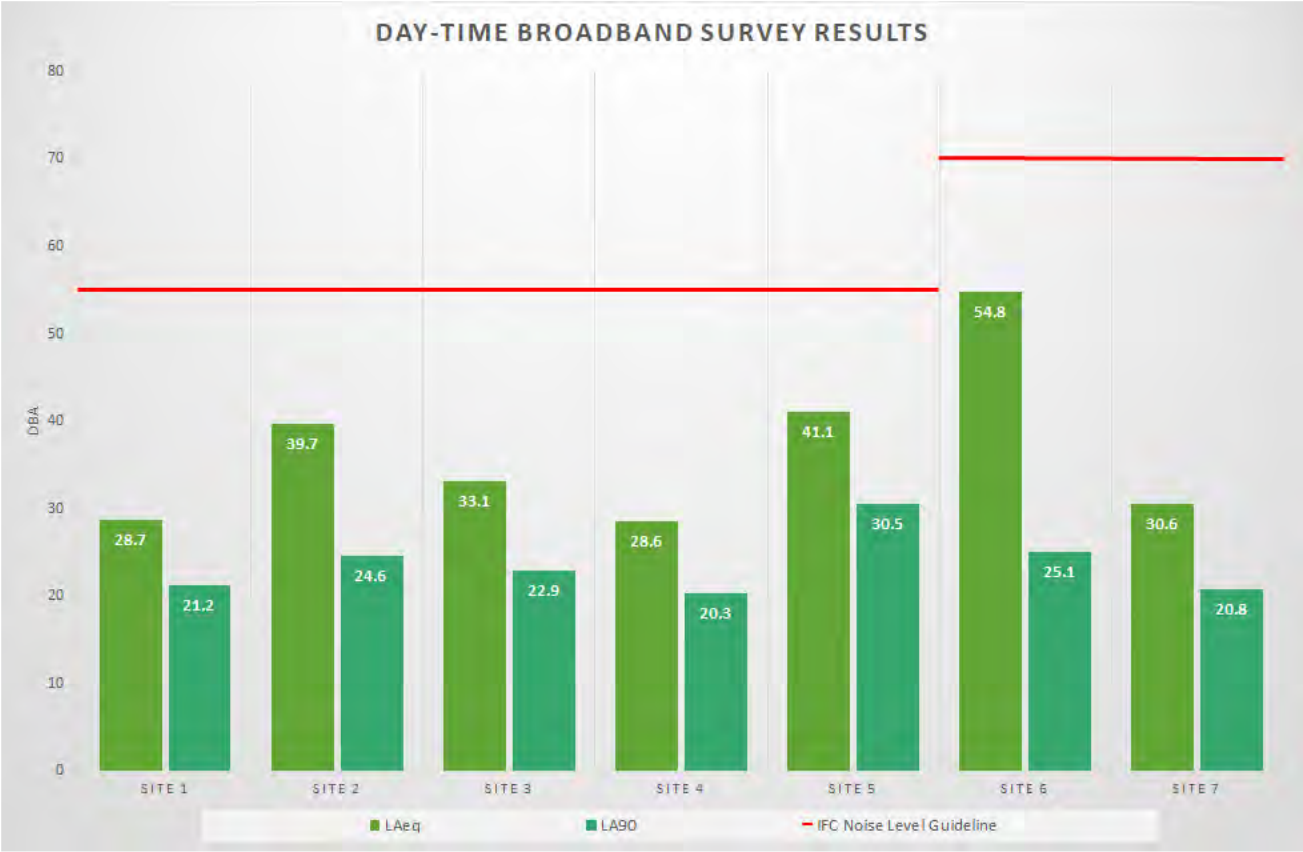


Figure 34 – A graph showing daytime broadband survey results

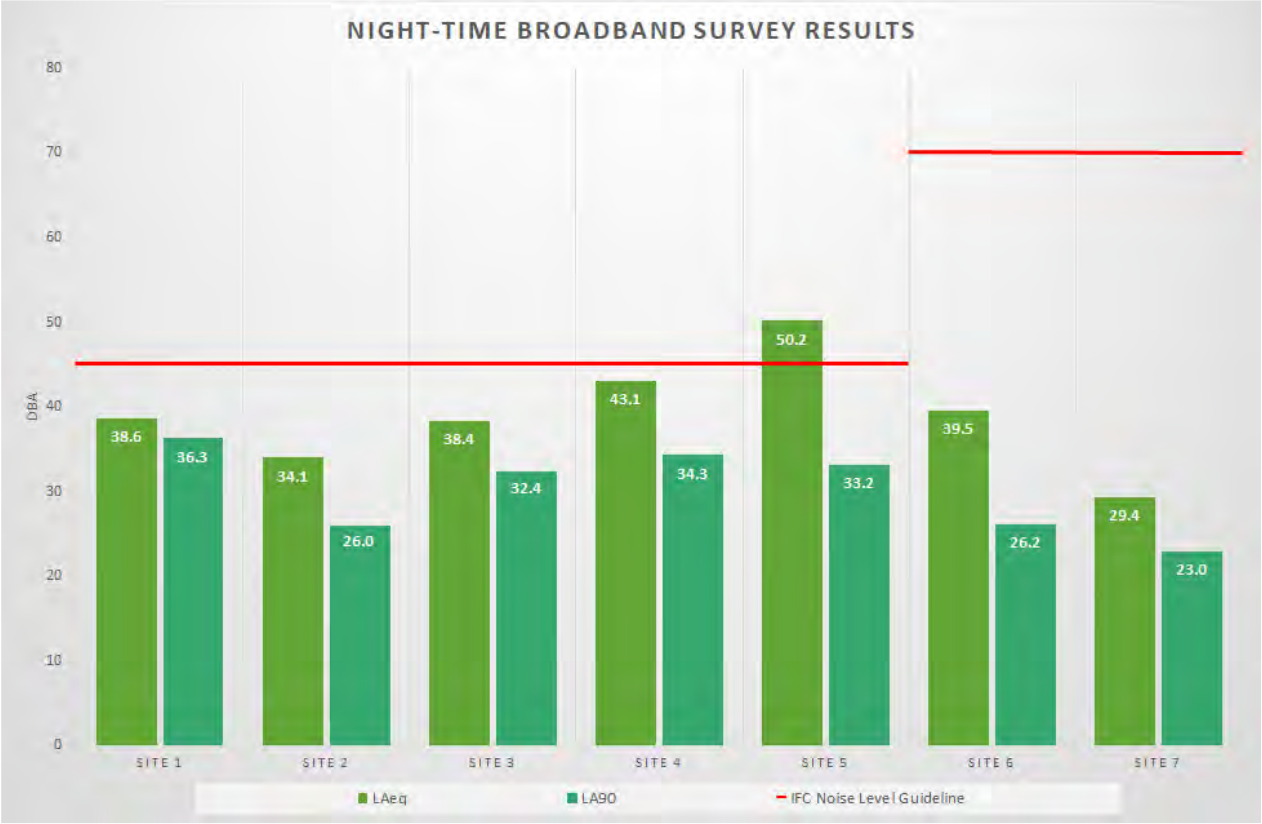


Figure 35 – A graph showing night-time broadband survey results

The aim of this investigation was to provide the basis for the environmental noise impact assessment plan to be conducted for the proposed Project. The following has been included in the environmental noise impact assessment study:

- Compilation of Project source term
- Attenuation modelling of all potential noise sources due to Project operations
- Evaluation of potential noise impacts on human receptors due to Project activities
- Recommendation of mitigation and management measures.

The baseline noise study is provided in Appendix C. The noise impact assessment report has been completed and the outcomes of the noise assessment reported on in the assessment chapter.

5.10 VISUAL AND SENSE OF PLACE

The proposed Twin Hills Gold Project is situated in a sparsely populated area, with few farmsteads or other possible receptors. Apart from the hunting farm, Okawayo, no other tourist sites are known in the immediate vicinity of the Project. The sense of place of the Project area has already been disturbed by farming activities and the marble quarry, as well as the presence of the nearby airfield.

The marble ridge running northeast southwest across the property may block the view of the mine from Karibib and the B2, but it will be visible from sections of the C33. The Project's mining landforms will be seen from sections along the C33 road and from the airfield. Project construction and operational processes may lead to excessive dust, and the waste rock dump and tailings

storage facility will alter the landscape in perpetuity. The visual assessment to be undertaken will include the viewsheds for several receptors. Figure 36 to Figure 40 render the expected viewsheds for WRDs and tailings of a facility height of 40m.

The residents of the properties to the northeast of the site will be able to see either a waste rock dump or a combination of waste rock dumps and tailing storage facilities from their properties. The sense of place will be altered for these residents.

The residents of the town of Karibib will not perceive the WRDs nor the tailings facility. They are approximately 15km away, and a 40m structure will not create an unpleasant horizon if sheltered by the marble ridge. Commuters along the C33 and members of the Namibian Airforce at the military airbase would be able to see these features.

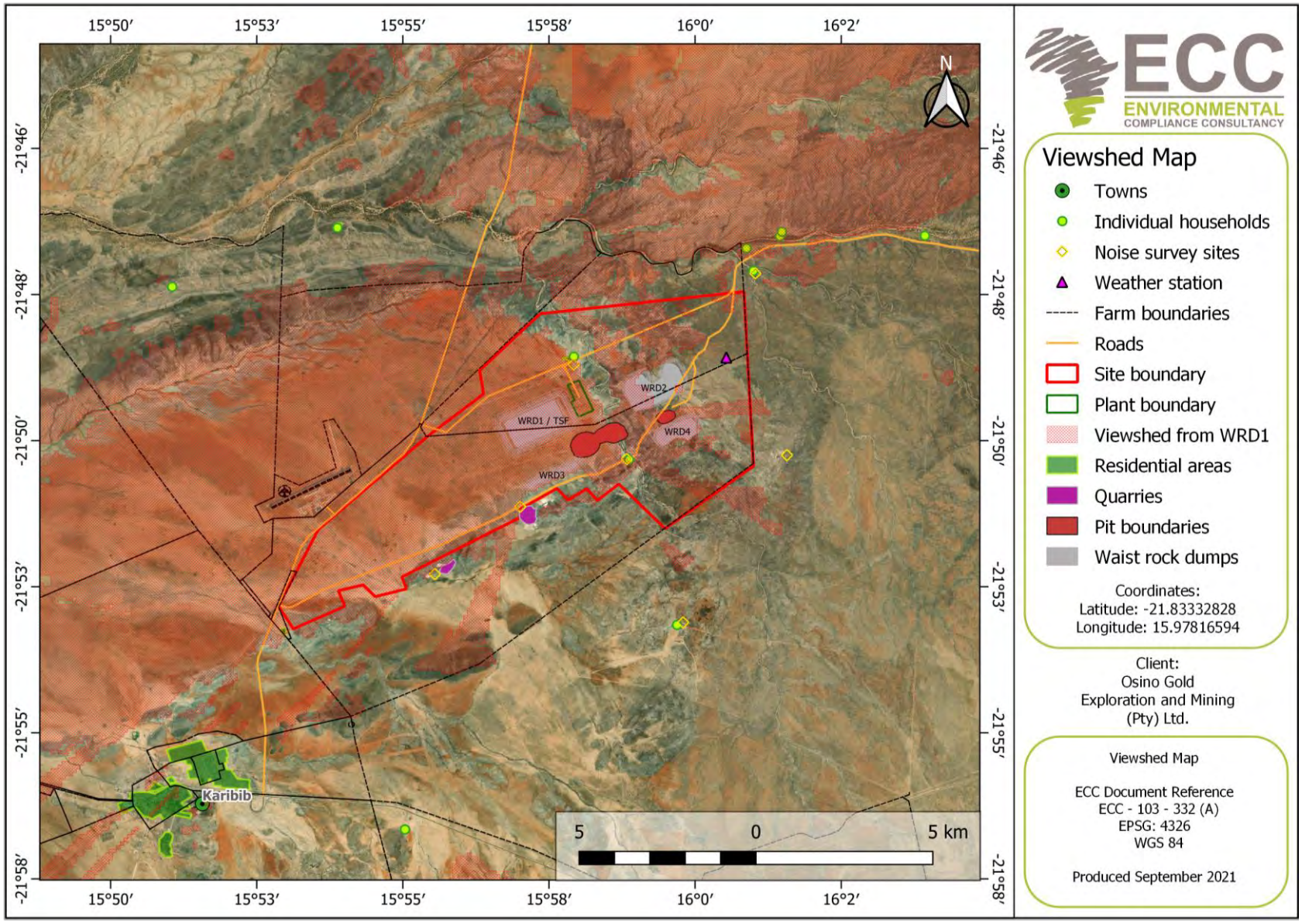


Figure 36 – Viewshed model from the centre of WRD 1

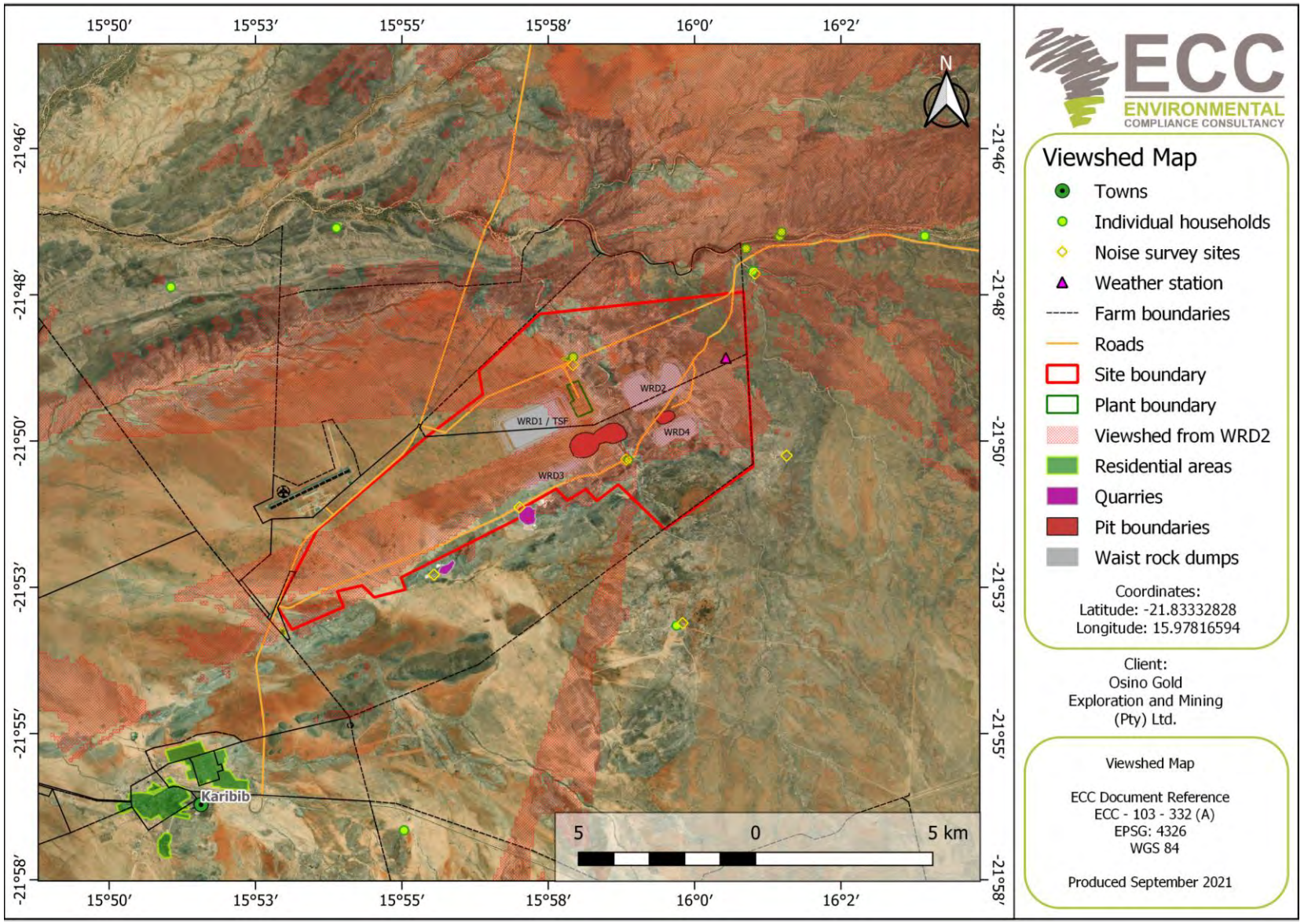


Figure 37 – Viewshed model from the centre of WRD 2

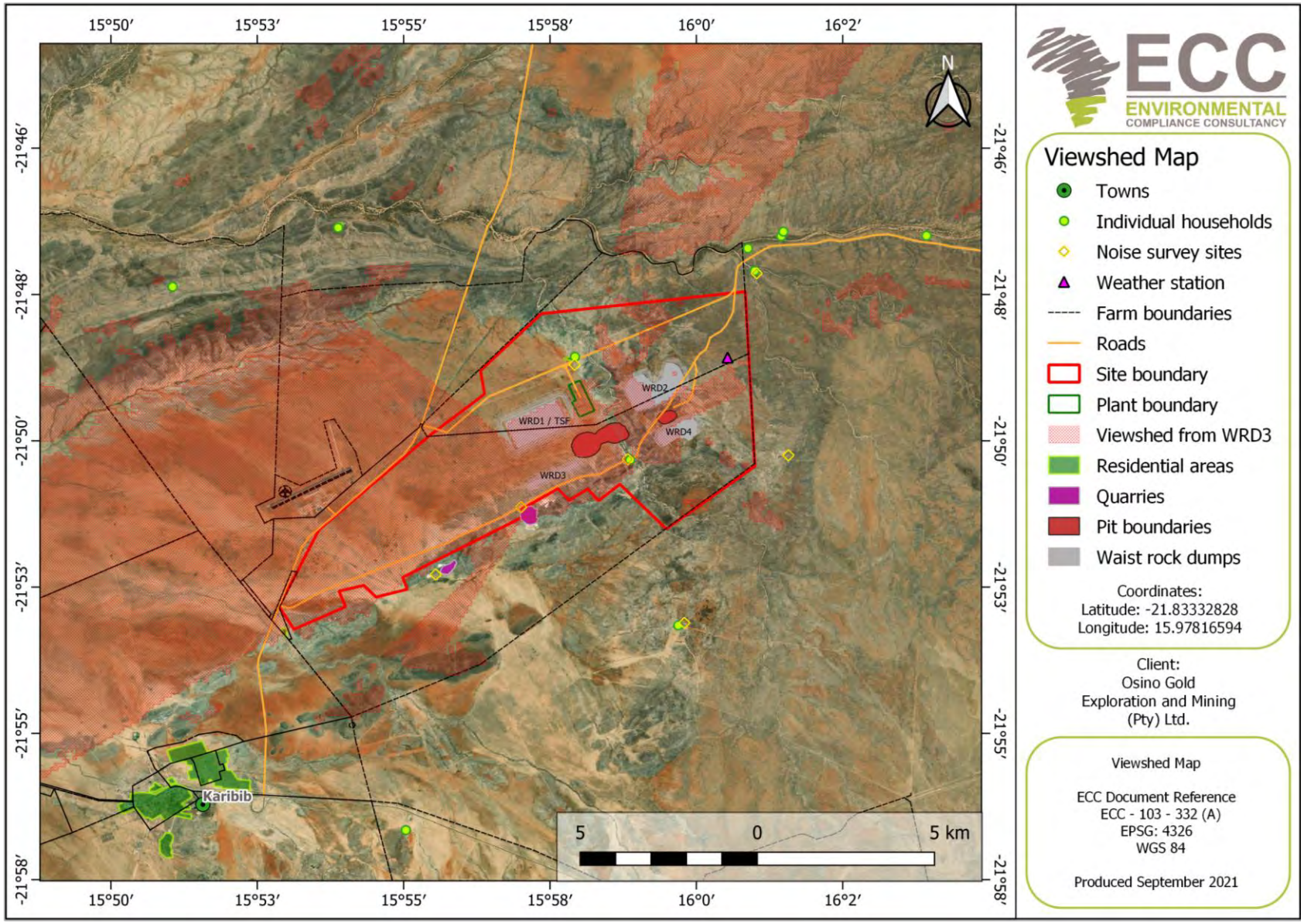


Figure 38 – Viewshed model from WRD 3

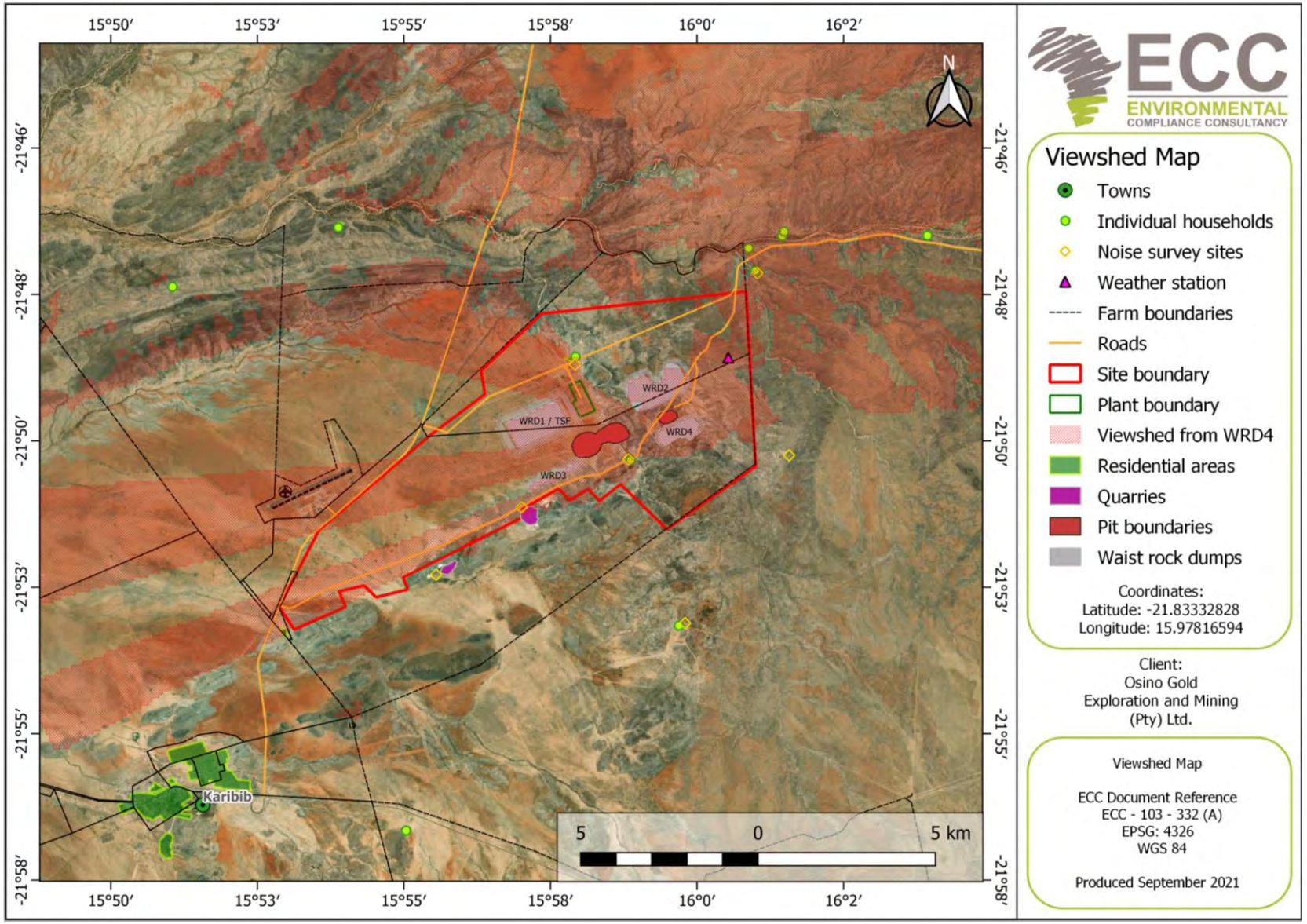


Figure 39 – Viewshed model from WRD 4

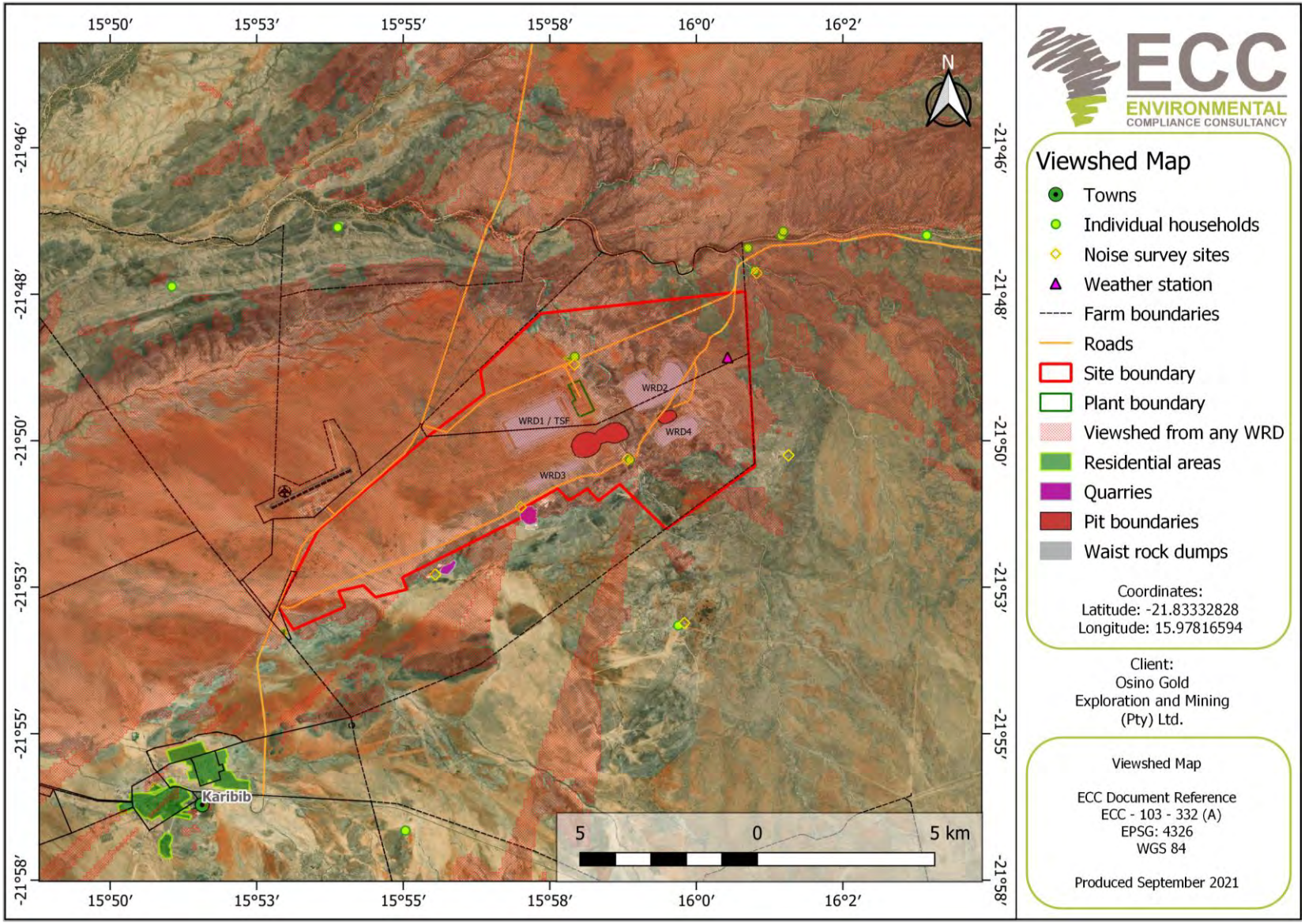


Figure 40 – Combined viewsheds from all waste rock and tailings facilities

5.11 LIGHTING

The night sky in the area is undisturbed. Namibia is known for its clear night skies and excellent stargazing settings. Artificial lighting, floodlights, and lighting for evening mining activities are not visible from the Project site, although there are sites in proximity to the Project that are using lights for mining activities during nightfall. The baseline of undisturbed night skies from lights will be altered during construction and operations of the Project. Impacts associated with lights, and the management and mitigation measures will be addressed in the assessment phase and EMP.

5.12 BIOPHYSICAL ENVIRONMENT BASELINE

5.12.1.1 Climate and meteorology

Namibia is a hyper-arid country. Regionally, there is a growing demand for water due to climate change, population growth, economic development, and urbanisation, which increases pressure on existing water sources. The Twin Hills Gold Project is located in central Namibia in an area that experiences generally hot daytime temperatures throughout the year, while the nights are mild to cool in winter.

The mean annual rainfall is highly variable, ranging between 200mm to 300mm. Generally, evaporation exceeds precipitation, especially during the winter months of April to August, when there is little to no rainfall. The hot and dry season from September to December is dry with high daytime temperatures. Namibia's rains tend to fall between January and April, but cognisance should be taken of potential changes in weather patterns because of climate change. Runoff in the ephemeral streams can be expected when the water deficit ratio is near neutral in January through April. Figure 41 below renders the wind roses for the period of July 2020 to July 2021 (AirShed, 2021).

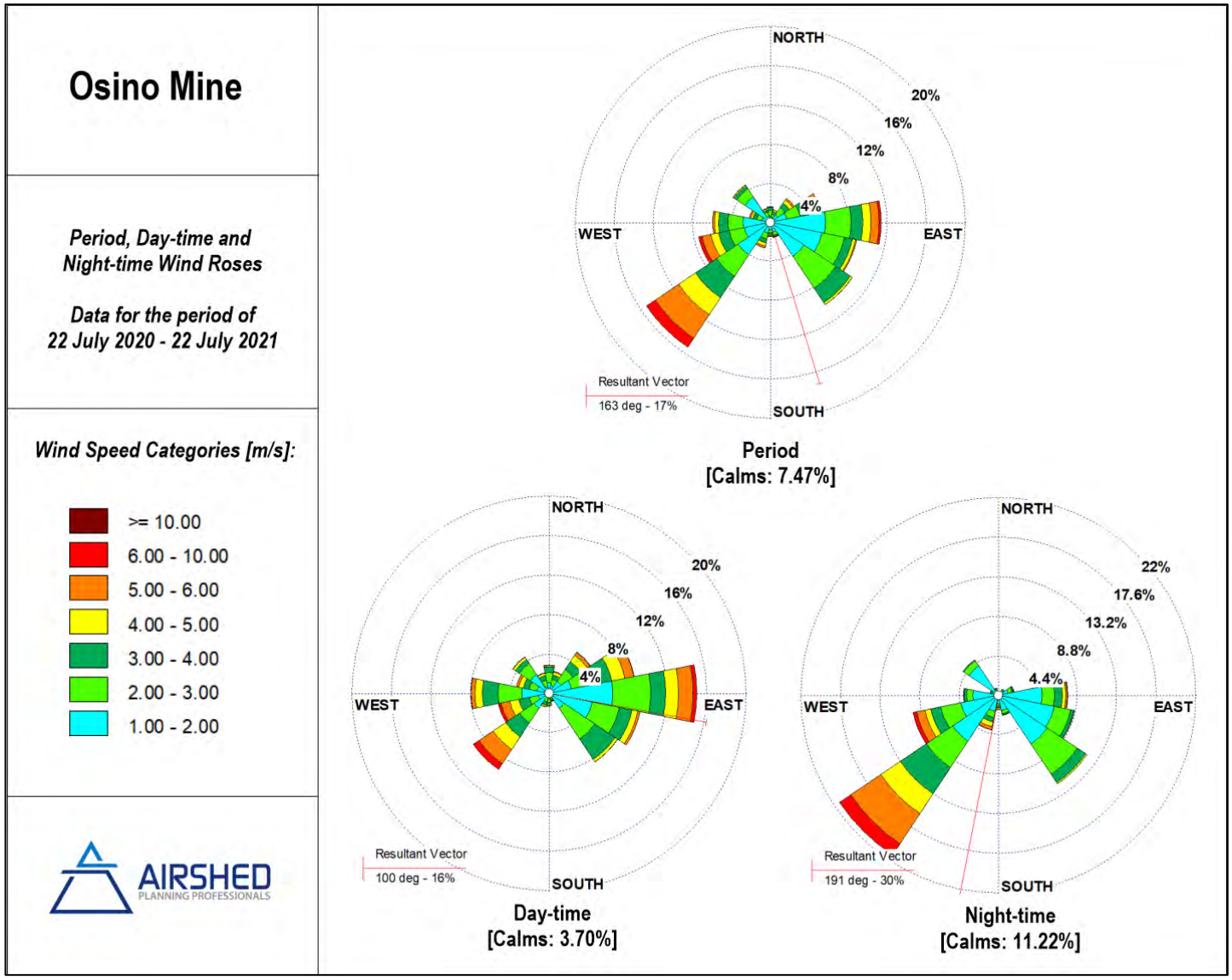


Figure 41 – Wind roses for the period 23 July 2020 – 22 July 2021 from data gathered from the on-site weather station

5.12.1.2 Soil

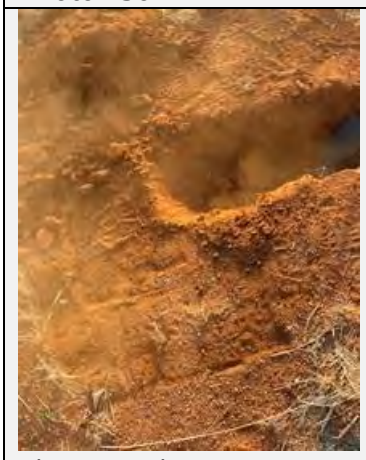
The soil in the Project area is dominated by calcisols, (commonly called calcretes), regisols, and rocky outcrops based on mapping in the Atlas of Namibia. The mapping from the Atlas of Namibia is considered high level, and sampling done during this investigation can be used to improve the mapping of soils in the area.

A soil analysis baseline provides a description of the environment specifically related to soils that occur in the study area. It summarises the soil composition, fertility, land use potential, and erodibility. This information will contribute to the material balance, which could be used for cover material of selected mining landforms.

Eight (8) soil sampling locations were determined by the visible soil differences found on satellite imagery and the planned footprint areas, as depicted in the preliminary economic assessment report (PEA). The baseline soil types in the Project area are presented in Table 12.

Table 12 – Classification of soil type

Sample photo	Type of soil	Reasoning
Photo - Soil 1	Gypsic / Neocarbonate	Soft and hardened gypsum accumulation in alluvial material. Calcareous (though soil material dominates horizon); apedal to weak structure; colour variegation; absence of gleying.
Photo - Soil 2	Gypsic / Neocarbonate	Soft and hardened gypsum accumulation in alluvial material. Calcareous (though soil material dominates horizon); apedal to weak structure; colour variegation; absence of gleying.
Photo - Soil 3	Gypsic / Neocarbonate	Soft and hardened gypsum accumulation in alluvial material. Calcareous (though soil material dominates horizon); apedal to weak structure; colour variegation; absence of gleying.

Sample photo	Type of soil	Reasoning
Photo - Soil 4	Gypsic / Neocarbonate	Soft and hardened gypsum accumulation in alluvial material. Calcareous (though soil material dominates horizon); apedal to weak structure; colour variegation; absence of gleying.
 Photo - Soil 5	Red apedal / Red Structured	Uniform red colouring; apedal to weak structure; non-calcareous. Uniform red colouring; moderate to strong structure; red cutans.
Photo - Soil 6	Red apedal / Red Structured	Uniform red colouring; apedal to weak structure; non-calcareous. Uniform red colouring; moderate to strong structure; red cutans.

Sample photo	Type of soil	Reasoning
Photo - Soil 7	Red apedal	Uniform red colouring; apedal to weak structure; non-calcareous. Quartz stone fragments within a red apedal horizon.
Photo - Soil 8	Neocarbonate	Calcareous (though soil material dominates horizon); apedal to weak structure; colour variegation; absence of gleying.

5.12.1.3 K-factor

The soil erodibility factor (K-factor) is a quantitative depiction of the characteristic of a particular soil's erodibility; it is the extent to which soil particles detach and are washed away by rainwater and runoff. The soil erodibility factor can in some cases be described as the rate of erosion per unit index from a specific area. The erodibility factor reflects the susceptibility between different soils when all other impacting factors (infiltration rate, permeability rate, dispersion and total water capacity, abrasion, and rain splash) are all kept constant. The soil erodibility factor (K- factor) ranges in value from 0.02 to 0.69, which is highly influenced by soil texture, although other factors such as permeability, organic matter content, and structure could play a contributing factor (Pacific Northwest National Laboratory, Environmental sciences and risk analyses tools, 2021: www.pnnl.gov/projects/earth).

$$K_{fact} = (1.292)\left[2.1 \times 10^{-6} f_p^{1.14}(12 - P_{om}) + 0.0325(S_{struc} - 2) + 0.025(f_{perm} - 3)\right]$$

In which:

$$f_p = P_{silt}(100 - P_{clay})$$

Where:

f_p is the particle size parameter (unitless)

P_{om} is the percent organic matter (unitless)

S_{struc} is the soil structure index (unitless)

f_{perm} is the profile-permeability class factor (unitless)

Soil infiltration rate is the most important factor because it determines how fast the transfer and distribution of water from surface to soil profile happens (Patle *et al*. 2018). The infiltration rate was calculated by means of a literature analysis, as it was not conducted on-site.

The infiltration rate was determined by making use of the sand, silt, and clay percentages, and the results are shown in Table 13. It was observed that sand content varies from 89% to 97%, with a mean value of 92.75%; silt content varies from 1% to 3%, with a mean value of 1.69%; and clay content varies from 2% to 9%, with a mean value of 5.63%. Table 14 to
Table 17 provide details into the factors used in this assessment. The analysis from the first-class method (Patle *et al*. 2018) was used to determine the infiltration rate of the 8 soil samples, and thus is represented by the following formulae:

$$\boldsymbol{EIR = 14,195.35 - 141.75(sand\%) - 142.10(silt\%) - 142.56(clay\%)}$$

Table 13 – The profile permeability class factor table

The profile-permeability class factor, fperm	
1	for very slow infiltration
2	for slow infiltration
3	for slow to moderate infiltration
4	for moderate infiltration
5	for moderate to rapid infiltration
6	for rapid infiltration

Table 14 – Soil structure index

The soil structure index	
1	for very fine granular soil
2	for fine granular soil
3	for medium or coarse granular soil
4	for blocky, platy, or massive soil

Table 15 – Table of K-Factor calculation

Sample	FP	EIR (CM/H)	KFACT ((T HA H)· (HA MJ MM)−1)	SAND (%)	FPERM	SSTRUC
Topsoil 1	182	3087.634	0.074457	89	5	2
Subsoil 1	182	3150.383	0.07462	89	5	2
Topsoil 2	93	2267.078	0.144082	92	6	3
Subsoil 2	186	2565.331	0.149459	91	6	3
Topsoil 3	184	2833.253	0.106936	90	6	2
Subsoil 3	276	3123.506	0.079819	89	5	2
Topsoil 4	98	870.4121	0.102726	97	6	2
Subsoil 4	96	1474.12	0.102639	95	6	2
Topsoil 5	96	1508.773	0.144754	95	6	3
Subsoil 5	94	2076.692	0.144624	93	6	3
Topsoil 6	180	1580.933	0.149901	95	6	3
Subsoil 6	192	1695.493	0.150637	94	6	3
Topsoil 7	97	1090.751	0.102707	96	6	2
Subsoil 7	192	1775.687	0.108282	94	6	2
Topsoil 8	192	1709.169	0.150368	94	6	3
Subsoil 8	186	2525.336	0.14996	91	6	3

Table 16 – Laboratory results for the element and organic matter (Geolab, 2021)

Sample no	PH (KCL)	P (OLSEN) MG KG^{-1}	K MG KG^{-1}	CA MG KG^{-1}	MG MG KG^{-1}	NA MG KG^{-1}	ORG-C %
Topsoil 1	7.5	4	238	2893	166	7	1.38
Subsoil 1	7.5	3	221	2978	165	10	1.21
Topsoil 2	7.7	1	91	2773	162	6	1.09
Subsoil 2	7.8	1	72	2756	167	4	0.90
Topsoil 3	7.6	2	217	2906	163	11	1.33
Subsoil 3	7.6	7	170	2935	264	63	1.21
Topsoil 4	7.4	2	226	1024	160	6	0.47
Subsoil 4	7.6	1	216	1074	152	4	0.37
Topsoil 5	6.9	1	144	792	224	7	0.12
Subsoil 5	7.1	0	112	951	283	6	0.10
Topsoil 6	7.1	2	182	775	196	3	0.08
Subsoil 6	7.7	1	137	2399	281	9	0.10
Topsoil 7	7.6	0	162	2839	214	22	0.37
Subsoil 7	7.7	1	138	2805	255	44	0.47

Sample no	PH (KCL)	P (OLSEN) MG KG^{-1}	K MG KG^{-1}	CA MG KG^{-1}	MG MG KG^{-1}	NA MG KG^{-1}	ORG-C %
Topsoil 8	7.6	4	199	2377	115	5	0.37
Subsoil 8	7.7	3	169	2899	124	7	0.37

Table 17 – Soil erodibility factor (After Stewart et al. 1975 as cited by PNNL, 2021)

P_{OM}(%)			
Textural class	**<0.5**	**2**	**4**
Sand	0.05	0.03	0.02
Fine sand	0.16	0.14	0.10
Very fine sand	0.42	0.36	0.28
Loamy sand	0.12	0.10	0.08
Loamy fine sand	0.24	0.20	0.16
Loamy very fine sand	0.44	0.38	0.30
Sandy loam	0.27	0.24	0.19
Fine sandy loam	0.35	0.30	0.24
Very fine sandy loam	0.47	0.41	0.33
Loam	0.38	0.34	0.29
Silt loam	0.48	0.42	0.33
Silt	0.60	0.52	0.42
Sandy clay loam	0.27	0.25	0.21
Clay loam	0.28	0.25	0.21
Silty clay loam	0.37	0.32	0.26
Sandy clay	0.14	0.13	0.12
Silty clay	0.25	0.23	0.19

5.12.1.4 Soil fertility potential

According to the laboratory results, soils 1, 3, 4, 5 and 6 have a high pH and do not require any lime application. The soil sodium adsorption ratio (SAR) is low and does not require gypsum application.

In relation to understanding the soil material for closure and rehabilitation purposes, to improve the fertility potential of the soil from samples 1, 3, 4, 5 and 6 for planting pasture grasses, broadcast 300Kg/ha in a ratio of 1:1:0 (32), add Zn immediately before planting, and work within 10cm. Top-dress 200Kg/ha of limestone ammonium nitrate (LAN) six weeks after planting (Geolab, 2021).

Soil 2 also has a high pH and does not require any lime application. The soil sodium ratio is low and does not require gypsum application. In order to improve the fertility potential of this soil for the establishment of pasture grasses, broadcast 500Kg/ha in a ratio of 2:3:4 (30), add Zn immediately before planting, and work within 10cm. The top-dress is the same as the other soils, and has a requirement of 200Kg/ha LAN six weeks after planting (Geolab, 2021).

In conclusion, the soil analysis survey has determined that the soils have calcrete and marble that can act as a neutralising agent. The topsoil must be kept for rehabilitation, as it is fertile enough to produce grasslands. There will be no need to add lime or gypsum to any of the soils if it gets used for cover material, as the soils have a high pH and low Na and SAR values. The soils have a low erodibility in general.

It is suggested that a detailed soil map depicting stripping depths and available cover soil volumes be created once the final site layout plans are available. These maps should be used to start the stripping and topsoil stockpiling plan, as well as inform the active topsoil balance for life of mine.

5.12.1.5 Air quality

Since June 2020, Environmental Compliance Consultancy has been conducting environmental monitoring and assessments for the Twin Hills Gold Project, for the purpose of reporting on depositional dust, at eight dust monitoring stations located on the Project site. Air quality monitoring is crucial for determining the potential impacts that planned mining operations may have in an environment.

The potential expected sources of dust particulate matter resulting from the operational activities include, but are not limited to: construction activities; mineral material handling and processing; and mining activities like drilling, blasting, and hauling. Therefore, depositional dust monitoring station locations were based on the proposed infrastructure locations likely to generate dust, taking into account prevailing wind. Figure 42 shows the locations of the dustfall sampling locations. Baseline dust fallout conditions do not exceed 200mg/m^2/day which is below the limits set for southern Africa. The threshold limits are included in the legend on Figure 42.

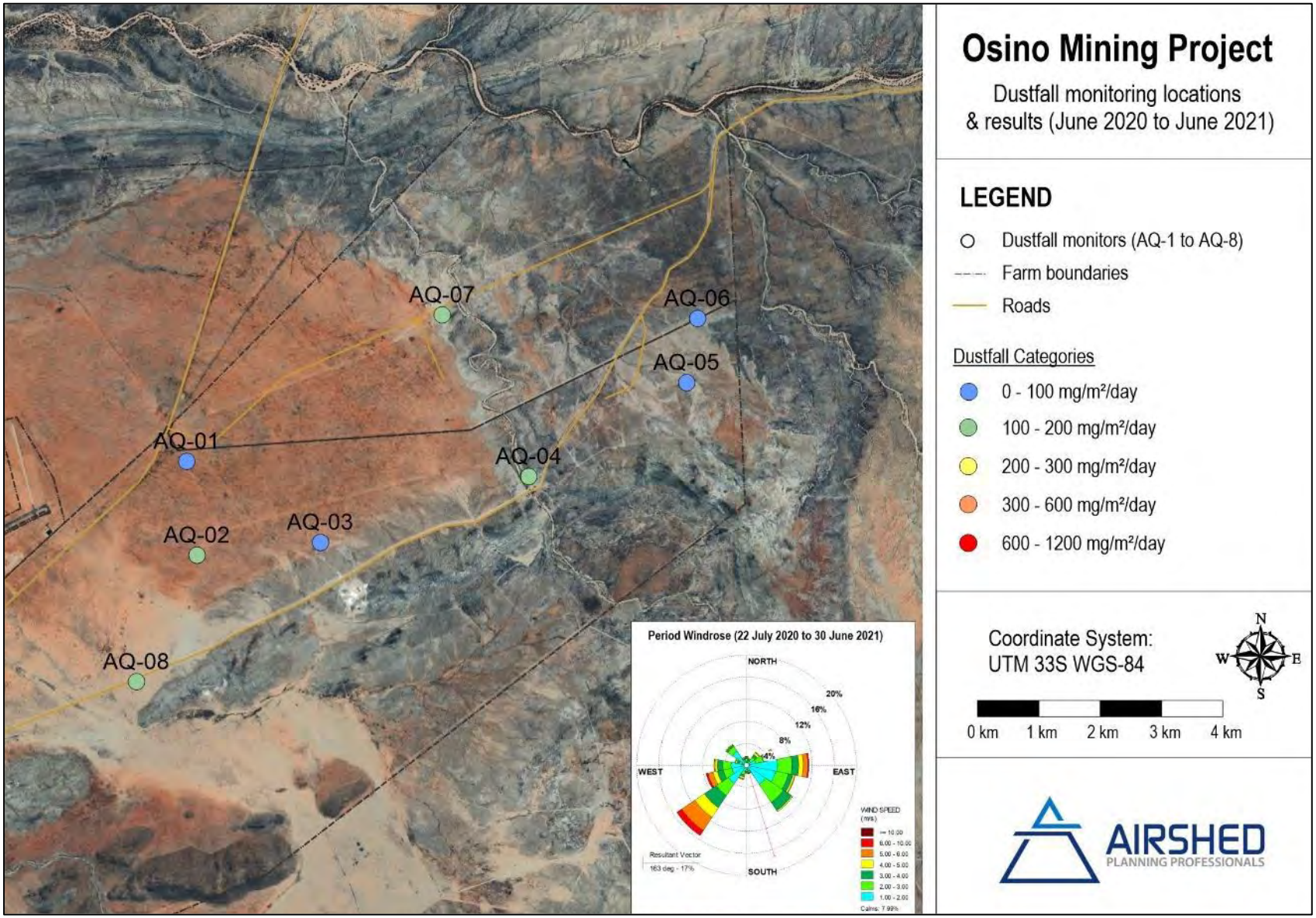


Figure 42 – Dustfall monitoring locations and results

Natural environments are complex systems that can be affected by anthropogenic interference such as mining activities, including mineral exploration. To understand the confounding factors and interpret the findings based on the baseline of the receiving environment, deductive and inductive approaches can be used. The wind vectors, topography (e.g. mountains and valleys), seasonal rainfall, and drought are identified as the potential factors that are likely to influence air quality. Wind direction and speed are the primary factors determining the distance of travel of a dust particle and the distribution of particles falling out.

Moreover, as the ESIA for the proposed gold mining activities at the Project site commenced, an air quality specialist study was deemed necessary to determine the potential impacts of atmospheric pollution to air quality for this Project. Airshed Planning Professionals were engaged to model and provide a technical report for the air quality baseline. The noise report has been completed and is provided in Appendix D.

The ambient air quality guidelines, as contained within the IFC and EHS guidelines of 2007, shall be applied to the assessment. The findings, recommendations, and the way forward, as described in the baseline report, are described hereafter. The main findings from the baseline study can be summarised as follows:

- The terrain is hilly, with a ridge to the north and northwest, and a ridge on the southern side
- On-site weather data is available for the period 23 July 2020 to 22 July 2021. The wind field is dominated by winds from the southwest and the east to southeast, with the strongest winds from the southwest. During the day, easterly winds prevailed with strong but less frequent winds from the southwest, and at night the wind field shifted to the southwest. Calm conditions were recorded for 7.5% of the time with a period average wind speed of 2.3m/s. Higher wind speeds occurred during the night, with the strongest winds recorded from the southwest. A maximum wind speed of 8.9m/s was recorded
- Monthly variation in the wind field showed more frequent south-westerly winds during the summer months and a shift to easterly winds in May, and then to the southeast during April to July – the so called “east-winds”. In August, winds from the northwest prevailed, whereafter it shifted to the southwest in September with a remaining easterly component. The winter months were dominated by high velocity north-easterly winds
- Maximum, minimum, and mean temperatures were given as 42°C, -3°C, and 23°C respectively from the Twin Hills Gold Project on-site weather station for the period Jul 2020 to Jul 2021
- Rainfall over the 12-month period totalled 254mm, with the highest rainfall month being January 2021 (115mm)
- The main pollutant of concern in the region is particulate matter (TSP; PM10 and PM2.5) resulting from vehicle entrainment on the roads (paved, unpaved, and treated surfaces), windblown dust, and mining and exploration activities. Gaseous pollutants such as SO2, NOx, CO, and CO2, would result from vehicles and combustion sources, but these are expected to be at low concentrations due to the few sources in the region

- Sources of atmospheric emissions in the vicinity of the proposed Twin Hills Gold Project include:
  - Vehicle entrainment from roads: The national road to the south (B2) of the Project is the main road between Windhoek and Swakopmund, and one of the roads in the region with the highest traffic counts. It is a paved road with vehicle entrainment calculated to be a significant contributor to the regional paved road PM2.5 and PM10 emissions. The C33 is a paved road connecting the Karibib Airport to the B2, and although no information was available for this road, it is expected to have very low traffic counts and low PM2.5 and PM10 emissions
  - Windblown dust: Windblown particulates from natural exposed surfaces, mine waste facilities, and product stockpiles can result in significant dust emissions with high particulate concentrations near the source locations, potentially affecting both the environment and human health. Windblown dust from natural exposed surfaces in and at the Twin Hills Gold Project is only likely to result in particulate matter emissions under high wind speed conditions (>10m/s), and since recorded wind speeds did not exceed 10m/s, this source is likely to be of low significance
  - Mines and exploration operations: Pollutants typically emitted from mining and quarrying activities are particulates, with smaller quantities associated with vehicle exhaust emissions. Mining and quarrying activities, especially open-cast mining methods, emit pollutants near ground level over (potentially) large areas. Mines in proximity to the proposed Project are Navachab Gold Mine, located approximately 20km west-southwest of Karibib, and a number of marble quarries – Capra Hill, Dreamland, and Savanna Marble
  - Regional transport of pollutants: Regional-scale transport of mineral dust and ozone (due to vegetation burning) from the north of Namibia is a significant contributing source to background PM concentrations.

The dust fall monitoring network comprises eight (8) single dustfall units placed at the Twin Hills Gold Project site, with dustfall data available for the period June 2020 to June 2021. Dustfall rates were generally low for the sampling period, and well within the dustfall limit of 600mg/m²/day (adopted limit for residential areas) and 1 200mg/m²/day (adopted limit for non-residential areas). Dustfall rates were the lowest during the months of June to September 2020, and might have been influenced by the regional lockdown due to COVID-19. The highest dustfall of 520mg/m²/day was recorded at AQ-02 in March 2021. The dustfall results show no clear spatial trend.

Based on the activities associated with the proposed Project (see Section 1.2 of Appendix D), an air quality impact assessment is proposed to be conducted as part of the ESIA. The scope of work included the following tasks:

- The compilation of an emissions inventory, including the identification and quantification of all emissions associated with the proposed mining, processing, and smelting operations. Pollutants quantified should, as a minimum, include particulate matter (TSP, PM10 and PM2.5) and gaseous emissions (SO2, NO2 and CO). Use should be made of engineering design parameters, emissions standards, and emissions factors published by the US EPA and Australian National Pollutant Inventory (NPI)
- Dispersion modelling will be conducted using an internationally approved dispersion model such as the United Kingdom (UK) Air Dispersion Modelling System (ADMS)
- An impact assessment is to be compiled by comparing ambient pollutant concentration levels to the relevant air quality limits/guidelines, as set out in Section 2.4 of Appendix D, to assess the potential impact on the surrounding environment and human health
- The identification of air quality management and mitigation measures based on the findings of the compliance and impact assessment.

5.13 GEOCHEMICAL

RGS-ECC is completing a geochemical assessment of mining materials for the Twin Hills Gold Project using relevant legislation, guidelines, and policies to inform the assessment (AMIRA, 2002; COA, 2016; and INAP, 2020). A geochemical analysis of the mine material (waste rock, and low-grade and high-grade ore) is being conducted to assess the mineralogical composition and potential for the generation of acid and metalliferous drainage (AMD), neutral and metalliferous drainage (NMD), saline drainage (SD), or dispersive issues from these materials.

A strategy was developed to collect and geochemically characterise representative samples of mining materials from drill core representing waste rock, low-grade ore and high-grade ore materials. The strategy was developed to align with Australian (AMIRA, 2002, COA, 2016) and international (INAP, 2020) technical guidelines for the geochemical assessment of mine waste materials.

Representative waste rock, and low-grade and high-grade ore samples for the assessment were collected as set out in the RGS-ECC Geochemical Sampling and Analysis Plan (RGS, 2021). A total of 131 samples from six drill holes from the Project were crushed and sub-sampled, pulverised to pass 75µm sieve size, bagged, labelled, sealed, and then transferred to a commercial laboratory (Analytical Laboratory Services in Windhoek and SGS in South Africa) for static geochemical testing as shown in Table 18.

Table 18 – Sample materials used for geochemical testing

Sample Description	Number of Samples
Twin Hills Central Waste Rock – no alteration, mineralisation	65
Clouds Waste Rock – no alteration, mineralisation	5
Twin Hills Central Waste Rock – alteration, mineralisation	28
Clouds Waste Rock – alteration, mineralisation	16
Twin Hills Central Ore – oxidised	3
Clouds Ore – oxidised	3
Twin Hills Central Ore – alteration, mineralisation	9
Clouds Ore – alteration, mineralisation	2
Total	**131**

The geochemical test program was designed to assess the degree of risk from the presence and potential oxidation of sulfides, acid generation, and the presence/leaching of soluble metals/metalloids and salts. The preliminary results from the ABA data trends are presented below.

pH: The pH of the samples tested ranges from 6.1-10.2 (i.e. in the neutral to moderately alkaline range) and has a median value of 9.4 (Figure 43). The only samples with a pH value less than 8 are three waste rock samples with phyllic alteration and pyrrhotite mineralisation from the Clouds deposit. Hence, the majority of the samples have moderately alkaline pH values greater than the deionised water used in the tests, suggesting that, at least initially, the addition of alkalinity to water in contact with these materials is likely.

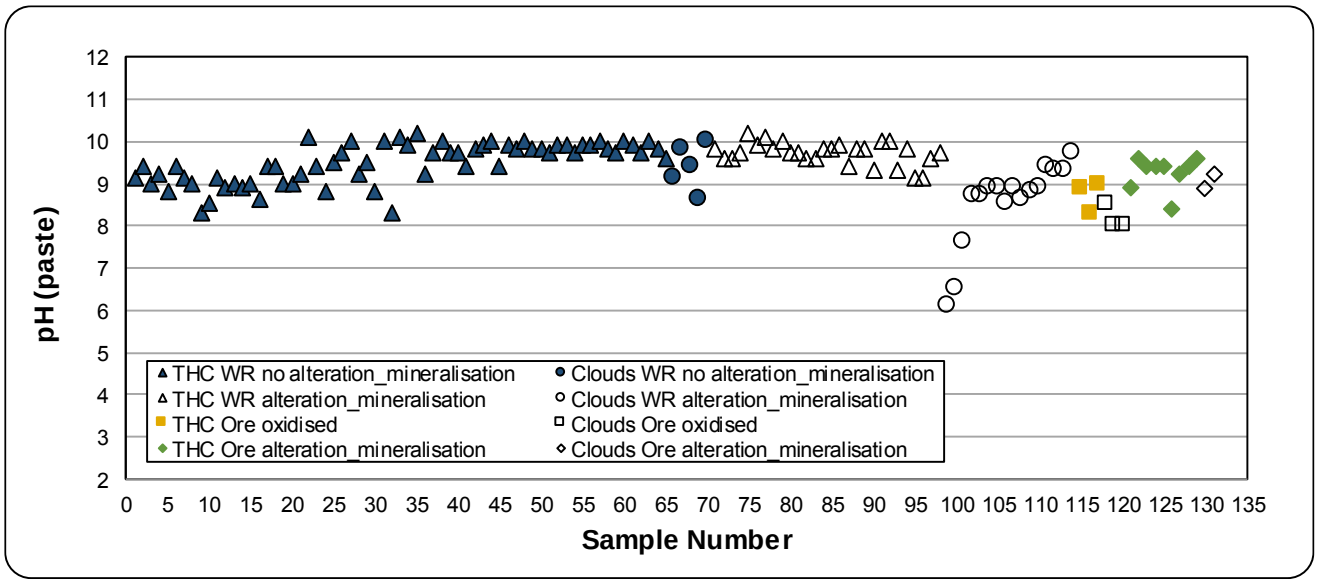


Figure 43 – pH values for waste rock and ore (Source ECC:RGS, 2021)

Electrical conductivity (EC): The EC value of the 51 samples ranges from 19 to 272µS/cm and is generally low (median 58µS/cm) (Figure 44). The only samples with an EC value greater than 200µS/cm are two waste rock samples with phyllic alteration and pyrrhotite mineralisation from the Clouds deposit. Hence, at least initially, waste rock and ore materials are likely to have a low salinity value.

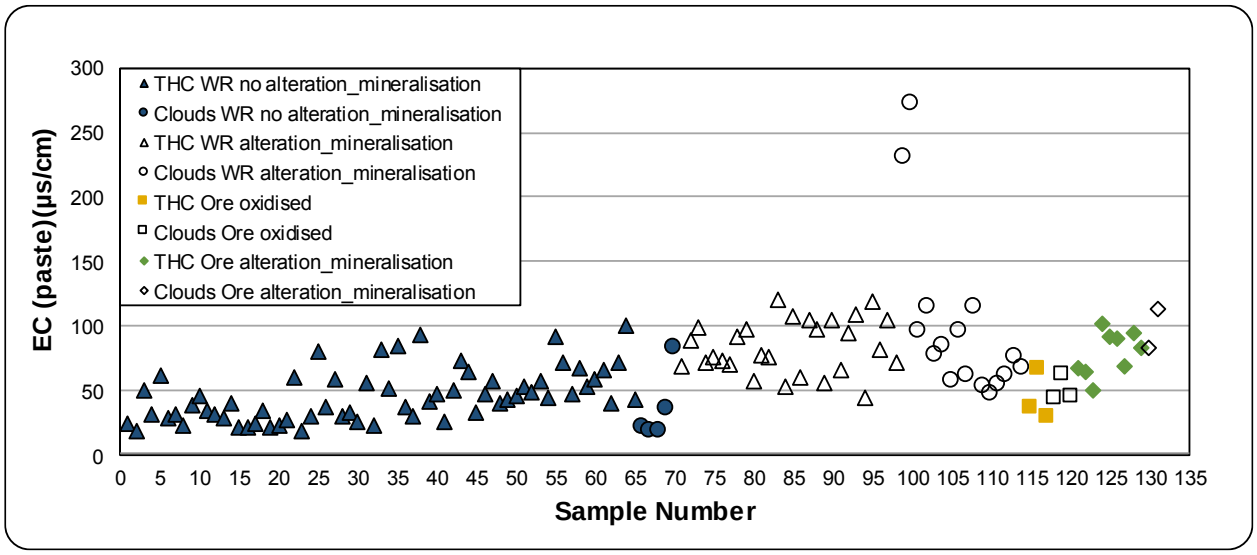


Figure 44 – EC values for waste rock and ore (Source ECC:RGS, 2021)

Total sulfur: The total sulfur content of the 131 waste rock and ore samples range from 0.005 to 3.08%S and has a low median value of 0.11%S. Most of the waste rock and ore samples that have not been altered, or are without mineralisation, have a very low total sulfur concentration below the median crustal abundance (0.1%S) for this element in unmineralised soils (INAP, 2020; Bowen, 1979).

In contrast, most of the waste rock and ore samples that are altered, and/or contain mineralisation, have elevated total sulfur concentrations that are likely to be present in the form of pyrrhotite and/or pyrite (Figure 45).

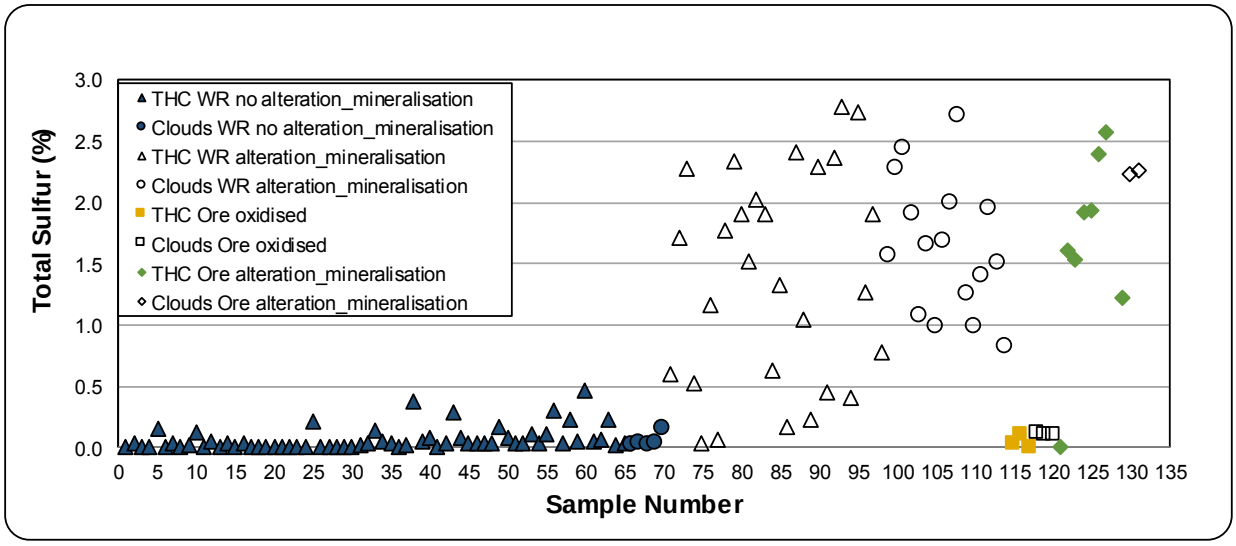


Figure 45 – Total sulfur concentrations for waste rock and ore (Source ECC:RGS, 2021)

Maximum potential acidity (MPA): Based on the total sulfur content, the maximum potential acidity (MPA) that could be generated by the 131 waste rock and ore samples ranges from 0.2 to 94.3kg H2SO4/t with a low median value of 3.4kg H2SO4/t. The altered and/or mineralised waste rock and ore samples have a much higher potential for generation of acidity through sulfide oxidation than the waste rock and ore with no alteration and/or mineralisation.

Acid neutralising capacity (ANC): The ANC value for the 131 waste rock and ore samples ranges from below the laboratory limit of reporting (0.5kg H2SO4/t) to 680.0kg H2SO4/t, and has a median value of 16kg H2SO4/t. The highest ANC values were recorded for the calcrete waste rock samples and is generally more than an order of magnitude greater than the median ANC value.

Net acid producing potential (NAPP): The NAPP is the balance between the capacity of a sample to generate acidity (MPA) minus its capacity to neutralise acidity (ANC). The calculated NAPP values for the 131 waste rock and ore samples ranges from -679.1 to +85.8kg H2SO4/t with a negative median value of -10.5kg H2SO4/t. The most negative NAPP values were generally recorded for the calcrete waste rock samples, and the most positive NAPP values were recorded for some of the altered and mineralised waste rock and ore samples.

The results of the information review and static geochemical test program to date have been used to provide some preliminary conclusions as to whether the exposed waste rock and ore materials at the Project will present environmental risks that will need to be managed.

The geochemical assessment to date has found that:

- Waste rock and ore materials that have not been altered and are not mineralised, generally have low sulfur content, excess ANC, and are classified as NAF. Calcrete waste rock is also a good source of acid consuming material as it has a very high ANC value
- Altered and mineralised waste rock and ore materials generally have elevated sulfur content, low to moderate ANC, and are generally classified as PAF. These materials will need to be selectively handled and managed at the Project.

The results of the initial static geochemistry assessment programme on waste rock and ore materials at the Project indicate that most waste rock that has not been altered and is not mineralised, is likely to be NAF. Thus, it is potentially suitable for use in surface infrastructure and final landforms at the Project. In contrast, altered and/or mineralised waste rock and ore stockpile materials are not suitable for use in surface infrastructure and final landforms.

5.14 WATER

The Project area falls in the Khan River catchment, which is in turn a sub-catchment of the Swakop River. Drainage in the area is dendritic with ephemeral streams, often steeply incised, forming small tributaries of the ephemeral Khan River, which flows south-westwards towards the Swakop River (Figure 46).

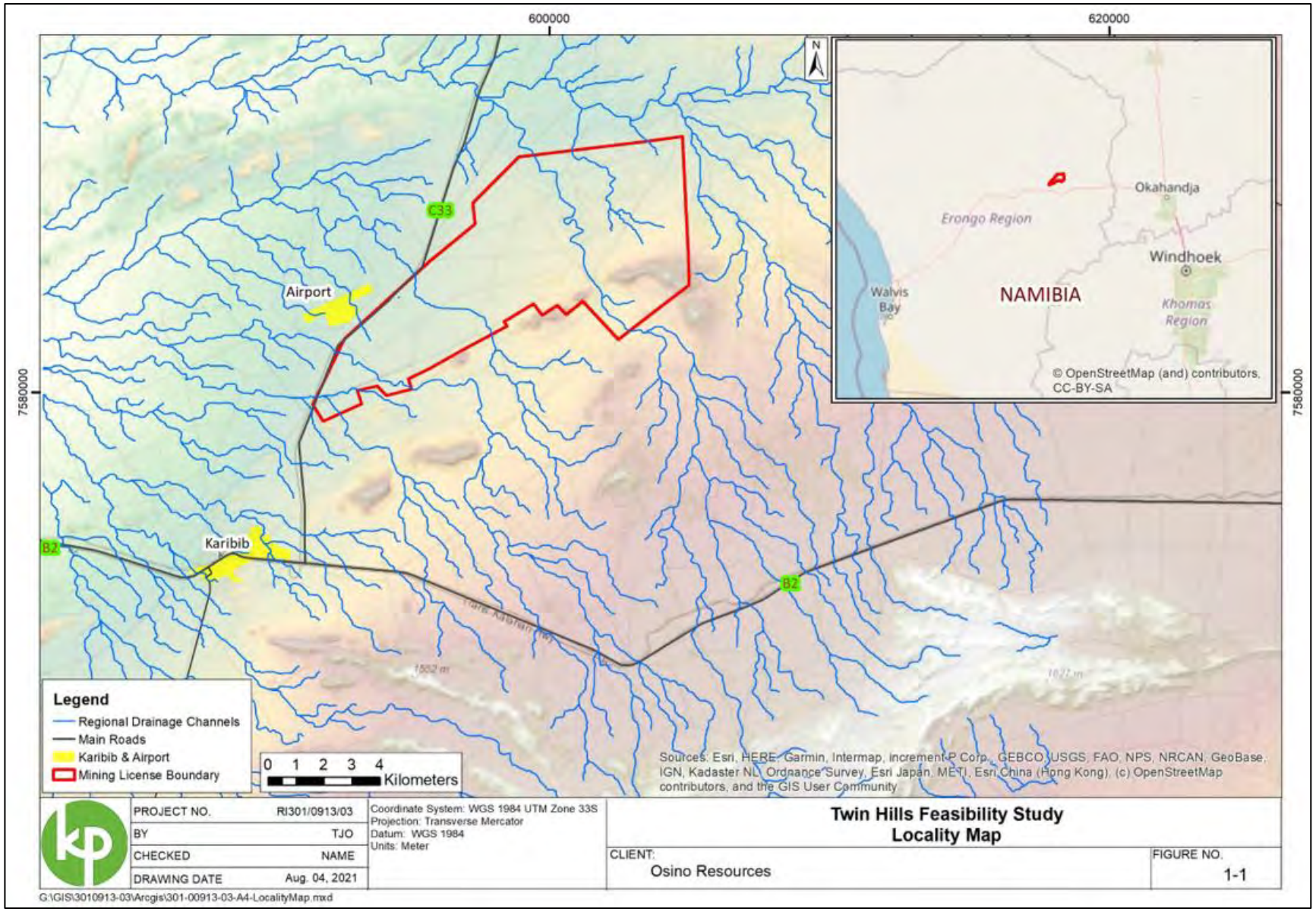


Figure 46 – Surface water flow showing ephemeral rivers and the Project area (source KP, 2021)

Major surface drainage lines in the Project area include the Aroab Minor in the west, the Okawayo Minor in the centre, and the Slang Minor river in the east. The catchment area (Figure 47) upstream of the planed mining pit is approximately 92km^2, with a watercourse length of roughly 28km (Knight-Piesold, 2021).

Small streams also flow southwards off the marble ridge into a stream that flows parallel to the ridge, before turning north-westwards to dissipate in the red sands south of the airfield.

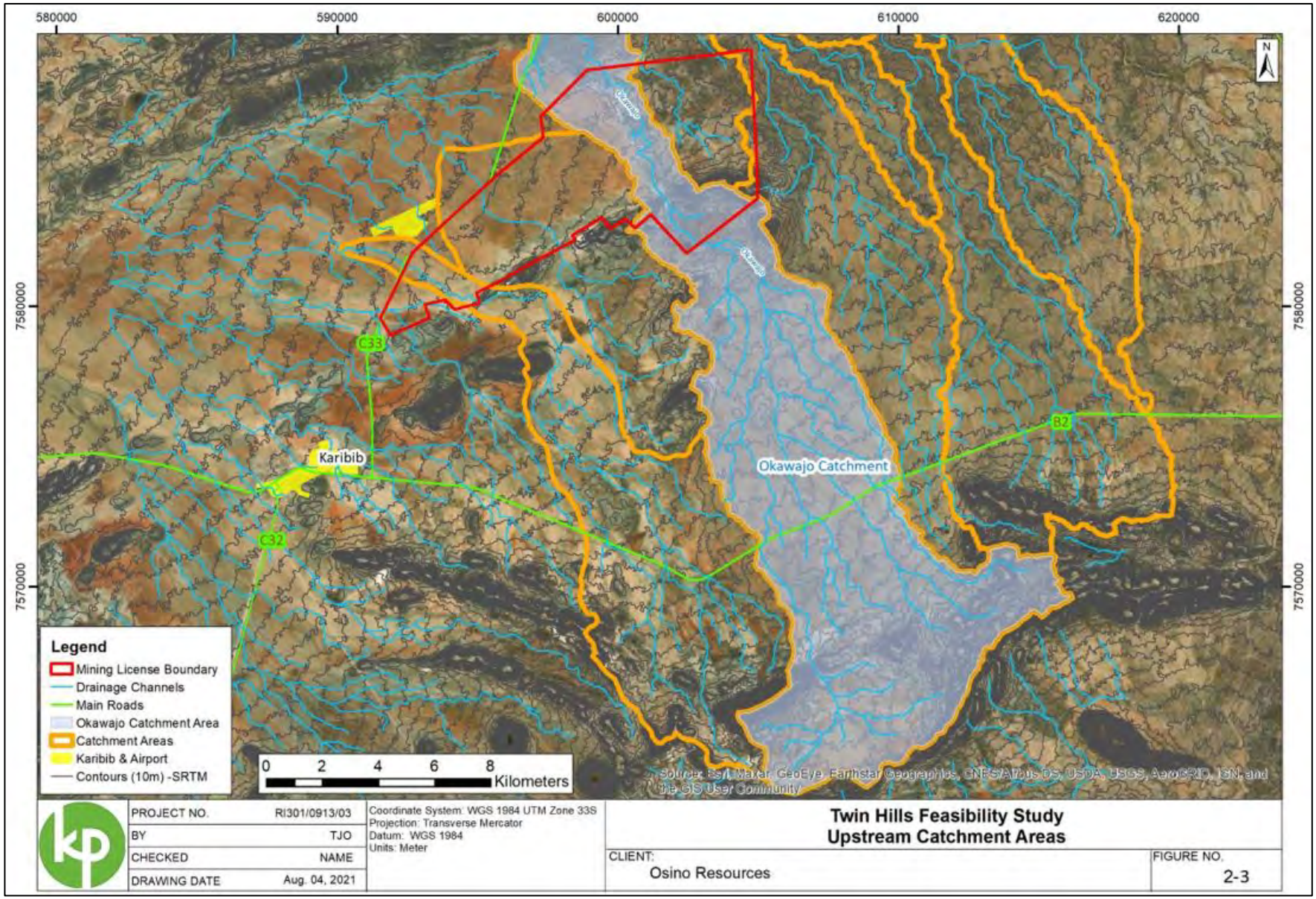


Figure 47 – Okawayo River catchment area (source KP, 2021)

The local surface water resources have not been significantly impacted by the current farming land use, although small dams and boreholes are expected to have supplied the farmsteads. There is also no urbanisation or industrial development in the larger catchment areas south of the proposed mine, so the local surface water resources are unlikely to be significantly polluted (SLR, 2020).

5.14.1.1 Stormwater control

Runoff generated within the planned mining area, processing plant, handling, haul, and waste management areas should be managed by adding stormwater infrastructure, consisting of diversion channels, silt traps, berms gutters, pollution control reservoirs, and other components. The infrastructure is required to prevent dirty water, which was in contact with the mining-related activities, to pollute the surrounding areas, and to allow for storage and retention of polluted water on-site (Knight-Piesold, 2021).

Knight-Piesold (2021) proposed that an attenuation dam be constructed upstream of the pit on the main catchment tributary, to prevent potential damage to infrastructure and pollution of the environment as result of a major flood event. The daily rainfall-runoff sequence was correlated against the scaled Spesbona flow gauging data, and it was determined that the simulated (i.e. modelled) runoff sequence is deemed acceptable for stormwater balance purposes upstream of the mining pit. This expectation is based on the conceptual model developed to date.

A high-level topographic assessment of the gorge upstream of the pit was conducted to determine elevation, area, and storage relationships. Two options were investigated:

Option 1 covers the construction of an attenuation dam and diversion channel upstream of the farmhouse (Figure 48). Studies suggest that there are heritage sites on the banks of the river in that ravine, and this option should not impact them. Figure 49 shows cross-sections of the infrastructure used in Option 1 simulations[2].

[2] *A conceptual option could be to introduce a subsurface storage dam and enhance recharge of the marble aquifer, which is the main water supply to the mine and other regional users, this is being considered as part of the hydrogeological studies that are ongoing.*

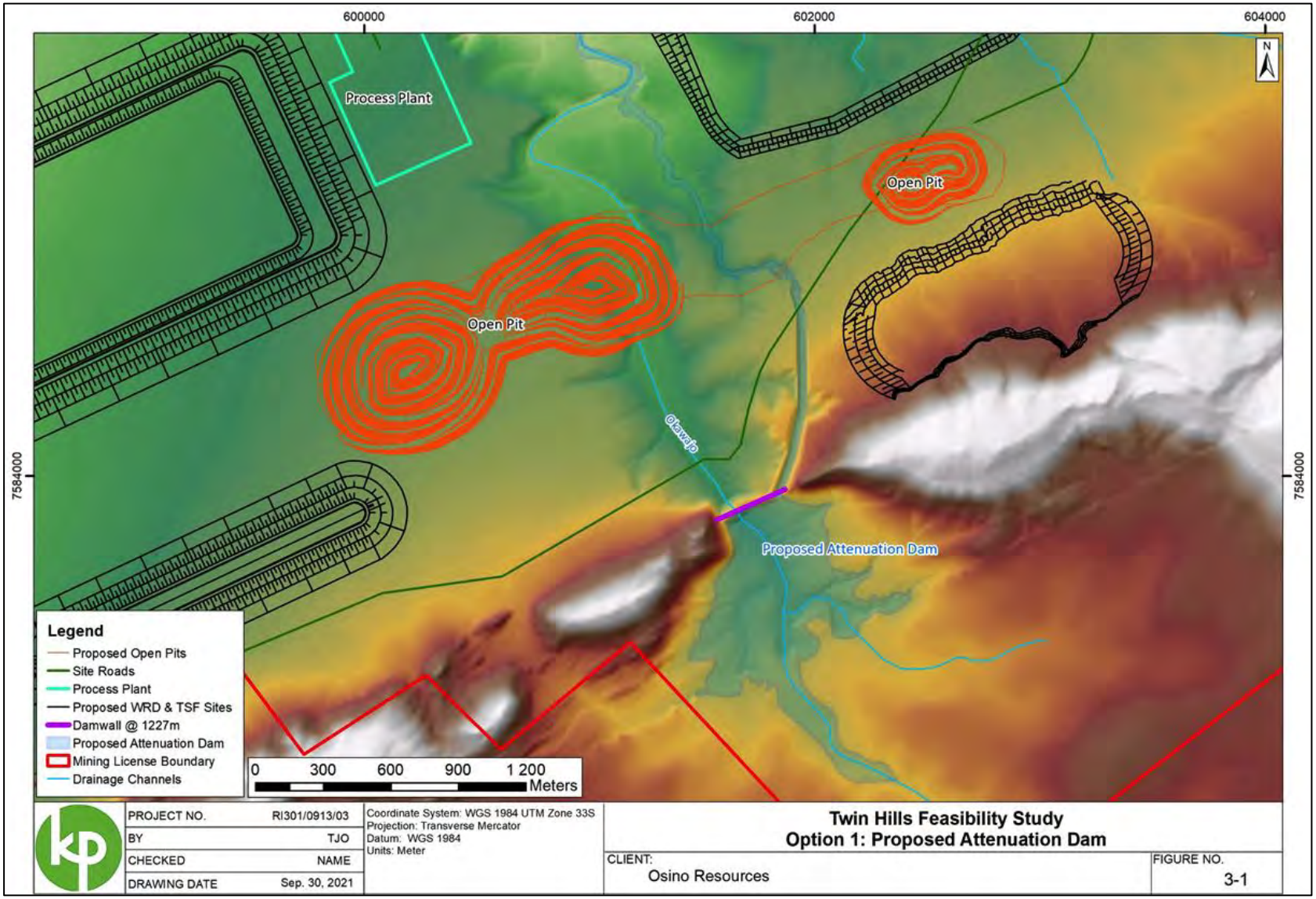


Figure 48 – Stormwater attenuation dam and diversion spillway (Option 1) (source KP, 2021)

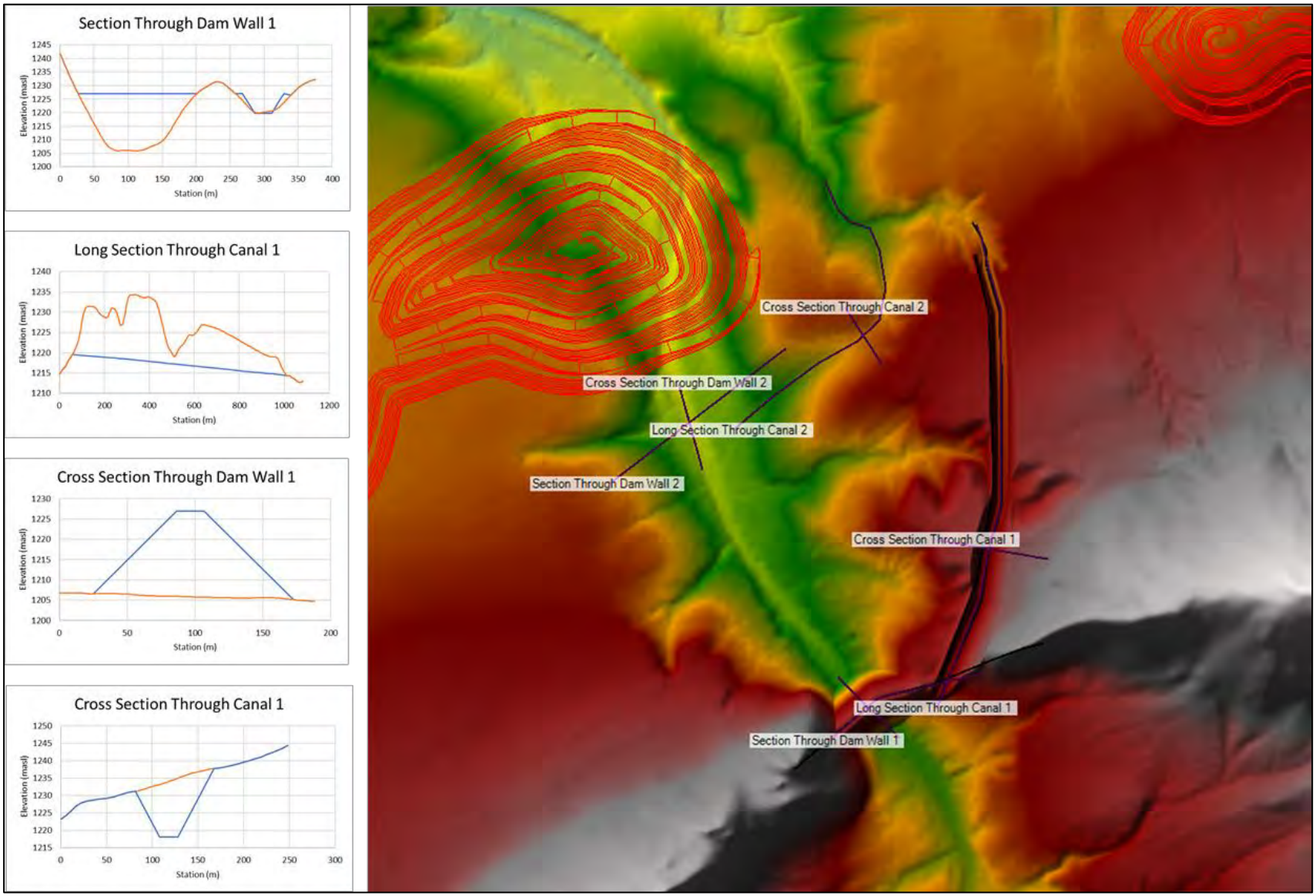


Figure 49 – Cross-sections of the stormwater attenuation dam and diversion (source KP, 2021)

Option 2 is the construction of a diversion weir and channel closer to the current proposed pit layout (Figure 50), which acts as a stormwater diversion structure on the main watercourse between the two open pits. Figure 51 shows cross-sections of the infrastructure used in Option 2 simulations.

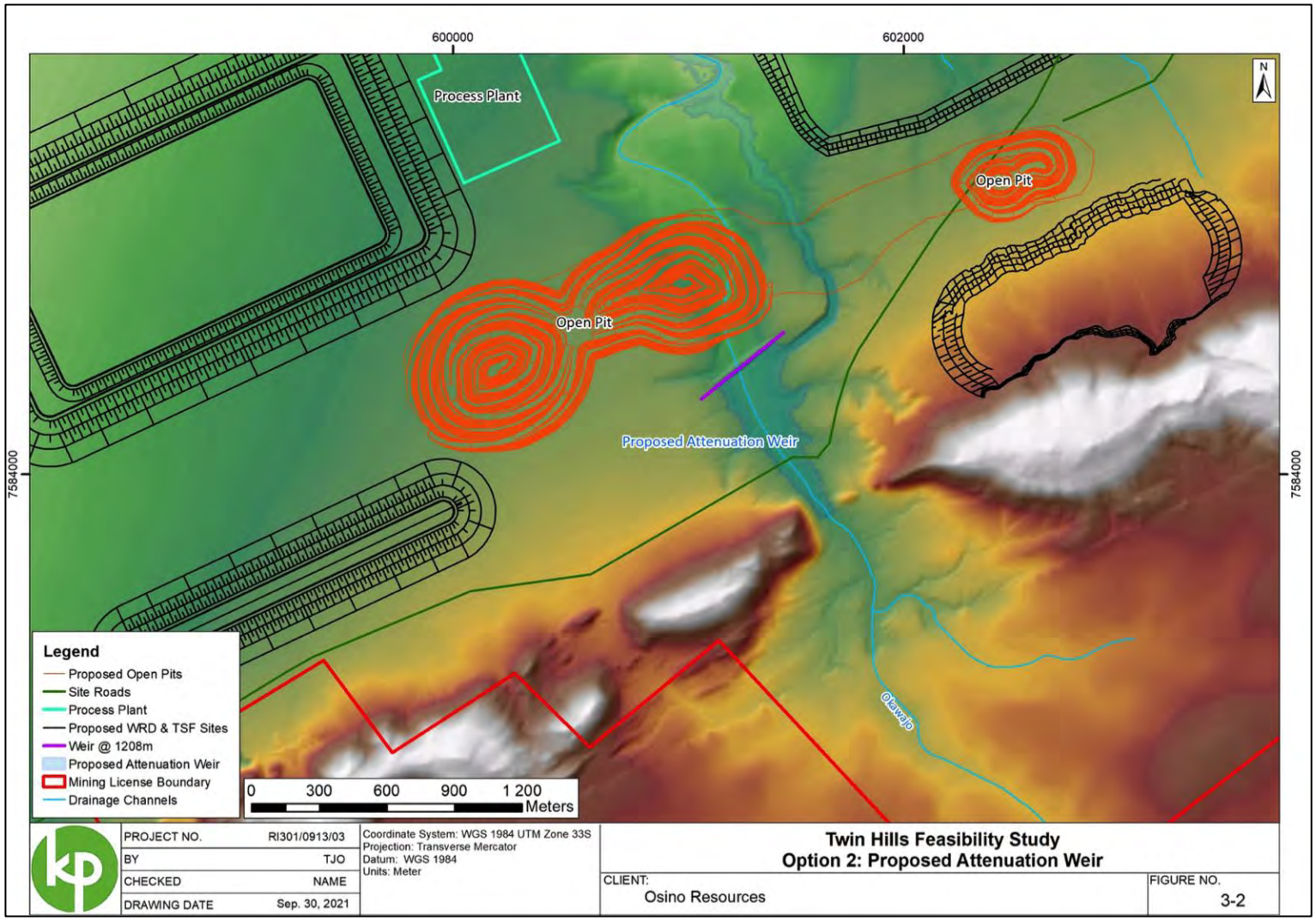


Figure 50 – The stormwater attenuation weir (Option 2) and diversion (source KP, 2021)

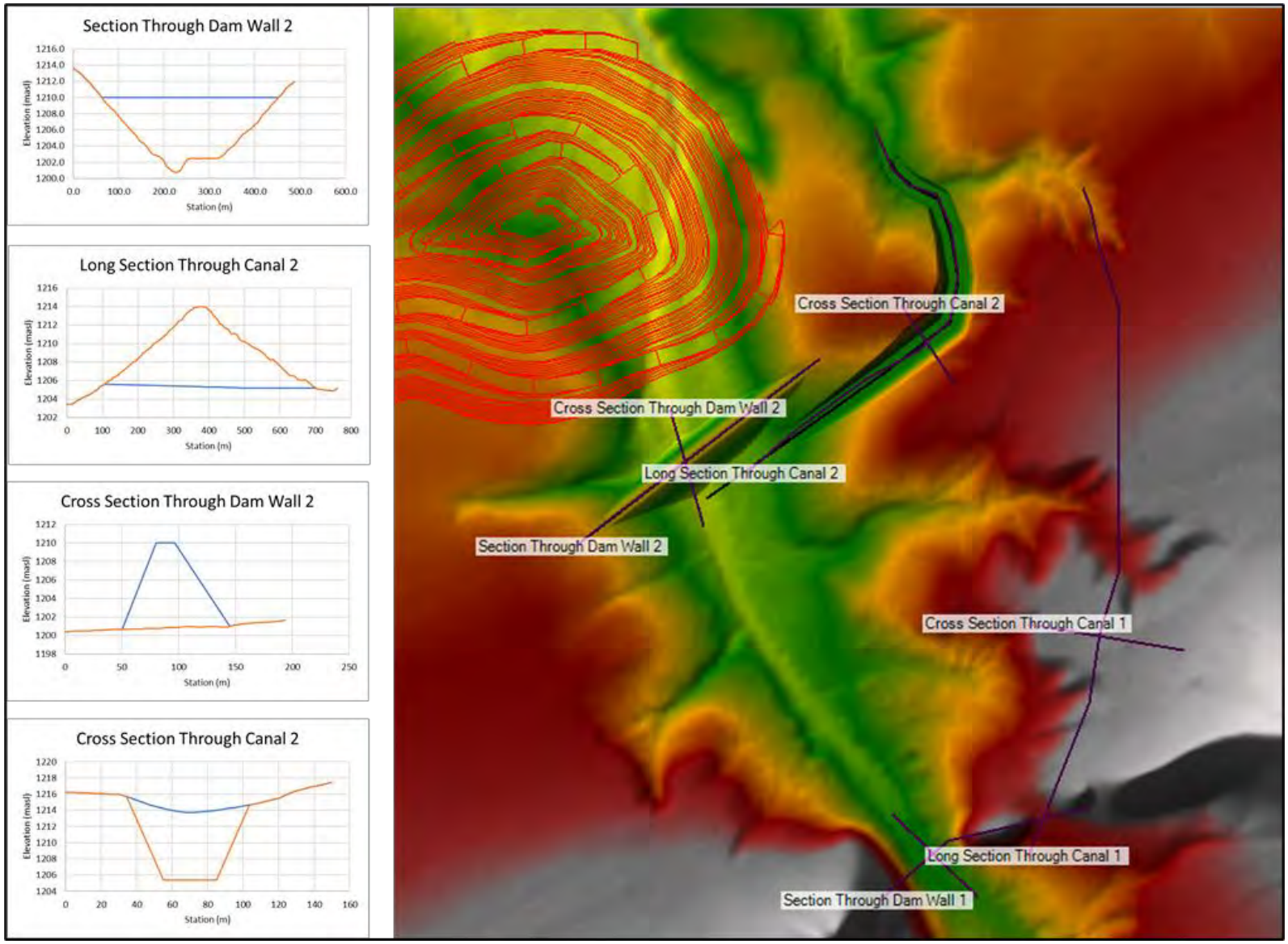


Figure 51 – Cross-sections of the stormwater attenuation weir and diversion (source KP, 2021)

The storage and elevation assessment for Option 1 indicated that the lowest elevation of the stormwater facility is at 1 205masl, and the highest level of the reservoir at 1 235masl, resulting in an approximate total storage volume of 18.4Mm^3. The storage and elevation assessment for Option 2 indicated that the lowest elevation of the stormwater facility is at 1 200.8masl, and the highest level of the reservoir is at 1 210masl, resulting in an approximate total storage volume of 864 000m^3 (Knight-Piesold, 2021).

The attenuation weir and diversion channel of option 2 would be sufficient for diverting storm water away from the open pit. The weir would also provide some surface water for use in the mine processing plant. There would be sufficient freeboard and most of the flood water flowing from the catchment upstream would bypass the open pits. Option 2 would require that both the attenuation weir and dam would need constructing, the former acting as a backup in the event of any failure in the dam wall upstream. Most if not all flood water would be collected in the attenuation dam as it takes into account the flood capacity of a 1 in 50 year flood event. Option 2 would provide in the order of magnitude, 20 times the capacity of the weir structure which could potentially resolve the water supply needs of the mine thereby placing less pressure on the existing sources of water in the area, be it groundwater or Namwater pipeline water. Additional points on water supply are discussed in the next section.

5.14.1.2 Mine water supply and preliminary studies

The current mine design indicates a daily requirement of 4 100m3/day (1.5 million m3/annum) for the estimated 3.5 million tons per annum (mtpa) ore throughput, to sustain mining operations and related activities.

Water supply options that were also addressed in the SLR (2020) Report, were as follows:

- Three potential local dam sites on the Khan River, with catchment areas ranging from approximately 2 100km2 to 2 400km2 (See Figure 52)
- Obtaining a water use license from the existing NamWater Swakoppoort to Karibib Pipeline, provided that there is sufficient capacity for mining activity
- Planned desalination pipeline, which will primarily be used to support the Central Area of Namibia (CAN). According to the CAN Surface Water Augmentation Report, the desalination pipeline will supply water at the earliest in 10 years
- Groundwater supply from boreholes.

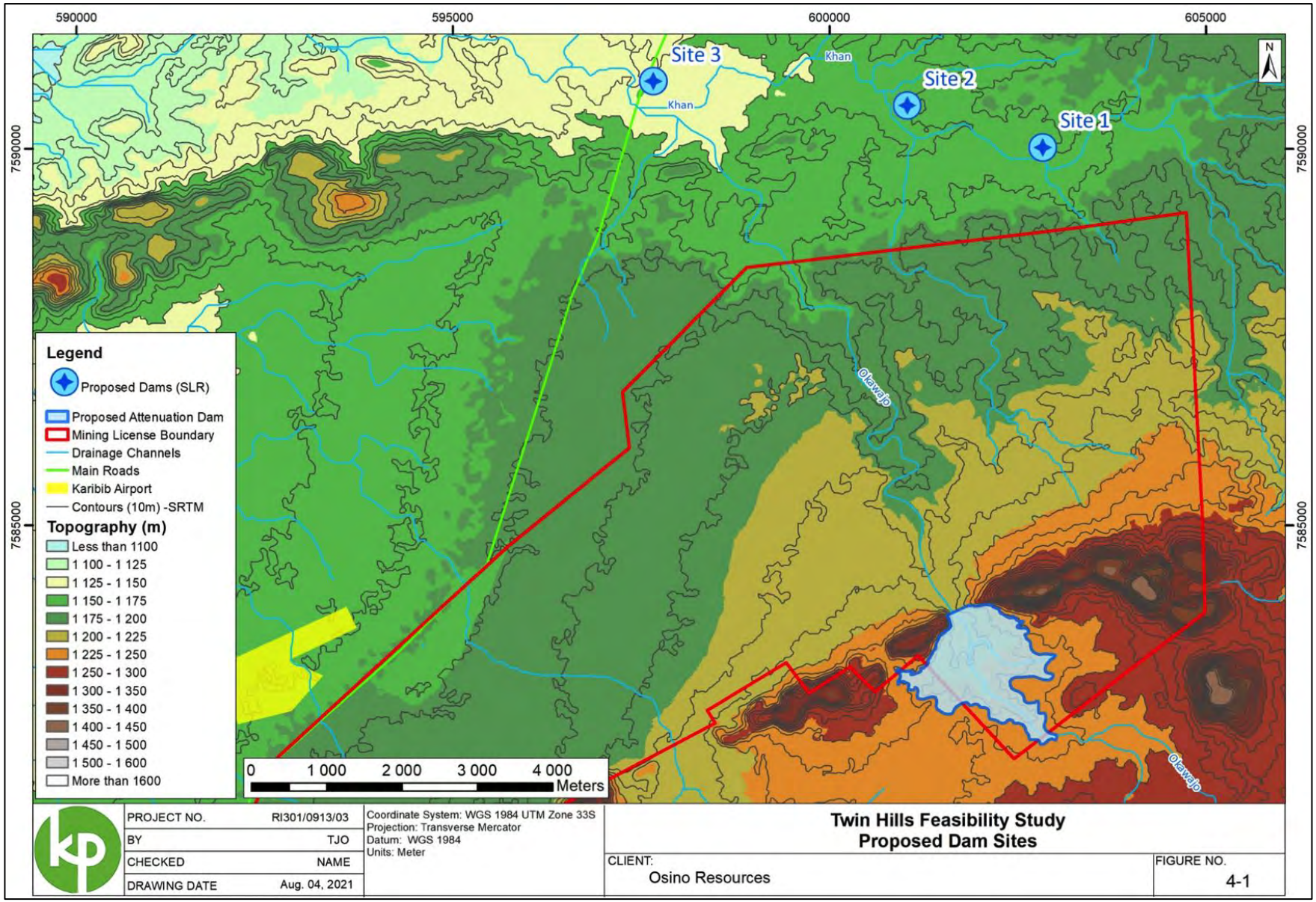


Figure 52 – Proposed dam constructions by SLR (2020) for surface water supply (source KP, 2021)

Long drought periods of up to seven years, typically referred to as critical periods, are common to the Namibian climate. During a long critical period, the groundwater table drops significantly due to limited recharge, causing some boreholes to dry up. Similarly, surface water sources, which are already stressed, might not be able to support priority users, resulting in water restrictions being enforced to prevent the failure of the water resource. Local dam options are typically developed over a long timeframe, in excess of 5 to 10 years, due to land acquisition, environmental and social studies, and full design and construction cycles. Developing water resources is also very costly due to the aforementioned factors (Knight-Piesold, 2021).

The pipeline route for the desalination support to the CAN will follow the B2 Road from Swakopmund to Okahandja, adjacent to the mining operation. Water supply from the desalination pipeline will be costly due to the high pumping costs and the expensive desalination process itself. The desalination plant and pipeline are planned to be implemented in 2031, and it is estimated that one cubic meter of water is going to cost more than N$ 45 at 2020 infrastructure costs. The official reports have not yet been made publicly available. The unit cost is likely going to increase significantly, due to the inflation of electricity and general costs (Knight-Piesold, 2021).

5.14.1.3 Groundwater

A desktop regional hydrocensus was conducted in 2020 (SLR, 2020) as part of the baseline studies, and a summary of the findings is presented here. Figure 53 provides a map of the classification of the aquifers and the hydrocensus results.

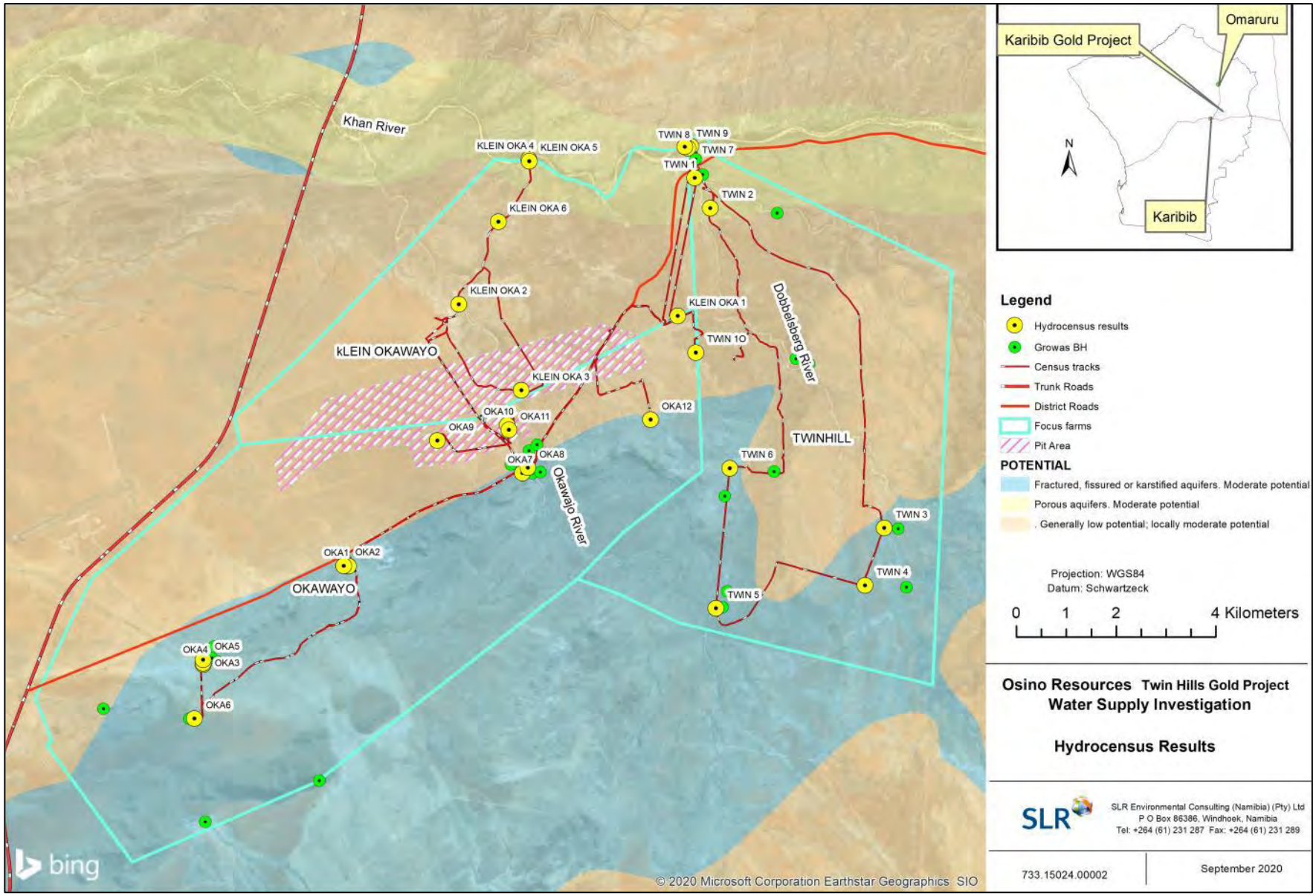


Figure 53 – Classification of aquifers and hydrocensus results (SLR, 2020)

The Project site falls within the Erongo groundwater basin. Twenty-four active boreholes were found in the Project area and show that the local groundwater table is relatively shallow, with water levels ranging from 6m to 57m below ground level. Groundwater is supplied from local boreholes to the farmers and quarry operations in the area. Borehole yields in the area are variable, and generally low, and the water quality is variable (SLR 2020).

The regional general groundwater flow, interpolated from the GROWAS database produced by SLR (2020), flows in a north-westerly direction from the high ground of the Otjipatera Mountains, southeast of the B2, across the proposed mine pit zone and towards the Khan River.

Knight Piesold is currently undertaking groundwater exploration on-site to determine the groundwater resource potential and have conducted drilling and aquifer test pumping. Figure 54 indicates the current distribution of boreholes that have been pump tested (including those from the SLR, Nov 2020 report), with the associated individual yields.

This investigation has shown that the main aquifer and likely water supply for the project is the silicified marble contact of the Karibib Formation, which forms the high topography in the area. Due to the high porosity of this unit, the main recharge to the aquifer occurs along this marble ridge during rainfall events.

As at the date of this report, the accumulated indicative yield is 70m^3/hr (Knight-Piesold, 2021).

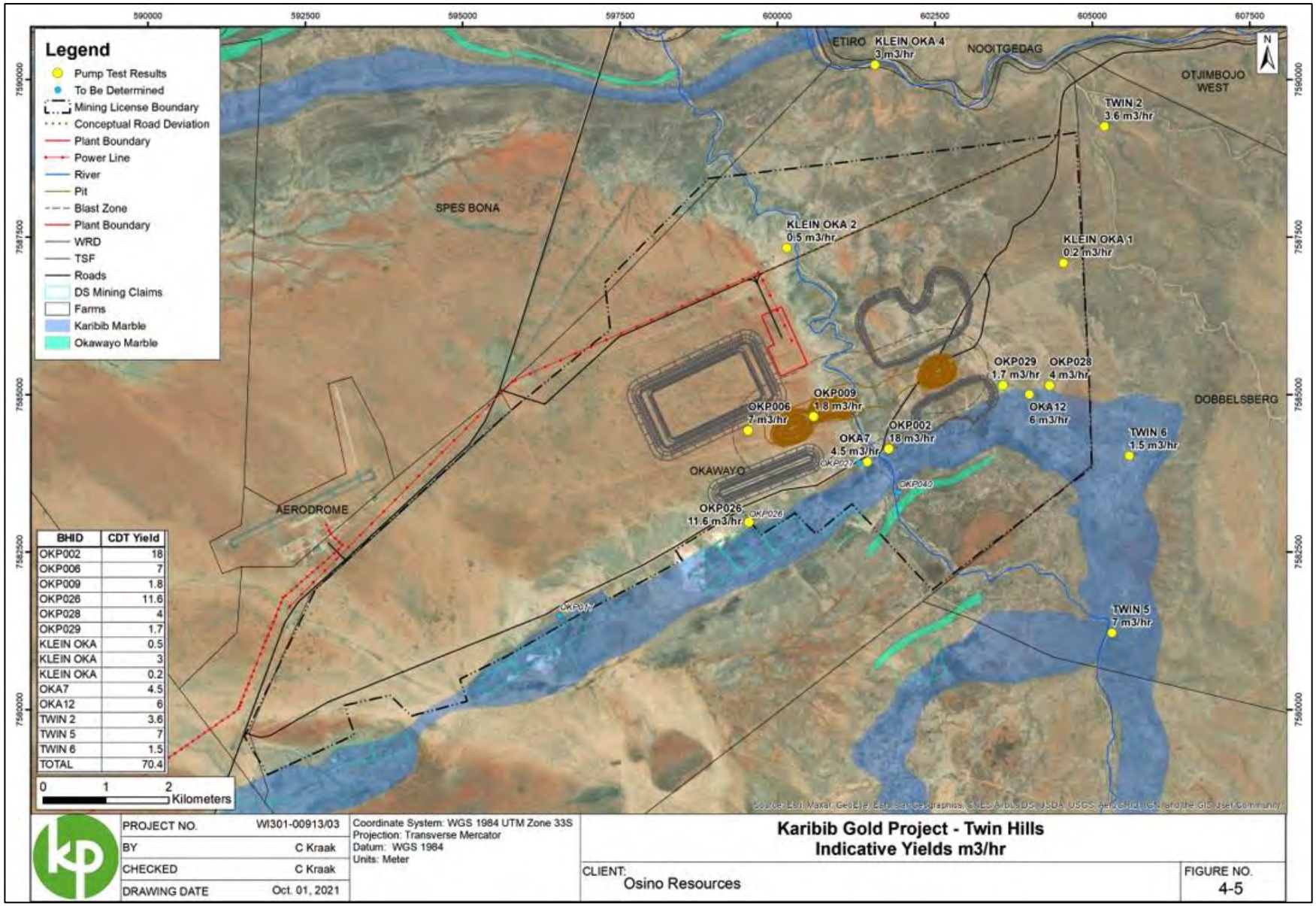


Figure 54 – Groundwater boreholes showing hourly yields (KP, 2021)

Additional boreholes that had higher blow yields are currently undergoing long-term constant discharge tests and will be added to the overall groundwater resource, which is estimated to add another 20m3/hr to 30m3/hr, making an estimated total of between 90m3/hr to100m3/hr. Once the exploration program is completed, the test pumping results will be integrated into a Feflow numerical model to determine sustainable yields when abstracting from multiple boreholes, and to identify further exploration targets. The model will also determine the inflow volumes to the pit over the LOM, which can be added to the total groundwater resource (Knight-Piesold, 2021).

The maximum expected groundwater yield per annum could potentially contribute approximately 800 000m3. Together with Option 2 of the surface water supply within the mining licence area of the same magnitude, the total supply to the mine could amount to 1.6Mm3 per annum thus excluding the need to tap into the NamWater supply.

The groundwater yield is conditional on the following:

- Only if the Proponents pump for 24 hours every day
- There is uncertainty as to how the boreholes will interact with each other (interference with drawdown cones), as the wellfield targets the same marble contact
- There is no need to adjust pumping rates and/or hours, etc.

These conditional points will be better understood with the numerical model and phase 2 fieldwork, which includes additional drilling and test pumping. This additional information will only be available at the end of the assessment phase. Due to the aforementioned drought conditions and current uncertainties regarding the sustainability of the groundwater yield, it will most likely be required that NamWater supply will also need to be considered.

Based on the Knight-Piesold (2021) study, the following conclusions were made:

- The mean annual runoff volume for the catchment is expected to be 650 000m^3, based on a unit runoff of 7mm per annum over the catchment upstream of storm water control Option 1
- The flood attenuation model captures multiple day events, indicating that a dam size of 17.9 million m^3 is required to absorb a flood without any spills
- The attenuated floodwater, in conjunction with a NamWater connection and/or groundwater resources, indicate that they can likely support the mining activities.

The following recommendations were made:

- The final dam and spillway capacity depends on a detailed financial and risk assessment, with detailed design
- A more detailed topographical survey upstream of the mine pit should be conducted to determine a more accurate inundation boundary near the existing farmhouse and other relevant structures
- Once the final mine layout is available, internal stormwater infrastructure and management should be assessed and stormwater intervention designed

- Review the proposed water supply options with the updated mine layout plan, as well as including the groundwater resource options
- Evaluate the option of artificially recharging the marble contact aquifer by way of a subsurface dam/attenuation dam.

5.15 BIODIVERSITY

Peter Cunningham (2021a; 2021b) undertook a rapid assessment study (screening initial project options) and a baseline study (fixed project scope) of the vertebrate fauna and flora. The reports are provided in Appendix F. The baseline study (Cunningham 2021b) is the basis upon which the full assessment will be carried out, notwithstanding the relevant information gathered and recorded in Cunningham's (2021a) rapid assessment report, which was produced subsequent to the winter and summer biodiversity surveys.

5.15.1 FLORA

A literature review of the vegetation done by Peter Cunningham (2021a; 2021b), the ecologist undertaking the baseline study and site visits, determined that the area around Karibib is commonly referred to as the Semi-desert Savannah and Transition Zone (Giess 1971, Van der Merwe 1983) or as the Western Highlands, as described by Mendelsohn et al. (2002). This semi-desert and savannah transition zone, as referred to by Giess (1971), is typified by shrubs such as *Blepharis pruinosa*, *Leucosphaera bainesii*, and *Monechma genistifolia*. Larger woody species such as *Acacia erioloba* are confined to the drainage lines.

It has been estimated that at least 74 to 101 larger tree and shrub species, and up to 80 grass species occur in the general Karibib area, of which a high proportion are endemics.

Summer field studies have been undertaken for the Twin Hills Gold Project. Vegetation was lush following exceptional rains during December 2020 and January 2021. Three zones of vegetation were defined, the plains, hills and rivers. Protected tree species that occur within these zones include: *Acacia erioloba, Albizia anthelmintica, Aloe littoralis, Boscia albitrunca, Cyphostemma currorii, Faidherbia albida, Ziziphus mucronata, Commiphora glaucescens, Commiphora virgata, Euphorbia guerichiana, Euphorbia avasmontana, Ficus cordata, Maerua schinzii, Moringa ovalifolia, Sterculia africana, Combretum imberbe, and Euclea pseudebenus.*

These trees provide habitat or food for much of the fauna that is found in the area. Large trees are found along the drainage lines and should be protected. The greatest biodiversity will be found on the marble ridge, and although some of its length is excluded from the gold mining activity, potential cumulative impacts associated with the dimension stone quarrying activities of the neighbours are likely.

Seventeen grass species were identified during the field study, as were several invasive and alien vegetation types, mainly in the vicinity of the farmhouses. The invasive species will need to be removed, particularly where they are invading along drainage lines.

The most important areas identified were the following:

- The limestone/marble hills and ridges (Figure 55)
- The ephemeral watercourses (Figure 56)
- The ephemeral pans (Figure 57).

Figure 55 – An image showing the vegetation on the marble ridge (Cunningham, 2021)

Figure 56 – An image showing vegetation within an ephemeral riverbed (Cunningham, 2021)

Figure 57 – An image of a pan with large trees creating a habitat for unique vertebrate species (Cunningham, 2021)

5.15.2 FAUNA

The Twin Hills Gold Project is located in an area of high biodiversity according to The Atlas of Namibia (Mendelsohn et al. 2002). Distribution maps show a high probability for the occurrence of leopard, brown hyena and African rock python. Various endemic reptiles and scorpions are also expected to potentially occur in the area. The area is also known for high levels of endemism for birds. Figure 58 renders an image of a rodent and lizard species.

The variety of geomorphological units (hill slopes, marble ridge, grasslands and streams) provides a number of diverse habitats, making it likely that there will be an equally high level of faunal diversity in the area. It is estimated that at least 75 species of reptile, 7 amphibian, 88 mammal, and 217 birds occur in the general/immediate Karibib area, of which a high proportion are endemics (e.g. reptiles ~45.3%).

The summer field investigation and results of surveys undertaken by the specialist in the same area confirmed that at least 34 species of mammals are present, including leopard and African wildcat. Another 3 species that were observed are: impala, Burchell's zebra, and eland but these were not included in the count as they were probably introduced to the game/hunting farm Okawayo.

Figure 58 – Photos from the field biodiversity survey (Cunningham, 2021)

Of the reptiles, only 12 species were confirmed from the area, which included 1 terrapin, 4 skinks, 3 Old World lizards, 2 agamas and 2 geckos. The farm manager confirmed another 8 species, which include: tortoise, python, 4 typical snakes (including black mamba), monitor lizard and a chameleon. Thus 20 species are confirmed from the area. A total of ± 26 species are confirmed if one includes species identified by the ecologist on other studies in the surrounding area.

The recent rains contributed to standing bodies of water on the farm and in the drainage lines. Most were unfortunately muddy and *Phrynomantis annectens* tadpoles were only seen in one drinking trough. Seven species of amphibians, of which 2 are endemic, are expected to occur in the area.

Field work confirmed the existence of 56 bird species of the 217 expected from the literature reviews. A total of at least 108 species are confirmed from the general area, with the inclusion of the farmer's sightings and other studies by the ecologist. The most important species confirmed from the area during the field work are Monteiro's hornbill (endemic), Kori bustard (NT), white-backed vulture (E), lappet-faced vulture (V), and secretary bird (V).

As an introduction to scoping out the potential impacts that could result from the Project, the specialist (Cunningham 2021a) stated the following:

- All developments change or are destructive to the local fauna and flora to some or other degree. Assessing potential impacts is occasionally obvious, but more often difficult to predict accurately. Such predictions may change depending on the scope of the development, i.e. development, once initiated, may have a different effect on the fauna and flora than originally predicted. Thus continuing monitoring of such impacts during the Project's phase(s) is imperative.

The initial baseline study included an earlier high-level assessment of the various alternatives that were presented during the screening phase of the ESIA (Cunningham, 2021a). Since then, some aspects of the Project have changed and certain alternatives have been discarded. The baseline study was updated to consider the fixed options for the assessment phase. The latest baseline study by Cunningham (2021b) can be found in Appendix F.

In light of the fixed scope and layout of the Project, the following potential infrastructure impacts are discussed. These feed directly into the assessment phase and each will be assessed in turn. These aspects will look at reptiles, amphibians, mammals, birds, and the flora.

Vertebrate fauna species most likely to be adversely affected by the proposed mining/prospecting in the Twin Hills Gold Project areas would be sedentary species (i.e. species with limited mobility), such as unique reptiles (i.e. tortoises *Stigmochelys pardalis* and *Psammobates oculiferus*; pythons – *P. anchietae* and *P. natalensis*; Namibian wolf snake (*Lycophidion namibianum*) – *Varanus albigularis*; some of the endemic and little-known gecko species, e.g. *Pachydactylus* species; and species viewed as "rare", i.e. *Rhinotyphlops lalandei*, *Mehelya vernayi*, and *Afroedura africana* (although very little is known about these species). Amphibians are not viewed as important in the area and mammals are more mobile. Although important species are known to occur and/or pass through the area (see elsewhere in this report), none are expected to be specifically associated and/or expected to be negatively affected by the developments. Although general disturbances could affect bird species of concern, i.e. species classified as endangered (violet wood-hoopoe, Ludwig's bustard, white-backed vulture, black harrier, tawny eagle, booted eagle, martial eagle, black stork), vulnerable (lappet-faced vulture, secretary bird), and near threatened (Rűppel's parrot, kori bustard, Verreaux's eagle, peregrine falcon, marabou stork), birds are also mobile and not limited to the area.

Flora species most likely to be adversely affected by mining/prospecting would be the various protected species, although these species are not specifically associated with the development

sites. Important areas in the general vicinity are viewed as hills (limestone/marble hills), ephemeral drainage lines, ground dams and pans, and bird flight paths.

The WRD 2 would cover parts of the northern tributaries of the Okawayo River and should be avoided. The proposed water pipeline should not be placed above ground, as this would act as a barrier to ungulates and ostrich and should be buried.

Bird flight diverters (BDFs) should be attached to the proposed 66kV transmission line from the tarmac road to the mine plant area, to minimise/prevent avifauna mortalities. Although the proposed Okawayo River diversion would affect vertebrate fauna and flora directly associated with the loss of habitat and thoroughfare, the diversion would eventually be vegetated again and serve the same purpose. This proposed diversion is viewed as the best option for the river diversion compared to other alternatives discussed in Cunningham (2021a).

It is not expected that mining/prospecting developments will adversely affect any unique vertebrate fauna and flora in the Twin Hills Gold Project areas, especially if the proposed recommendations (mitigation measures) are incorporated. The recommended mitigations are not listed here, as they need to be finalised based on the final assessment. These recommended mitigation measures can be read in each section of the Cunningham (2021b) baseline biodiversity report found in Appendix F. An assessment of the potential impacts using the impact assessment methodology is provided in the assessment chapter.

6 IMPACT IDENTIFICATION & EVALUATION METHODOLOGY

6.1 INTRODUCTION

Chapter 2 provides an overview of the approach used in this ESIA process, and details each of the steps undertaken to date. Predication and evaluation of impacts is a key step in the ESIA process. This chapters outlines the methods followed, to identify and evaluate the impacts arising from the proposed Project. The findings of the assessment are presented in chapter 7.

This chapter provides comprehensive details of the following:

- The assessment guidance used to assess impacts
- The limitations, uncertainties, and assumptions with regards to the assessment methodology
- How impacts are identified and evaluated, and how the level of significance derived
- How mitigation is applied in the assessment, and how additional mitigation will be identified
- The cumulative impact assessment (CIA) method used.

The aims of this assessment are to determine which impacts are likely to be significant; to scope the available data and identify any gaps that need to be filled; to determine the spatial and temporal scope; and to identify the assessment methodology.

The scope of the assessment was determined through undertaking a preliminary assessment of the proposed Project against the receiving environment, and was obtained through a desktop review, available site-specific literature, monitoring data, and site reports, as set out in the scoping report and this ESIA report.

6.2 ASSESSMENT GUIDANCE

The following principal documents were used to inform the assessment method:

- International Finance Corporation standards and models, in particular performance standard 1: 'Assessment and management of environmental and social risks and impacts' (International Finance Corporation, 2012 and 2017)
- International Finance Corporation Cumulative Impact Assessment (CIA) and Management Good Practice Handbook (International Finance Corporation, 2013)
- Namibian Draft Procedures and Guidance for EIA and EMP (Republic of Namibia, 2008).

6.3 LIMITATIONS, UNCERTAINTIES AND ASSUMPTIONS

The following limitations and uncertainties associated with the assessment methodology were considered in the assessment phase:

- Topic specific assessment guidance has not been developed in Namibia. A generic assessment methodology will be applied to all topics using IFC guidance and professional judgement
- Guidance for CIA has not been developed in Namibia, but a single accepted state of global practice has been established. The IFC's guidance document (International Finance Corporation, 2013) will be used for the CIA.

6.4 ASSESSMENT METHODOLOGY

The ESIA methodology applied to this assessment has been developed by ECC using the International Finance Corporation (IFC) standards and models, in particular performance standard 1: 'Assessment and management of environmental and social risks and impacts' (International Finance Corporation, 2017); Namibian Draft Procedures and Guidance for EIA and EMP (Republic of Namibia, 2008); international and national best practice; and over 25 years of combined ESIA experience. The methodology is set out in Figure 59 and Figure 60.

The evaluation and identification of the environmental and social impacts require the assessment of the Project characteristics against the baseline characteristics, ensuring that all potentially significant impacts are identified and assessed. The significance of an impact is determined by taking into consideration the combination of the sensitivity and importance/value of environmental and social receptors that may be affected by the proposed Project, the nature and characteristics of the impact, and the magnitude of any potential change. The magnitude of change (the impact) is the identifiable changes to the existing environment that may be negligible, low, minor, moderate, high, or very high; temporary/short-term, long-term or permanent; and either beneficial or adverse.

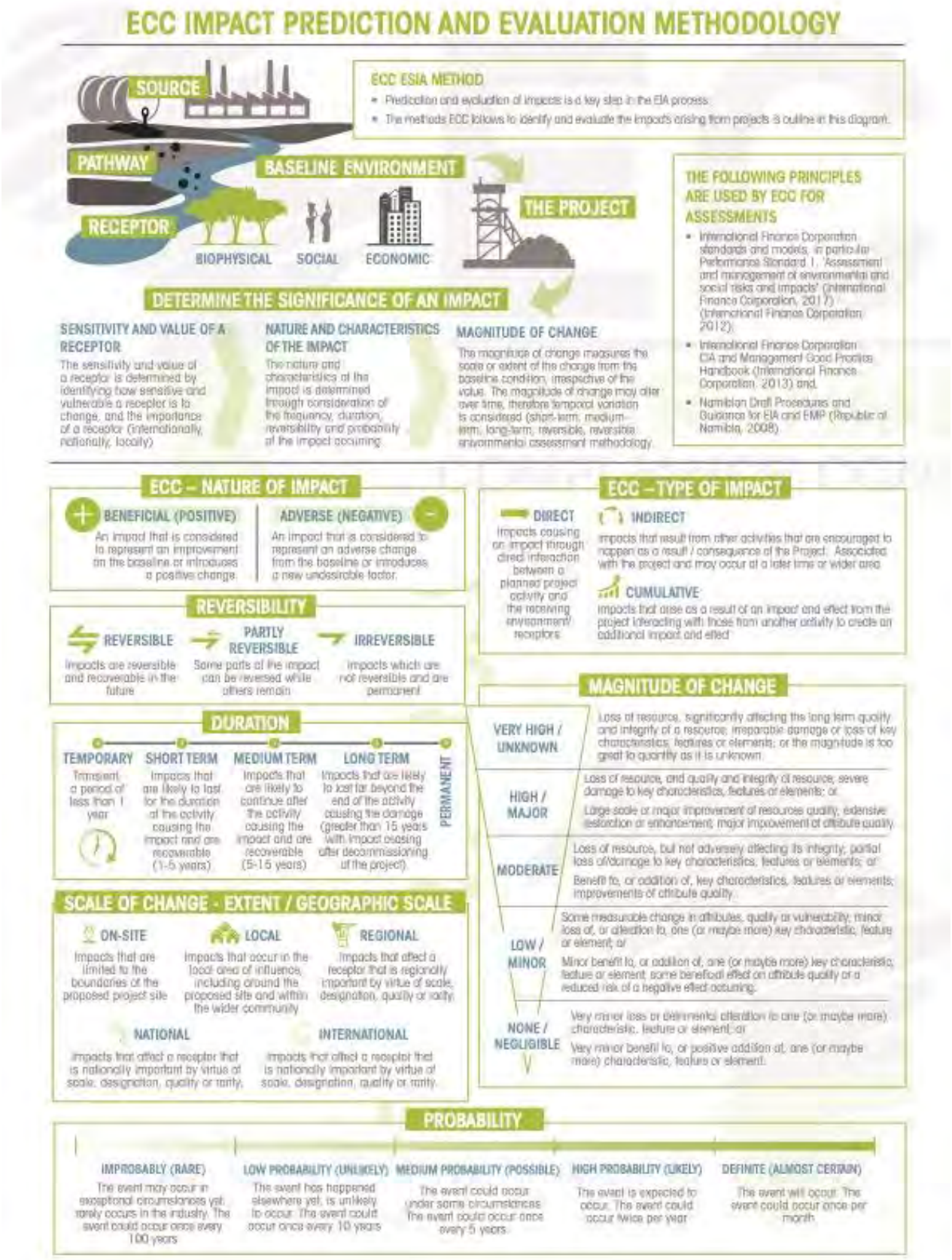


Figure 59 – ECC ESIA methodology based on IFC standards

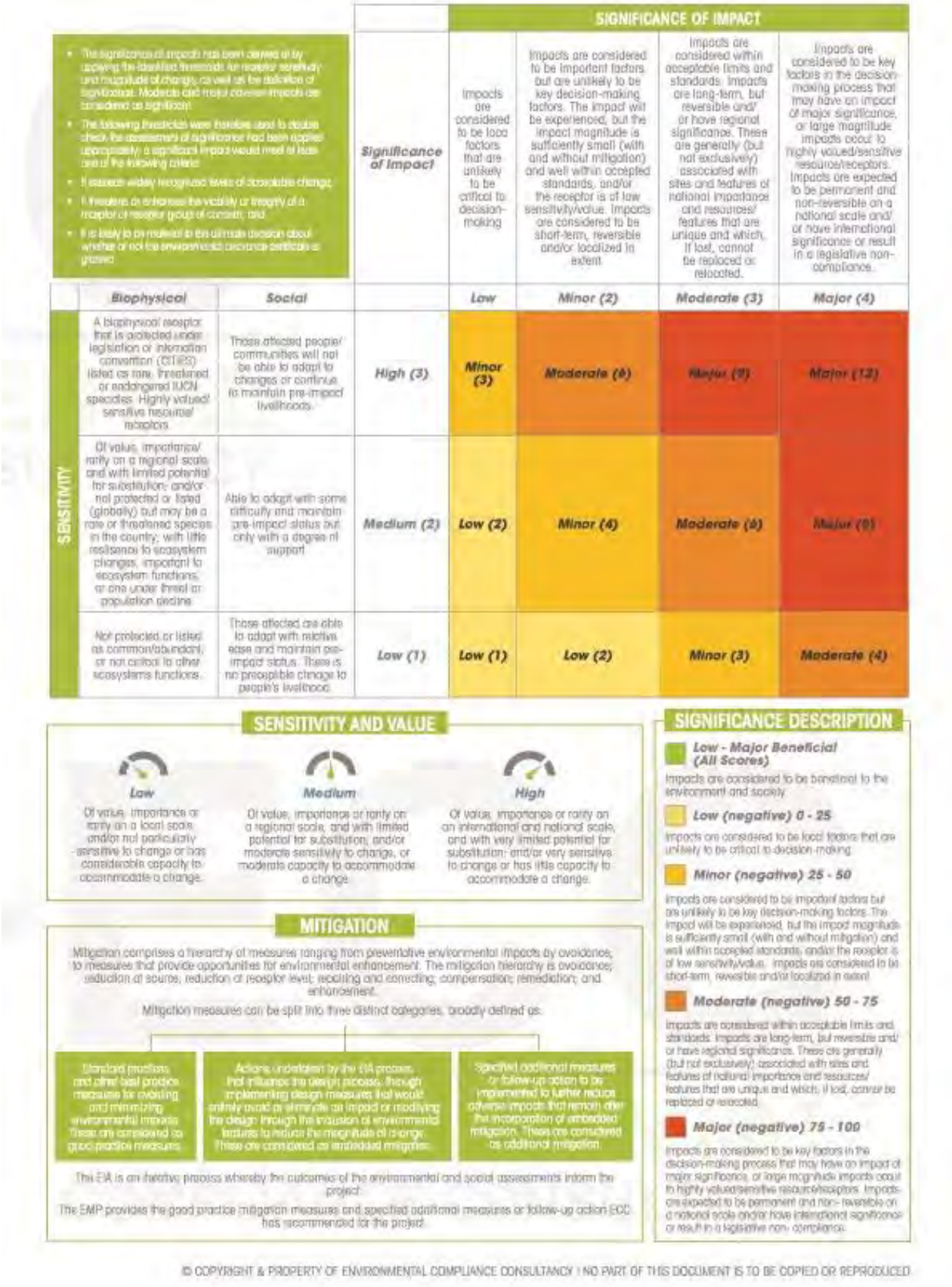


Figure 60 – ECC ESIA methodology based on IFC standards

6.5 MITIGATION

Mitigation comprises a hierarchy of measures ranging from preventative environmental impacts by avoidance, to measures that provide opportunities for environmental enhancement. The mitigation hierarchy is: avoidance; reduction at source; reduction at receptor level; repairing and correcting; compensation; remediation; and enhancement.

Mitigation measures can be split into three distinct categories, broadly defined as:

1. Actions undertaken by the ESIA process that influence the design process, through implementing design measures that would entirely avoid or eliminate an impact, or modifying the design through the inclusion of environmental features to reduce the magnitude of change. These are considered as embedded mitigation
2. Standard practices and other best practice measures for avoiding and minimising environmental impacts. These are considered as good practice measures
3. Specified additional measures or follow-up action to be implemented, in order to further reduce adverse impacts that remain after the incorporation of embedded mitigation. These are considered as additional mitigation.

The ESIA is an iterative process whereby the outcomes of the environmental assessments inform the Project.

The EMP (Appendix A) provides the good practice measures and specified additional measures or follow-up action.

Embedded mitigation and good practice mitigation was taken into account in the assessment. Additional mitigation measures will be identified when the significance of impact requires it and causes the impact to be further reduced. Where additional mitigation is identified, a final assessment of the significance of impacts (residual impacts) will be carried out, taking into consideration the additional mitigation.

7 IMPACT ASSESSMENT FINDINGS & MITIGATION

This impact assessment was completed taking into consideration the input received from stakeholders during the public participation phase. Specialist studies that had previously been conducted were reviewed and reassessed based on the input from the public participation phase. As part of the final impact assessment, a final environmental management plan (EMP) was produced to manage residual impacts that cannot be mitigated through the project evolution process.

This chapter presents the findings of the ESIA for the proposed project as per the ESIA process, scope and methodology set out in Chapters 2 and 6. The aim of this ESIA report is to focus on the significant impacts that may arise as a result of the proposed project. This chapter therefore only considers the significant impacts and or those that may have specific interest to the community and stakeholders. A summary of impacts that are not considered significant is discussed in section 7.1.

The list of high level and likely impacts that are considered significant or of interest to the community and stakeholders are as follows:

- Socio-economic: employment and employee occupational health and safety
- Socio-economic: road diversion, traffic, and potential housing related impacts
- Socio-economic: nearby heritage site
- Environment: river diversion and related ecological functioning impacts
- Environment: surface and ground water quality and quantity
- Environment: soil, air quality, and noise impacts.

For each potential significant or sensitive impact, a summary is provided which includes the activity that would cause an impact; the potential impacts; embedded or best practice mitigation (stated where required / available); the sensitivity of receptor that would be impacted; the severity, duration, and probability of impacts; the significance of impacts before mitigation and after mitigation measures are applied.

7.1 IMPACTS NOT CONSIDERED SIGNIFICANT

As a result of an iterative project evolution process, mitigation has been incorporated and embedded into the project plan, thereby designing out potential environmental and social impacts or reducing the potential impact so that it is not significant. The EMP provides best practice measures, management and monitoring for identified impacts. Impacts that have been assessed as not being significant are summarised in Table 19 and are not discussed further, unless otherwise indicated.

Table 19 – Non-significant impacts

Environment or social topic	Potential impact	Summary of assessment findings
Climate change – adaptation	The potential for climate change to impact the proposed project, for example, extreme fire, heat or (extreme) storm events	The proposed project will not be significantly impacted by the impacts of climate change as the design has considered management measures in the event of increasing temperatures emergency response plans will be in place in the event of a fire and sufficient dewatering systems will be in place for managing potential water inflows into the mine workings.
Climate change – cause / contribute to	The proposed project contributing to climate change through the discharge of greenhouse gas emissions	The proposed project will generate emissions contributing to greenhouse gas however the emissions from the mining operations are expected to be like existing and similar sized mines, and likely lower due to improved equipment fuel efficiencies and utilisation of renewable energy sources. The Equator Principles carbon dioxide equivalent (CO2e) trigger limit of 100,000 tonnes CO2e / year is one that medium scale mines could reach. At and beyond the trigger, a thorough climate change assessment is typically required by lenders and investors. The Proponent has stated that the Project is of a similar scope and size as the Navachab and Otjikoto mines. Navachab has previously reported 31,000 tonnes CO2e / year in 2011, and Otjikoto has reported 135,000 tonnes CO2e /year in emissions for 2020. Otjikoto uses a heavy fuel oil (HFO) plant to generate power, and so its emissions are higher than might be expected for a medium size gold producer.

Environment or social topic	Potential impact	Summary of assessment findings
		The Twin Hills Gold Project, based on its PEA description of fleet and power requirements, will emit approximately 53,000 tonnes CO2e / year, based on the year 5 (of the proposed LOM plan). The electricity requirement of NamPower grid power will be 16 MW, and the diesel consumption will be approximately 20 million litres per year. The estimate and consideration of Navachab and Otjikoto comparison, although approximate, is likely a reasonable estimate for these purposes. Although below the Equator Principles threshold, a more thorough estimate and climate change plan is warranted.
Noise and Vibration	Potential for vibrations from construction and operations of the mine and mineral processing plant could cause vibration on surface. Noise impacts to neighbours are described below. A heritage site is within the high blast sensitivity zone and is therefore exposed to possible blast impact. It is described further under vibration and heritage sections below.	The potential for the mine to generate noise that will impact neighbours is unlikely given the distance from the operations to the nearest sensitive receptor. Vibrations from mining are variable, depending on the blast size, location within the site (depth), and blasting and mining methods. With mining there is the potential for vibration to follow fault lines and sometimes vibrations can be felt some distance away from the operation. The site will monitor vibrations and ensure vibrations are below allowable limits. A second heritage site and two boreholes are within the medium sensitivity zone and mitigation is described below.
Dust	Suspended dust plumes over the Karibib Air Force Base (KAFB) during construction and operation. Other dust impacts are described below.	The KAFB lies southwest of the ML and not within the prevailing wind direction. It is not expected that dust plumes generated from construction and operation activities will cover the airspace over the KAFB. Furthermore, waste rock dump 1 the TSF would lie between the mine site and the KAFB effectively screening it from on-site dust nuisances.

Environment or social topic	Potential impact	Summary of assessment findings
		Mitigation measures ensure effective dust management within the EMP include operations and facilities such as the waste rock dump and TSF. In addition, the KAFB is 8km from the main pit which will allow the dust plumes to dissipate.
Land ownership	Displacement of the inhabitants of Farm Okawayo.	This impact is considered non-significant because farms Okawayo and Klein Okawayo are in the process of being acquired by the Proponent and the existing housing infrastructure will be incorporated into the mine's operational plan.
Noise	Noise impacts to sensitive receptors within range of active mining activities	Noise levels due to the proposed project operations are predicted to exceed the day and night-time IFC noise guideline for residential areas at the Okawayo farmhouse south of the Twin Hills pit and the night-time IFC noise guidelines for residential areas at the Klein Okawayo farmhouse north of the Twin Hills plant. At the marble quarry site closest to the mine operation, the night-time difference in simulated noise in Year 10 is expected to be 5 to 10 dBA, in which case the expectation is that there will be 'little' to 'medium' reaction. At the two closest farmhouses noted above, the simulated daytime and night-time noise increase will be 10 to 20 dBA, however Osino has confirmed that these houses will not be occupied by members of the public as the property's ownership will be transferred to Osino once the land purchase agreement is concluded.
Light disturbance	Light disturbance on surrounding neighbours. Light impact on fauna is described below	It is not expected that light pollution from sources within the ML will affect human receptors surrounding the ML on an extended basis (i.e. every night). Users of the new diverted D1941 road will experience some measure of light presence beside the road, but this will not constitute a hazard or nuisance.
Temporary road closure of the D1941	Inaccessibility of the D1941 gravel road to the public running through the ML toward Omaruru.	Approximately 10 km of the D1941 gravel road that traverse the ML will be closed off temporarily while construction of the new gravel road takes place on the northern periphery of the ML (See Chapter 4).

Environment or social topic	Potential impact	Summary of assessment findings
		The C33 bitumen road between Karibib and Omaruru will not be affected and remain open for public use, therefore the daily movement between the two towns will not be negatively impacted on. Although the temporary road closure may be experienced as significant to some farmers in the direct vicinity of the ML, it can at best be described as a short-lived inconvenience that will not affect livelihoods.

7.2 SOCIO ECONOMIC ENVIRONMENT: ECONOMIC

7.2.1 ECONOMIC STIMULATION

A potential impact associated with the use of a contractor mining company will be the influx of workers and potential families to the area, this is considered beneficial as it stimulates the economy as an indirect impact. The sensitivity of the economy is considered medium as economic development is an important regional issue, albeit with limited progress within the two districts to date. The magnitude of change will be major as local spends from the families of workers will contribute to the economy and is likely to result in medium scale improvements within the towns of Karibib and Omaruru.

7.2.2 EMPLOYMENT AND SKILLS DEVELOPMENT

Whilst Namibia has a generally high unemployment rate, the Erongo Region is one of the regions with a below average unemployment rate of 30% in Namibia because of its affluent status. One measure of affluence is the per capita income of residents per region. The Erongo Region has the second highest per capita income of N$16,819 per annum.

Mining in the Erongo Region has a more significant contribution to employment than the agricultural and fishing sectors, with a 14% contribution to the national GDP. The populations of the Khomas and Erongo regions are projected to increase the most based on an upward urbanisation trend, with over a third of Namibia's population expected to live in these two regions (Namibia Statistics Agency, 2011). The value and sensitivity of employment is considered high as it is of importance to the country and explicitly stated as a priority by the municipality.

7.2.3 DIRECT EMPLOYMENT - CONSTRUCTION

Approximately 1500 jobs will be generated during the construction phase, and the proponent will employ the specialised services of contractors from time to time to develop the open pit, plant, and ancillary infrastructure. This phase of the project is likely to last approximately 18 months. The proponent will employ expats to support the building of the mine process and is estimated to account for approximately twenty percent of the overall job requirement. The expats will then train Namibian counterparts to transition into their roles and take over responsibility from them once the mine is within its operational phase.

Another potential impact resulting from the influx of workers and their families is the potential impact on community cohesion. The demographics of the workers that will fill the skilled roles during the open pit development phase of the Project, is diverse as well as those who will fill unskilled positions. The Omaruru and Karibib communities where workers would live are accustomed to change with the inflow and outflow of workers depending on the regional needs. Diverse communities are accustomed to change and therefore are not considered as sensitive, however there is potential for a reduction in community safety and cohesion as well as an increase in substance abuse to be experienced because of the influx of people to the area.

Therefore, the beneficial impact of creating 1500 jobs in the development stage will result in a short-term impact with a major magnitude of change. A moderate beneficial impact on the economy is therefore expected.

7.2.4 DIRECT EMPLOYMENT – OPERATIONS

Approximately 750 - 800 jobs will be generated during the operational mine life of 15 years. Therefore, the magnitude of change during operations is considered as major because of the duration and frequency of spending within the local economies therefore having medium term impacts and resulting in a major beneficial impact on the community and economy.

7.2.5 INDIRECT EMPLOYMENT IMPACTS

The Twin Hills Gold Project's construction, operation and decommissioning development phases will have various indirect employment opportunities throughout its LOM. The contracting of various service providers will translate into an increase in indirect employment opportunities for locals and within the wider region beyond district level.

7.2.6 EMPLOYMENT DURING DECOMMISSIONING AND CLOSURE

If an extension of the LoM of the Twin Hills Gold Project is not possible the mine will enter the decommissioning and thereafter closure stages. Downsizing of the workforce is anticipated with all non-essential and production personnel to be made redundant according to operational requirements. The receptor's sensitivity to the loss of employment is high and therefore the significance of it is deemed moderate because this would not hamper an individual to seek and obtain future employment as set out in Table 20. The impact to the local and regional economies is of moderate significance and therefore a sensitivity rating of medium is expected. The impact is expected to be long term with little opportunity to maintain preimpact status unless a similar project is brought to the area as a replacement.

Table 20 – Impacts on employment and influx of contractors to neighbouring towns

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
Construction works - general	Community Job seekers Local economy	Creation of 1500 jobs	Beneficial Direct Regional Short Term Reversible	Medium	Moderate	Beneficial Moderate (6)
Downstream job creation	Community Local economy	Creation of 3rd party jobs (suppliers and secondary contractors)	Beneficial Indirect Regional Medium Term Reversible	High	Moderate	Beneficial Moderate (6)

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
Operations of the proposed project	Community Job seekers Local economy	Creation of 750 - 800 permanent jobs	Beneficial Direct Regional Medium Term Reversible	High	Moderate	Beneficial Moderate (6)
Skills transfer to the Twin Hills Gold Project Namibian workforce	Community	Transfer of hard skills to Namibian eligible people to transition into expat roles during the operational phase of the mine	Beneficial Direct Onsite Short term Reversible	High	Moderate	Beneficial Minor (3)
Influx of workers & families	Community	Changes to community cohesion	Adverse Direct Local Short Term Reversible	Medium	Moderate	Adverse Minor (4)
Decommissioning and closure	Community	Reduction in workforce size.	Adverse Direct Regional Permanent Irreversible	High	Moderate	Adverse Moderate (6)

7.2.7 CORPORATE BASED INVESTMENTS

The Proponent established a Non-Governmental Organisation (NGO) named the Twin Hills Trust. The Trust was established for the purpose of supporting social, economic and environmental development projects in the country (Twin Hills Trust fact sheet, 2021). The trust is already in operation and has to date received seed funding worth N$ 2 million which was invested in projects during the first half of 2021. Projects which are funded are mostly situated near the towns of Omaruru and Karibib, where Osino is active (Twin Hills Trust fact sheet, 2021). Five projects have benefited from this fund thus far and are listed below:

- Early Childhood development support to informal settlements in Omaruru through the Development Workshop of Namibia
- Developing low-cost serviced plots for low-income earners in Karibib through the Development Workshop of Namibia

- Upgrading of bulk sewer lines in the informal settlements of Usab and Karibib through the Namibia Housing Action Group (NHAG)
- Online marketing of San arts and crafts through the Omba Arts Trust to implement an online marketing strategy to increase product sales
- Food security for San artists through the Omba Arts Trust to help reduce malnutrition rates amongst the San communities.

The magnitude of change to the receiving social environment as set out in Table 21 is considered high based on the economic vulnerability of receptors as status quo, therefore it is expected that an increase in attribute quality will occur.

Table 21 – Expected economic impacts from the project

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
Influx of workers & families	Community Local economy	Influx of contractor (workers and families) stimulating the local economy through increased spending	Beneficial Direct Local Medium Term Reversible	Medium	Moderate	Beneficial Moderate (6)
Direct Procurement	Local economy	Purchasing of goods and services directly from the local and regional economy on an assumed equal basis	Beneficial Direct Local Medium Term Reversible	Medium	Moderate	Beneficial Moderate (6)
Corporate Social responsibility	Community	Development support provided to vulnerable communities through the Twin Hills Trust	Beneficial Indirect Regional Medium Term Partly reversible	High	High	Beneficial Major (9)
Decommissioning and closure	Local and regional economies	Decline in local economic activity	Adverse Direct Regional Long term Partly reversible	Medium	High	Adverse Moderate (6)

7.3 SOCIO ECONOMIC ENVIRONMENT: SOCIAL

7.3.1 AIR QUALITY IMPACTS

The main pollutant of concern associated with the mining operations is particulates. Particulates are divided into different particle size categories with total suspended particulates (TSP) associated with nuisance impacts and the finer fractions of PM10 (particulates with a diameter less than 10 µm) and PM2.5 (diameter less than 2.5 µm) linked with potential health impacts. Gaseous pollutants (such as sulphur dioxide, oxides of nitrogen, carbon monoxide etc.) will derive from vehicle exhausts and possibly from the mineral processing operations but are regarded as negligible in comparison to particulate emissions[3].

Although there are no villages or homesteads near the project, the Karibib Airforce Base is situated 8 km west of the proposed plant area. It is separated by a waste rock dump, which is approximately 6 km away, and expected to buffer site-generated dust. The closest settlement – farmhouses – is directly to the south of Twin Hills pit, with another at the proposed processing plant (which is proposed to be purchased and or relocated). The town of Karibib (and Usab suburb) is located about 8 km to the southwest from the site boundary and 16km from the proposed metallurgical plant site. Other settlements in the vicinity include scattered homesteads to the north of the mine boundary, along the Khan River.

Sources of atmospheric emissions in the vicinity of the proposed project include:

- Vehicle activity from roads including: the national road B2 highway south of the project which experiences high traffic and the possibility of significant PM2.5 and PM10 emissions; C33 paved road from the Karibib Airforce Base to the B2 and is expected to have low traffic counts and low PM2.5 and PM10 emissions,
- Windblown dust: Windblown particulates from natural exposed surfaces, mine waste facilities, and mine site stockpiles can result in significant dust emissions with high particulate concentrations near the source.

For receptors closest to the sources of dust, and with the use of dust suppressants and water trucks to minimize dust at the source, the impact is reduced to minor from moderate, considering the moderate to high magnitude of the potential impact, high probability, and moderate sensitivity of the receptor whether air quality or impact to flora and fauna. The scale of impact associated with the potential deterioration in air quality from particulate matter is considered direct and limited to the local areas, the nature of the potential impact is considered medium term and reversible - when operations cease the potential impact also ceases, therefore the magnitude of change is considered minor to moderate.

[3] Airshed, 2012: Air Quality Impact Assessment for the Otjikoto Gold Project in Namibia, Namibia (Report No. APP/11/ASE-03B)

In addition to the impact of particulates, the impact of poorly equipped and maintained laboratory exhaust stacks and fume hoods was assessed. The receptors include flora, fauna, people, and water.

The chemicals, solutions and heat produced in an onsite gold mine laboratory releases fumes from furnaces operating at 1000 degrees for gold sample preparation and aspirated acids from the atomic absorption (AA) analyzers, among other processes and equipment. Although there can be various other exhausted materials, the furnace and AA exhausts are released daily and are potentially harmful to the environment.

Most lab furnaces and fume hoods from AAs have basic to very effective scrubbers and filters. Regular and proper maintenance of the exhaust equipment helps minimize the risk. Laboratory placement within the mine site is typically far from flora and fauna, and the above noted equipment helps ensure people are protected from over exposure of exhausts and fumes. However, not all laboratories have exhaust systems with fit-for-purpose scrubbers and filters. In addition, poor maintenance, and the failure of exhaust equipment, likely due to corrosion, can have a significant impact on biodiversity and human health. The impacts were assessed with mitigation and the proper systems and maintenance protocols in place.

The change is local in extent and cannot be kept onsite. The receptors have a medium sensitivity, and the expected magnitude of change will be moderate to high, resulting in moderate dust and air quality related impacts as set out in Table 22.

Table 22 – Air quality impacts

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
Construction and operations	Birds Airforce base Tourism	Visual impairments due to dust pollution	Adverse Direct Reversible Medium term Local Almost certain	Medium	High/ Major	Adverse Moderate (6)
Construct and operate mining, waste, processing sites	Flora & fauna habitat	Dust contamination from mine site and related processing operations	Adverse Direct Reversible Medium term Local Almost certain	Medium	Moderate	Adverse Moderate (6)
Operations	Environment - flora and fauna people	Air/environmental contamination from poorly maintained lab fume	Adverse Direct Partly reversible Medium term Local	Medium	High/ Major	Adverse Moderate (6)

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
		hoods, furnace exhausts, and related exhausts	Medium probability			

7.3.2 VISUAL IMPACTS

The following visual impacts were assessed as moderate:

- Poor visual amenity for the site from dis-used borrow pits or quarry
- Visual amenity impacts due to the waste rock dump
- Visual amenity impacts due to the tailings site
- Visual amenity impacts due to the construction and operation of a dam
- Light impact on insects, birds, and bats.

Farmers adjacent to the site, motorists and tourists will be affected by visual amenity impacts from the construction and operation of the large open pit and waste dump facilities at the mine, as well as the borrow pits and quarries used to build the metallurgical plant.

Progressive rehabilitation can lessen the impacts; however, the anthropogenic earthworks are obvious especially in the relatively flat expanse of the mine area. The entire site and it open pits and quarries are in the proximity of nearby farms, three national roads, and the airforce base and within view of their respective receptors. Progressive rehabilitation will help to lessen the visual amenity impacts and ensure the project related earthworks become integrated into the local landscape thereby reducing their visual impact on receptors.

Mitigation includes limiting the height of the earthworks, with a trade-off that the larger footprint would have a greater spatial impact on environmental receptors such as flora, fauna, habitat, and water resources. Progressive and effective rehabilitation is the best mitigation and a critical part of the Namibia Mine Closure Framework.

7.3.3 SENSE OF PLACE

The Twin Hills Gold Project is classified as a greenfield project that will permanently change the physical landscape and character of the area. Therefore, the magnitude of change on the social environment is considered moderate and the sensitivity of the receptor is deemed low during the construction phase. However, during the operational phase of the Project the magnitude of change may decrease as road users get accustomed to the new man-made features modifying the horizon. The sensitivity of road users may increase as the waste rock dumps (height and width), increases in size. Commuters along the C33 and members of the Namibian Airforce at the military airbase would be able to see these features. Progressive rehabilitation on the waste rock dumps is required to lower this impact.

Industrial lighting required for construction and operations will attract flying insects which in turn attracts birds and bats. The disturbance and impact, although reversible will occur at a local level with a moderate magnitude of change. Birds migrating at night will be affected by lighting, and being nocturnal bats are likely to be affected by lights as well.

Reducing and managing lighting and reducing stray light while using lights that minimize the attraction of insects will help to minimize the impacts to birds and bats that feed on them. Regardless, the extent of the impact could remain regional on migrating bird species, and the sensitivity remains moderate. The mitigated impact remains moderate and is important to monitor and track as set out in Table 23.

Table 23 – Visual and sense of place impacts

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
Construction and operations	Farmers Motorists Tourists	Poor visual amenity for the site from dis-used mine pits or quarries	Adverse Direct Irreversible Permanent Local Definite	Medium	High/ Major	Adverse Moderate (6)
Construction and operations	Farmers Motorists Tourists	Visual amenity impacts due to the waste rock dump	Adverse Direct Irreversible Permanent Local Definite	Medium	High/ Major	Adverse Moderate (6)
Construction and operations	Farmers Motorists Tourists	Visual amenity impacts due to the tailings storage facility	Adverse Direct Irreversible Permanent Local Definite	Medium	High/ Major	Adverse Moderate (6)
Construction and operations	Farmers Motorists Tourists	Visual amenity impacts due to the construction and operation of a diversion dam	Adverse Direct Irreversible Permanent Local Possible	Medium	High/ Major	Adverse Moderate (6)
Plant construction	Road users of the D1941 gravel road	Visual amenity and sense of place	Adverse Direct Local Short term Irreversible	Low	Moderate	Adverse Low (2)
Open pit mine and plant operation –	Road users of the D1941 gravel road	Visual amenity and sense of place	Adverse Direct Local	Medium	Minor	Adverse Minor (4)

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
operational phase			Medium term Irreversible			
Decommissioning of the mine site	Road users of the D1941 gravel road	Visual amenity and sense of place	Adverse Direct Local Short term Partly reversible	Low	Minor	Adverse Low (1)
Lighting for construction and operations	Insects, birds, and bats	Light impacts due to industrial lighting for construction and operations	Adverse Direct Reversible Short term Local to regional High Probability	Medium	Moderate	Moderate (6)

7.3.4 ROAD IMPACTS - RE-ALIGNEMENT D1941 ROAD

During operations, increased traffic to and from the project site may disrupt normal traffic flow by local road users, the broader farming community, and occasional tourists. It is anticipated that traffic volumes will increase (285 trips are expected along this route per day) (ITS, 2021) triggering suspended dust (PM2.5) cover over the road from increased use by both the mine and the public, potentially causing accidents. The Proponent is responsible for ensuring a practical traffic management plan is implemented to manage the potential effects on traffic conditions surrounding the site to reduce the level of significance on sensitive receptors.

Covering D1941 with asphalt and reducing the speed along C33 to 80 km/hr on approach to the new D1941 will mitigate the impact. The magnitude of change is considered low/minor and the sensitivity of the receptor is medium.

7.3.5 ROAD DEGRADATION

The C33 road is surfaced with asphalt and is in very good condition from the B2 intersection until about halfway to Omaruru. From that point on the road is in fair condition and is currently undergoing maintenance (ITS, 2021). Maintenance of this section toward Omaruru mainly comprises plugging numerous potholes and resurfacing it as a result of continuous heavy and light vehicle loads. The additional truck, bus and LDV loads affiliated to the Project may amplify maintenance requirements on the C33. The Proponent will develop a traffic management plan to reduce and manage residual effects of road use for mining activities.

Mitigation could include negotiations with Roads Authority to determine the most practical method of shared maintenance or to tar access points to the C33 road and the mine itself on

approach to the mine site. The magnitude of change is therefore considered moderate, and the sensitivity of the receptor is medium due to its regional level impact.

7.3.6 TRAFFIC IMPACTS

During the operational phase a total of 52 trips per day is anticipated (26 In and 26 Out). Most trips in and out of the site will be worker commuting traffic coming to and leaving the site. Worker commuting traffic would utilise the stretch of B2 between the bridge and town.

Most trips to and from this development should make use of mine supplied transport (i.e. buses) as part of mitigation the effect of excessive traffic volumes on the road and therefore appropriate infrastructure should be in place. It is recommended that bus embayments with sufficient circulating radii (minimum 15 meters), lighting and shelter be provided on-site at the development entrance to facilitate this measure. According to ITS (2020) all intersections would continue to operate acceptably and would have sufficient capacity up to year 2040. Furthermore, it is anticipated that the stretch of road on approach to the mine entrance may be tarred to dissipate dust impacts.

The magnitude of change is therefore considered moderate and the sensitivity of the receptor medium due to its regional level impact and road network capacity to withstand more traffic sufficiently as set out in Table 24.

Table 24 – Summary of traffic impacts

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
D1941 diversion - increased traffic and accidents	Community Tourists Motorists New workforce	Increased traffic along diverted D1941 causes increased dust and accidents	Adverse Indirect Local Partly reversible Minor Short term	Medium	Low/minor	Adverse Minor (4)
Traffic flow	Community road users Visitors to the area New workforce	Disruption to normal traffic flow from pre-construction baseline conditions	Adverse indirect Regional Partly reversible Moderate Medium term	Medium	Moderate	Adverse Minor (4)
Road degradation	C33 road	Increased maintenance requirement due to additional traffic loads	Adverse Direct Regional Reversible Moderate	Medium	Moderate	Adverse Minor (4)

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
			Medium term			

7.3.7 MINE BLAST VIBRATION IMPACTS

Open pit blasting will affect the area farms, boreholes, any nearby heritage sites, ecosystems, fauna and possibly small quarry operators south of the proposed mine. The heritage sites and boreholes are most likely to be affected as determined by the specialist.

The area within 3500 m of the open pit edge may experience ground vibration, air blast and fly rock related impacts. The high sensitivity and medium sensitivity areas are 500 m and 1500 m from the edge of the open pit, respectively. The nearest heritage site, referred to as Okawayo 480, is within the high sensitivity range at 331 m from the open pit and would be exposed to elevated blast vibration, air blast and fly rock. A second heritage site, referred to as Okawayo 481, and two Osino boreholes Oka7 and Oka12 are within the medium sensitivity zone, at 607 m, 647 m, and 1238 m from the open pit, respectively and will still be exposed to elevated ground vibration and air blast but will be out of the fly rock zone.

Mitigation includes the use of electronic detonators rather than shock tubes and modified stemming (including increased stemming length). The first will help manage ground vibration, and the latter will manage air blast and fly rock. Drilling designs and layouts can further mitigate the potential impacts. Specific blast design for specific blocks is suggested, to account for rock type and structures.

Descriptions of the impact and further mitigation for the main heritage site is provided below within the heritage and culture section of this chapter.

7.3.8 HERITAGE AND CULTURE IMPACTS

The historic colonial farm building appears to be vulnerable, as is the well-constructed Okawayo farmstead, which was established in the late 19th century and is in relatively good condition. Both may potentially be affected by vibrations from mine blasting that will take place nearby. The significance of this building is determined within the confines of the National Heritage Act, 2004 and ECC's assessment methodology. According to the Act the definition of archaeological is stated as "...(a) any remains of human habitation or occupation that are 50 years or more years old found on or beneath the surface on land or in the sea."

The earliest recorded history of the building remains on the ML dates to the earliest occupation of Namibia by Germany (1884-1920) where the property was used as a military station by the colonial regime. From letters dated prior to 1920 farm Okawayo was consistently leased to colonial settlers for agricultural use because of its favourable natural conditions (water and

grazing potential). All infrastructure on this property can be deemed as constructed by the colonial regime and used for the purpose of military operations.

The definitions presented in the National Heritage Act, 2004 defines the buildings as an archaeological site with heritage significance. Therefore, the appropriate notification of such objects and permitting provisions within the National Heritage Act should be applied. The magnitude of change is then considered high if the building be destroyed from blasting or other anthropogenic actions by the mine during their ML tenure. The sensitivity of the site is regarded as high as shown in Table 25, pre-mitigation and will remain high even with preservation works applied to it. The significance of the site can be reduced to acceptable levels if relocation and display of the main historic features and attributers of the site can occur as per the directive of the National Heritage Act, 2004.

Table 25 – Heritage impact

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
Open pit construction and mining operations	– Cultural heritage	Loss of heritage objects or place	Adverse Direct Irreversible Permanent Onsite Likely	High	High	Adverse Major (12)

7.4 BIOPHYSICAL ENVIRONMENT

7.4.1 SOIL AND GEOLOGICAL IMPACTS

The Project includes construction and operation phases of both the mine, mine waste facilities and the processing plant. The activities related with site wide construction and operation will have impacts on soils including scarring of pristine landscapes, impact on the environment, potential impacts to tourism and loss of potential agricultural land.

Permanent scarring of the local landscape is definite and irreversible and will affect the local flora and fauna, water, watercourses and viewscape, which have a high value and sensitivity and will have a moderate magnitude of change. Loss of potential agricultural land is definite, irreversible and permanent, with moderate magnitude and low sensitivity. The special features in the proposed mine area include the confluence of several ephemeral rivers and marble ridges to the south, both of which are high value habitat for flora and fauna and also have high agricultural value due to water supply.

7.4.2 GEOLOGICAL IMPACTS ON INFRASTRUCTURE

Minor to light earthquakes have been recorded in the area at a level that may cause damage to infrastructure (https://earthquaketrack.com/na-29-karibib/biggest, 2021) if not considered at the design stage. Such earthquakes could also affect the foundations of site facilities which could

have impacts on site wide environmental systems and controls, such as waste rock and tailings facilities, and hazardous materials and hazardous waste facilities.

Mitigation measures includes progressive rehabilitation focused on supporting local ecosystems' reestablishment and in consideration of viewscape. Further mitigation includes designing, constructing, and operating all facilities to the area geohazard rating and aligned with national and international codes. All facilities will be suitably designed, approved, and authorised for use by qualified and competent persons such as engineers. Furthermore, the sites proposed mine plan will be approved by the Chef Inspector of Mines at the MME before construction commences. High risk facilities such as the TSF will be designed to comply with international standards for tailings storage facilities including but not limited to the international commission on large dams (ICOLD) and the ICMM frameworks/standards if applicable.

The impacts have a local extent and are not limited to the site as set out in Table 26. Receptors have a low to high sensitivity and value, with magnitude of change at moderate to high resulting in minor to moderate impacts.

Table 26 – Impacts on soils and geology

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
Construction and operations	Environment - flora, fauna tourism	Scarring of pristine landscapes	Adverse Direct Irreversible Medium term Local Medium probability	High	Moderate	Adverse Moderate (6)
Construct and operate pit, waste dump	Land and soil (agriculture)	Loss of potential agricultural land	Adverse Direct Irreversible Permanent Local Definite	Low	Moderate	Adverse Minor (3)
Construction and Operations	Environment	Damage and loss of environmental protection systems due to tremors and earthquakes	Adverse Direct Irreversible Permanent Regional Improbable	High	Very High	Adverse Moderate (6)

7.4.3 ACID MINE DRAINAGE IMPACTS

The geological model and mine plan provide an excellent guide to sampling the rocks and materials that will form the waste rock dumps and tailings. Testing and analysis of rocks is the best way to characterise the geochemical potential of the proposed mine. A geochemical

sampling program was conducted based on the mine plan. For the impact assessment, the characterization was required to assess the likelihood of acid mine drainage, acid rock drainage, and neutral mine drainage and consider mitigation options, if required.

The presence of sulphur in rocks and tailings at mines, combined with exposure to air at surface and water as a transport mechanism, can lead to contamination of local water resources. The contamination can either be acid or metals leached by acid. Sometimes, neutralizing minerals within the mine rock and tailings can control the acid. Other times, the neutralizing minerals are not adequate to prevent leaching and mobilization of other metals contained within the mine rock and tailings. Knowing if such contamination is possible prior to mining and identifying which rocks and tailings might lead to contamination, allows mine personnel the opportunity to identify the materials in the field and apply protective measures such as transport to a fit-for-purpose storage facility.

The 131 samples characterized for this assessment proportionately represent the various rock types that will be mined and either stored as waste rock or end up as tailings after processing. Four of nine rock types, representing a relatively low volume to be mined, were identified as potentially acid forming. They include the Bulge waste rock, Twin Hills Central waste rock, Clouds waste rock, and Twin Hills Central ore. The samples were consolidated in to 15 samples, and static and kinetic tests were conducted, and the kinetic tests are still underway to help further determine leachate character at the end of 12 months. As might be expected, the waste rock that is not altered and not mineralized is not acid generating. The host rock has a high acid consuming content and paste pH of much of the waste rock is typically above 8. In fact, much of the waste rock could be used for onsite infrastructure construction and operation. Regardless, the presence of pyrrhotite in the altered and mineralized rock is critical to note and identity. Pyrrhotite can be 5 – 10 times more reactive than pyrite, even in concentrations of 2-5%.

The impact to water from ARD is shown in Table 27 and may be irreversible and permanent, of regional extent within groundwater, with a high sensitivity of the receptor and medium magnitude of change. With mitigation, the impact is considered moderate.

Table 27 – Impacts on water and soils from acid mine drainage

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
Construction and operations	Soil and water	Contamination of soils, surface water, or groundwater	Adverse Direct Irreversible Permanent Regional Medium probability	High	Moderate	Moderate (6)

7.4.4 SURFACE AND GROUNDWATER IMPACTS

This section describes the nature of the impacts to surface water flow (hydrology) and groundwater status as a result of the mining activities. To conclude the section, mitigations to reduce these impacts are provided. Recommendations are made where further information is needed.

The Twin Hills Gold Project's overall water demand will be approximately 1.5 million cubic meters (Mm^3) per annum. The site hydrology and recommendations for the surface water supply are documented by Knight-Piesold (2021a & 2021b). These specialists envisage that surface water requirements would need to be supplemented with groundwater and, if needed supplemented through bulk water supply by Namwater.

The groundwater levels in the area of the mine workings range from about 20 meters below the surface (mbs) to a maximum depth of 74 mbs and have a poor correlation with the topography (Knight-Piesold 2021b). This suggests that the aquifers in this region are dynamic and have been somewhat impacted by the active groundwater abstraction. Surface runoff from the elevated regions onto the flat quaternary and calcrete units, from high rainfall events, will result in more overland surface flow than direct infiltration to groundwater. Regional groundwater flow indicates movement towards the Khan River, in a north-westerly direction, following the topography and water lines, however, there is an indication that there is an interaction between the faults and dykes inhibiting groundwater flow in areas (Knight-Piesold 2021b).

The Twin Hills Gold Project is located within the greater Khan River catchment. The Khan River catchment is approximately 8400 km^2 (SLR, 2020), and the Okawajo River in which the Twin Hills Gold Project falls is 92 km^2, (Knight-Piesold, 2021a) which is 1% of the total Khan catchment area. The preliminary model predicted volumes to flow into the pit and ultimately be used by the mine, approximates 25% of the model's domain budget, which equates to less than 0.25% of the Khan River Catchment. It is therefore anticipated at this stage that the mine workings will have a very low risk of impact on the Khan River volumes and that will therefore not be listed as a receptor (Knight-Piesold, 2021b).

The Okawayo River that runs through the proposed mine boundary is ephemeral and flows after direct precipitation and flash floods. However, it is likely that there is a significant component of subsurface flow in the alluvials which supports the vegetation and was the main water supply to the farmhouse in the past. The drainage channel is structurally controlled, and even if the surface flow is diverted, there is likely to be an ongoing component of baseflow through the pit walls in this area, which could result in seasonally transient high pore pressures as well as the disruption of baseflow to the downstream riparian habitat.

DC Mines (a neighbouring mining company) have mining rights along the Karibib marble ridge for the exploitation of marble for dimension stone and are likely to have boreholes on-site for water supply for quarrying the marble. It is presumed that water from the pit sumps is also used

in their mining process. The impacts on the quantity and quality of the water abstracted due to these operations is not known at this stage but must be quantified to evaluate cumulative impacts in the BFS.

The water impacts are divided into water supply requirements and water quality impacts of mining activities. In addition to this, occupational health and safety impact in connection with pit slope integrity and the role that water has on it is also considered.

7.4.5 WATER REQUIRMENTS, AVAILABILTY AND SUSTAINABLE USE

Knight-Piesold (2021a) provided the following important general points for consideration in assessing surface water supply options. Long drought periods of up to 7 years, typically referred to as critical periods, are common to the Namibian climate. During a long critical period, the groundwater table drops significantly due to limited recharge, causing some boreholes to dry up. Similarly, surface water sources, which are already stressed, might not be able to support priority users, resulting in water restrictions being enforced to prevent the failure of the water resource. Local dam options are typically developed over a long-time frame, in excess of 5 to 10 years, due to land acquisition, environmental and social studies, and full design and construction cycles. Developing water resources is also very costly due to the aforementioned factors. Making use of existing infrastructure up to Karibib should be considered as an intermediate solution until further water resources can be developed. A pipeline link from Karibib to the mine may be required, provided there is excess capacity available.

The exploration drilling currently being undertaken within the mine boundary, coupled with the abstraction of groundwater from water supply boreholes, has had some impact on the groundwater levels in the area. The impact resulting from these activities appears to be localised and temporary and should not impact the identified receptors.

As the pit is excavated, the subsequent dewatering will produce a Cone of Drawdown (COD). The preliminary modelling suggests that the COD extends approximately 1.7 km in a NW-SE direction and 5 km in a NE-SW direction. The modelled extent is expected to reduce in size following refinement of the model during Phase 2 of the Bankable Feasibility Study (BFS). This preliminary COD does not extend beyond the proposed mine boundary, and the more significant drop in groundwater level occurs closer to the pit area.

Abstraction from boreholes exploiting the marble contact aquifer will result in the COD extending further and would stretch along that strike in a NW-SE direction. This could potentially impact DC Mines operations and visa versa by dropping the groundwater levels in this area. The DC operations may potentially have an impact by reducing the recharge to the marble aquifer, as the silicified ridges are mined out.

The potential impacts associated with groundwater abstraction from boreholes are considered to be minor, although most of the boreholes are along the same marble contact zone and management of the wellfield will be required to ensure the sustainable yield of the wellfield.

The preliminary model outputs indicate that the mines overall impact on the volumes to the greater Khan River catchment are considered negligible.

Knight-Piesold (2021a) concluded their risk assessment of water supply as follows. A basic assessment scheme was created to determine the reliability and associated risk of the different supply options. The following three overarching categories were used to compare the five water supply options with each other:

- Accessibility concerns describe if the infrastructure already exists, the effort involved in developing the infrastructure and the distance from the infrastructure to the mine site. (Low to medium weight)
- Overall lifecycle cost based on all the capital and operating expenses related to the water supply option. (Medium weight)
- Reliability and yield concerns relate to the expected resource reliability, if and how often the resource is expected to fail, as well as the available volume. (High weight).

It is therefore advised to consider the development of groundwater sources, if readily available, in combination with a Namwater connection to the existing Karibib Scheme. A graphical matrix was created to emphasise how the different options were compared based on their reliability and associated risk, as shown in Table 28.

Table 28 – Risk matrix

Option		**Accessibility Concerns**	**Overall Lifecycle Cost**	**Reliability and Yield Concerns**	**Overall Risk**
Local Dams	Khan River (3 Potential Sites)	High	High	Low – Medium	High
	Storm Attenuation	High	High	Medium - High	High
Namwater Pipeline		Low	Low	Medium	Medium
Desalination		High	High	High	High
Groundwater		Medium	High	Medium	Medium

The water specialists conclude their water supply impact assessment as follows:

- The mean annual runoff volume for the catchment is expected to be 650,000m^3, based on a unit runoff of 7 mm per annum over the catchment upstream of the mine
- The proposed flood attenuation model captures multiple day events, indicating that a dam size of 17.9 million m^3 is required to absorb a flood without any spills
- A spillway must be considered to safely route floods through the proposed attenuation dam or diversion weir so that the maximum capacity attenuation dam capacity is not required
- The attenuated flood water in conjunction with a Namwater connection and/or groundwater resources are indicating that they can likely support the mining activities

- The long term desalination water supply option should be considered once it becomes available to prevent water supply shortages and minimise water supply issues.

Table 29 lists the significance of these aforementioned impacts prior to mitigation.

Table 29 – Water availability impacts

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
Water levels in neighbouring boreholes used for water supply	Water (availability)	During pre-mining, groundwater is impacted due to water abstraction for use in the exploration drilling, as well as test pumping of groundwater exploration holes. The temporary lowering of the groundwater will occur, and may impact boreholes that are located along the marble contact	Adverse Direct Reversible Temporary On-site Low probability	Low	Minor	Adverse Low (2)
Groundwater cone of depression	Water (availability)	Lowering of the groundwater within the zone of influence may impact on groundwater users and their water supply	Adverse Direct Partly reversible Medium term On-site Medium probability	Minor	Moderate	Adverse Minor (3)
Impact on the Kahn River Catchment quantities	Water (availability)	Abstraction of the groundwater and catchment of the surface runoff for use in the mining process will reduce the water load to the Kahn River Catchment	Adverse Direct Partly reversible Long term (reptiles & birds) Permanent (amphibians, mammals and trees & shrubs) On-site High probability	Low	Moderate	Adverse Minor (3)

7.4.5.1 Water supply additional mitigation measures

The following mitigation measures put in place with regards to groundwater supply reduce the potential impact to a low significance:

- Update the numerical model and develop a dewatering and well field strategy to reduce the extent of the COD along the marble strike.
- Monitor the groundwater levels around the pit and outside the expected COD.
- Reuse water within the mining process.
- Explore artificial recharge of the marble contact by way of an attenuation/subsurface dam upstream on the Okawayo River.

The BFS hydrogeological numerical model that is to be completed will re-evaluate the COD with the inclusion of dewatering and water supply boreholes. This impact will be re-examined and the appropriate changes to the mitigation measures made. With respect to water supply from surface or groundwater sources the following recommendations are made:

- The final flood attenuation dam and spillway capacity depends on a detailed financial and risk assessment, with detailed design.
- The flood mitigation options should be implemented over time to match the open pit progression, to allow for timely construction.
- A more detailed topographical survey upstream of the mine pit should be conducted to determine a more accurate inundation boundary near the existing farmhouse and other relevant structures.
- Once the final mine layout is available, internal stormwater infrastructure and management should be assessed and stormwater intervention designed.
- Engage with the relevant government departments to be accounted for the water requirements along the desalination pipeline.
- Engagement with Namwater is required for the development of a connection to the Swakoppoort to Karibib Water Supply Scheme.
- Capacity details should be clarified to inform further study details.
- If the Namwater pipeline does not have spare capacity, the development of local dams will need to be considered, as the desalination support pipeline from the Namibian coast to the central area of Namibia (CAN) will only be operational after 10 years.
- Review the proposed water supply options with the updated mine layout plan as well as including the groundwater resource options.

These mitigations will result in a low significance rating for the impacts described.

7.4.6 WATER QUALITY

The Proponent has proposed that there will be a combined TSF and WRD. It has not been established whether the co-disposed TSF and WRD will be lined or unlined at this stage. The model simulations of the unlined facilities have incorporated all four proposed WRD footprints, including where the TSF is located within the WRD1.

Due to the dewatering of the pit and subsequent hydraulic gradient, it is predicted that groundwater flow from the WRDs and TSF will be towards the pit. This will increase the pit wall pore-pressures in those regions as well as inflow volumes to the pits. In addition to this, the quality of the pit sump water will deteriorate over time.

The TSF and WRDs will be exposed to evaporation which will result in potential salt precipitation on the surface. High-intensity rainfall that results in increase runoff from these facilities would transport these salts off the facility and onto the surrounding soil. This impact is mitigated through surrounding drainage design.

The WRDs overlying the marble contact would provide a source of contamination to the target aquifer. Water abstraction from boreholes along this contact will result in a hydraulic gradient on that strike which would pull contaminants into the aquifer, and potentially into the water supply. This impact is mitigated through redesigning the WRD's footprint.

Due to the slow migration and low hydraulic conductivity of the underlying rock, these impacts are considered minor.

With respect to the post closure phase, the model simulations extended past LOM to 50 years post-closure to predict the groundwater recovery once groundwater abstraction has ceased, as well as the contamination plume extent. At the 50 years mark the model predicted that flow from the TSF and WRDs will still be towards the pit, as the evaporation from the resulting pit lake will exceed that of the inflows and recharge.

The contaminants from the TSF and WRDs will result in salt loading to the groundwater and pit lake water, and the high evaporation rate will concentrate this further. Should there be a flood event, the pit lake could breach the pit walls and decant into the Okawajo River and to the Khan River catchment. This event is considered to be rare and unlikely.

The specialists' model simulations do not take surface runoff from the TSF and WRDs into account in terms of contaminant transport, as well as the hydropedology characteristics in the shallow subsurface. Evaporation from the TSF and WRDs would result in the precipitation of salts, which could be washed down gradient during rainfall and flood events. To quantify this, a combined surface-groundwater model is still required. Table 30 summarises the impacts and their significance rating prior to mitigation.

Table 30 – Water quality impacts

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
Groundwater contamination from unlined TSF and WRD	Water quality	Potential for acid mine drainage, increased salt load to the groundwater due to seepage	Adverse Direct Partly irreversible Long term	Low	Minor	Adverse Minor (3)

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
		from the mine facilities	On-site Possible			
Contaminant load to surface runoff and soil from TSF and WRDs	Water quality	The TSF and WRD will undergo evaporation which will result in the precipitation of salts. Any rainfall that falls onto this infrastructure may wash these salts off and deposit them down gradient via surface flow. This will result in contamination of the surrounding soil.	Adverse Direct Irreversible Long term Local Possible	Low	Moderate	Adverse Minor (3)
Flooding and decanting of pit lake Post-closure due to excessive rainfall events	Water quality	The water quality of the pit will deteriorate over time due to inflow contaminant from the remaining TSF and WRD, pit wall exposure to the elements, as well as salt concentration due to evaporation. Should an excessive rainfall event occur and flood the pit, decanting from the pit will likely enter the water channel and flow towards the Kahn River	Adverse Direct Partly irreversible Temporary Local Improbable	Low	Moderate	Adverse Low (2)

7.4.6.1 Water quality additional mitigation measures

To reduce the significance of the impact on the groundwater quality, the following mitigation measures are proposed:

- Evaluate option of recharging the marble aquifer with the clean Okawayo flows upstream of the mine through use of a subsurface dam/diversion dam

- Incorporate the long-term geochemical analyses on the waste rock material and tailings into the updated numerical model to determine the potential contamination load to the groundwater
- Undertake permeability tests on waste rock and tailing samples
- Update the contaminant transport model to provide higher confidence to the plume migration
- Ensure suitable stormwater design and slope benches to capture and reduce runoff from these facilities and contact with contaminants produced during the mining processes such as fuel, explosives, and suspended solids
- Liner options for the TSF facility should be investigated based on the potential long-term impact, to reduce contaminant load to the underlying aquifers
- Locations for the WRD to be evaluated and if possible, moved off the marble contact. Seepage from the WRD could cause dissolution on the marble contact and could impact the stability of the facility
- Design the WRD to ensure that any seepage is captured.

To quantify the final pit lake elevation and water qualities, pit lake modelling is recommended, to incorporate the effects of evapotranspiration, salt loading and the final pit geology. Stormwater management plans and designs by qualified specialists should be put in place to mitigate this impact.

The proposed mitigation measures for the potential TSF and WRD surface water runoff impacts include:

- Generate a combined surface-groundwater model to simulate the groundwater-surface water interaction
- Update the current numerical model for more accurate post-closure simulations, inclusive of groundwater abstraction from boreholes
- Continued groundwater quality and level monitoring post-closure
- Stormwater management around the pit and WRD/TSF facilities to prevent decanting to the pit or to the environment

These mitigations will result in a low significance rating for the impacts described.

7.4.7 BIODIVERSITY

The summary of the significance of the impacts to biodiversity is provided in the tables below. The water pipeline, electrical powerline and access roads are situated in the plain habitat but do transect the Okawayo River and its tributaries. The weir and attenuation dam, and river diversion channels straddle the plain, Okawayo River and the marble hills.

The layout of the mine site is illustrated in Figure 10 shows the position of the processing plant, WRD, TSF and open pits. The WRD 1 and 2 are situated in the plain habitat, while the WRD 3 and 4 skirt both the plain and limestone hills. The TSF is situated in the plain habitat. The open pits are situated in the plain and the Okawayo River.

These will all alter the habitat in which they occur either by destroying it or removing it and creating in its place an artificial or new habitat that may or may not be habitable by various organisms in the long term. The changes will occur over time, some rapidly within weeks and others over months and even years. This will start at the construction phase and continue into the operational phase of the mine.

The full impact assessment of the construction and subsequent operations on the biodiversity and ecology of the reptiles, amphibians, mammals, birds, trees, shrubs and grasses are given in Appendix F. Overall, the impacts of this activity on biodiversity are expected to be low or minor in terms of significance before mitigation. The only exception is for bird biodiversity. For ecological functioning, the significance rating varies between minor and major prior to mitigation. The magnitude of change is negligible for biodiversity but high for ecological functioning. Each organism grouping is discussed hereafter in greater detail.

7.4.7.1 Reptiles

The impact of an aboveground plant site infrastructure, waste rock dump and TSF is not expected to be detrimental to reptiles as it would not impede their movement. However, these structures are expected to attract certain types of reptiles to the area (e.g., certain gecko species, snakes, agamas etc). The lighting and artificial habitat specifically from the plant are likely to attract a variety of reptiles. The waste rock dump 2 is proposed to cover parts of the northern tributaries of the Okawayo River and should be avoided.

The impacts of the open pit on reptiles associated with the affected area/habitat, could act as a pitfall trap and is expected to be detrimental to reptiles. However, most reptiles known or expected to occur in the area are small lacertid and gecko species that would probably use the pit(s) as part of their habitat and/or rather be attracted to the rocky waste dumps as a more suitable habitat.

Mitigation will include covering the natural landscape with rock and other excavated material and the removal of all flora on site. All vehicle activities (including long hauling) should abide by the speed limits to avoid road mortalities. However, the overall low densities of all reptile species in the mining area would negate the problem.

Therefore, the magnitude of change of this impact is considered moderate, whilst the sensitivity of the receptor is considered low due to the ability of the receptor to recover after disturbance as shown in Table 31.

Table 31 – Impacts on reptiles

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
Construction and operation of the plant site infrastructure	Reptiles	Lighting and artificial habitat specifically from the plant are likely to attract a variety of reptiles	Adverse Direct Partly reversible Long term On-site High probability	Low	Moderate	Adverse Minor (3)
Construction and operation of the open pit		The open pit could act as a pit fall trap	Adverse Direct Partly reversible Long term On-site High probability	Low	Moderate	Adverse Minor (3)

7.4.7.1 Amphibians

The impact of an aboveground plant site infrastructure, waste rock dump, TSF and open pit is not expected to be detrimental to amphibians. These structures would not affect their habitat or impede their movement. However, waste rock dump 2 is proposed to cover parts of the northern tributaries of the Okawayo River. The artificial habitat of the TSF could potentially attract amphibians to the area. Lastly, the Okawayo River (and its tributaries), pans, ground dams and farm reservoirs are all potential amphibian habitats and affecting these would affect the available habitat throughout the area.

Mitigation will include that all vehicle activities (including long hauling) should abide by the speed limits to avoid road mortalities. However, the lack of open surface water and overall marginal amphibian habitat in the mining area would negate the problem. The covering of parts of the northern tributaries of waste rock dump 2 should be avoided and an alternative alignment direction of this facility should be considered.

With mitigation the overall magnitude of change of the impact to amphibians from project features can be lowered to a minor rating and the sensitivity of the receptor to low as shown in Table 32.

Table 32 – Impacts to amphibians

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
Waste Rock Dump (WRD)	Amphibians	Potential loss of habitat in parts of the northern tributaries of the Okawayo River	Adverse Direct Irreversible Permanent On-site High probability	High	Moderate	Major (9)
Tailings Storage Facility (TSF)		Loss of existing habitat on site in the form of pans, ground dams and farm reservoirs removal in turn affecting ecological functioning	Adverse Direct Irreversible Permanent On-site High probability	Medium	Moderate	Adverse Moderate (6)

7.4.7.1 Mammals

The impact of an aboveground plant site infrastructure, waste rock dump and TSF is not expected to be detrimental to mammals as they would not impede their movement. However, these structures are expected to attract certain types of mammals to the area (e.g., certain bats, small carnivores and rodents, etc). The lighting and artificial habitat specifically from the plant are likely to attract a variety of mammals. The waste rock dump 2 is proposed to cover parts of the northern tributaries of the Okawayo River and should be avoided.

The impacts of the open pit on mammals associated with the affected area/habitat, could act as a pitfall trap, and is expected to be detrimental to mammals. However, most larger mammals known or expected to occur in the area would instinctively avoid the active mining areas and or be deterred by the waste rock dump sites around the pits while the smaller mammals would probably use the pit(s) as part of their habitat and or rather be attracted to the rocky waste dumps as more suitable habitat.

Active mitigation to avoid mammal fatality will include all vehicle activities (including long hauling) should abide by the speed limits to avoid road mortalities. Furthermore, larger mammals are very adaptable to disturbances, range over vast areas, and are attracted to areas with grazing after localised rainfall events (i.e. mostly avoid disturbed areas) while the overall low densities of all mammal species in the mining area would negate the problem.

The magnitude of change is considered moderate and the sensitivity of the receptor in relation to such a change as low, with mitigation as shown in Table 33.

Table 33 – Impacts to mammals

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
Construction of the open pit	Mammals	The open pit could act as a pit fall trap to mammals present in the area.	Adverse Direct Partly reversible Permanent On-site High probability	Low	Moderate	Adverse Minor (3)

7.4.7.1 Avian

The impacts of the open pit on birds associated with the affected area or habitat, could act as a pitfall trap, and is expected to be detrimental to ostriches associated with the affected area or habitat. However, Ostrich known or expected to occur in the area would avoid the active mining areas and or be deterred by the waste rock dump sites around the pits while the smaller birds would probably use the pit(s) as part of their habitat and or rather be attracted to the rocky waste dumps as more suitable habitat.

Mitigation should include all vehicle activities (including long hauling) to abide by the speed limits to avoid road mortalities. Filling up of the pits after mining and/or sloping the pits would negate the pitfall problem. Furthermore, most birds are very adaptable to disturbances, range over vast areas, and are attracted to areas with grazing after localised rainfall events (i.e. mostly avoid disturbed areas). However, raptor breeding trees (especially vulture species) should be avoided during infrastructure layout planning where possible, especially during the breeding season, as they might abandon nests when regularly disturbed.

Mitigation measures to ensure safe levels of residual chemicals namely cyanide from the process water has included the design mitigation measures such as a detoxification circuit, and dry stacked or co disposed tailings to limit water use and as a result reduces the volume of potentially free-standing water is on site. If this well-known issue arises during the operational phase additional mitigation measures such as bird deterrents may be required and this will be determined during operations through monitoring in accordance with the EMP.

The magnitude of change is expected to be moderate as the impact is within acceptable limits of change as shown in Table 34. The sensitivity of the receptor is considered low as the receptor is not exclusively associated with the site.

Table 34 – Avian impacts

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
Construction of the open pit	Birds	The open pit could act as a pit fall trap to flightless birds and raptors present in the area	Adverse Direct Partly reversible Permanent On-site High probability	Low	Moderate	Adverse Minor (3)
Operational water bodies and dams	Birds	Standing free surface water could attract birds as a drinking water source, birds could consume water that potentially could have fatal effects due to residual chemicals in the water	Adverse Direct Partly reversible Permanent On-site High probability	Low	Moderate	Adverse Minor (3)

7.4.7.2 Flora

The impact of aboveground plant site infrastructure, waste rock dump, TSF and open pit is expected to be detrimental to the trees and shrubs associated with the affected area or habitat. The construction of the plant would involve land clearing, while the waste rock dump, TSF and open pit will remove larger trees and shrubs and grass species and would cover the natural landscape with rock and other excavated material and the open pit would involve the removal of all flora on site.

Mitigation would include offsets such as planting of endemic tree species in the vicinity of the ML for every protected tree removed to accommodate the open pit, waste rock dump, TSF and processing plant. All vehicle activities (including long hauling) should abide by the speed limits to minimise dust pollution on vegetation not in the immediate vicinity of proposed development areas as dust deposition on plant leaves may inhibit photosynthesis of plants.

The magnitude of change is expected to be moderate as shown in Table 35, the impact is within acceptable limits of change. The sensitivity of the receptor (vegetation structure) is considered low as the receptor is not exclusively associated with the site.

Table 35 – Impacts to flora

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
Construction and operation of the open pit, waste rock dump, TSF and processing plant	Trees and shrubs	Loss of vegetation and landscape change	Adverse Direct Irreversible Permanent On-site High probability	Low	Moderate	Minor (3)

7.5 BIOPHYSICAL ENVIRONMENT IMPACTS: ANCILLARY WORKS

7.5.1 OKAWAYO RIVER DIVERSION OPTION

At the time of compiling this assessment the Proponent had investigated a worst-case scenario that included the potential option of diverting the Okawayo River around the proposed open pit. Detailed studies are ongoing on the project site to determine the most suitable option for managing the intermittent flow of water. The primary option being considered is to let the seasonal flow (if any), flow directly into the open pit and pumping this water out to re-joining the Okawayo River downstream of the open pit. The geotechnical stability of the pit for this option needs to be evaluated as well as the impacts of in-pit contact water being contaminated due to the mining processes (blasting, fuel spills, suspended sediments, etc.).

Other options include diverting the river or constructing a diversion dam/subsurface dam to enhance aquifer recharge to the mine wellfield supply, or a weir, or a combination of these options. The most suitable option will depend on the feasibility of each option, taking into consideration that the impacts on the downstream environment must be minimised. The assessment was conducted using a worst- case methodology, therefore the options potentially most disruptive to the river system were assessed. Before implementation of any of these options the MME Chief Inspector of Mines approval will be required for the final mine layout plan. Following this, the environmental assessment will be updated, and an amendment lodged with the MEFT to reflect the preferred solution. The worst-case options relating to the diversion of the Okawayo River are discussed in further detail below.

The Okawayo River may need to be diverted to avoid the flooding of the planned Twin Hills Main open pit. The proposed diversion option is rendered in the layout map of Figure 10. The full impact assessment tables for these aspects are provided in Appendix E. The summary of significance ratings for biodiversity and ecological functioning because of the construction and

operation of the diversion channel, dam, and weir are listed below in Table 36, Table 37, and Table 38, respectively. In general, the impacts expected prior to mitigations are minor for biodiversity but major for ecological functioning.

If a river diversion option is chosen as per Knight-Piesold (2021) it would need to ensure that the diverted water flows back into the Okawayo River to the north of the open pit area. The diversion channel should allow a sustainable water flow to the water table of the riparian habitat downstream of the pit. Excavating a deeper channel may be needed should the flow to the habitat downstream not be sufficient to sustain the trees and shrubs along the banks of the Okawayo River.

By way of mitigating the effects to ecological functioning, the construction of the planned dam will be considered with other options, such as river diversions around the pit. The objective of this option is to divert and rechannel the Okawayo River around the pit to maintain flow downstream and protect the pit. It must be noted that the open pit itself going through the Okawayo river will inevitably impact on the downstream habitat as it will disrupt the subsurface baseflow and surface flow due to the cone of depression that the open pit will create.

The magnitude of change to ecological functioning because of the river diversion is considered moderate, while the receptor (riparian habitat) is deemed to have a medium sensitivity.

Table 36 – River diversion impacts on ecological functioning

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
Okawayo River Diversion	Reptiles	Ecological functioning reduced	Adverse Direct Irreversible Permanent Local Possible	High	Moderate	Adverse Moderate (6)
Okawayo River Diversion	Amphibians	Ecological functioning reduced	Adverse Direct Irreversible Permanent Local Possible	High	Moderate	Adverse Moderate (6)
Okawayo River Diversion	Mammals	Ecological functioning reduced	Adverse Direct Irreversible Permanent Local Possible	Medium	Moderate	Adverse Minor (4)
Okawayo River Diversion	Birds	Ecological functioning reduced	Adverse Direct Irreversible Permanent	Medium	Moderate	Adverse Minor (4)

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
			Local Possible			
Okawayo River Diversion	Riparian vegetation (trees & shrubs)	Ecological functioning reduced	Adverse Direct Irreversible Permanent Local Possible	High	Moderate	Adverse Moderate (6)

7.5.2 DIVERSION DAM OPTION - CONSTRUCTION

Further to the diversion plan, the alternative of construction of a dam that will hold water from a 1 in 50-year flood is currently being assessed. Again, the primary purpose of the dam is to protect the pit from flooding and would have a beneficial impact by recharging the clean water upstream of the mine to the marble aquifer that the mine wellfield will be exploiting. This dam would serve to further ensure that the flooding of the open pits would not occur. The construction of the dam could potentially cut off water from this habitat downstream and thereby alter its ecological functioning completely. However, mining through this drainage channel as per the current mine plans will in any case cut off water from the downstream habitat and have the same impact.

Due to the local extent of the impact both the magnitude of change and sensitivity of the receptor are considered high. The correct placement and construction of the diversion/subsurface dam will have a nett positive impact by recharging the marble aquifer for the sustainability of the mine wellfield, and other groundwater users. With proper infrastructure planning and placement, the significance of the impact could be significantly reduced.

Table 37 – Dam construction impacts on plants and animals

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
Dam construction	Plants and animals	Biodiversity reduced	Adverse Direct Partly reversible Permanent Local Likely	Low	High	Adverse Minor (4)
Dam construction	Plants and animals	Ecological functioning reduced	Adverse Direct Irreversible Permanent Local Likely	High	High	Adverse Major (9)

7.5.3 DIVERSION WEIR OPTION - CONSTRUCTION

As an alternative to the diversion dam, a weir is considered as second option and would divert the water into a constructed channel around the pit making use of an existing water course. The details of the planned weir can be found in the specialist hydrology report by Knight-Piesold (2021). The construction of the weir alone would reduce water flow downstream but not completely cut off water supply to the riparian habitat.

The impact is localised as its influence can be contained within the site only and a moderate magnitude of change. The sensitivity of the receptor is deemed medium resulting in a moderate impact level.

Table 38 – Weir construction impacts on plants and animals

Activity	Receptor	Impact	Nature of impact	Value & Sensitivity	Magnitude of change	Significance of impact
Weir construction	Plants and animals	Ecological functioning reduced	Adverse Direct Irreversible Permanent Local Definite	Medium	Moderate	Adverse Moderate (6)

7.6 FURTHER CONSIDERATION CUMULATIVE IMPACTS

The EIA regulations clearly states that cumulative impacts should be considered as part of the ESIA for a proposed project. Good practice requires that, as a minimum, cumulative impacts are assessed during the ESIA process. Cumulative impacts can arise when a single resource or receptor is affected by more than one impact from the proposed project. For example, a local resident could be affected by noise from construction vehicles and dust from ground excavation during the construction stage. In isolation, the impacts of noise and dust may be insignificant, however when combined, the impacts on the receptor (if present) may result in a significant impact. This is termed 'Intra-Project Cumulative Impacts'. A project specific example of an intra project cumulative impact is:

- During the construction phase, there will be noisy activities such as blasting, ground excavation and haulage and general construction which could generate dust. A site boundary fence would be erected, plant and machinery will be distributed across the site, and construction traffic (mine and the road diversion activities) will access the site via the D1941. If all these activities were undertaken at the same time, a local receptor living or in any other way using the land near the site would be exposed to an increase in noise levels, dust and traffic blockage and constitute a nuisance on a short-term basis.

Cumulative impacts may also arise as a result of the combination of two or more projects. A receptor could be impacted by similar types of impact from different developments, or a receptor

could be impacted by different types of impact from different developments. This could occur at the same time or at different times. This is termed Inter-Project Cumulative Impacts.

An example of an inter project cumulative impact is as follows:

- Noise generated during the construction stage of the proposed project may not cause a significant effect in isolation; however, a sensitive receptor (e.g., local resident) may be significantly impacted when noise from the proposed project is combined with noise generated from other projects. These projects could be future projects while the mine is operational or existing projects which may have ongoing influences on the environment in the future and are expected to interact with the same environmental and social receptors as the proposed project (International Finance Corporation, 2013).

Cumulative impacts have a wide temporal and spatial scope and are not restricted to a local area nor need to happen at the same time. It is, therefore, crucial to identify a suitable study and assessment area, as well as a timeframe to assess. Cumulative impacts can also be vast and complicated; therefore it is important to focus on the significant impacts.

The six-step rapid CIA process has been followed:

- Step 1: Scoping - determine spatial and temporal boundaries
- Step 2: Scoping - identify valued environmental and social receptors and identify reasonably foreseeable developments
- Step 3: Determine present condition of valued environmental and social receptors (the baseline)
- Step 4: Assessment of cumulative impacts and evaluation of the significance of the cumulative impacts
- Step 5: Identification of mitigation measures to avoid or reduce cumulative impacts.

The cumulative impacts that may arise because of the project are provided in Table 39 and Table 40.

Table 39 - Intra-project cumulative impacts assessment table

Receptor	Impacts			Significance of impact	Impact management
Farming community north of the project site, road users and members of the Karibib Airforce airbase for the duration of the 18 months construction period.	**Activity**: General mine construction activities and the diversion of the D1941 road (including blasting) both resulting in increased noise levels and generation of dust from the project site. **Impact:** Farmer's amenity affected.	**Activity:** Increase in construction traffic and to the local flow of traffic movement. **Impact:** Severance to road users, increased travel times on affected roads (B2, C36 and C33) and increased driver stress.	**Activity & Impact:** Introduction of mining infrastructure and waste rock dumps causing a visual impact to road users and the members of the Namibian Airforce at the military base. **Impact:** Road user's and members of the KAFB sense of place will be altered.	Moderate	– Traffic calming measures (road signs) to be installed on public roadways. – Daily dust suppression measures to be applied on all access and haulage routes and laydown areas. – Technical noise attenuation measures to be applied on machinery use on site. – Alter the blast pattern to detonate in sequence rather than one big blast.
	MINOR ADVERSE SIGNIFICANCE	**MINOR ADVERSE SIGNIFICANCE**	**MODERATE ADVERSE SIGNIFICANCE**		

Table 40 - Inter project cumulative impacts

Receptor	Impacts			Significance of impact	Impact management
Osino Workforce	**Activity**: Mine construction and operation. Total LOM of 14 years. **Impact:** Lack of housing infrastructure and amenities in Karibib.	**Activity:** Mine construction and operation. Total LOM of 14 years. **Impact:** Lack of housing infrastructure and amenities in Omaruru.	**Activity & Impact:** Possible dimension stone quarrying south of the ML combined with active mining on the Twin Hills Gold Project. **Impact:** Severe loss of sense of place with the gradual destruction of the marble inselbergs. **Impact**: Strain on the housing infrastructure in Karibib and Omaruru.	Moderate	– Karibib and Omaruru councils to fast track their housing delivery projects under their strategic plan objectives. – The proponent to consider a PPP with local authority councils to deliver low and medium cost housing schemes through The Twin Hills Trust. – Local authorities to attract a wider range of investments to develop and expand the infrastructure in both towns.
	MODERATE ADVERSE SIGNIFICANCE	**MODERATE ADVERSE SIGNIFICANCE**	**HIGH ADVERSE SIGNIFICANCE**		
Local economies of Karibib and Omaruru	**Activity:** Increased spend (inflow of capital) on local businesses and available real estate from both the Twin Hills Golf Project and the future dimension stone quarry project. **Impact:** Growth and diversification of the local economies if facilitated proactively and timeously			Benefit	Develop PPP to establish and develop infrastructure projects within the two towns.

The combined adverse inter-project impacts on the identified receptors cannot be easily quantified mainly due to the lack of other project schedule information. A qualitative approach was then used to assess the possible combined effects that may arise should the Project coincide with the other project identified. The combined beneficial socio-economic cumulative impact will be experienced by the shared receptor base for both projects. Should the two projects develop simultaneously, the local economy will experience an increase in downstream spending from both personnel and business aspects.

8 CONCLUSION

A full and comprehensive Environmental and Social Impact Assessment (ESIA) has been undertaken for the Twin Hills Gold Project. All aspects have been considered in the impact assessment. These aspects have been thoroughly investigated against planned activities. Public participation has been positive with all issues raised considered in the report for the decision making and impact assessment. All specialist input has been considered and the recommended mitigations have been incorporated into the environmental and social management plan (ESMP).

The scoping phase of the ESIA described the receiving environment adequately. The Proponent made adjustments to the layout after the screening phase and the project description and plan was fixed for the assessment phase, however the plan might be updated as details are refined in which case an amendment to this assessment will be prepared. Alternatives were provided in terms of mineral dump sites, water management and water sourcing, these were also assessed by the specialists.

Table 41 below summarises the impacts after mitigation. On a scale from 1 to 12, low to high, the beneficial (B) and negative (N) impact significance is stated. Some variation between the sub-sections of these aspects exists so the average significance is stated for some aspects.

Table 41 - Summary of the significance ratings after mitigations for the expected impacts (B=beneficial impact; N=negative impact; scale of 1-12 from low to high)

Socio economic environment: economic		Socio economic environment: social		Biophysical environment	
Economic stimulation	B6	Noise impacts	N4	Soil and geological impacts	N6
Employment and skills development	B3	Air quality impacts	N6	Acid mine drainage impacts	N6
Direct employment – construction	B6	Visual impacts	N6	Surface and groundwater impacts – availability & sustainable use	N3
Direct employment – operations	B6	Sense of place	N6	Surface and groundwater impacts - water quality	N3
Indirect employment impacts	B3	Road impacts - Re-alignment D1941 Road	N4	Biodiversity (biodiversity & ecological functioning)	N3
Employment during decommissioning and closure	A6	Road degradation	N4	Biophysical environment impacts: Okawayo river diversion	N6
Corporate based investments	B6	Traffic impacts	N4	Biophysical environment impacts: Diversion dam construction	N9
		Heritage and culture impacts from mine blast vibration	N12	Biophysical environment impacts: Diversion weir construction	N6

Socio economic environment: economic	Socio economic environment: social	Biophysical environment	
		Further consideration cumulative impacts	N6

Three aspects remain high after mitigation, namely, social impacts of blasting and vibrations, heritage impacts, and flood attenuation by dam construction associated with the potential river diversion. Strategies to reduce the significance of these potential impacts are being devised and will be implemented via amendments to this approval and site plans as the project evolves.

Mitigation measures to reduce the impact of blast vibration with respect to the proximity of the sensitive heritage sites must be found. It may not be realistic to re-locate these structures so in situ interventions may be needed to shield them – management of this area will be done in close consultation with the Heritage Council although the sites are not listed it would be deemed best practice.

The Proponent will carefully plan the water supply for the mine. Further investigations by the hydrogeologists and hydrologists will provide further evidence required to fine turn the hydrological and hydrogeological models. Where the construction of an attenuation dam will potentially impact the sustainable functioning of the riparian ecosystem downstream, strategies to mitigate this potential impact will need to be sought. The additional hydrological studies will advise with more confidence how the water table of the Okawayo downstream of the dam can be maintained either through artificial recharge or the surface runoff from the landscape north of the marble ridge. The mitigations already mentioned in this report need to be considered.

Another aspect that needs highlighting is the geochemical assessment. The specialist studies thus far indicate that with respect to mineral waste, altered and mineralised waste rock and ore materials have elevated sulphur content and low acid neutralising capacity. These materials will need to be selectively handled and managed. Calcrete waste rock in the area will be a good source of material for neutralising waste with acid mine drainage tendencies.

With respect to non-significant impacts, it is noteworthy to discuss the issue of climate change carbon dioxide emissions. The planned project will generate emissions which contribute to greenhouse gas concentrations to the order of 53,000 tonnes of carbon dioxide. Half of the amount that a medium scale mine would trigger to the IFC and Equator Principles threshold.

In closing, this ESIA report adequately outlines the process of impact assessment for the Twin Hills Gold Project and lists all the foreseeable outcomes and recommended mitigations to reduce the potential impacts. The ESMP includes the required monitoring of the project at all stages of the project. All stakeholders and registered interested and affected parties can now provide comments, if any, on the final ESIA and ESMP reports directly to the office of the Environmental Commissioner as this final ESIA and ESMP report will be submitted to the competent authorities for review, and a record of decision.

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APPENDIX A – ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

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