Draft Initial Environmental Examination and Environmental and Social Management Plan

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PNG: Pacific Telecommunications Modernization Project

Prepared by ERIAS Group PNG Limited for ATH International Venture Pte Limited as a requirement of the Asian Development Bank.

ATH-Vodafone PNG Mobile Telecoms Project

Initial Environmental Examination and Environmental and Social Management Plan

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Acronyms and Abbreviations

Term	Definition
ADB	Asian Development Bank
ATH	Amalgamated Telecom Holdings Limited
AZE	Alliance for Zero Extinction
BTS	base transceiver stations
CAP	corrective action plan
CASA	Civil Aviation Safety Authority
CEPA	Conservation and Environment Protection Authority
CSR	corporate social responsibility
DLO	District Land Officer
EHS	environmental, health and safety
EMF	electromagnetic field
ERIAS	ERIAS Group Pty Ltd
ESMP	environmental and social management plan
ESMS	environmental and social management system
GIIP	good international industry practice
ICNIRP	International Commission on Non-Ionizing Radiation Protection
ICT	information and communications technology
IFC	International Finance Corporation
IFI	International Finance Institution
IEE	Initial Environmental Examination
IPP	Indigenous Peoples Plan
ILG	Incorporated Landowner Group
LIR	Land Investigation Report
OHS	occupational health and safety
NAC	PNG National Airport Corporation
NCD	National Capital District
NICTA	National Information and Communications Technology Authority
PNG	Papua New Guinea
RDS	rapid deployment structure
RF	radio frequency
PSOD	Private Sector Operations Department
SPS	Safeguard Policy Statement
SST	self-supporting tower
WHO	World Health Organization

Executive Summary

The Project

Amalgamated Telecom Holdings Limited (ATH) International Ventures (IV) is launching a US$ 400 million mobile telecommunications venture in Papua New Guinea (PNG) through its subsidiary Vodafone PNG, known as the ATH-Vodafone PNG Mobile Telecoms Project ('the Project'). The Project includes a network of new telecom tower sites to be located across PNG, a 24/7 contact/call centre in Port Moresby, core radio network equipment, fibre-optic and satellite links, and leased retail outlets. The proposed PNG transmission network will support 3G, 4G and Pre-5G service to deliver high speed mobile, internet, voice, messaging and corporate solutions across the country. Vodafone PNG proposes to replicate the proven Vodafone Fiji technology model to reduce delivery risks and leverage on established Fiji vendor and supplier relationships to deliver a homogenous network architecture across Fiji and PNG.

In accordance with ADB Safeguard Policy Statement (SPS) 2009 (ADB, 2009), ADB has classified the Project as follows:

- Environment: Category B, with potential environmental impacts likely to be site-specific, mostly reversible and readily managed. An Initial Environmental Examination (IEE) is required by ADB for projects classified as Category B.
- Involuntary Resettlement: Category C. There will be no involuntary land acquisition or involuntary land restriction for the land leased by Vodafone PNG for the Project, therefore Safeguard Requirements 2: Involuntary Resettlement is not triggered.
- Indigenous Peoples: Since some of the towers will be greenfield sites located on Indigenous Peoples/ customary owned land, the project is classified as Category B for Indigenous Peoples safeguards. An Indigenous Peoples Plan (IPP) is required by ADB for projects classified as Category B.

This document, prepared by ERIAS, provides the IEE and framework for the environmental and social management plan (ESMP) for the Project. The Project will be implemented under Vodafone PNG's environmental and social management system (ESMS).

Through the Project, Vodafone PNG seeks to increase access to information and communications technology (ICT) infrastructure and services across PNG, filling gaps in network coverage, providing greater choice and driving affordability across the market. A number of different options were considered through Project planning and design to ensure the Project responds to the constraints and opportunities presented in the PNG context, minimises potential adverse impacts and maximises benefits for Papua New Guineans.

Potential Environmental and Social Impacts

The IEE describes the environmental and social setting of the Project and identifies and describes potential Project-related environmental and social impacts. The Project is expected to result in

impacts that are site-specific, mostly reversible and readily managed. Only a small area of land (around 400 m^2) is required to install each tower, and these will be constructed only on sites where landowners enter voluntary lease agreements. Culturally appropriate consultation and negotiation will be undertaken leasing sites on customary-owned land. Sites will be avoided in sensitive areas for biodiversity, including critical habitat (e.g., for threatened species or of special significance for endemic or restricted-range flora and fauna). In particular, sites that may trigger Category A project categorisation under ADB Safeguard Requirements (due to biodiversity or cultural heritage considerations) will be considered 'no go' areas that are screened out during the site selection process. Potential impacts are primarily related to construction activities such as soil erosion from ground disturbance to construct tower sites and new access roads (where required), workplace health and safety, waste management, risks from accidental spill or leaks of fuel, and emissions from generators required for base stations during operations. Construction of new access roads, where required, also has the potential to have impacts on biodiversity by increasing access for hunting and vegetation removal.

Potential adverse impacts on Indigenous Peoples and other affected communities include changes to land use (i.e., from community use or subsistence agriculture to telecommunications) and associated economic displacement during the lease period, loss of visual amenity (i.e., visual, or due to noise), risks associated with electromagnetic fields (EMF), and the potential for interactions with the Project and its construction workforce to increase transmission of communicable diseases and reduce community cohesion, particularly in rural and remote communities. Most of the socio-economic impacts will be beneficial and include increase employment and training opportunities and increased access to telecommunications services, with related benefits in health, education and safety.

Environmental and Social Management

Management measures will be implemented to avoid and minimise environmental and social impacts and support the realisation of benefits arising from the Project. These management measures are described in aspect-specific environmental and social management plans that are integrated into Vodafone PNG's ESMS. These plans address Project pre-construction (site selection and acquisition), construction, operations and decommissioning phases. Beneficial measures have been identified that will contribute toward long-term social capital and sustainable development via the implementation of Vodafone PNG's Corporate Social Responsibility (CSR) Plan.

Vodafone PNG is ultimately responsible for the implementation of management measures outlined in this IEE and the CSR Plan. However, Vodafone PNG recognises that it cannot effectively deliver all identified programs and initiatives to provide community benefit alone, and will pursue partnerships with local-level, provincial and national governments and non-governmental organisations. Vodafone PNG will work with these organisations to avoid duplication and improve efficiency of program planning, implementation and monitoring.

Monitoring and Reporting

Vodafone PNG has prepared a 'Monitoring and Measurement Procedure' under its ESMS to guide what will be monitored, and when and by whom the monitoring will be carried out. Monitoring records will be kept for management review and reporting, and monitoring results will

be documented and reviewed to provide for continual improvement of environmental and social performance and consideration of unanticipated impacts. Vodafone PNG will prepare and submit environmental and social monitoring reports to ADB and regularly conduct audits in accordance with its ESMS. An annual environmental performance report will also be submitted to the PNG Conservation and Environment Protection Authority (CEPA) that reports on compliance with conditions of the Environment Permit for the Project.

Information Disclosure, Consultation and Grievances

Disclosure of Project information will be made available to Indigenous Peoples and Project-affected communities using a range of methods, including face-to-face engagement, visual presentations and other culturally and gender-appropriate means, e.g., women-only focus groups. All relevant materials will be presented in an appropriate form understandable to affected communities, including translation into the local language as required. Negotiations and agreements will be made based on the principles of free, prior and informed consent.

Vodafone PNG has established a grievance redress mechanism to ensure effective resolution of Indigenous Peoples and Project-affected communities' concerns and grievances concerning Project implementation. The mechanism will support the timely and transparent resolution of complaints, and is gender sensitive, culturally appropriate, and readily accessible to all affected communities. Vodafone PNG also maintains an employee handbook which details the process for addressing employee concerns and grievances with the Company and/or other employees and contractors/suppliers.

Project Benefits

With application of the proposed management measures, the impact of the Project will be highly beneficial for Papua New Guineans. The establishment of Vodafone PNG will introduce improvement and variety of mobile communications services in PNG. It will improve ICT services in areas of the country where it is currently limited, particularly remote and low-income parts of the country, and increase competition in other areas, resulting in lower costs and better service.

Access to affordable mobile telecommunications technology provides access to information on socio-economic opportunities and public services, especially to the poor and vulnerable population living in rural, mountainous, and hard to reach areas. This will increase domestic and regional connectivity of rural and urban communities and provides a powerful tool for customers to access health and education services, support agriculture activities and undertake mobile banking and money transfers. Papua New Guineans living in both rural and urban areas will also benefit from the employment and livelihood opportunities in the construction of towers and operation of Vodafone PNG's administration and technology support services, retail stores and call centres. Economic empowerment of women will also be increased through greater employment opportunities and improved access to telecommunications and related social and economic services.

1. Introduction

1.1 Background

The Private Sector Operations Department (PSOD) of the Asian Development Bank (ADB) is making an equity investment in Amalgamated Telecom Holdings Limited (ATH) International Ventures (ATH IV) to fund the launch of its Papua New Guinea (PNG) mobile telecommunications venture through Vodafone PNG.

ATH is a publicly listed company and Fiji's principal telecommunications company whose business ventures comprise a range of telecom industries, including Vodafone Fiji. Vodafone Fiji is a leading mobile telecommunications provider in Fiji, is ISO 9001:2015 certified, and will hold the management contract to operate the new telecommunications operation in PNG, called the ATH-Vodafone PNG Mobile Telecoms Project (the Project). All Vodafone Fiji organisational policies, management processes and standards will be adapted to the Vodafone PNG business.

The new US$ 400 million mobile telecommunications network to be built by Vodafone PNG includes a network of new telecom tower sites to be located across PNG, a 24/7 contact/call centre in Port Moresby, core radio network equipment, fibre-optic and satellite links, and leased retail outlets.

The key implementation strategy in the new telecommunications operation in PNG is also to replicate the proven Vodafone Fiji technology model. This approach will reduce delivery risks and leverage on established Fiji vendor and supplier relationships to deliver a homogenous network architecture across Fiji and PNG.

To satisfy ADB Safeguard Policy Statement (SPS) 2009 (ADB, 2009) and other policy requirements, the ADB funding mechanism required ATH IV to conduct a corporate audit on the ATH/Vodafone Fiji environmental and social management system (ESMS) and an environment and social compliance audit on past and current activities of Digitec Communications[1]. ERIAS Group Pty Ltd (ERIAS) conducted the environment and social compliance audit on behalf of ATH IV and subsequently delivered the audit report and corrective action plan (CAP) (ERIAS, 2020) in January 2020 and an ESMS framework report (Digitec, 2020) in February 2020.

Based on information provided and site visits, ADB has classified the Project in accordance with SPS as follows:

- Environment: Overall Category B, with potential environmental impacts likely to be site-specific, mostly reversible and readily managed. An Initial Environmental Examination (IEE) is required by ADB for projects classified as Category B.
- Involuntary Resettlement: Category C. There will be no involuntary land acquisition or involuntary land restriction for the land leased by Vodafone PNG for the Project. Safeguard Requirements 2: Involuntary Resettlement therefore is not triggered;

[1] Digitec Communications (Digitec) is the previous business name for Vodafone PNG.

however, a documented process will be in place to ensure that the land lease is done on a willing lessee basis.

- Indigenous Peoples: Since some of the towers will be greenfield sites located on Indigenous Peoples/ customary owned land, the project is classified as Category B for Indigenous Peoples safeguards. An Indigenous Peoples Plan (IPP) is required by ADB for projects classified as Category B.

Consequently, the CAP identified the requirement to prepare an IEE and IPP and further develop Vodafone PNG's ESMS prior to ADB's disbursement to comply with ADB SPS and national requirements. This document, prepared by ERIAS, provides the IEE and framework for the environmental and social management plan (ESMP) for the Project. The ESMP will be implemented under Vodafone PNG's ESMS.

1.2 Objectives and Scope

The IEE report has been prepared to align with ADB outline and guide notes for an IEE, described in ADB SPS 2009. The purpose of the IEE is to provide information on the nature and extent of potential environmental and social impacts arising from the rollout of Vodafone PNG's new telecommunications operation in PNG. The report describes the Project and the environmental and social setting in which it will occur. It then identifies areas of potential concern and impacts on the environment and communities and describes the management measures to be implemented to avoid and minimise these impacts. These measures are summarised and presented in a framework environmental and social management plan (ESMP) and will be incorporated into management plans and procedures within Vodafone PNG's environmental and social management system (ESMS).

Vodafone PNG will disclose Project information and consult with communities using a range of methods, including face-to-face engagement, visual presentations and other culturally and gender-appropriate means. Negotiations and agreements will be made based on the principles of free, prior and informed consent. A grievance redress mechanism has also been established within the ESMS to ensure effective resolution of concerns and grievances concerning Project implementation.

The IEE is structured as follows:

Chapter 1 – Introduction

Chapter 2 – Policy, Legal and Administrative Framework

Chapter 3 – Project Description

Chapter 4 – Description of Physical, Biological and Socio-economic Environment

Chapter 5 – Potential Impacts and Management Measures

Chapter 6 – Analysis of Alternatives

Chapter 7 – Information Disclosure, Consultation and Participation

Chapter 8 – Grievance Redress Mechanism

Chapter 9 – Environmental and Social Management Plan

Chapter 10 – Conclusion

Chapter 11 – References.

2. Policy, Legal and Administrative Framework

2.1 Applicable Legislation, Standards and Guidelines

The *Environmental Act 2000*, *Land Act 1996*, and *Telecommunications Act 1996* are the key legislation for regulation of telecommunications projects throughout Papua New Guinea, such as the ATH-Vodafone PNG Mobile Telecoms Project. These acts provide the basis for environmental and social impact assessment and management, land acquisition/access and compensation, and technical or technology requirements to be implemented. These acts are described in the sections below and information is provided on associated legislation where warranted.

2.1.1 Environment Act 2000 and the Environment (Amendment) Act 2014

The *Environment Act 2000* and the *Environment (Amendment) Act 2014* must be closely observed in all aspects of development activities and stages, in order to minimise or avoid serious negative impacts and promote sustainable development of the environment and the economic, social and physical well-being of people. This legislation, which is administered by the Conservation and Environment Protection Authority (CEPA), provides for the protection of the environment in accordance with Papua New Guinea's Fourth National Goal and Directive Principle. Under Section 42 of the Act and the *Environment (Prescribed Activities) Regulation 2002*, activities are prescribed as either Level 1, 2 or 3. This determines the level of environmental assessment and management that is required.

Vodafone PNG has consulted with CEPA on environmental permitting and provided requested information on the Project. Site visits to example telecommunications tower sites were also undertaken with the assigned CEPA officer to provide familiarisation with the Project. CEPA advised in letter dated 21 June 2020 that the Project is categorised as Level 2 (under Category 10 'Energy Production') under the *Environment (Prescribed Activities) Regulation 2002*; however, is not a prescribed activity given it has very low risk of causing environmental harm. CEPA subsequently issued an Environment Permit for the Project in September 2020 (Permit Number EP-L2 (748)) to cover construction of communication towers at all sites, valid for a period of 10 years. Project activities are required to be carried out in accordance with the terms and conditions of the permit. Relevant management measures and reporting requirements described in the permit are included in the aspect-specific management plans and reporting section in Chapter 9, and are also incorporated into Vodafone PNG's ESMS.

2.1.2 Laws Relevant to Land Acquisition and Compensation

2.1.2.1 Land Act 1996

The Land Act 1996 (and related Land (Amendment) Act 2013, and the Land (Amendment) Act 2018) relates to all aspects of land in Papua New Guinea, e.g., ownership, access, leases, improvements, reserves, special purpose activities, urban development, etc., and is administered by the PNG Department of Lands and Physical Planning. The Land Act consolidates and amends legislation relating to land that were in place under the previous colonial administration. The Land

Act covers all land in Papua New Guinea, and there are specific provisions dealing with customary land. The Land Act and other complimentary legislations governing land (both State and customary) are important for the Project in its consideration of ADB's Social Safeguard Policy on Indigenous Peoples and Involuntary Resettlement.

The majority (97%) of the land in Papua New Guinea is customarily owned, with the remaining 3% of land in private hands, held under a 99-year State lease or held by the State. The Project will use customary land in the roll out of its tower and associated infrastructure. Section 7 of the Act describes the modes of acquisition which are (a) by agreement or (b) by compulsory process. In the context of the Project, the acquisition of customary land is by negotiated agreement with landowners through a lease arrangement administered by the Department of Lands and Physical Planning. For customary land, the lease agreement requires the preparation of a Land Investigation Report (LIR) to establish land ownership.

Section 12 of the Act describes the compulsory acquisition process which is mostly used for infrastructure projects such as highways and roads. The payment of compensation is described in Part 4 of the Act. Division 4 of the Act describes the process for determination of compensation by agreement. Division 5 deals with business and residential leases, which are usually for a period of 99 years.

2.1.2.2 Incorporate Land Groups Act (Amendment) Act 2009

The *Incorporate Land Groups Act (Amendment) Act 2009* provides the mechanism that allows customary landowners to use their land in the formal economy while protecting their land interests. The main vehicle for this is a form of 'incorporation' which is a legal term for when a customary landowning group forms a body, i.e., Incorporated Landowner Group (ILG), that has legal status.

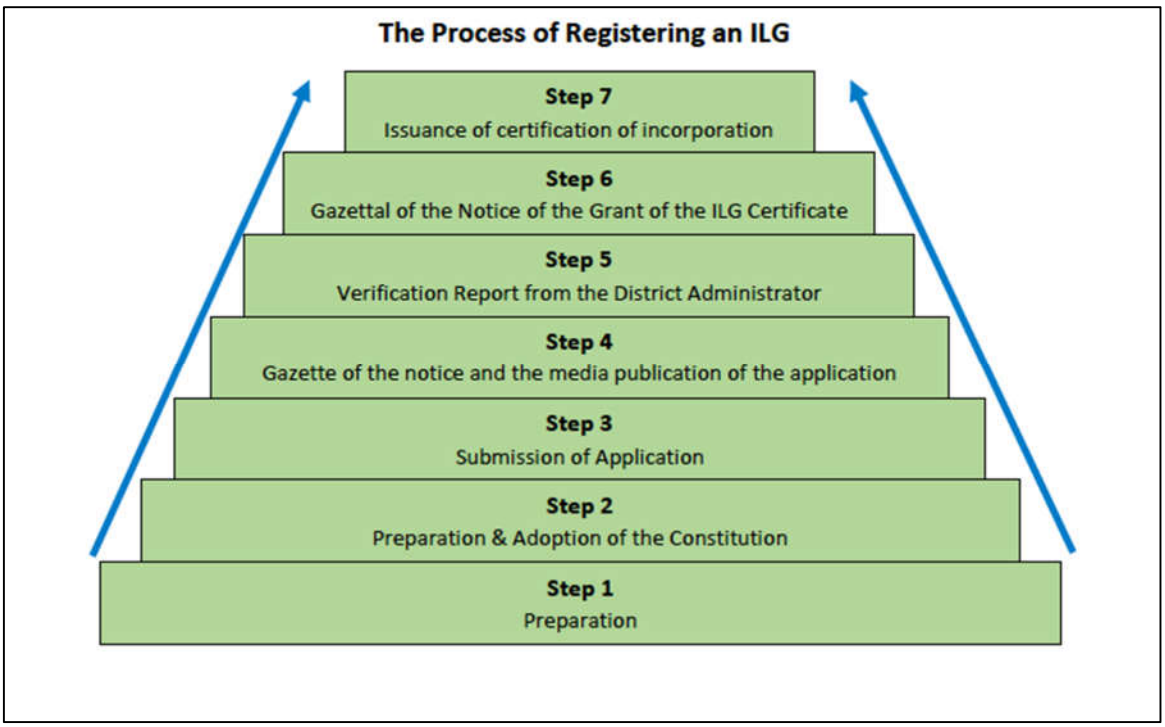
The Act gives effect to the National Goals and Directive Principles of the PNG Constitution as they relate and apply to ownership of lands held under customary tenure and dealings to those lands which are as follows:

- Allows development to take place through PNG forms of social and political organisations.
- Encouraging, facilitating and organising of the legal recognition of groups engaging in development activities.
- Ensuring integrity and viability of these associations.
- Provision of transparent and effective management.

The PNG experience of ILGs is that, when well established and managed and supported by government regulation, they can be an effective way for customary landowner groups to engage in the formal economy. They also provide a convenient mechanism for managing royalty and compensation payments for project-affected customary landowners in order to avoid conflict and disputes.

The Act identifies the specific responsibilities of the Registrar of Incorporated Land Groups, district administrators, village court officials, management committee of ILG and the Dispute Settlement Authority in the formation of a new ILG. The steps involved in the incorporation of an ILG are shown in Figure 2.1.

Figure 2.1 – Process of Registering an Incorporated Land Group



Another statute of relevance that works in parallel with the *Incorporate Land Groups Act (Amendment) Act 2009* is the *Voluntary Customary Land Registration (Amendment) Act 2009* which relates to the process for customary land registration which is outlined below.

2.1.2.3 Voluntary Customary Land Registration (Amendment) Act 2009

In 2009, the *Land Registration Act* (Chapter 191) was amended to provide for a legislative scheme where customary land can be directly registered under the *Land Act 1996*. This change came about after amendment of the *Land Groups Incorporation Act 2009.* The Act provides a system of registration of portions of customary land that the landowners, through their ILG, decide to register for economic development activity. The involvement of State agencies in this process is minimal, and the landowners are in full control of the process through their ILG. The Department of Lands and Physical Planning's role is in maintaining standards and compliance. The Director of Customary Land Registration oversees and manages the administrative process.

2.1.2.4 Valuer-General Compensation Schedule for Trees and Plants

The Office of the Valuer-General is a division of the Department of Lands and Physical Planning. Since 1985, the Valuer-General has published a compensation schedule of values for small, medium and mature economic trees and plants. This schedule was expanded in 2013 to include ceremonial grounds, grave sites and sacred sites—Valuer-General Compensation Schedule for

Trees and Plants, All Regions (August 2013). The Valuer-General's schedule relates to Part 4 of the *Land Act 1996* in which compensation is payable for any damages to trees and economic crops. The Valuer-General's schedule is used to establish compensation rates for trees and plants that are then incorporated into the compensation agreement with landowners.

For the ATH-Vodafone PNG Mobile Telecoms Project, the Valuer-General compensation schedule is to be used as a guide for payment of compensation for the value of trees, plants (including garden plants), sacred and burial sites that may be destroyed or damaged on customary land for Project site development. It is important that the process of compensation assessment is conducted in a transparent manner involving the customary landowners of the Project site and the District Land Officer (DLO) from the Department of Lands and Physical Planning from each district where sites will be developed. The role of the DLO is to witness and verify the process. The compensation assessment is then signed off by the District Administrator of the district in which the Project site(s) will be constructed.

2.1.2.5 Project Process for Site Selection and Acquisition

The planning and approvals process for the Project for selecting and acquiring locations for tower sites, that has been developed considering the abovementioned legislative requirements, policies and guidelines, is described in the 'Site Selection and Acquisition Procedure', which is provided in Appendix 1. This procedure is included within the Vodafone PNG ESMS.

2.1.3 National Information and Communications Technology Act 2009

The *National Information and Communications Technology Act 2009* regulates the information and communications technology industry in PNG and provides for the establishment of the National Information and Communications Technology Authority (NICTA). A key function of NICTA is to exercise all licensing and regulatory functions in relation to the information and communications technology (ICT) industry. Important to the Project, NICTA is responsible for overseeing the performance of ICT licensees including investigation of complaints relating to market conduct. The authority is also responsible for developing and monitoring procedures for ensuring the safety and quality of ICT services and radiocommunications.

Section 75 of the Act relates to 'Land Access Rules' for network licensees that NICTA can make to set out: (a) procedures that a network licensee must follow in exercising powers relating to sites; and /or; (b) procedures that a network licensee must follow in complying with obligations relating to owners or occupiers of sites; and/or (c) procedures that address environmental issues; and/or (d) procedures to be followed for consultation between network licensees concerning the sharing of facilities.

NICTA granted an Individual Applications Licence, Individual Network Licence and an Individual Network (Gateway Service) Licence for the Project on 19 December 2018, valid for a period of 10 years. There are no associated conditions on the licenses relating to 'Land Access Rules'.

2.1.4 Civil Aviation Act 2000 and Civil Aviation Rules

The PNG *Civil Aviation Act 2000* and subsequent Civil Aviation Rules (CASA, 2017) regulate the construction of structures that may constitute a hazard in navigable airspace in PNG and provided for the establishment of the Civil Aviation Safety Authority (CASA). Under the Civil Aviation Rules, the director of CASA must be notified of a proposal to construct a structure if the structure:

- Extends more than 60 m in height above the ground level at its site.
- Exceeds the general tree height by 18 m and is located in an area of low flying activity.

The director of CASA will then determine if the structure is deemed a hazard in navigable airspace and will notify the proponent of any conditions of the determination (e.g., the requirements for lighting or other visual aids on the structure).

2.1.5 Other Potentially Relevant PNG Legislation

Other PNG legislation that may be relevant to the Project is listed in Table 2.1.

Table 2.1 – Potentially Relevant PNG Legislation

Topic	Legislation and Regulations
Environment, social and health	• *Fauna Act 1966 and Fauna Act 2014* • *Conservation Areas Act 1978 and Conservation Areas Act 2014* • *National Cultural Property Act 1965 and Regulations 1965* • *Environment (Ozone Depleting Substances) Regulation 2007* • *Plant Disease and Control Act 1953 (Chapter 220)* • *Environment (Registration of Contaminants and Hazardous Contaminants) Regulation 2011* • *National Water Supply and Sanitation Act 2016 and the Public Health (Sewerage) Regulation 1973* • PNG Technical guideline for air discharges and noise discharges • *National Museum and Art Gallery Act 1992* • *National Cultural Property (Preservation) Act 1965* • *National Cultural Property (Preservation) Regulation 1965*
Land acquisition and compensation	• *Land Groups Incorporation Regulation 1974* • *Land (Ownership of Freeholds) Act 1976* • *Land Disputes Settlement Act 1975* • *Land Titles Commission Act 1962* • *Land Regulation 1999* • *Valuation Act 1967* (Chapter 327) and the *Valuation (Amendment) Act 2016*
Employment and industrial relations	• *Employment Act 1978* and *Employment Regulation 1980* • *Employment of Non-citizens Act 2007, Employment of Non-citizens (Amendment) Act 2007* and the *Employment of Non-Citizens Regulation 2008* • *Industrial Organizations Act 1962*, *Industrial Organizations (Amendment) Act. 2016* and the *Industrial Organizations Regulation 1963* • *Industrial Relations Act 1962* and the *Industrial Relations Regulation 1972* • *Workers' Compensation Act 1978* and the *Workers' Compensation Regulation 1983* • *Discriminatory Practices Act 1963* • *Industrial Safety, Health and Welfare Act 1961.*
Buildings, transport, planning, infrastructure, telecommunications	• *Building Act 1971*, *Building (Amendment) Act 1973* and *Building (Amendment) Act 2016* • *Roads Maintenance Act 1971* and the *Roads Maintenance Regulation 1973* • *Physical Planning Act 1989*, *Physical Planning (Amendment) Act 2016* and the *Physical Planning Regulation 1990.* • *Inflammable Liquid Act 1953* and the *Inflammable Liquid (Amendment) Act 2016.* • *Fire Service Act 1962* and the *Fire Service (Amendment) Act 2005.* • *Customs Act 1951.* • *Licensing of Heavy Vehicles Act 1977.*

2.1.6 Potentially Relevant International Conventions and Treaties

The international conventions and treaties that Papua New Guinea is signatory to, and which may be relevant to the Project, are listed in Table 2.2.

Table 2.2 – Potentially Relevant International Conventions and Treaties

Topic	Title
Conservation and Biodiversity	• International Plant Protection Convention (1952) with associated Plant Protection Agreement • Convention on Biological Diversity (1992) • Convention for the Protection of the Natural Resources and Environment of the South Pacific Region related Protocols (SPREP) (Nouméa, 1986) • Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Convention) (1971) • Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) (1979) • Convention Concerning the Protection of World Cultural Heritage and Natural Heritage (1972) • Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES) (1973)
Emissions and Climate Change	• United Nations Framework Convention on Climate Change (1992)
Pollution Prevention	• Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989) • Convention to Ban the Importation into Forum Island Countries of Hazardous Wastes and Radioactive Wastes, and to Control the Transboundary Movement and Management of Hazardous Wastes within the South Pacific Region (Waigani Convention) (1995) • Stockholm Convention on Persistent Organic Pollutants (POPs) (2001) • International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (1992)
Resource Use	• International Tropical Timber Agreement (ITTA) (Geneva, ITTA2 1994, ITTA3 2006)
Labour	• International Labour Organization conventions (1976 – 2000) • UN Convention on the Rights of the Child, Article 32.1 • UN Convention on the Protection of the Rights of all Migrant Workers and Members of their Families
Human and Civil Rights	• International Covenant on Civil and Political Rights (1966) • International Covenant on Economic, Social and Cultural Rights (1966) • Convention on the Elimination of All Forms of Discrimination Against Woman (1979) • International Convention on the Elimination of All Forms of Racial Discrimination (1965) • Convention on the Rights of Persons with Disabilities (2006)

2.1.7 Project Legal Compliance Register

An environmental and social legal compliance register has been developed for the Project that lists the potentially applicable regulations, provides an overview of requirements and identifies responsible regulatory authorities. This is provided as Appendix 2 and is included in the Vodafone PNG ESMS.

2.2 International Finance Institution Requirements

2.2.1 Asian Development Bank

Financing in the international finance institution (IFI) market for the Vodafone PNG network rollout is being sought from ADB through an equity investment. Applicable requirements of the ADB include compliance with the following polices and strategies.

2.1.1.1 Safeguard Policy Statement

The Safeguard Policy Statement (ADB, 2009) includes the three requirements described below.

Safeguard Requirement 1 – Environment

Safeguard Requirements 1 outlines the requirements that borrowers/clients are required to meet when delivering environmental safeguards for projects supported by the ADB. It discusses the objectives and scope of application and underscores the requirements for undertaking the environmental assessment process. These requirements include assessing impacts, planning and managing impact mitigations, preparing environmental assessment reports, disclosing information and undertaking consultation, establishing a grievance mechanism, and monitoring and reporting. The document also includes particular environmental safeguard requirements pertaining to biodiversity conservation and sustainable management of natural resources, pollution prevention and abatement, occupational and community health and safety, and conservation of physical cultural resources. The applicability of particular requirements is established through the environmental assessment process and compliance with the requirements is achieved through implementation of environmental management plans agreed to by ADB and the borrower/client.

Safeguard Requirement 2 – Involuntary Resettlement

Safeguard Requirements 2 outlines the requirements that borrowers/clients are required to meet in delivering involuntary resettlement safeguards to projects supported by the ADB. It discusses the objectives, scope of application, and underscores the requirements for undertaking the social impact assessment and resettlement planning process, preparing social impact assessment reports and resettlement planning documents, exploring negotiated land acquisition, disclosing information and engaging in consultations, establishing a grievance mechanism, and resettlement monitoring and reporting. However, since the sites that will be used for the Project will be leased from the landowners through negotiated agreement, Safeguard Requirement 2 is not triggered.

Safeguard Requirement 3 – Indigenous Peoples

Safeguard Requirements 3 outlines the requirements that borrowers/clients are required to meet in delivering Indigenous Peoples safeguards to projects supported by ADB. It discusses the objectives and scope of application, and underscores the requirements pertaining to (i) undertaking the social impact assessment and planning process; (ii) preparing social impact assessment reports and planning documents; (iii) disclosing information and undertaking consultation, including ascertaining consent of affected Indigenous Peoples community to selected project activities; (iv) establishing a grievance mechanism; and (v) monitoring and reporting. This set of policy requirements will safeguard Indigenous Peoples' rights to maintain, sustain, and preserve their cultural identities, practices, and habitats and to ensure that projects affecting them will take the necessary measures to protect these rights.

2.2.1.2 Social Protection Strategy

The Social Protection Strategy (ADB, 2001) describes ADB's policies and programs designed to reduce poverty and vulnerability by promoting efficient labour markets, diminishing people's exposure to risks, and enhancing their capacity to protect themselves against hazards and interruption/loss of income. Social protection consists of five major elements: (i) labour markets, (ii) social insurance, (iii) social assistance, (iv) micro and area-based schemes to protect communities and (v) child protection. Social protection, as an integral part of social development and one of the three pillars of the ADB Poverty Reduction Strategy, aims to assist individuals to break the cycle of poverty and enhance the ADB's developing member countries quality of growth by investing in human capital, increasing productivity, and reducing citizen's vulnerability to risks.

2.2.1.3 Gender and Development Policy

ADB's Policy on Gender and Development (GAD) (ADB, 1998) is the guiding framework for gender and development activities. The Policy adopts gender mainstreaming as the key strategy for promoting gender equality and women's empowerment across the full range of ADB operations—from country partnership strategies to the design and implementation of gender-inclusive projects and programs. The key elements of ADB's policy include gender sensitivity, gender analysis, gender planning, mainstreaming, and agenda setting.

2.2.1.4 Access to Information Policy

The objective of the Access to Information Policy (ADB, 2019) is to promote stakeholder trust in ADB and to increase the development impact of ADB activities. The policy reflects ADB's commitment to transparency, accountability, and participation by stakeholders in ADB-supported development activities in Asia and the Pacific. It also recognizes the right of people to seek, receive, and impart information about ADB's operations. The policy applies to documents and information that ADB produces, requires to be produced by its borrowers or clients, or are produced and provided to ADB by other parties in the course of ADB operations. The policy will be implemented in accordance with detailed arrangements approved by ADB Management and made publicly available in accordance with ADB's normal procedures.

2.2.2 International Finance Corporation

The ADB also requires that the Project complies with the following International Finance Corporation (IFC) environmental, health and safety (EHS) guidelines.

2.2.2.1 IFC EHS General Guidelines

The IFC EHS General Guidelines (IFC, 2007a) provide guidance to users on common EHS issues potentially applicable to all industry sectors, with specific examples of good international industry practice (GIIP). When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines are appropriate, in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment.

2.2.2.2 IFC EHS Guidelines for Telecommunications (IFC, 2007b)

The IFC EHS Guidelines for Telecommunications (IFC, 2007b) are technical reference documents with industry specific examples of GIIP for telecommunications projects. They provide a summary of EHS issues associated with telecommunications projects and infrastructure which occur during the construction and operational phase, along with recommendations for their management. The industry sector EHS guidelines are designed to be used together with the IFC EHS General Guidelines (IFC, 2007a).

2.3 Project Environmental Standards

This section describes the applicable standards (national and international) and guidelines comprising numeric and qualitative emission measures that may apply to all phases of the Project.

For projects requiring international finance institution finance, it is standard practice to adopt host government regulations, or those set out by the IFC, whichever is more stringent. If less stringent measures are deemed appropriate due to special circumstances associated with the Project or the local setting of the Project, a full and detailed justification for any proposed alternative is needed as part of the site-specific environmental and social assessment. If equivalent local standards do not exist, then IFC standards typically apply.

2.3.1 Noise

There are currently no known government policies or guidelines for environmental noise in Papua New Guinea with the exception of the *Building Regulation 1994*. According to s.116 of this regulation, 'the exhaust from a motor or cooling system contained in a plant room shall be suitably baffled or muffled so that the resultant sound pressure level measured at any point on the boundary of the site does not exceed 70dB'.

Noise levels relevant for the construction and operation of the Project are therefore based on the IFC EHS General Guidelines (IFC, 2007a). Noise impacts should not exceed the levels presented in Table 2.3 or result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site.

Table 2.3 – Noise Level Guidelines – IFC

Receptor	One Hour LA_{eq} (dBA)	
	Day (07.00-22.00)	Night (22.00-07.00)
Residential / Institutional / Educational	55	45
Industrial / Commercial	70	70

Source: IFC EHS General Guidelines (IFC, 2007a)

2.3.2 Air Quality

In the absence of any PNG ambient air quality standards, the Project will adopt the World Health Organization (WHO) ambient air quality guidelines, as recommended in the IFC EHS General Guidelines (IFC, 2007a). Emissions for the Project should not result in pollutant concentrations that reach or exceed the criteria shown in Table 2.4.

Table 2.4 – Air Quality Guidelines – IFC

Parameter	Averaging Period	Guideline Value in µg/m^3
Sulfur Dioxide (SO_2)	24-hour 10-minute	125 (Interim target 1) 50 (Interim target 2) 20 (guideline) 500 (guideline)
Nitrogen Dioxide (NO_2)	1-year 1-hour	40 (guideline) 200 (guideline)
Particulate Matter PM_{10}	1-year 24-hour	70 (Interim target 1) 50 (Interim target 2) 30 (Interim target 3) 20 (guideline) 150 (Interim target 1) 100 (Interim target 2) 75 (Interim target 3) 50 (guideline)
Particulate Matter $PM_{2.5}$	1-year 24-hour	35 (Interim target 1) 25 (Interim target 2) 15 (Interim target 3) 10 (guideline) 75 (Interim target 1) 50 (Interim target 2) 37.5 (Interim target (3) (25 (guideline)
Ozone	8-hour daily maximum	160 (Interim target 1) 100 (guideline)

Source: IFC EHS General Guidelines (IFC, 2007a)

2.3.3 Water Quality

2.3.3.1 PNG Water Quality Criteria for Aquatic Life Protection

Water resource management and the management of potential water contaminants for the Project are regulated by the *Environment Act*. According to the *Act*, 'unless otherwise permitted, a person shall not discharge into, or use, water where any such discharge, or use, shall cause a lowering of water quality below the prescribed water quality criteria'. Schedule 1 of the *Environment (Water Quality Criteria) Regulation 2002* includes the water quality criteria relevant to the Project and are presented in Table 2.5.

Table 2.5 – PNG Water Quality Criteria for Aquatic Life Protection

Parameters	Freshwater*	Seawater*
Ammonia –nitrogen	Dependent on pH and temperature	
Arsenic	0.05	0.05
Barium	1.0	1.0
Boron	1.0	2.0
Cadmium	0.01	0.001
Chlorine (total residual)	0.005 at pH 6	0.005
Chromium (as hexavalent form)	0.05	0.01
Colour	No alteration to natural colouration (for both fresh and seawater)	
Cobalt	Limit of delectability (for both fresh and seawater)	
Copper	1.0	0.03
Cyanide (as HCN)	0.005	0.01
Faecal Coliform Bacteria	≤200 per 100 ml**	
Fats	None	None
Fluoride	1.5	1.5
Grease	None	None
Insoluble residues	No insoluble residues or sludge formation to occur (both fresh and seawater)	
Iron (in solution)	1.0	1.0
Lead	0.005	0.004
Manganese (in solution)	0.5	2.0
Mercury	0.0002	0.0002
Nickel	1.0	1.0
Nitrate (as No3-+NO2-)	45.0	45.0
Odour	No alteration to natural odour (for both fresh and seawater)	
Oil	None	None
Oxygen	Not less than 6.0	Not less than 5.0
Pesticides	None	None
Phenols	0.002	0.002
Potassium	5.0	450.0
Radioactivity	None	None
Selenium	0.01	0.01
pH	No alteration to natural pH (for both fresh and seawater)	
Silver	0.05	0.05
Sulfate (as SO4)	400.0	-
Sulfide (HS)	0.002	0.002
Tars	None	None
Taste	No alteration to natural taste (for both fresh and seawater)	
Temperature	No alteration greater than 2 degrees Celsius (for both fresh and seawater)	
Tin	0.5	0.5
Toxicants (miscellaneous)	None	None
Turbidity	No alteration greater than 25 NTU (for both fresh and seawater)	
Zinc	5.0	5.0

* All values are in mg/L unless otherwise specified
** Criteria for faecal coliform bacteria is based on not fewer than five samples taken over not more than a 30 day period, in which the median value of the faecal coliform bacteria content of the water shall not exceed 200 per 100 ml.

2.3.3.2 PNG Public Health (Drinking Water) Regulation 1984 and WHO Guidelines for Drinking Water Quality

Project discharges may affect community potable water supplies. The Papua New Guinea *Public Health (Drinking Water) Regulation 1984* sets criteria for potable drinking water. The Project will be required to comply with the criteria where discharges may affect community drinking water supplies. The IFC also recommends the implementation of World Health Organization's guidelines for drinking water quality (WHO, 2017). Table 2.6 presents the criteria; where specific criteria differ, the more stringent is presented.

Table 2.6 – Drinking Water Quality Standards (PNG and WHO)

Parameter	Guideline (Max. allowable, in mg/L) in Drinking Water
Arsenic	0.01**
Barium	1.3**
Benzene	0.01**
Boron	2.4**
Cadmium	0.003**
Calcium (as Ca)	200*
Chloride	1000*
Chlorite	0.7**
Chromium	0.05**
Copper	2**
Cyanide	0.05*
Fluoride	1.5**
Iron	0*
Lead	0.01**
Manganese	0.5*
Magnesium	150*
Mercury	0.006*
Selenium	0.01*
Nitrate	0*
Nickel	0.07**
Sulphate	400*
Silver	0.05*
Toluene	0.7**
Uranium	0.03**
Xylenes	0.5**
Zinc	15*
Aesthetic quality standards: Colour Odour Taste Suspended material (turbidity) Total solids pH range Mineral oil Total hardness ($CaCO^3$)	 50 units* Unobjectionable* Unobjectionable* 25 units* 1,500* 5 to 9.2* 0.30* 600*

Table 2.6 – Drinking Water Quality Standards (PNG and WHO) (cont'd)

Parameter	Guideline (Max. allowable, in mg/L) in Drinking Water
Biological standards:	
Total coliforms	0/100ml*
Faecal coliforms	0/100ml*

* Schedule 1 and 2 of PNG *Public Health (Drinking Water) Regulation 1984.*
** Guidelines for Drinking-Water Quality, (WHO, 2017).
Most stringent guidelines are shown.

2.3.4 Electromagnetic Fields

Radio waves and microwaves emitted by transmitting antennae on telecommunications towers are a form of electromagnetic field (EMF) at the lower end of the non-ionising radiation spectrum. Reference levels for safe exposure to EMF have been developed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). The ICNIRP has exposure levels for the general public, and for occupational exposure. These are detailed in Table 2.7.

Table 2.7 – ICNIRP Reference Levels for Electromagnetic Fields

Frequency	Electric Field Strength (Vm^{-1})	Magnetic Field (Am^{-1})	Incident Plane Wave Power Density (Wm^{-2})
General Public Exposure			
0.1 – 20 MHz	560/f	2.2/f	N/A
>20 – 30 MHz	28	2.2/f	N/A
>30 – 400 MHz	28	0.073	2
>400 – 2000 MHz	$1.375f^{0.5}$	$0.0037^{f0.5}$	f/200
>2 – 300 GHz	N/A	N/A	10
Occupational Exposure			
0.1 – 20 MHz	1220/f	4.9/f	N/A
>20 – 30 MHz	61	4.9/f	N/A
>30 – 400 MHz	61	0.16	10
>400 – 2000 MHz	$3f^{0.5}$	$0.008f^{0.5}$	f/40
>2 – 300 GHz	N/A	N/A	50

Source: ICNIRP (2018) – ICNIRP Reference Levels for Whole Body Exposure to Time-varying Far-field Electric, Magnetic and Electromagnetic Fields.
1. f is frequency in MHz.
2. For frequencies up to 2 GHz, compliance is demonstrated if either the electric or magnetic fields or incident plane wave power density value is within the reference levels; only one is required.
3. For frequencies up to 400 MHz: For reactive and radiative near-field exposure conditions, exposure is compliant with the reference levels if both electric and magnetic field levels are within the relevant far-field reference levels.
4. For frequencies above 400 MHz: Far-field reference levels are also applicable to radiative near-field exposure conditions; no reference level is provided for reactive near-field exposure conditions.

3. Project Description

3.1 Project Components

The Project will comprise the development and operation of a telecommunications network consisting of a variety of telecom facilities in Port Moresby and in provinces across the country including several of the islands.

The Project main components include the company headquarters, support facilities and the network of transmission towers.

3.1.1 Headquarters and Support Facilities

Corporate Headquarters are located at Port Moresby, National Capital District. The company leases the ground and first floors of the building. Building owners consent, National Capital District Commission (NCDC) building permit, and PNG National Airport Corporation (NAC) approvals have all been obtained to support tower construction. Other facilities leased in Port Moresby include a storage warehouse/centre, located at Napanapa Road, Motukea Island, and retail shops. Regional warehouses and offices will also be located in Lae, Morobe Province.

3.1.2 Telecommunications Network

3.1.2.1 Network Equipment

A mobile telecommunications network consists of a series of base transceiver stations (BTS) that are linked via microwave transmission links to send and receive communications. Each BTS serves a geographical area within the network, sending and receiving radio frequency (RF) energy signals to and from customers. A single 3G BTS may service a 5 to 10 km radius depending upon topography. Telecom equipment installed in the BTS relays the call to switches located in the network, rerouting the call to the recipient. A BTS facility typically consists of a small parcel of leased land (around 400 m^2), a tower or mast, a microwave antenna and RF antenna mounted on the tower, switch gear at the base of the tower, a diesel generator and fuel tank, security fencing and an earth access road leading to the site.

Telecommunications antennas, consisting of microwave link transmission dishes (usually two to provide a network link between several nearby BTSs) and radio frequency communications transceiver panel antennas are installed on the transmission tower. Telecom and related gear at the base of the tower consists of the BTS connected to the antennas by cables and a battery cabinet. Towers in areas potentially hazardous to aviation have a night-time light on the crest of the tower.

The most common telecommunications sites in urban areas are rooftop sites. A typical rooftop site is located on the roof of a building with the antennae mounted on short poles or tripods on top of the roof. The equipment room is normally located inside the building, and power supply is generally provided though the building landlord. In rural areas, greenfield sites are the most common type with antennae mounted on top of masts or towers. The typical greenfield structure, in terms of masts and towers, consists of monopole towers, guyed steel masts or multi-legged galvanized steel lattice towers.

3.1.2.2 Transmission Towers

The network of transmission towers to be installed throughout PNG will include rapid deployment structure (RDS), grillage/lattice, monopole, hardwood pole, camouflage and rooftop tower designs. The rooftop sites will be located in urban locations, with many locations having existing mobile antennae. The majority of these sites will be on office buildings, malls and apartments complexes. Monopole masts, commonly to a height of 25 to 30 m, are also preferably installed in urban areas to minimise visual impact, being less obvious and less intrusive than a lattice tower.

Towers will conform to Australian Standard/New Zealand design standard AS/NZS 1170-2202; AS 3995-1994 or equivalent, and earthquake standard NZS 4203:1992. The majority of towers will be RDS towers, which have a base system that provides self-standing, self-supporting, rapid-deployable features and eliminates the need for a permanent foundation for the tower. All equipment is installed directly on the steel base with no need for trenching or concrete slabs. Topsoil to a depth of 0.5 to 1 m is removed prior to installing the base and is reused to backfill the base.

Security fencing consists of either mesh steel panels bolted to the RDS base or a chain wire fence around self-supporting towers and monopole masts, with triple razor wire on top. Safety signs are placed on the fence prohibiting entry and warning of the safety hazard of doing so.

3.1.2.3 Site Access

The number of sites that have existing access roads or will be accessed by helicopter or boat during this period is therefore not known at this stage. Where there is an existing track to a tower site, this may require upgrading to improve access for delivery of construction materials and subsequent fuel deliveries. It is expected that new roads, which will be unsealed, will typically be of 500 m length but possibly ranging from 50 m to 2,500 m. Disturbance from earth road construction (vegetation clearance, movement of soil using excavators and bulldozers, and surface grading) is minimised by generally limiting the road surface width to 4 m and cut and fill batters to the minimum area required.

3.1.2.4 Power Requirements

Transmission towers will be powered by the main electricity grid where available, i.e., rooftop and urban sites, or by lithium batteries and diesel generators (gensets) at off grid sites. Diesel will be stored on site, preferably providing secondary containment and overfill prevention, and secured in lockable cages within the perimeter tower perimeter fence.

3.1.2.5 Materials Supply

All communications equipment, gensets, solar panels and materials for tower construction will be sourced from China, except pine monopoles that will be sourced from Australia. All equipment and materials are shipped by sea to warehouses located in Port Moresby and Lae. Where road access to tower sites is available, materials are trucked to site by logistics companies. Otherwise, helicopter lifts are used to transport materials to site.

Opportunities for local communities to provide supply of construction materials (such as quarries for sand and gravel), or other supplies, will be sought and pursued on a case-by-case basis and on a priority basis for individual sites by construction contractors.

3.1.2.6 Land Disturbance

Tower sites will utilise between 25 to 900 m^2 of land for the tower yard, depending on the tower height (see Table 3.1). The land area needed for a helipad, where required, is approximately 100 m^2. Land use change also occurs where a new access road is installed. As described in Section 3.1.2.3, this typically will involve an area of 2,000 m^2, based upon a 500-m-long access track of 4 m width.

During construction only, additional land may be temporarily required at each site to provide sufficient space to store tower beams and other components, and to establish a small workforce camp in rural areas. All additional land needed for temporary use will be secured based on consultation with, and agreement by, the landowner. Less than 1,000 m^2 of ground is temporarily required for this purpose.

3.3 Project Activities

3.3.1 Site Selection and Acquisition

The optimum location for towers is determined based on modelling of expected coverage considering local topography. Site selection criteria includes a preference for higher terrain to provide improved reception from a lack of line-of-site obstacles, good road access (or ease of road construction) for construction and maintenance and adequate setback from facilities that may cause interference.

Following selection of candidate sites for tower installation, site visits are undertaken to assess suitability considering environmental and social factors and to consult with landowner/s. In addition to tower sites, lease arrangements are also made for areas of land required for site access, i.e., any new access roads or helipads. Preliminary discussions occur with the landowner/s to determine their willingness to lease the land, while consultation also occurs with local authorities in relation to site acquisition and permitting. Where the preferred site is not feasible, or when the landowners refuse to lease the land or when lease agreements cannot be concluded, then an alternative site is selected. Geotechnical site investigations are also conducted to assess the suitability of foundation conditions or, for rooftop sites, a structural assessment of the building is undertaken. If the site meets the screening criteria, leasing negotiations are undertaken to reach in-principle agreement. Final local authority approvals are obtained, including Building Board and Civil Aviation Safety Authority (CASA) approval and a site acquisition report is completed. The lease agreement is then finalised by Vodafone PNG's legal department and entered into with the landowner/s.

This process of site selection and acquisition for the installation of towers is described further in the 'Site Selection and Acquisition Procedure', which is provided in Appendix 1 and included under Vodafone PNG's ESMS. In particular, this document guides selection and acquisition of greenfield sites on customary land, including consultations required with Indigenous Peoples and

requirements for site lease agreements, and site selection criteria to assess location suitability based on environmental and social considerations.

3.3.2 Construction Phase

3.3.2.1 Activities

Tower site construction for greenfield sites will typically involve the following activities:

- Clearing land of vegetation and soil for roads or helipads for access, where no existing access roads are present.
- Clearing land and soil excavation for tower foundations.
- Transport of tower and associated materials to site laydown area (see Section 3.1.2.6).
- Erection of towers, including reinstatement and compaction of excavated soil at tower foundation.
- Installation of communications equipment.
- Installation of power, diesel gensets and/or solar panels and earthing systems.
- Erection of security fences.

The typical duration of tower construction including ground foundation and civil works takes from four to six weeks for small to medium-size towers (up to 45 m high) in urban and rural areas. For larger towers over 60 m high in remote areas where new access roads or helipads are required, the construction period can be up to four to five months. Vegetation clearing and ground works will be undertaken with hand tools and bulldozer. No cranes or heavy machinery will be used. The typical period required to install a rooftop site is three to four weeks.

Heavy (e.g., 30 tonne) trucks will be used to transport tower equipment to site over several days and only during daylight hours. In remote areas with no land access, helicopters will be used to transport equipment (usually via 500 kg lifts) and fuel required for generators.

Specialist contractor companies undertake the tower construction. The construction crew typically comprises up to 10 skilled workers (site engineer/supervisor and riggers) and a further 10 to 20 unskilled workers recruited from local communities to assist with ground clearing, security and other general labour. The contractor workers will be accommodated either in self-contained temporary fly camps or, if agreeable by affected local Indigenous communities, in existing accommodation hired from local communities where available.

Temporary barricading is erected to keep the community out of the site for security and safety reasons. Local landowners are hired as security during construction. Fresh water for cooking/ablutions is either obtained by pumping from local water sources or transported in drums to site. The contractor is responsible for removing all waste materials from the site for disposal and/or recycling as appropriate.

3.3.2.2. Contractor Responsibilities

Contractors will comply with and implement the environmental and social management and mitigation requirements defined in the Vodafone PNG ESMS and its appendices and attachments, as applicable to each contract scope of work. The Vodafone Code of Ethical Purchasing also sets out contractor obligations in relation to social, environmental and ethical compliance; and the Vodafone Health, Safety and Wellbeing Policy sets out contractor obligations in relation to occupational health and safety to be contained in all procurement agreements with suppliers.

A close-out report is to be provided by contractors for each tower site following completion of construction, describing compliance with ESMS and associated management plans and procedures and regulatory requirements, and identifying any complaints received from local communities and actions to resolve. Vodafone PNG shall review site closeout reports and reporting of engagement with local communities, identifying any lessons learned and corrective actions to be implemented.

3.3.3 Operations Phase

3.3.3.1 Tower Servicing

The mobile communications equipment will be powered by the main electricity grid, where available, and elsewhere with sealed lead acid and lithium batteries with diesel generators (gensets), and/or solar panels where appropriate. The fuel tanks will be refilled every two to three months in remote locations and more frequently in urban/peri-urban areas. Refuelling is usually outsourced to contractors with fuel normally transported in 200 L drums. Fuel trucks will be used to transport the fuel to sites in urban/peri-urban areas and in rural areas where access is available. Remote sites without access roads will be refuelled by helicopter.

Besides refuelling, the sites require minimal activity during operations, and are remotely operated and monitored. The sites are checked routinely to maintain their condition and communications equipment is usually replaced around every five years.

Local community representatives are provided with basic training in maintaining the site (cutting grass) and in monitoring security of the site (reporting alarms).

Yearly, or more regular as required, maintenance works are conducted on access roads (e.g., filling of potholes) and helipads (e.g., cutting of vegetation) to maintain safe access, with local villagers engaged for this activity. Should there be significant damage to an access road, then contractors are engaged to repair/regrade the road. Maintenance activities are conducted either on a need basis as per request/report from field engineers or captured under the yearly routine maintenance program.

3.3.4 Decommissioning

Towers have a life of between 20 and 25 years at which point the tower is replaced. The refresh program also involves turnover of communications equipment approximately every ten years.

Site closure is a business decision based on coverage pattern changes or inefficient performance of a site covering an area for which an alternative site location needs to be considered.

Consultation with relevant local Indigenous Peoples or customary landowners will be conducted prior to the closure of the relevant sites. If the site is to be closed, decommissioning activities include:

- Disassembling the tower and associated power, fencing material and removal from site.
- Removing fuel drums/container, and associated bunding, and solar panels (as appropriate) from site.
- Excavation and removal of any foundation materials and removal from site.
- Checking soil for any hydrocarbon contamination in vicinity of tank, and removal/treatment as appropriate.
- Tidying-up of site and rehabilitating as appropriate.

Some materials from the site may be of use to local communities (e.g., solar panels, fencing) and will be donated to communities upon request only and if considered to represent low safety risk. Access roads may also be of use to communities and on-going use and maintenance shall be formally negotiated with local communities as part of decommissioning and closure activities. These agreements with local communities will be facilitated through the Vodafone PNG Corporate Social Responsibility (CSR) program.

Contractors undertake site decommissioning. Vodafone PNG requires closeout reporting by the contractor that includes sign-off by project-affected communities to confirm closure works have been undertaken to community satisfaction.

3.4 Project Workforce

As described in Section 3.3.2, specialist contractors will undertake tower construction with the crew at each site comprising up to 10 to 15 skilled workers (riggers, technicians and engineers) at rural sites, supported by two to three Vodafone PNG personnel for supervision and commissioning. A further 10 to 20 unskilled workers are recruited from local communities at each tower site, in particular the owners of affected customary land. Contractor personnel required for rooftop and urban tower sites is typically 6 to 10 riggers and technicians, supported by two to three Vodafone PNG personnel for supervision and commissioning.

Vodafone PNG will employ staff in various business sections as follows: marketing, customer care, technical network operations, business finance and administration. Vodafone PNG will ensure equal opportunity employment and implement gender affirmative initiatives including measurable targets for employment of women workers. Vodafone PNG is also committed to providing women's development and leadership programs for women at all levels within the workforce.

Roles and responsibilities for planning and implementation of the suite of environmental and social management measures described in this document are detailed in Chapter 9.

4. Description of Physical, Biological and Socio-economic Environment

4.1 Approach to Describing Existing Conditions

As described in Section 3, the Project is a national project involving rollout of a new mobile telecommunications across PNG. Description of existing environmental and socio-economic conditions in which the Project will be developed has therefore been undertaken at a country level based on desktop literature review, rather than by undertaking site-specific field investigations and descriptions of individual site. Conditions at individual sites will be assessed using procedures and checklists provided in the 'Site Selection and Acquisition Procedure' (Appendix 1). These procedures and checklists outline specific criteria for assessing environmental and social suitability during site selection, e.g., exclusion from environmentally sensitive areas, critical habitats or sites that may trigger Category A project categorisation under ADB Safeguard Requirements.

4.2 Physical Environment

4.2.1 Regional Location

Papua New Guinea is the largest country in the Pacific Islands region, having a total land area of 452,860 km^2 (Figure 4.1). The Pacific Islands region is divided into three geographical groups: Micronesia in the north, Polynesia in the east, and Melanesia in the west. Besides PNG, Melanesia includes Fiji, Vanuatu, New Caledonia and the Solomon Islands.

Papua New Guinea is made up of the eastern half of the island of New Guinea (about 85% of the country), with the large islands of New Britain, New Ireland, Bougainville and Manus, plus around 600 smaller islands making up the remaining 15%.

4.2.2 Landform and Geology

Situated at the collision line of the Australian and Pacific tectonic plates, Papua New Guinea has a diverse range of landforms. Uplift and faulting that began during the late Oligocene to early Miocene period has resulted in spectacularly jagged mountain ranges (Bleeker, 1983). Seismic and volcanic activity has caused large areas to be covered in volcanic deposits, while weathering and denudation of the steep mountains has resulted in extensive alluvial floodplains. The islands are widely spread and range from small coral atolls to larger, mountainous and volcanic islands.

The mainland is dominated by the Owen Stanley Range, a continuation of the complex chain of mountains that runs through the centre of New Guinea with many peaks over 4,000 m (Figure 4.2). The broad valleys of the Sepik, Ramu and Markham rivers which flow to the Bismarck Sea dominate the landform to the north of the range. The valleys of the Fly, Strickland, Kikori, and Purari rivers, which flow into the Gulf of Papua, dominate to the south of the range.

Figure 4.1 – Regional Location

Figure 4.2 – Topography of Papua New Guinea

The geological history of Papua New Guinea is complex, resulting in many distinct landform types (Figure 4.3). The mountain ranges are generally metamorphic and igneous intrusions from the Miocene age. The Central Ranges contains the largest area of karst in PNG, covering approximately 15,000 km^2 (Bleeker, 1983). Karsts form from the dissolution of soluble rocks (such as limestone), giving way to striking landscapes often characterised by complex underground drainage networks composed of sinkholes and doline depressions. Karst features are also found in the central parts of the islands of New Britain and New Ireland. In the West Papuan Shelf in the south west of PNG, Mesozoic and Tertiary period rocks are overlain by Quaternary period deposits derived from the mountain ranges (Bleeker, 1983). Southeast PNG is perhaps the most geologically complex, containing metamorphosed sedimentary rocks from the Cretaceous and Jurassic periods, as well as basic igneous Tertiary rocks. North of the Owen-Stanley Ranges is largely covered by volcanic Quaternary deposits. By contrast, the islands of PNG are primarily composed of Tertiary rocks, except for Bougainville and the north coast of New Britain, which have extensive Quaternary deposits.

Most areas in Papua New Guinea contain a mosaic of soil types, however some are generally more represented than others. The most common soil type in PNG are entisols, which are very young soils, typically with little soil profile except for a thin humic horizon (Bleeker, 1983; Bleeker, 1988). These soils mostly occur on recent alluvium and steep slopes where erosion takes place. In the basins surrounding the highlands, entisols occur on alluvial fans, sand sheets and alpine gravels. Inceptisols (characterised by deep organic rich horizons overlaying clayey subsoils) are most common in more stable settings, such as montane areas (Bleeker, 1983; Bleeker, 1988). The limestone terrains in the Central Ranges give way to mollisols, which are deeper soils with higher levels of biological activity (from worms, ants, termites, etc.). Soil water balance (precipitation over evapotranspiration) in Papua New Guinea is positive, which means that plant growth is rarely limited by soil moisture. Soils at higher altitudes are saturated for most of the year. This causes reduced decomposition and increased risk of landslides, tunnelling and piping, particularly on steep slopes or erodible locations (Bleeker, 1983; Bleeker, 1988).

4.2.3 Climate

Papua New Guinea has a moderate tropical climate and is generally hot and humid throughout the year. It is one of the wettest regions on earth, with mean annual rainfall typically between 2,000 and 4,000 mm (McAlpine et al., 1983), but can be as high as 8,000 mm in parts of the central ranges and 7,000 mm in the Islands region (Shearman et al., 2008).

Two pressure systems influence overall climate processes in PNG; the southeast trade winds (May to October) and the northwest monsoon (December to March) (Australian Bureau of Meteorology and CSIRO, 2011). During the southeast trade wind season, the south and southeast facing ranges experience high rainfall compared to protected slopes. The northwest monsoon develops from December to March, bringing with it winds from the northwest and heavy rains for the mountain regions (McAlpine et al., 1983). In coastal regions, rainfall is typically lower and more evenly spread throughout the year.

Mean wind speeds in PNG are generally less than 20 km/h; however, maximum mean wind speeds can reach over 50 km/hr (McAlpine et al., 1983). Localised squalls known as ‘Gubas’ occur in the Papuan Gulf area, usually during the northwest monsoon season. Wind speeds

Figure 4.3 – Landform Map of Papua New Guinea

sometimes reach between 90 to 130 km/h, lasting for about 30 minutes. Gubas occur about five times a year at Port Moresby. There are only slight seasonal temperature variations with monthly variation generally between 1 to 2.5°C; however, temperatures vary significantly according to altitude. The lowlands and coastal plains are typically warmer than the higher altitude highlands. In the lowlands, temperatures range from 28 to 32°C during the day and decrease to between 20 to 24°C at night.

Average maximum temperatures decrease with increasing altitude, at approximately 6.7°C per 1,000 m (McAlpine et al., 1983). Papua New Guinea's climate varies year to year due to the El Niño-Southern Oscillation. The El Niño-Southern Oscillation has two distinct phases, El Niño and La Niña. Generally, El Niño years have less rainfall compared to La Niña and can result in droughts. La Niña years typically have high rainfall, which can result in increased flooding and landslides (Australian Bureau of Meteorology and CSIRO, 2011). Climate change projections indicate that the annual average air temperature and sea surface temperature will increase in the future in PNG (Australian Bureau of Meteorology and CSIRO, 2011). Model projections show extreme rainfall days are likely to occur more often and average annual and seasonal rainfall is projected to increase over the course of the 21st century. Projections in the PNG region tend to show a decrease in the frequency of tropical cyclones by the late 21st century and an increase in the proportion of the more intense storms. Sea level is expected to continue to rise in PNG, with an increase in the range of 4 to 15 cm by 2030 under a high emissions scenario. The sea-level rise combined with natural year-to-year changes is expected to increase the impact of storm surges and coastal flooding (Australian Bureau of Meteorology and CSIRO, 2011).

4.2.4 Surface Waters

The heavy rainfall regimes in PNG are reflected in the dense network of over 5,000 river systems, lakes and wetlands (DEC, 2010). There are six major river systems in PNG. The Fly, Purari and Kikori rivers flow southward to the Gulf of Papua, and the Sepik, Markham and Fly rivers flow northward, terminating in the Bismarck Sea (see Figure 3.1). Rivers in PNG are typically fast flowing with very high discharges, due to high rainfall and steep topography. Consequently, most rivers have poorly developed flora and fauna (DEC, 2010). Major rivers and their tributaries typically develop into meandering floodplains (Plate 4.1) towards the coast. The meander floodplains are typically characterised by a meandering channel, oxbow, back swamps and lakes (Bryan and Shearman, 2008). Seasonally inundated floodplains and swamps are often present in the lower reaches of rivers.

There are over 5,000 freshwater lakes in PNG, with most lakes covering an area of less than 0.1 km^2 (Chambers, 1987). The largest lake is Lake Murray which covers an area over 647 km^2 and connects with the Strickland River in western PNG. Lake Kutubu (Southern Highlands Province) is the second largest lake in PNG and contains the highest number of endemic species of any lake in the entire New Guinea-Australia region (Chambers, 1987; Ramsar, 2020). Due to its high biodiversity value, Lake Kutubu is a designated 'Wetland of International Significance' under the Ramsar convention (Ramsar, 2020). Lakes in PNG are generally fluvial in origin, although many have also formed from tectonic basins (uplift), volcanic activity (e.g., craters or maars), glacial activity or sinkholes (from solution of limestone). Most lakes are located in the floodplains of major rivers approximately 40 m above sea level but can occur at elevations up to 4,000 m (Chambers, 1987).

Plate 4.1 – Meander Floodplain in the Gulf Province

Most water quality data for PNG comes from studies undertaken by resource development projects as part of their environmental baseline studies and monitoring programs (Nicolls, 2004). The water quality of watercourses in PNG is variable depending on the stream types. The large rivers are highly turbid and carry large loads of sediment particularly after rain events. Smaller streams in mountainous areas generally have clear water although turbidity does increase during periods of high flows after rain events. Many streams are alkaline reflecting the widespread occurrence of limestone geology throughout PNG. The water quality of streams and lakes is generally good with regard to anthropogenic contamination by metals and hydrocarbons, the exception being some locations downstream of mining activities. Microbial quality of water is often poor; however, with elevated levels of coliforms occurring, particularly in areas of human settlement. A significant portion of morbidity and mortality is attributed to water-borne diseases in PNG (Horak et al., 2010).

4.2.5 Air and Noise

Air pollution in PNG is mainly restricted to urban areas and is caused by vehicle emissions, smoke from grass and refuse burning, a few industrial emissions, and dust and other aerial particulate matter from construction works and landfill disposal sites. Although there is a lack of data, the concentrations are believed to be low and generally well below World Health Organization standards and other assessment criteria. In the absence of data or substantive complaints, the issue of air pollution in PNG is considered to be relatively insignificant (Nicolls, 2004).

Noise pollution is mostly limited to very localised incidents in urban areas and is also not regarded as a significant environmental issue in PNG (Nicolls, 2004).

4.2.6 Seismicity

Papua New Guinea is situated at the edge of the Pacific ‘ring of fire’ on the point of collision of several geologically active tectonic plates. As a result, the country experiences frequent earthquakes and volcanic eruptions. Large earthquakes are relatively common, with two

magnitude 7 and above earthquakes occurring each year since 1900 (Anton, 2015). Seismic activity is greatest in the northern Solomon Sea, western Bougainville, southern New Ireland and Eastern New Britain. Conversely, the south and southwest of PNG contain the lowest levels of seismic activity (Ripper and Letz, 1993). Earthquakes are sometimes accompanied by tsunamis when they occur offshore, with the highest risk zones being the northern coast of mainland PNG and island provinces (Anton, 2015).

Papua New Guinea is divided into Seismic Hazard Zones for construction safety by the PNG building standards (PNGNSC, 1982). These zones, as well as epicentres of historical seismic activity, are shown in Figure 4.4.

4.2.7 Natural Hazards

The steep and erodible terrain, high rainfall and seismic activity of Papua New Guinea results in a high frequency of natural disasters in PNG. Natural disasters can threaten the safety of citizens, but also their livelihoods of farming, fishing and small-scale cash crops. Subsistence agriculture is the livelihood for approximately 85% of the population (CFE-DM, 2019). It is estimated that natural disasters incur financial costs of up to US$85 million annually (UNDRR, 2019).

4.2.7.1 Volcanoes

The distribution of active, dormant and extinct volcanos is shown in Figure 4.5. Papua New Guinea contains approximately 63 volcanoes, including 14 that are considered active (UNDRR, 2019). High rates of volcanism in PNG have contributed to very fertile soils and consequent diverse vegetation (Bleeker, 1983); however, volcanic eruptions are more commonly associated with humanitarian disasters. For example, eruptions in New Britain in 1994 caused displacement of over 45,000 individuals (OCHA, 2007). Manam volcano off the coast of Madang erupted in 2005 causing displacement of over 12,000 people to the mainland (OCHA, 2007).

4.2.7.2 Landslides

Landslides pose a significant threat to health and safety and infrastructure in PNG, with multiple occurrences each year. Geomorphological factors (e.g., slope gradient and soil properties) are the main influencers in determining locations of landslide events. These factors in combination with a trigger event (e.g., earthquake or heavy rainfall) typically result in a landslide occurrence (Robbins, 2016). Landslides occur most often during the wet season and during La Niña years. They are a common occurrence in the highlands and other mountainous regions where steep topography and high rainfall are conducive to high landslide risk (UNDRR, 2019; Robbins, 2016).

A recent magnitude 7.5 earthquake on 26 February 2018 in Hela and Southern Highlands provinces resulted in large landslides around the epicentre of the quake (Plate 4.2). This caused the downing of power poles and telecommunications transmission towers affecting power and communications networks, with 60 Digitel towers destroyed. A report by the World Food Program for the United Nations, compiled two days after the earthquake, estimated 465,000 people were exposed to the disaster, of which 143,000 needed urgent humanitarian assistance and 64,000 were suffering from extreme food insecurity (Business Advantage, 2018).

Figure 4.4 – Seismic Zones and Historical Seismic Activity in Papua New Guinea

Figure 4.5 – Volcanoes of Papua New Guinea

Plate 4.2 – Landslip near Earthquake Epicentre in Southern Highlands

Source: Oil Search

4.2.7.3 Flooding

Heavy rainfall coupled with steep mountains and extensive floodplains in PNG results in widespread flooding events. This can lead to displacement of populations and widespread food shortages from inundation of crops and severing of transport routes (UNDRR, 2019). Much of PNG's land area is classified as high risk for coastal and riverine flooding, with flooding estimated to have affected over half a million people across the country between 1990 and 2015 (UNDRR, 2019).

4.2.7.4 Cyclones

Tropical cyclones are infrequent in the low latitudes of western Melanesia. While cyclones frequently occur around the Solomon Islands, their occurrence in low latitudes decreases westwards towards the New Guinea mainland (McAlpine et al., 1983). The region around the southeast tip of PNG, including Milne Bay and surrounding islands, is the most susceptible area.

4.2.8 Biological Environment

4.2.8.1 Forests

Papua New Guinea's tropical climate supports the growth of dense forests throughout the country. These forest ecosystems form one of the largest and most diverse areas of tropical forest in the world (Shearman et al., 2008). The forests of the island of New Guinea constitute the third largest expanse of tropical rainforest on the planet, covering approximately 71% of the land area (Brooks et al., 2006*)*. The forest estate of Papua New Guinea is comprised of diverse lowland forest (57%), montane rainforest (29%) and swamp forest (10%), with the remaining estate comprised of dry evergreen (2%) and mangrove forest (2%) (Shearman et al., 2008).

The remaining non-forested area of PNG consists of lowland to mid-montane grasslands, subalpine and alpine shrubland and grassland, human settlements and water bodies (Shearman et al., 2008). Approximately 80% of the human population is dependent on subsistence

agriculture for food (Bryan and Shearman, 2015). Patches of forest are routinely cleared to make way for subsidence gardens, which are then cultivated for typically two to five years (Plate 4.3). Gardens are abandoned once soil nutrients are depleted in favour of newly cleared sites. This cycle can result in large areas of forest completely replaced by mosaics of current garden plots, and abandoned plots in various states of succession (Shearman et al., 2008).

As of 2014, approximately 13% of total closed-canopy rainforest in Papua New Guinea has been logged at least once since 1972 (Bryan and Shearman, 2015). Rainforest is currently being lost at the rate of 1.4% per year, with losses largely due to expansion of commercial logging (Plate 4.4) and plantations such as palm oil, and subsistence agriculture activities. By comparison, dry evergreen forest, swamp forest and mangroves have remained relatively stable since 1972 (DEC, 2010).

Plate 4.3 – Land Used for Semi-permanent Agriculture

Source: Shearman et al., 2008.

Plate 4.4 – Commercial Logging Activities in the Southern Highlands Province

4.2.8.2 Flora and Fauna

Papua New Guinea contains 5% of the world's biodiversity in less than 1% of the world's total land area, making it one of the countries with the richest biodiversity. Due to the country's landscape heterogeneity, much of the biodiversity has evolved separately resulting in high levels of plant and animal endemism. The flora and fauna of Papua New Guinea are poorly known. Large areas of Papua New Guinea have not been systematically surveyed, resulting in poorly understood species diversity and abundance (DEC, 2010). It is estimated that more than half the plants and animals found in PNG have yet to be scientifically named (DEC, 2010).

Estimates for the number of vascular plant species for the entire island of New Guinea range from 11,000 to 25,000 species. Topographical barriers from geological processes has resulted in high habitat heterogeneity, allowing for high rates of species radiation and species endemism. Endemism probably exceeds 30% for Papua New Guinea and is well over 70% for Papuasia (Katovai et al., 2015).

Papua New Guinea has a rich array of fauna (Plate 4.5), including an estimated 150,000 species of insects, 314 species of freshwater fishes (82 endemic), 641 species of amphibians and reptiles (328 endemic), 636 species of birds (98 endemic), and 276 species of mammals (69 endemic) (Birdlife International, 2020; DEC, 2010).

Plate 4.5 – Papua New Guinea Fauna

(a) Pesquet's Parrot (*Psittrichas fulgidus*). Source: I. Woxvold

(b) Eastern Long-beaked Echidna (*Zaglossus bartoni*). Source: I. Woxvold

Birds are among the most widely studied vertebrate group in PNG due to their large scientific and public following (Bryan and Shearman, 2015). Generally, most birds can be split into the following groups: breeding land and freshwater species, seabirds, and migrants from the north and from Australia/New Zealand along the East Asian–Australasian flyway. Most Papuan bird species have specific habitat requirements and typically live in just one type of habitat among marine, mangrove, aquatic, savannah, wet tropical forest and alpine habitats. Consequently, bird diversity in a given area depends on the diversity of available habitat types (Dumbacher and Mack, 2006).

Relatively few bird species (18%) are endemic compared to other vertebrate groups (Bryan and Shearman, 2015). Seventy-five species of migratory birds (listed under the Japan-Australia Migratory Bird Agreement and the China-Australia Migratory Bird Agreement) are known or expected to pass through or stay in PNG (Dumbacher and Mack, 2006). Additionally, a significant

number of native Australian birds over-winter in PNG as part of the Australo-Papuan migration (Pratt, 1982).

The current status of species in PNG according to the IUCN red list (IUCN, 2020) includes: 65 critically endangered, 123 endangered, 468 vulnerable, and 355 near threatened species. The main threats to biodiversity in PNG are the rapidly expanding human population, the expansion of industry (primarily mining, oil and gas, forestry), forest conversion and degradation and climate change (DEC, 2010). Conservation of threatened species is primarily managed through the use of protected areas.

A total number of 123 restricted-range (global range of less than 50,000 km^2) endemic reptiles and amphibians have been identified in PNG. Thirty seven restricted-range endemic mammals have also been identified (Independent State of Papua New Guinea, 2014). Less than 10% of their defined habit is presently within protected areas.

A list of protected fauna of Papua New Guinea, compiled from Fauna (Protection and Control) Act 1976 and subsequent amendments, is provided in Table 4.1.

Table 4.1 – Protected Fauna Of Papua New Guinea

Family	Species
Mammallia	
Tachyglossidae	Long beaked Echidna (*Zaglossus bruijni*)
Phalangeridea	Black spotted cuscus (*Spilocuscus rugoniger*)
Macropodidae	Doria's Tree Kangaroo (*Dendrolagus dorianus*)
	Good fellow's Tree Kangaroo (*Dendrolagus good fellow*)
	Grizzled Tree Kangaroo (*Dendrolagus inustus*)
	Huon Tree Kangaroo (*Dendrolagus matschiei*)
	Scott's Tree-kangaroo (*Dendrolagus scottae*)
	Lowland Tree-Kangaroo (*Dendrolagus spadix*)
	White Throated Tree Kangaroo
	Black Tree-Kangaroo (*Dendrolagus ursinus*)
	Black Dorcopsis Wallaby (*Dorcopsis atrata*)
Pteropodidae	Bulmer's Fruit Bat (*Aproteles bumerae*)
Dugongidae	Dugoong (*Dugong dugon*)
Aves	
Ardeidae	Greater Egret or White Egret (*Egretta alba*)
	Lesser or Plumed Egret, Intermediate Egret (*Egretta intermedia*)
	Little Egret (Egreeta garzatta)
Anatidae	Salvadori's Teal, Salvadori's Duck (*Anas waigiuensis*)
Accipitridae	New Guinea Harpy-Eagle (*Harpyopsis novae-guinea*)
	Osprey (*Pandion haliaetus*)
Columbidae	Imperial Pigeon (*Ducula finschii*)
	Red-knobbed Imperial Pigeon (*Ducula rubricera*)
	Western Crowned Pigeon (*Goura scheepmakeri*)
	Victoria Crowned Pigeon (*Goura victoria*)
Psittacidae	Palm Cockatoo (*Probosciger aterrimus*)
	Pesquet's Parrot or Vulturine Parrot (*Psittrichas fulgidus*)
Bucerotidae	Blyth's Hornbill or Papuan Hornbill (*Rhyticeros plicatus*)

Table 4.1 – Protected Fauna Of Papua New Guinea (cont'd)

Family	Species
Paradisaeidae	Ribbon-tailed Bird of Paradise (*Astrapia mayeri*)
	Arfak Astrapia (*Astrapia nigra*)
	Huon Astrapia (*Astrapia rothschildi*)
	Splendid Astrapia (*Astrapia splendidissima*)
	Stephanie's Astrapia (*Astrapia stephaniae*)
	Magnificent Bird of Paradise (*Cicinnurus magnifics*)
	King Bird of Paradise (*Cinnurus regius*)
	Wilson's Bird of Paradise (*Cicinnurus respublica*)
	Loria's Bird of Paradise (*Cnemophilus loriae*)
	Crested Bird of Paradise (*Cnemophilus macgregori*)
	Buff-tailed Sicklebill (*Epimachus albertisi*)
	Pale-billed Sicklebill (*Epimachus bruijnii*)
	Black sicklebill (*Epimachus fastuosus*)
	Brown sicklebill (*Epimachus meyeri*)
	Yellow-breasted Bird of Paradise (*Loboparadisea sericea*)
	Superb Bird of Paradise (*Lophorina superba*)
	Macgregor's Bird of Paradise (*Macgregoria pulchra*)
	Glossy-mantled Manucode (*Manucodia atra*)
	Crinkle-collard Manucode (*Manucodia chalybata*)
	Curl-crested Manucode (*Manucodia comrii*)
	Jobi Manucode (*Manucodia jobiensis*)
	Trumpet Manucode (*Manucodia keraudrenii*)
	Long-tailed Paradigalla (*Paradigalla carunculate*)
	Short-tailed Paradigalla (*Paradigalla brevicauda*)
	Greater Bird of Paradise (*Paradisaea apoda*)
	Goldie's Bird of Paradise (*Paradisaea decora*)
	Emperor Bird of Paradise (*Paradisaea guilielmi*)
	Lesser Bird of Paradise (*Paradisaea minor*)
	Raggiana Bird of Paradise, Count Raggi's Bird of Paradise (*Paradisaea raggiana*)
	Red Bird of Paradise (*Paradisaea rubra*)
	Blue Bird of Paradise (*Paradisaea rudolphi*)
	Carola's parotia (*Parotia carolae*)
	Lawes's parotia (*Parotia lawesii*)
Reptilia	
Dermochelyidae	Leatherback turtle (*Dermochelys coriacea*)
Boidae	Boelen's python (*Python boeleni*)
Actinopterygii	
Salmonidae	Brown Trout (*Salmo trutta*) (less than 203 mm^2 in length)
	Rainbow Trout (*Onorhynchus mykiss*) (less than 203 mm^2 in length)
Insecta	
Papilionidae	Queen Alexandra's Birdwing Butterfly (*Ornithoptera alexandrae*)
	Allott's Birdwing Butterfly (*Ornithoptera allottei*)
	Ornithoptera chimaera
	Ornithoptera goliath
	Ornithoptera meridionalis
	Ornithoptera paradisea

Table 4.1 – Protected Fauna Of Papua New Guinea (cont'd)

Family	Species
Papilionidae (cont'd)	*Ornithoptera victoriae*
	Common Birdwing (*Ornithoptera priamus*)

* Source: CEPA (1996)
# Species names are listed as they appear in CEPA (1996), there may be some inconsistency with current nomenclature.

4.3.8.3 Invasive Alien Species

Invasive alien species include any taxa that are introduced beyond their original geographic range. They include species not native to New Guinea, and species originally present only in other parts of New Guinea.

Weeds

The current number of invasive plant species in PNG is not known but is likely to be greater than 200 species (CEPA, 2019). In areas where weeds have become established, their prevalence tends to increase with degree of disturbance to the forest canopy. Higher weed loads are observed in more open and disturbed environments, including along broader strips of open-canopy roadside scrub, Relatively low weed biomass and diversity is observed on less disturbed sites such as roadside habitats where primary/mature forest persists close to the road edge. Lower levels of light exposure at these sites limit the growth of light-hungry alien pioneers and support a relatively high proportion of native plant species. Limestone present a partial natural barrier to weed infestation due to their often shallow and typically nutrient-poor soils The potential for weed invasions on karst is therefore less than elsewhere.

Invasive Fauna

Common invasive alien fauna in PNG include introduced rodents (the Pacific rat (*Rattus exulans*), black rat (*R. rattus*) and house mouse (*Mus musculus*)), feral pigs (*Sus scrofa*), domestic and wild dogs (*Canis familiaris*), cane toads (*Rhinella marina*), feral cats (*Felis catus*) and Eurasian tree sparrows (*Passer montanus*) (CEPA, 2019). Except for dogs and feral pigs, most invasive species are restricted to disturbed or anthropogenic habitats since in forested areas they are typically out competed by native rodents. Dogs have been linked to the decline of multiple native and IUCN listed mammals such as the long-beaked echidna, tree kangaroos and various wallaby species (Long, 2003; Wilson and Mittermeier, 2015). The cane toad is a rapidly spreading, and highly toxic, amphibian introduced to Australasia from South America. It occurs up to 1,600 m asl in New Guinea where it is predominantly restricted to open and disturbed forest environments; it is rare in closed canopy rainforest.

4.2.8.4 Protected Areas

The country has 57 protected areas under PNG law, including wildlife management areas, national parks, and reserves. The different types and areas of gazetted protected areas are listed in Table 4.2. The total area of terrestrial protected areas amounts to 3.7% of the country's total land area (UNEP-WCMC, 2020). The Torricelli Mountain range has also been submitted as a Conservation Area and if designated the percentage of terrestrial PAs will increase to 4.4% (CEPA, 2019).

Table 4.2 – Gazetted Protected Areas in PNG

Protected Area Type	Number	Total Area (ha)
Conservation area	1	75,000
District park	1	12
Historical reserve	1	71
Memorial park	3	167
National park	5	8,241
Natural reserve	2	272
Provincial park	1	77
Protected area†	3	2,576
Reserve	1	29
Sanctuary	2	1,211
Scenic reserve	1	13
Wildlife management area	33	1,622,621
Wildlife sanctuary	3	74,745
Total gazetted protected area	***57***	***1,784,954***

† Protected area of unknown type.
Source: Leverington et al. (2017)

The objectives of the protected areas are to protect subsistence resources from over harvesting by customary landholders, protect biodiversity, gain formal recognition of tenure and resource ownership, provide opportunities for income generation, protect cultural values, and provide scientific research and educational opportunities. Of these areas, 44 are protected areas under the International Union for Conservation of Nature (IUCN) categories. Papua New Guinea has two sites of international significance under the Ramsar Convention: Lake Kutubu in the Southern Highlands Province and Tonda Wildlife Management Area in the Western Province (Ramsar, 2020).

Launched in 2005, Alliance for Zero Extinction (AZE) engages governments, multilateral institutions and non-governmental biodiversity conservation organisations working to prevent species extinctions (AZE, 2018). AZE members have identified 853 sites worldwide that are recognised as holding the last-remaining populations of one or more endangered or critically endangered species on the IUCN Red List. Eight areas in PNG are recognised as zero extinction sites by AZE. Locations of AZE sites in PNG can be accessed at https://zeroextinction.org/site-identification/2018-global-aze-map/. The sites and the species that trigger protection are listed in Table 4.3.

Table 4.3 – AZE Sites and Trigger Species

Name of site	Province	Trigger Species
Central Manus	Manus	Manus Island mosaic-tailed rat, *Melomys matambuai*
West Torricelli Mountains	Sanduan	Northern glider, *Petaurus abidi*
Telefomin	Western	Telefomin cuscus, *Phalanger matanim*
Kemp Welch River	Central	New Guinea big-eared bat, *Pharotis imogene*
Goodenough Mountains	Milne Bay	Black forest wallaby, *Dorcopsis atrata*
Maybole Range (West Fergusson)	Milne Bay	Tate's triok, Dactylopsila tatei
Kiriwina	Milne Bay	David's spiny bandicoot, *Echymipera davidi*
Mt Elimbari	Simbu	*Choerophryne siegfriedi*

Source: AZE (2018).

The Key Biodiversity Area (KBA) Program is an international, non-governmental conservation partnership that was established in 2018 which designates sites of global importance for biodiversity conservation, based on strict scientific criteria (KBA, 2020). In PNG, 132 areas covering a total area of land and sea of 328,782 km^2 have been identified as biodiversity areas of international significance using previously established criteria and thresholds. Locations of these areas can be accessed at http://www.keybiodiversityareas.org. Most of these areas have not been yet been reassessed using the revised KBA criteria and thresholds that are based on stricter scientific criteria set out in the KBA Global Standard. Their status for qualification as KBAs is therefore yet to be determined (KBA, 2020). The exceptions are the eight areas identified as AZE sites. These areas also qualify as KBA of international significance, meeting the threshold for at least one criterion described in the Global Standard for the Identification of KBAs (IUCN, 2016).

Five areas in PNG are also classified as Important Bird and Biodiversity Areas (IBAs) by BirdLife International. These are sites of international significance for the conservation of the world's birds and other wildlife. The five IBAs in PNG are all marine locations, with no terrestrial IBAs yet identified.

The World Database of Protected Areas (WDPA), a joint project between UN Environment and the International Union for Conservation of Nature (IUCN), provides a comprehensive global database of marine and terrestrial protected areas, updated on a monthly basis, and is one of the key global biodiversity data sets being widely used by scientists, businesses, governments, international secretariats and others to inform planning, policy decisions and management (Protected Planet, 2020). Locations of protected areas in PNG can be accessed at https://www.protectedplanet.net/. Information from this website will be used to identify sites to be avoided when selecting locations for tower installation.

Existing and tentative World Heritage Sites, which are considered important for conservation of natural and cultural heritage in PNG, are described in Section 4.3.9.

4.2.8.5 Ecosystem Services

Ecosystem services are the direct and indirect benefits that ecosystems provide to human wellbeing, including but not limited to food, fresh water, income and spiritual value. They can be grouped into four main categories (IFC, 2019):

- Provisioning services – the goods or products obtained from ecosystems, such as food, timber, fibres, freshwater and medicinal plants.
- Regulating services – the contributions to human wellbeing arising from an ecosystem's control of natural processes, such as climate regulation, disease control, erosion prevention, water flow regulation, surface water purification, carbon storage and sequestration, and protection from natural hazards.
- Cultural services – the non-material contribution of ecosystems to human wellbeing, such as recreational, spiritual values and aesthetic enjoyment.
- Supporting services – the natural processes, such as soil formation, nutrient cycling and primary production, that maintain the other services.

Table 4.4 provides examples of the four categories of ecosystem services. The majority of the population who live on their own customarily owned land and subsist from it for food are essentially reliant upon ecosystem services for their survival; supporting services of soil formation and nutrient cycling for gardening and food security, provisioning services for food, water, materials, firewood, regulating services of water and cultural services of identification with place, customs and heritage (CEPA, 2019). Specific information on ecosystem services utilised by local communities at individual tower sites will be obtained by community profiling undertaken as part of the 'Site Selection and Acquisition Procedure' (Appendix 1).

Table 4.4 – Habitat Types Relevant to Ecosystem Services

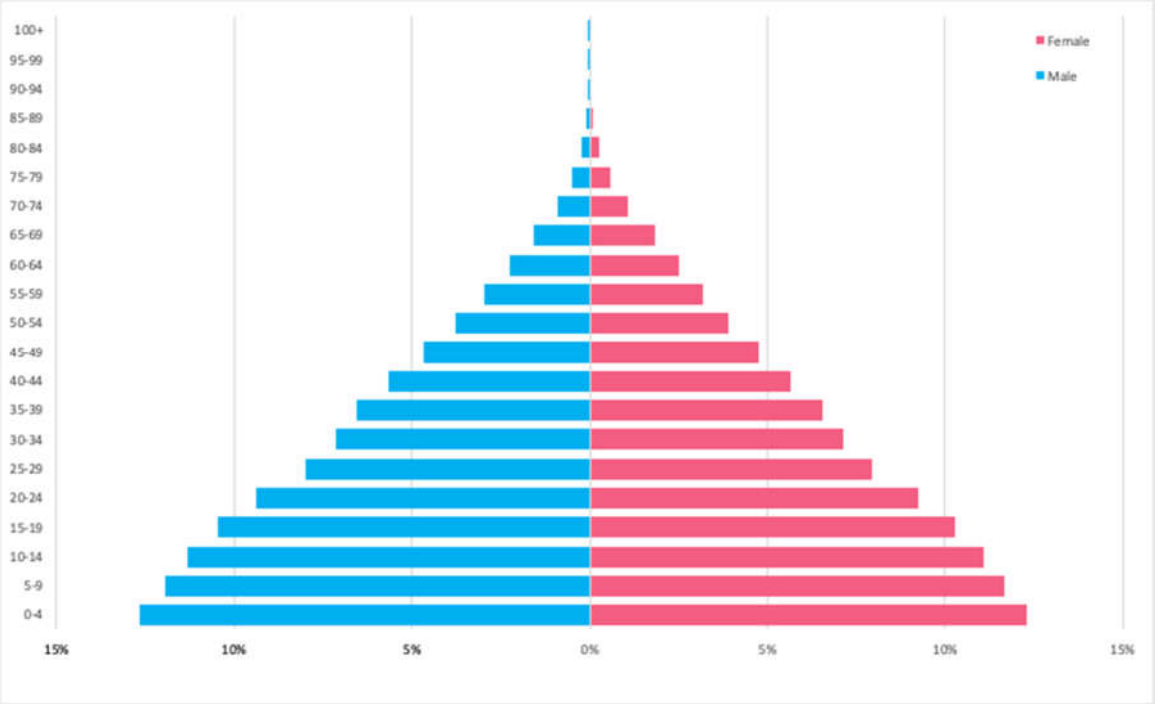
Provisioning Services	Regulating and Maintaining Services
• Wild food (bushmeat). • Wild food (plants, nuts and fruit). • Wild food (freshwater and marine species). • Food (crops). • Food (livestock). • Fuel (firewood). • Traditional medicine. • Timber and other wood products. • Non-timber forest products (fibres, resins). • Fresh water (domestic use). • Rivers (transportation). • Marine transportation. • Commercial marine fisheries. • Timber and logging concessions.	• Control of erosion and sedimentation. • Regulation of surface and groundwater (including flows). • Regulation of natural hazards. • Regulation of air quality. • Regulation of climate. • Water purification and waste treatment. • Regulation of soil quality. • Regulation of diseases. • Regulation of pests. • Pollination and seed dispersal. • Seed bank for natural regeneration.
Cultural Services	**Supporting Services**
• Cultural sites. • Traditional practices.	• Provision of habitat for plant and animal species. • Nutrient cycling. • Primary production. • Water cycling. • Soil formation. • Genetic resources.

4.3 Socio-economic Environment

4.3.1 Population, Language and Ethnic Groups

Papua New Guinea has a population of approximately 8.9 million, and an estimated annual growth rate of 1.95% (WPR, 2019). The country's growth rate has been slowing in recent years, but there is still a disproportionately high number of young people not yet old enough to work and help support the rest of the population, with more than 35% of its population under the age of 15 (DoE, 2016). Figure 4.6 presents a population pyramid for the country, which is described as an 'expansive' pyramid, which signifies a high birth rate and high mortality, a hallmark of developing countries.

Figure 4.6 – Papua New Guinea Population Pyramid



Source: PopulationPyramid.net, 2019.

Data from the last national census (2010) indicates that approximately 39% of the population live in the Highlands region followed by Momase region (26%), while Southern and Island regions made up 20% and 15% of the total country population respectively (NSO, 2013). More than 88% of the population live in rural areas, making PNG the fifth least urbanised country in the world (UNDP, 2014). Table 4.5 summarises some of the key demographics by province.

Table 4.5 – Population Statistics for PNG

Province	% Population	Province Area (km^2)	Population Density (people/km^2)	Average Household Size	Sex Ratio
Bougainville	3.4	9,384	26.6	5.2	105
Central	3.7	29,998	9.0	6.5	112
Chimbu (Simbu)	5.2	6,112	60.1	4.9	110
Eastern Highlands	8.0	11,157	52.0	4.2	108
East New Britain	4.5	15,274	21.5	5.6	106
East Sepik	6.2	43,426	10.4	5.2	101
Enga	5.9	11,704	37.0	5.7	118
Gulf	3.2	34,472	4.6	6.1	107
Hela	3.4	10,498	23.8	3.8	107
Jiwaka	4.7	4,798	71.7	5.3	108
Madang	6.8	28,886	17.1	5.7	109
Manus	0.8	2,000	30.2	5.8	106
Milne Bay	3.8	14,345	19.3	5.0	108

Table 4.5 – Population Statistics for PNG (cont'd)

Province	% Population	Province Area (km^2)	Population Density (people/km^2)	Average Household Size	Sex Ratio
Morobe	9.3	34,705	19.4	5.2	108
National Capital District (NCD)	5.0	240	1,517.2	7.7	115
New Ireland	2.7	9,557	20.3	6.5	112
Oro (Northern)	2.6	22,735	8.2	5.5	109
Sandaun (West Sepik)	3.4	35,820	6.9	5.5	106
Southern Highlands	7.0	15,089	33.4	5.8	107
Western (Fly)	2.8	98,189	2.1	6.4	106
Western Highlands	5.0	4,290	84.6	4.3	103
West New Britain	3.6	20,387	13.0	5.2	111

Notes: Population data sourced from NSO (2013) and Province areas from Statoids (2015).
The sex ratio is the number of males for every female.

The provinces identified as locations where the greatest numbers of towers are to be erected during Year 0 of the Project represent some of the most populous in PNG – Morobe is home to 9.3 % of the population, Eastern Highlands is home to 8%, Madang 6.8% and the NCD 5% (see Table 4.5). Where population density is also high (e.g., NCD, Eastern Highlands, Western Highlands and in urban areas throughout other provinces), Indigenous Peoples may be more likely to have existing access to the basic services (such as education, health, telecommunications and economic infrastructure[2] – see Sections 4.3.6 and 4.3.7) that enable them to benefit from the additional network. In other areas, where population density is much lower (e.g., Central, Madang and Morobe provinces) and where people live in more remote communities, this infrastructure may not be in place, and Indigenous Peoples in these areas may experience barriers to benefiting from the Project.

Whilst the PNG government does not formally recognise its citizens as Indigenous People, this does not prevent people from self-identifying as Indigenous. For policy application purposes, ADB (2013) uses the term 'Indigenous Peoples' in a generic sense to refer to a distinct, vulnerable, social, and cultural group possessing the following four characteristics in varying degrees:

- Self-identification as members of a distinct indigenous cultural group and recognition of this identity by others.
- Collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories.
- Customary, cultural, economic, social, or political institutions that are separate from those of the dominant society and culture.
- A distinct language, often different from the official language of the country or region.

[2] Noting that in remote highland areas transportation and connectivity can be very low, which may impede service accessibility.

Socio-cultural groups therefore need to be both distinct and vulnerable and affected by the Project to trigger application of the term Indigenous Peoples in the SPS for ADB-supported projects (ADB, 2009). In the context of this Project, therefore, Project-affected Indigenous Peoples are primarily those ethnic groups whose customary lands are used as greenfield sites for tower erection.

There is significant diversity in the Indigenous Peoples living in different regions of PNG. As one of the most heterogeneous nations in the world, PNG has over 10,000 different ethnic clans. Most people living in PNG are Melanesian, Papuans, Micronesian and Polynesian. A small portion of the population comprises expatriates, mostly from Australia and China, but Europeans, Indonesians and Filipinos are also represented.

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There are over 850 known languages in PNG, although 12 are classified as extinct (Lewis, Simons & Fennig, 2016). PNG is the most linguistically diverse area in the world and 89% of the languages are spoken by 10,000 people or less. English, Tok Pisin (Pidgin), and Hiri Motu (the lingua franca of the Papuan region) are the official languages. In PNG, the language that people speak defines where people came from, their ancestors and ancestral migration history (from the land on which they originated to the land they occupy in the present). As a result, it defines their cultural values, where they live, with whom they communicate, trade and marry, and in many cases, the behavioural and social norms they are expected to observe.

Provinces in PNG where languages are most diverse include Madang (165 languages), Sandaun (101 languages), Morobe (97 languages) and East Sepik (94 languages). Provinces that have the lowest language diversity include Western Highlands (3 languages), Hela and Jiwaka (both with 6 languages) (John, 2015).

The dominant religion among PNG's population is Christianity (95.6%), followed by indigenous beliefs (3.3%) (Scroope, 2016). Followers of indigenous traditions consider that ritual practice is necessary for someone's spiritual and physical wellbeing. For those communities where indigenous traditions continue to flourish, mediums and religious practitioners play an important role (Scroope, 2016).

4.3.2 Governance and Administration

The political culture in PNG is vibrant with intense political competition. Elections have been held every five years since independence and are contested by increasing numbers of candidates. While many changes of government have been enabled by motions of no confidence on the floor of the Parliament, transitions of power have taken place without major disruption, although are sometimes accompanied by localised violence. No government in PNG has been removed by military force (Hayward-Jones, 2016; IFC, 2019).

Papua New Guinea is a constitutional monarchy. The Head of State is HM Queen Elizabeth II, represented by the Governor General who is elected directly by Members of the National Parliament and performs mainly ceremonial duties. The National Parliament is elected for five-

year terms by universal suffrage. The Prime Minister is appointed and dismissed by the Governor-General on the proposal of Parliament, and the Cabinet is appointed by the Governor-General on the recommendation of the Prime Minister. The Supreme Court, National Court, and local and village courts form an independent justice system (DFAT, undated). PNG has developed a complex and decentralised system of government, with three tiers (national, provincial, and local), and four levels of administration (national, provincial, district, and local level government (LLG)). District Development Authorities, chaired by the local Member of Parliament and including the council presidents, have recently emerged as another prominent and often well-resourced tier of government.

In total the country is divided into four regions, 22 provinces (including the National Capital District), 89 districts and 326 LLGs. The national government also maintains 33 ministries and over 140 departments and agencies. Within LLGs are wards, which are represented by a councillor and have a ward development committee, village court and land mediator, although in practice this is not always the case. Figure 4.7 shows the regions and provinces of PNG.

Combined with the widely distributed population, low connectivity and issues with corruption and low transparency, this highly distributed and decentralised model of governance has created significant confusion about responsibilities, making it difficult for communities to hold leadership to account. It also creates significant challenges for the efficient and effective functioning of government services across the country (Hayward-Jones, 2016; Pryke and Barker, 2017; IFC, 2019).

Historically, PNG is a nation of culturally diverse tribal societies organised on the basis of kinship. Societies commonly practice either the patrilineal system, where descent is through the father, or the matrilineal system with descent passing through the mother. Approximately three quarters of the country practices patrilineal descent, while the matrilineal system is largely confined to coastal provinces (Prideaux, 2006). Customs, norms and traditions are complex and diverse, and operate to influence the practice of leadership at community, regional, organisational, and governmental levels. Customs, norms and traditions practiced in one region may embrace similarities with other regions but may also be very different (Prideaux, 2006).

Traditional leadership still plays a key role in PNG society, especially in rural villages. It is mainly practiced in an informal setting, at the village or community level, particularly where the tribe or village structure is not formalised through government administration. Leadership status is gained through displaying leadership qualities and through inheritance, either from family, clan or tribe, however practices differ between major cultural regions (Prideaux, 2006). For example, the traditional Highlanders practice chiefly, or ‘big-man’ methods of leadership, which is based on the individual’s status in the community in terms of wealth and money and upheld through threat and aggression. Whereas Sepik leadership is based on respect, trust and integrity of the individual and leaders are chosen by elders.

The role of traditional leaders has changed as government officials, church leaders and in areas where resource projects have developed, company employees or company-elected representatives, have played more prominent roles in various aspects of village life.

Figure 4.7 – Regions and Provinces of Papua New Guinea

4.3.3 Customary Land Ownership

Papua New Guinea is a country with rich soil, natural and cultural resources, with little feudal legacy and no large landowning families. As such, PNG has perhaps one of the most equal distributions of land in the world, providing a basis for very broad access to basic food and shelter, as well as identity and social security (Anderson, 2015).

Clans and language groups occupy (or have rights to occupy) specific territories. Rights are traditionally held by the clan or by sub-clans (that are related extended families), which are protected through agreements with neighbouring clans. The rights of customary landowning groups are based on mutually agreed-upon histories that describe how clans came into being and occupied the land. The majority (97%) of land in PNG is under customary ownership. Most Papua New Guineans live on customary-owned (clan) land where they have a right to live, hunt, collect resources and grow food. Generalisations about customary land-owning practices are difficult given widely varying traditions and practices amongst PNG clans; the exact nature of customary titles vary from one clan or culture to another. However, the smallest portions of land are held by the individual heads of extended families and their descendants, and clan land is available for communal activities such as hunting.

Customary land cannot be purchased or sold, however, it can be alienated by the State and leased to other users. In these cases, customary landholders legally lose interest in the land. Less than 3% of land in PNG has been alienated from customary ownership and is in private hands (held under a 99-year State lease) or held by the State.

Rights over land access and use have always been a fundamental concern to PNG society; however, traditionally, Papua New Guineans have maintained multi-layered customary rights of access to land that were malleable to changing social alliances and changes in residence, and land was not treated as a commodity that is subject to exchange, barter and sale (Trebilcock, 1983). As both private and State development has become more commonplace in recent years, land rights and ownership have gained prominence with clans exhibiting tighter control over clan boundaries and markers of cultural difference, since rights are associated with lease rental payments, government compensation payments or other financial benefits. The lack of written records coupled with this relatively new link to economic opportunities has caused greater self-identification on the part of Indigenous Peoples and can cause conflict between landowning clans (Weiner and Glaskin, 2007).

4.3.4 Economy and Livelihoods

Papua New Guinea is a lower-middle income developing economy with a Global Domestic Product (GDP) of PNGK 61.7 billion (or US$17.5 billion) in 2016 (NSO, 2020). In early 2020, the World Bank forecast GDP growth in PNG at around 3% on average for 2020-2022, which while positive, is lower than initial forecasts, due mainly to due to delays in finalising agreements of new resource projects. PNG's revenues continue to face challenges arising from low global commodity prices and potentially an over-supply in the global LNG market (WBG, 2017; WBG, 2020).

Papua New Guinea is a dual economy, with a small formal economy and a much larger, widely spread informal subsistence agriculture-based economy (i.e., activities that are un-taxed, unregulated or minimally regulated and does not feature in GDP calculations) (ADB, 2012a). The formal economy is dominated by petroleum and mining; principally oil, gas (liquefied natural gas

(LNG)), copper and gold resources that generate most of the country's export earnings. Commercial agriculture, tuna processing, logging and manufacturing are the other main economic sectors (ADB, 2015). The informal economy supports approximately 85% of people through semi-subsistence agriculture, with the majority of people living in rural areas still directly dependent on the land and natural environment for their subsistence and livelihoods (ADB, 2015).

The agriculture sector in PNG is constrained by rugged terrain, logistical constraints (such as poor transport networks), lack of value chain infrastructure (such as cold storage), and complex customary land ownership, which can inhibit private investment. The sector includes cash and subsistence crops and is dominated by family farmers in rural settings. There are a small number of medium to large sized enterprises which operate in oil palm, copra, tea, coffee and fisheries exports (ADB, 2015). While agriculture is a significant part of the PNG economy, the country's agricultural exports are almost entirely limited to coffee, palm oil and copra (Piesse, 2019).

Mining and petroleum provide the most significant share of GDP (ADB, 2015). While successive PNG leaders have focused on investment in resources as a key driver for development of the country, relying on revenue from the extractives industry alone is likely to be insufficient to make life better for future generations of Papua New Guineans, as evidenced by the slow progress made in delivering the benefits of the most recent resources boom (Hayward-Jones, 2016).

The manufacturing sector remains small and consists of food, soft drinks, beer, food canning, tobacco processing and furniture making. Small-scale engineering and metal processing, clothing, and other light industries are also present (ADB, 2015).

Formal wage employment in PNG is extremely low, estimated at less than 6% of the total population, with only 15% of the country's working age population formally employed (Pryke and Barker, 2017). Formal employment is higher than the country average in urban centres. For example, 36.5% of the working age population in Port Moresby reported having a wage-paying job, 16.5% were engaged in the informal sector and 43.6% were not in the labour force (Sharp et al., 2015).

There are significant gender differences within these figures. Men are twice as likely as women to have wage employment in urban areas, and women on average earn less than half as much as men (Pryke and Barker, 2017). Women are more prominent in the informal economy; double male participation in Port Moresby, and three times male participation in other urban centres (Sharp et al., 2015). Throughout PNG, economically active women maintain responsibilities for home and family in addition to economic activities (both formal and informal), and many women report working on average nearly twice as many hours as men.

Subsistence-based livelihoods for most of PNG's population are based principally on subsistence cultivation supplemented with collecting wild plants, fishing and hunting. Staple crops vary depending on geography and climate, and include sweet potato, yam, taro, sago and banana. Sweet potato accounts for approximately 70% of food produced in villages, with other staples accounting for about 22% (Piesse, 2019). Hundreds of different fruits and vegetables account for the remaining 8%. Most rural Papua New Guineans have little to no access to imported foods. Much of the population relies on a relatively small variety of food, leading to a high potential for food security issues and malnourishment (Piesse, 2019) (see also Section 4.3.6.1).

Small-scale economic activity primarily involves the sale of garden produce, fresh foods, livestock, betel nut and cocoa, forest products or fish, fuel and store goods. Palm oil is generally not produced by villagers, but by large-scale commercial farms (Piesse, 2019). Plates 4.6 and 4.7 highlight the substance lifestyles and small-scale economic activities prevalent throughout much of rural PNG.

Plate 4.6 – Crop Cultivation at Kaipu, Southern Highlands Province

Plate 4.7 – Sale of Local Produce at Kaimari Market, Southern Highlands Province

On a wide range of social indicators PNG remains one of the world's most underdeveloped nations. More than a decade of strong economic growth has not improved the welfare of most Papua New Guineans, with GDP per capita little different today than from that at independence (1975) (Sharp et al, 2015).

In many countries in the South Pacific including PNG, the concept of income-based poverty can be seen as having limited applicability due to the capacity for informal subsistence-based agriculture to provide adequate subsistence (ADB, 2012a). However, income-based poverty is only one dimension of poverty. Pryke and Barker (2017) report on data from the 2009 Household Income and Expenditure Survey (HIES), which showed that the proportion of the country's population living below the basic needs poverty line was 36.2% in 2009/10, meaning approximately 2.43 million people were living in hardship at that time. One of the main features of poverty in PNG is that it is largely rural, with 94% of the poor residing in rural areas, and economic growth rates much lower in rural than in urban areas (ADB, 2012a). Approximately 37.5% of national poverty exists in the Highlands Region, 29% in the rural Momase Region, and 15.2% in the Islands Region (ADB, 2015).

4.3.5 Law and Justice

Levels of crime and violence in PNG are high compared with crime and violence rates in other countries and provides a major obstacle to economic development (Hayward-Jones, 2016). Crime trends in PNG are difficult to track accurately, with records from different sources showing significant variance in the numbers of types of crimes committed, and under-reporting further complicates attempts to determine trends (Lakhani and Willman, 2014; Hayward-Jones, 2016). However, robbery, assault, and violence against women and girls are the most commonly reported crimes, and tribal violence continues to occur in many areas, often without legal recourse (Hayward-Jones, 2016). Crime 'hot spots' in PNG include Lae, Port Moresby, Madang, East New Britain, West New Britain, Western Highlands, and Enga (Lakhani and Willman, 2014).

The types of crime and violence experienced vary significantly between men and women, with gender-based (or domestic) violence the most common form of crime against women (Lakhani and Willman, 2014). Women are five times more likely to be victimised at home than on the street, and an estimated two out of three women report to have personally experienced violence (Lakhani and Willman, 2014; Darko et al., 2015). Human Rights Watch (2015) reports that police rarely take family violence seriously and often do not pursue investigations or prosecute the accused, leaving women with minimal or no forms of redress when they experience domestic violence.

Due to much of PNG being under customary land ownership (see Section 4.3.3), disputes over land and natural resources are common to all regions of PNG, particularly in rural areas, and cause social and economic disruption. Active conflicts between clans can take place almost continuously, and are never fully resolved, but rather continue over long periods of time, even decades. (Lakhani and Willman, 2014). Land ownership disputes are emphasised in areas where development is taking place, as land ownership is connected to financial benefits.

The law and justice sector's ability to address the high levels of crime is constrained by poor performance, funding problems, and capacity weaknesses in the Royal Papua New Guinea Constabulary (RPNGC). At independence, police coverage in PNG extended to only 10% of the

country's land area and 40% of the population (Dinnen, 2017). Since then, the reach of the RPNGC has diminished; although the overall population has more than trebled, leaving very low police to population ratio of 78:100,000 compared to 268:100,000 in Australia (Hayward-Jones, 2016; Dinnen, 2017).

The lack of accountability of the police, weak enforcement and corruption contribute to a poor human rights record for the country (HRW, 2020). Human Rights Watch (2020) reports that gender-based violence, murder, sorcery-related violence (which is predominantly targeted at women) and violence by police are all common occurrences. A 2018 report by the US Department of State highlighted key human rights issues in PNG include unlawful or arbitrary killings by police, torture, government corruption, gender-based violence, trafficking in persons, the criminalisation of same sex conduct between men, (although the law was not enforced) and child labour (USDoS, 2018).

4.3.6 Health and Education

Social services in PNG are delivered through a decentralised model involving multiple government agencies at varying levels (i.e., national, provincial or local) and non-government organisations, in particular faith-based organisations. Churches, with government funding, run approximately half of PNG's health and education systems, particularly in rural areas (Pryke and Barker, 2017; Grundy et al., 2019).

4.3.6.1 Health Services and Outcomes

Health care in is delivered by government at a national, provincial and local level, and is supported heavily by churches (Grundy et al., 2019). The National Department of Health (NDoH) is responsible for the national referral hospital and 21 provincial hospitals. Provincial and LLGs are mandated by law to provide primary health care services through a network of district hospitals, sub-health centres, community aid posts, and outreach services. Many health facilities lack staff, medical equipment and supplies, and do not have sufficient funding to provide basic services. For example, Pryke and Barker (2017) report that 43% of clinics need significant maintenance and 60% do not have electricity or refrigeration. They also report that 30% of staff were not paid on time, and 73% of staff were not conducting patrols in the local community.

The churches operate over 50% of the rural health service network (Grundy et al., 2019). In addition, there are also employer-provided health care services (e.g., agriculture, mining), a small private for-profit medical sector, and some small non-government organisations (NGOs) that provide health care services. The coverage of health service delivery varies significantly by geographical region and by programme type (Grundy et al., 2019).

While the National Health Plan 2011–20 (GoPNG, 2010) provides a framework for improving health services, inadequate health funding and the distribution of responsibilities has hindered implementation. For example, UTS (2011) describes that for the water, sanitation and hygiene (WASH) sector alone, there are between 20 to 40 NGOs who play the role of primary service delivery providers in rural areas.

The deficiencies in health infrastructure and service delivery across the country have an impact on health outcomes. For example, the 2009 HIES found that the overall rate of use of medical care by those reporting as unwell was only 54%, which is nearly 20% less than other countries in

the region (ADB, undated). Human Rights Watch (2020) reports that an estimated one in thirteen children die each year from preventable diseases, and large numbers of children experience malnutrition resulting in stunted growth.

Plate 4.7 shows a typical rural health facility. Table 4.8 highlights some of the health issues and indicators for the country.

Plate 4.8 – Community Health Centre, Ai'io, Southern Highlands Province

Table 4.7 – Papua New Guinea Health Indicators

Indicator	Description
Leading causes of premature death	The top causes of pre-mature death in 2017 were (IHME, 2019): • Neonatal disorders • Ischemic heart disease • Lower respiratory infections • Stroke
Burden of disease	Risk factors that account for the most disease burden in PNG are malnutrition and dietary risks, high fasting plasma glucose, tobacco smoking, and household air pollution from solid fuels (many households still rely on firewood for heating and cooking). Kitur et al (2019) describes the main burden of disease breakdown as: Communicable, maternal, neonatal and nutritional causes – 41% (male), 49% (female) Non-communicable diseases – 45% (male), 42% (female)

Table 4.7 – Papua New Guinea Health Indicators (cont'd)

Indicator	Description
Communicable diseases	Tuberculosis (TB) and malaria are both highly prevalent across PNG; although for TB, incidences are higher in West New Britain, Western (Fly) and Gulf provinces, whereas incidences of malaria are higher in Milne Bay and Sandaun provinces (NDoH, 2018). There are an estimated 900,000 cases of malaria each year (DFAT, 2017) and in some areas of PNG, (e.g., Gulf Province) TB is at epidemic levels (Cross et al, 2014). Sexually transmitted diseases (STDs) including human immunodeficiency (HIV)/AIDS are also prevalent, with an estimated 45,000 people living with HIV (Kelly-Hanku, 2018). The prevalence of HIV/AIDS is highest in Enga, Western Highlands and Jiwaka provinces (NDoH, 2018). Water-related diseases such as diarrhoea, typhoid, malaria and cholera are major causes of illness and death in PNG and are among the principle causes of deaths in children under five years. PNG ranks at the bottom of all Pacific countries for all WASH related health statistics, with over 6,000 diarrheal deaths per year (UTS, 2011).
Non-communicable diseases (NCDs)	The incidence of non-communicable diseases is rising in PNG. Cases of tobacco-related and alcohol-related illness appear to be increasing, along with diabetes and hypertension. Mouth cancer is the most common cancer in PNG and has a largely preventable cause (betel chewing and tobacco smoking) (WHO, 2011). NCDs are driven primarily by a changing lifestyle, from subsistence foods to a more Western-style diet. Changes in income, particularly conversion from subsistence to wage based, can drive increased western-style trade-store product, alcohol, and cigarette consumption. Under-nutrition is a significant issue in PNG, with under-five stunting at 49.5%, which is significantly greater than the developing country average of 25% (GNR, 2020). The prevalence of stunting is higher in rural areas (50%) compared to in urban areas (35%) (ADB, 2015). A combination of limited to no emergency response capacity, particularly in rural areas in PNG, and a high number of risk factors (e.g., animals, use of tools and weapons, tribal fighting, unregulated road use), accidents and injuries (in particular road traffic related) are significant cause of pre-mature death in PNG. The IHME (2019) reports that road accidents rate the ninth highest in causes of the most deaths in PNG in 2017.
Life expectancy	Although PNG's life expectancy has improved during the last few decades, it is still one of the lowest in the Asia Pacific region. IHME (2019) reports female life expectancy as 61.3 years and 56.3 years for males.
Under 5 years mortality	The under 5 years old mortality rate is 47.8 deaths per 1,000 live births (as at 2018) (GNR, 2020).
Maternal mortality	The maternal mortality rate is a major health concern in PNG as it is the highest in the Asia Pacific region, at 215 deaths per 100,000 live births (as at 2017) (Dennis, 2018).
Births attended by skilled personnel	Forty percent of births recorded in 2011 were attended by a skilled health professional (ADB, undated). In rural areas in particular, many women do not have access to medical facilities and staff due to the distances and costs to reach them.
Health infrastructure	There are approximately 800 sub-health centres and 2,500 community aid posts, of which only an estimated 1,800 of these aid posts are functional (Grundy et al., 2019).
Health staffing	PNG has limited health human resources, as outlined below (GNR, 2020): Physicians – 0.06 per 1,000 people Nurses and midwives – 0.53 per 1,000 people Community health workers – 0.59 per 1,000 people Staffing varies across provinces, with health worker numbers lowest in Bougainville, West New Britain, Hela, East-Sepik, Jiwaka and Southern Highlands provinces, and highest in the NCD, Central, Milne Bay, West Sepik and Manus (NDoH, 2018).

Table 4.7 – Papua New Guinea Health Indicators (cont'd)

Indicator	Description
Health funding	From 1995 to 2014, public health expenditure averaged 4.1% of GDP, which is substantially higher than other lower-middle income countries. This partially reflects the higher costs of service delivery (i.e., remoteness, low connectivity and a largely rural population) and inefficiencies in spend (WBG, 2017). In 2019 the PNG government allocated 10% of its budget to health (Deloitte, 2018).

4.3.6.2 Education Services and Outcomes

Similar to the health system, the delivery of quality education is affected by a decentralised and overlapping service delivery model, remoteness, poor teacher training and development, lack of adequate infrastructure (i.e., classrooms, teachers' houses, water and sanitation), lack of teaching materials, and school affordability.

While the education system in PNG has undergone significant reform and made tangible progress since the country's first education plan launched in 1995, more remains to be done to improve access, retention, quality, equity and management to address remaining challenges in education (DoE, 2009; DoE, 2016).

Table 4.8 highlights some of the key issues and indicators relevant to education in PNG and Plate 4.9 provides an example of the type of education facilities available to many rural communities in PNG, where they are available at all.

Table 4.8 – Papua New Guinea Education Indicators

Indicator	Description
Education system overview	The current system of education in PNG is known as 3-6-4, which involves three years of elementary, six years of primary, and four years of secondary school. In alignment with the Australian system, and other education systems, the PNG has committed to transitioning to 1-6-6, meaning one year of elementary and six years of primary and secondary, respectively. The number of operating schools by sector in 2014 are (DoE, 2016): • Elementary – 7,298 • Primary – 3,543 • Secondary – 219 • Vocational – 114
Literacy rate	The overall literacy rate (literate in at least one language) is 68% (DoE, 2016). The adult and youth literacy rates in PNG are one of the lowest in the region, with literacy levels among women lower than those of men (ADB, 2012a). Adult literacy may be lower than reported, as one study (cited in Anderson, 2015) suggests that self-reported literacy could be three to four times the actual rates.
Enrolment rate	Disparities between rural and urban areas in terms of gross enrolment rates for primary and secondary education are wide (ADB, 2012a), and there are differences in enrolment rates by gender as well (Edwards, 2015; DoE, 2016). In 2014, the reported enrolment rates for males was 55% and for females 45% (of the total school-aged population) (DoE, 2016). Projected enrolments for 2020 are 2.47 million students across all school sectors (DoE, 2016).
Attendance rate	While children's school attendance rates have improved, UNICEF estimates that a quarter of primary and secondary school-aged children do not attend school, and only 50% of girls enrolled in primary school make the transition to secondary school (HRW, 2020).

Table 4.8 – Papua New Guinea Education Indicators

Indicator	Description
Education funding	From 2004 to 2013, education funding by all levels of government more than tripled and the annual funding per student almost doubled. In the four years from 2010 to 2013, government funding of the national education system more than doubled in nominal terms (DoE, 2016). However, teacher funding (i.e., salaries and allowances) fell significantly (comprising 79% of total funding in 2004 to 42% in 2014), as funding was re-directed to a government service improvement program and the Tuition Fee Free (TTF) program (DoE, 2016). In 2019 the PNG government allocated 8% of its budget to education (Deloitte, 2018).

Plate 4.9 – Community-run Elementary School, Soro, Southern Highlands Province

4.3.7 Economic Infrastructure

4.3.7.1 Transport

Papua New Guinea's road network is estimated to total approximately 30,000 km. Around 30% comprises 'national' roads, which are gazetted as falling under the responsibility of the national government. All other roads are 'non-national' and the responsibility of the provincial government or in some cases, private operators (e.g., forestry or resource companies). Only 13% of PNG's national road network is in good condition, with 59% considered to be in very poor condition (Slattery et al., 2018). The PNG government has recognised that the lack of maintenance and decline in quality of road infrastructure in the country has negatively impacted service delivery and economic opportunity (Slattery et al., 2018), however public expenditure on maintenance of infrastructure remains insufficient to bring the network up to acceptable standards for most rural areas.

Air transport is an important alternative to road travel, and PNG maintains a well-developed system of air services that includes 22 national airports and some 600 smaller airports (although approximately 30% of these smaller airfields were reportedly closed in 2012) (GoPNG, 2013). Several airlines provide regular domestic flights and/or charter services, the largest being the state-owned Air Niugini. Commercial aviation companies also provide helicopter charter services throughout PNG, including fleets for mining, oil and gas and telecommunication companies. Additionally, missionary groups and resource companies provide air services, often flying into otherwise isolated communities.

Approximately 60% of the population resides on 6,500 km of coastline and waterways, often without access to roads, and so water transport predominates in these areas (ADB, 2015). Maritime travel is essential for the many island and coastal communities, although PNG's network of 16 state-operated and at least 5 privately-operated commercial ports are generally expensive (for the region), inefficient and some are in need of upgrades to accommodate increases in marine traffic (ADB, 2012a; ADB, 2015; GoPNG, 2013).

4.3.7.2 Electricity

Papua New Guinea lags behind in the region in terms of access to and consumption of electricity, and improvements to access to electricity have been slow (ADB, 2012a). Approximately 12% of the population has access to electricity, which is predominantly available only in urban areas, where the supply is often unreliable. The country is serviced by two main power grids; the Port Moresby grid and the Ramu grid, (which serves the Lae, Madang and Highlands areas), and a number of smaller grids servicing the smaller urban centres (ADB, 2015).

Lack of access to affordable, reliable power is limiting economic growth in urban areas, constraining growth in smaller urban centres, and contributing to poverty in rural areas (ADB, 2015). Electricity generation is primarily via fossil fuels, with hydro supplementing it. Rural villages often have no access to wired electricity and typically utilise small-scale solar (i.e., personal solar powered chargers) or generators.

A lack of reliable electricity as well as poor affordability to pay for mobile phones is a significant barrier to the realisation of the benefits associated with an increased telecommunications network for Indigenous Peoples, since the use of mobile and the internet requires a power supply. With mobile infrastructure reaching beyond access to utility networks and services, there is a growing divide between access to mobile networks and access to electricity (Highet et al., 2019). Rural areas with lower population density are less likely to have access to reliable electricity than people living in towns or cities.

4.3.7.3 Water and Sewerage

Eda Ranu has responsibility for the provision of water and sewerage in Port Moresby, while water and sanitation in other urban areas (88 district towns and 20 provincial towns) is the responsibility of Water PNG. Both are state-owned enterprises, which has limited the reach of Water PNG infrastructure to only 14 provincial and 6 district towns (DNPM, 2015). In rural areas, the responsibility for provision of safe drinking water and sanitation is less defined. Further, the improvement of access to water has been slow, with monitoring data indicating that access to improved water across PNG increased from 33% in 1990 to only 40% in 2011 (DNPM, 2015).

The proportion of the population in PNG with access to safe drinking water is well below that in the other major economies in the region. The PNG government's WASH Policy 2015-2030 reports that 89% of people in urban areas and 33% in rural areas have access to safe water while 57% of urban dwellers and only 13% of the rural population have access to basic sanitation (DNPM, 2015).

4.3.7.4 Waste Management

There is a general lack of public awareness and education about waste management and associated impacts throughout PNG (ADB, 2014). Most households are not served by municipal services. Consumers still burn their wastes or dump it; household segregation is virtually absent except for food waste, nonferrous metals, and other ad hoc items of perceived value.

Papua New Guinea has only two official controlled sites for waste disposal (apart from private facilities such as those constructed and operated by mining and oil and gas companies), which are located in Port Moresby and Lae (PRIF, 2018). There are reported to be 21 unregulated disposal sites by PRIF (2018).

The official municipal facility for the disposal of Port Moresby's waste is the Baruni disposal site. The Asian Development Bank (ADB, 2014) estimates that Port Moresby alone generates around 135 tonnes of municipal solid waste per day, equivalent to over 50,000 tonnes per year. The waste is collected by 36 private contractors under contract to the National Capital District Commission. Solid waste from medical institutions, commercial facilities and sanitation and wastewater are collected by a single company (PRIF, 2018). However, the majority of the 63 settlements in Port Moresby are not serviced for solid waste collection (PRIF, 2018).

Lae City Council is responsible for providing a waste collection service, which usually benefits the higher-income areas of the city. The council uses private contractors to operate Lae's Second Seven disposal site (PRIF, 2018).

In 2014, formal recycling services in Papua New Guinea comprised two commercial recycling operators in Port Moresby, that collect and export ferrous and nonferrous metals, used lead-acid batteries and e-waste material to destinations in Asia (PRIF, 2018). A local registered company, with processing facilities at Badili, provides hazardous waste management and recycling services to commercial and industrial clients throughout PNG. Waste oils are refined and recycled in Port Moresby and plastic bottles, e-waste and mercury-containing waste are exported to Asia and Australia. Informal, household, and community recycling is also practiced, including the use of food waste as animal feed; and reuse of materials such as plastics. Waste pickers work in dangerous and unhealthy conditions, at the Baruni disposal site and other dumping grounds, sorting through piles of garbage to segregate and recover recyclables (ADB, 2014).

A commercial operator (TWM PNG Limited) is currently expanding its integrated waste management facility (IWMF) at Porebada, Central Province, located approximately 20 km by road from Port Moresby to consolidate and manage wastes in-country including hazardous solid and liquid wastes. The IWMF will be the first facility of its kind in Papua New Guinea, increasing the country's capacity to treat, recover and recycle waste material and dispose of hazardous contaminants in an environmentally sustainable manner, reducing the current need to export waste to Asia and Australia and current uncontrolled waste stockpiling practices in PNG.

4.3.7.5 Communications

Access to information and communications technology (ICT) in PNG is low but increasing steadily. The implementation of Digicel's mobile network commenced in 2008 which significantly increased access to communications in PNG, and now an estimated 67% of the PNG population have access to mobile coverage (Highet et al., 2019). Sumawaru (2014) report that by 2014, the mobile phone penetration rate (i.e., the number of actual connections as a proportion of the population) had reached 41%, although more recent figures published in Highet et al. (2019) indicates that this rate is closer to 30%. Prior to this, fixed-line communications reached around 1% of the population, and mobile penetration was approximately 5% (ADB, 2012b). Results from the 2009 HIES indicated that 42.5% of rural households contained one or more mobile phones, although only 1.4% of rural households possessed a personal computer (NSO, 2013).

Highet et al. (2019) notes that there are up to 1 million unique mobile internet subscribers in PNG, primarily in cities where mobile internet penetration grew by 20 per cent in 2018. And although mobile internet penetration continues to grow, mobile broadband availability and network quality, affordability of devices and services, and limited digital literacy skills are key barriers to its broader adoption and use (Highet et al., 2019).

There is also a gender gap in mobile phone ownership and usage in PNG, preventing Indigenous women from realising the full range of benefits of mobile technology, which include access to health information, financial services and employment opportunities. Women cite key barriers to mobile adoption as affordability, accessibility (including limited access to identification documents, electricity and limited mobility to access network coverage), safety concerns, and usability skills (Highet et al., 2019).

There are a range of applications for the expanding mobile phone network in PNG, including in the education and healthcare sectors. For example, students have reported using short message service (SMS) to coordinate group work and to contact teachers and parents, and teachers used mobile phones to arrange substitutes when incumbents were unable to take classes and to contact headquarters (Suwamaru, 2014). Mobile phones were also used to disseminate healthcare tips via SMS and to source medical drugs from provincial centres (Suwamaru, 2014).

4.3.8 Vulnerable Groups

The identification of vulnerable people and/or groups is a requirement of ADB's Safeguard Policy Statement (ADB, 2009), as these people may be more likely to be adversely impacted by development. Pre-existing vulnerability refers to groups or individuals who might find it difficult to sustain themselves or their families under everyday conditions. Some of the factors that influence vulnerability include gender, age, ethnicity, culture, literacy, economic disadvantage and dependence on natural resources for livelihoods (IFC, 2012a).

4.3.8.1 Gender Inequality

While the PNG Constitution outlines equal protection under the law, in practice gender inequality remains a major challenge in PNG and gender-based violence is unacceptably high. Chandler (2014) reports that the women of PNG endure some of the most extreme levels of violence in the world. In 2018, PNG ranked 153 out of 189 countries of the Gender Inequality Index, and faces one of the highest, if not the highest, levels of inequality in the Asia Pacific region (ADB, 2012a;

UNDP, 2019). Women are under-represented at all levels of government, limiting their power to influence public policy and voice issues, have substantially less access to health care and education services than men, and face insurmountable challenges to gaining legal redress when victims of violence (Hayward-Jones, 2016; UNFPA, 2019).

Women face barriers in the social, cultural, political and economic spheres as evidenced by the data below, which covers the subjects discussed in the preceding sections:

- Women's roles in leadership vary across the country. In many areas, men dominate leadership and preserve the right to disregard women. In others, women are able to become community leaders, playing often influential roles in local-level decision-making, and are often supported by the churches. While women are increasingly assuming leadership roles in the public service and the corporate sector in PNG, there is currently no women on the national Parliament, and only seven women have ever been elected to parliament since Independence in 1975 (Edwards, 2015).
- Men make most of the decisions in the family and control most of the resources (including land), and women are expected to conform to various societal rules and norms, often having their basic rights denied.
- Women can expect to earn less than half as much as men and are half as lively to have wage employment in urban areas (this figure would be much less than half in rural areas, where wage employment of very low) (see Section 4.3.4).
- Women in PNG suffer high incidences of violence, and often have no access to justice through the police or courts system (see Section 4.3.5).
- Poor access to health services, excessive workloads, poor nutrition, lack of access to safe water, a high number of pregnancies and a high rate of family violence all contribute to poor health outcomes for women (Hinton and Earnest, 2010). Women are also more affected than men by the lack of access to clean water and sanitation, as in communities where the quantity or reliability of water is inadequate, the burden falls mostly upon women to collect water from unimproved sources such as creeks or unprotected wells and spend significant amounts of time collecting water (WBG, undated) (see Section 4.3.6.1).
- Girls have less access to education due to cultural practices (that favour boys' education over girls), responsibilities at home (such as caring for younger siblings or helping with household labour) and typically finish school earlier than boys (Edwards, 2015). Girls often miss school due to lack of family finances, safety issues, lack of running water and separate toilets and WASH facilities. This affects women's literacy which is 10 percentage points lower than men in PNG (see Section 4.3.6.2).
- Women in PNG are 10% less likely than men to own a mobile phone and 23% less likely to use mobile internet. Ninety six percent of women without a mobile phone cited affordability as a reason they did not own one (Highet et al., 2019) (see Section 4.3.7.5).

- In rural and urban areas in particular, men commonly hold onto traditional cultural beliefs and practices, including bride price, under-aged marriage and polygamy (see Section 4.3.9).

4.3.8.2 Youth

People under 25 years old comprise nearly 60% of the population in PNG (UNFPA, undated). Youth face a range of challenges, such as high unemployment, lack of access to education and high incidences of drug and alcohol use, and lack of opportunity to participate in decisions that affect them, that classify many PNG youth as vulnerable. Young women and girls can be particularly vulnerable as suffer from higher levels of violence and generally have less access to education than boys.

Youth face barriers in the social, cultural, political and economic spheres as evidenced by the data below, which covers the subjects discussed in the preceding sections:

- Papua New Guinean youth are exposed to the highest rate of violence in the East Asia and Pacific Region (UNFPA, undated).
- The formal justice system is often unresponsive to the needs of youth in this respect. Less than 20 per cent of child victims of violence have access to courts, either because of distance or cultural norms such as payment of compensation in lieu of court action (UNFPA, undated)
- Only one in three children complete their basic education (UNFPA, undated).
- With limited job training opportunities and a high unemployment rate, youth are often not fully engaged or able to participate in the development of their community (UNFPA, undated).
- It is not uncommon for young people to engage in opportunistic crimes and violence (UNFPA, undated).

4.3.8.3 Migrants and Settlers

Papua New Guineans are becoming more mobile, seeking livelihood and wage employment opportunities, even in remote areas of the country (Koczberski et al., 2009). Migration within PNG is occurring more frequently and in large numbers, and is itself driving urbanisation, as most wage employment is found in large urban centres. However, not all migration is from rural to urban areas (Koczberski et al., 2009). Some is between rural areas, as people seek agricultural land or follow the employment opportunities presented through resource projects.

Migrants or settlers are often perceived by local inhabitants as ‘outsiders’ and trouble-makers. They very often do not have land rights and have limited rights to participate in local leadership structures. This can create an ‘immigrant underclass’, where large groups of people are landless and unable to make a living from subsistence agriculture, are unable to participate in the governance or decision-making within their community, and may be viewed as primarily responsible for crime, and anti-social behaviours, including prostitution, gambling, drug and alcohol use.

4.3.9 Cultural Heritage

The environment and cultural heritage are intrinsically linked in PNG where cultural heritage signifies the relationships between people and landscapes. This is due mainly to the high percentage of customary land ownership and subsistence lifestyles throughout the country.

Tangible cultural heritage values have a physical presence that can be seen or touched and include archaeological sites where physical remains of past cultural activity are present (e.g., pieces of pottery or shell on the ground surface), landscape features such as hills, caves and river mouths, individual trees or strands of vegetation or other landscape or biogeographic manifestations of spiritual, sacred or ritual significance. In addition, tangible cultural heritage values include movable material cultural items (e.g., ancestral heirlooms, traditionally made items used in day-to-day subsistence or leisure activities).

The ADB IP Safeguards (define tangible cultural heritage as physical manifestations of an indigenous community's cultural heritage, including movable or immovable objects, sites, structures, and remains of archaeological, architectural, historical, religious, spiritual, cultural, ecological, or aesthetic value or significance (ADB, 2013). They may also include natural features and landscapes, and be in urban or rural settings, above or below ground, or under water. Communities affected by commercial development of physical cultural resources include those using such resources for long-standing cultural practices or for those within living memory.

The vast range of beliefs, practices, traditions, and knowledge of IP are often referred to as intangible cultural resources, encompassing music, dance, language, crafts, belief systems, folklore and spiritual wisdom, medicinal and healing practices, ceremonies and intellectual knowledge. They are mainly transmitted from generation to generation and are constantly recreated by communities and groups in response to their environment, their interaction with nature and their historical conditions. They provide communities with a sense of identity and social continuity. Safeguarding such intangible cultural resources promotes and sustains cultural diversity (ADB, 2013).

There is currently only one World Heritage Site in PNG; the Kuk Early Agricultural Site consisting of some 116 ha of swamps in the western highlands. Archaeological excavation has revealed the landscape to be one of wetland reclamation worked almost continuously for possibly 10,000 years, with evidence of independent agricultural development and changes in agricultural practice over a long period of time (UNESCO, 2020a). Seven other sites are currently included in the tentative World Heritage List (UNESCO, 2020b) including:

- Kikori River Basin/Great Papuan Plateau in the Western and Southern Highlands Provinces of the Gulf region.
- Kokoda Track and Own Stanley Ranges in the Central and Oro Provinces.
- Trans-Fly Complex in the Western Province.
- Milne Bay Seascape (Pacific Jewels of Marine Biodiversity) located across Bramble Heaven, Conflict Group, Lunn Island, Jormard Island and Samarai Island.

- The Sublime Karsts of Papua New Guinea, East New Britain, Southern Highlands and Western Provinces.
- Upper Sepik River Basin, East and West Sepik Provinces.
- Huon Terraces – Stairway to the Past, Morobe Province.

These tentative World Heritage List sites consist of mixed cultural and natural significance providing resources for understanding landscape evolution, biological history and human occupation (UNESCO, 2020b).

Tangible and intangible heritage in PNG have national, regional and local significance, which is determined through consultation with knowledgeable communities and the consideration of rarity, representativeness of an historic period, the potential for the site to be scientifically informative, the preservation state and whether the site is vulnerable to destruction (Bowdler, 1984).

Examples of tangible and intangible heritage values relevant to PNG are described in Table 4.9, with two intangible values shown in Plates 4.10 and 4.11.

Table 4.9 – Types of Tangible and Intangible Cultural Heritage

Type	Description
Tangible Heritage	
Economic site	Place acknowledged as significant for economic reasons such as gardening, harvesting sago, hunting and making traditional tools.
Ossuary cave	Cave used for the interment of secondary burials and accompanying rituals.
Open burial site	Place used for various forms of open burial whether former incarnation, platform or fenced enclosure, Christian burial, or other form of interment.
Traditional canoes, spears/daggers, food bowls, masks, kundu (drums)	Traditional cultural materials used for economic, hunting/household/cooking and/or cultural purposes. May now be kept as ancestral heirlooms.
Shell ornaments	Shell rings, necklaces, breast plate, bride adornment (often used in bride price transactions) etc used for cultural purposes.
Stone and clay artefacts	Spear heads, pottery shards, stone tools, clay bowls, etc., used for various cultural purposes.
Intangible	
Language	There are over 10,000 different ethnic clans using over 850 distinct languages in Papua New Guinea with some now becoming extinct (Lewis, Simons & Fennig, 2016)
Masalai place and/or spirit site	Place that is the residence of or associated with a *masalai* or spirit.
Story/*tumbuna* site	Place that has a significant story, whether spiritual, mythological or historical.
Origin story site	Place associated with the origin of a particular group or thing, whether animal, plant or inanimate element (e.g., rock, stone, mountain, waterfall, etc).
Old settlement site	Location of former villages, which may contain burials (post-missionary period).
Spirits of the dead site	Place where the spirits of the dead reside.
Ritual/ceremonial site	Place at which significant rituals or ceremonies of various forms occurred.
Women's/men's places/sites	Place where specific women's or men's rituals or ceremonies of various forms occurred.

Table 4.9 – Types of Tangible and Intangible Cultural Heritage (cont'd)

Type	Description
Oral traditions and knowledge related to traditional medicines and subsistence activities	Ancestral knowledge passed onto family members, youth, etc., relating to traditional medicinal and subsistence practices.
Traditional song, dance and dress	Rituals and 'sing-sings' performed by various tribes throughout Papua New Guinea for various cultural purposes.
Sorcery and witchcraft	Known locally as *sanguma*, belief in sorcery exists across PNG and often results in accusations and violence.

Plate 4.10 – Traditional Dancing at Kaevaria, Gulf Province

Plate 4.11 – Spirit Site, Aivai, Gulf Province

5. Potential Impacts and Management Measures

5.1 Assessment Method

The approach to the identification and management of anticipated adverse impacts and benefits on environmental and socio-economic values or receptors[3] is based upon the approach described in the Company's environmental and social management system (ESMS)[4]. The ESMS establishes a preliminary list of risks and impacts associated with the Vodafone PNG mobile communications network. This list was developed based upon:

- ADB's policies and strategies including ADB's Safeguard Policy Statement (2009), Social Protection Strategy (2001), ADB Gender and Development Policy (1998) and Access to Information Policy (2019),
- Risk identification and assessment approaches described in the IFC ESMS Implementation Handbook – General (IFC, 2015).
- Hazards and risks for telecommunication projects described in the IFC EHS Guidelines for Telecommunications (IFC, 2007).
- Impact assessment undertaken by the Department of Communications and Information for the PNG Rural Communications Project[5] (DCI, 2010), which considered:
  - Impacts associated with the setting up of telecommunications systems (including construction of access roads, cell towers/antennas/mast erection, cable laying, telephone pole erection, and construction of buildings for telecentres).
  - Impacts associated with the operation and maintenance of the telecommunications systems, including energy consumption, maintenance of telephone exchanges systems and cables and the generation of hazardous wastes.
  - Impacts associated with decommissioning of telecommunications systems, including removal of infrastructure and management of waste.

The anticipated impacts discussed in this chapter use this preliminary list as a basis, and also consider:

- A desktop review of available information relevant to the Project design and alternatives, including those related to Year 0 activities in the areas where towers are located on greenfield sites under Indigenous Peoples/customary ownership.

[3] The individuals, organisations, groups or resources that can be affected by Project activities.
[4] Digitec Communications (Digitec) is the previous business name for Vodafone PNG.
[5] The PNG Rural Communications Project was a similar project to Vodafone PNG's proposed activities, involving rollout of a mobile telecommunications network in PNG. It also considered lessons from similar projects in other developing countries funded by the World Bank.

- Relevant current legislation (see Chapter 2).
- Pre-existing vulnerability of some groups within PNG communities (see Chapter 4).
- On-site observations and preliminary stakeholder feedback from site visits undertaken by ERIAS personnel and ADB representatives in November 2019.
- Audit undertaken and corrective action plan prepared by ERIAS to identify Project requirements to comply with ADB's Safeguard Policy Statement and other applicable policy requirements, national regulations and international treaties pertaining to environment, health, safety, social and labour (ERIAS, 2020).
- Stakeholder engagement activities being undertaken by Vodafone PNG.
- ERIAS' extensive experience working in PNG.

Project activities that could result in predictable direct and indirect impacts or benefits were considered for all Project phases, as follows:

- Pre-construction (site screening, selection and acquisition).
- Construction.
- Operations.
- Decommissioning.

Potential trans-boundary and cumulative impacts were also considered.

5.2 Potential Impact Summary

Overall, the impact of the Project will be highly beneficial for Papua New Guineans, as it will improve mobile service in areas of the country where it is currently limited, and increase competition in other areas, resulting in lower costs and better service. Improved mobile and internet services will bring economic opportunities and social benefits, such as improved access to health and education services. Potential adverse impacts such as land clearing and associated impacts on biodiversity and land use changes are minimal to negligible, given the procedures in place to preferentially select and develop sites in populated areas and/or where towers already exist, and the small footprints required for this infrastructure. No net loss of biodiversity is anticipated, through establishment of offsets if necessary for any impacts on natural habitat. Waste and emissions are also negligible. With the implementation of appropriate management measures, cumulative impacts with other existing and nearby telecom towers, or trans-boundary impacts, are not anticipated.

Site selection for towers will avoid areas that may cause significant environmental or social impacts, including noise, air quality, landform and soils, water resources, terrestrial biological resources, cultural and historical land uses, and aesthetic and visual. In particular, sensitive sites such as biodiversity protected areas that may trigger Category A project categorisation under ADB Safeguard Requirements and therefore require further detailed environmental and social impact assessment and approval will be avoided.

Rooftop sites and monopole masts or towers in urban areas present fewer environmental and social constraints compared to greenfield sites, as they tend to be placed in less sensitive commercial and industrial urban areas (i.e., hotel, office, apartment, industry roofs), and are located with other transmission and services operations. Nonetheless, potential issues in relation to noise, visual amenity and EMF in relation to nearby sensitive receptors require consideration.

For greenfield sites in rural areas, land acquisition for construction of towers and access roads has the potential to restrict customary land uses and have adverse impacts on local communities of Indigenous Peoples, i.e., loss of/damage to assets, restricted access to resources or reduced amenity. Land use changes and benefits distribution can also trigger disputes within affected communities and reduce community cohesion, particularly in rural, remote areas with minimal experience of development. Site selection on customary land will be through voluntary agreements with landowners and consultation with the affected communities of Indigenous Peoples. No Project activity will take place on land where the ownership is under dispute or community members do not support changes in land use. A 'Site Selection and Acquisition Procedure' (Appendix 1) has been developed to guide site selection at each tower site and assess environmental and social suitability.

Table 5.1 summarises the identified potential environmental and socio-economic impacts related to all phases of the Project.

Table 5.1 – Potential Impacts

Activity/Aspect	Project Phase	Potential Impact, Risk or Benefit
Environmental		
Site clearance; Construction of roads	Construction, operations	Terrestrial habitat loss or degradation and associated loss of biodiversity
Site clearance; Construction of towers and supporting infrastructure; Project traffic	Construction	Introduction or spread of invasive species
Operation of towers	Operations	Harm to fauna from electromagnetic radiation
Construction of towers and supporting infrastructure; Operation of towers	Construction, operations	Noise disturbance to fauna
Operation of towers	Operations	Harm to avifauna due to tower bird strikes
Site clearance; Construction of towers and supporting infrastructure; Operation of towers	Construction, operations, decommissioning	Alteration of aquatic habitats
Construction of towers and supporting infrastructure; Transport, storage, use and disposal of hazardous materials	Construction, operations, decommissioning	Accidental spills or leaks of hazardous materials
Project traffic; Construction of towers and supporting infrastructure; operation of towers	Construction, operations	Reduced air quality
Consumption of energy and resources	Construction, operations	Energy use and waste generation
Socio-economic and Cultural		
Land access	Pre-construction	Change of land use and loss of community access to land
Land access; Project employment and procurement	Construction, operations	Increased revenue, employment and on-job training for local communities

Table 5.1 – Potential Impacts (cont'd)

Activity/Aspect	Project Phase	Potential Impact or Benefit
Land access; Construction of towers and supporting infrastructure	Construction	Loss or damage to archaeological or cultural heritage values
Land access; Construction of towers and supporting infrastructure; Equipment maintenance	Construction, operations	Decline in intangible heritage values (e.g., local languages, traditional knowledge and practices)
Land access; Construction of towers and supporting infrastructure; Transport, storage, use and disposal of hazardous materials	Construction, operations, decommissioning	Economic displacement resulting from loss of subsistence resources or income
Construction of towers and supporting infrastructure	Construction, operations	Reduction in visual amenity due to towers and landscape changes
Construction of towers and supporting infrastructure	Construction, operations	Reduction in amenity from noise emissions
Transport, storage, use and disposal of hazardous materials; Project traffic; Workforce (fly camps); Electromagnetic fields (EMF); Site access and security; Operation of towers	All phases	Risks to community and workforce health and safety including: • Increased accidents and injuries • Increased incidence of communicable diseases or malaria • Exposure to hazardous materials or waste • Exposure to/spread of COVID-19
Operation of towers	Operations	Reduction in community and workforce health from EMF
Land access; Project employment and procurement; Workforce (fly camps), Construction of towers and supporting infrastructure	Pre-construction, construction	Reduction in community cohesion resulting from: • Lease benefits distribution • Landowners or local communities not being properly consulted • In-migration/influx of people looking for employment opportunities • Increased use of alcohol and drugs and associated anti-social behaviour
Project employment and procurement	All phases	Workplace discrimination and exclusion of minorities and women
Telecommunications network operation	Operations	Increased access to telecommunications services, and associated economic, health and education benefits for local communities

Section 5.3 below further describes the potential environmental, socio-economic and cultural impacts and benefits resulting from the Project. It also identifies the management measures proposed to be implemented to mitigate or minimise impacts and support the realisation of benefits. Beneficial measures that will contribute toward long-term social capital and sustainable development will be implemented through the Vodafone PNG CSR Plan (Appendix 4).

Management measures, including beneficial measures, are allocated a unique reference number (e.g., MM01, MM02, etc) to aid with tracking of measures, incorporation into the ESMS, site management plans and contracts.

5.3 Potential Impacts and Management Measures

5.3.1 Environmental

5.3.1.1 Terrestrial Habitat Loss or Degradation and Associated Loss of Biodiversity

The immediate impact of vegetation clearing is habitat loss and associated loss of terrestrial biodiversity by reducing the carrying capacity in the local landscape (Weigand et al., 2005). Vegetation clearing can also alter ecosystems through barrier and edge effects. Barrier effects are caused when cleared habitat creates a barrier to the movement of fauna, causing fragmentation or restricting access to important resources (e.g., water source). Edge effects occur from cleared habitat having a marked effect on adjacent non-cleared habitat. Edge environments are more susceptible to burning, desiccation and the establishment of invasive species (Laurance & Bierregaard, 1997; Oliveira et al., 2004). Construction of new access roads also has the potential to open up forested areas to increased hunting and vegetation removal.

Tower sites are to be preferentially located in areas with existing towers and road access, and where land is unused, minimally used or degraded rather than forests and land used for agriculture. The main land type that will be converted to telecommunications use is ridgeline supporting grassland with scattered trees. Other land types that are affected to a lesser degree are cultivation and plantations. Clearing of forested areas is expected to be required for a minor number of tower sites.

Most tower sites will utilise existing roads as much as practicable (see Section 3.1.2.2), which will minimise the area of vegetation clearing required. However, certain sites may require construction of an access road (typically approximately 500 m long, but possibly up to 2,500 m long, and 4 m wide; representing an area of 2,000 m^2). Helicopter landing pads may also need to be cleared and maintained at sites inaccessible by road. The land area required for each tower type is provided in Table 3.1, with the area being less than 250 m^2 for most sites. During construction only, additional land may be temporarily required at each site to provide a laydown area and to establish a small workforce camp in rural areas. Less than 1,000 m^2 of ground is temporarily required for this purpose.

A ‘Site Selection and Acquisition Procedure’ (see Appendix 1) has been developed under Vodafone PNG’s ESMS to guide site selection at each site and assess environmental and social suitability. Areas already converted from natural habitat are preferred for greenfield sites, especially where access roads and existent infrastructure are available. Sites will be avoided in sensitive areas for biodiversity, such as critical habitat (e.g., for threatened species or of special significance for endemic or restricted-range flora and fauna). In particular, sites that may trigger Category A project categorisation under ADB Safeguard Requirements (such as protected areas) and Alliance for Zero Extinction (AZE) sites; see Section 4.2.8.4) will be considered 'no go’ areas that are screened out during the site selection process. Sites proposed to be located in Key Biodiversity Areas (KBAs) that are not recognised as AZEs will also be assessed for risk to critical habitat. Siting in areas of natural habitat or habitat in KBAs will trigger further assessment (as described in the Site Selection and Acquisition Procedure) to establish if additional management measures are required or significant adverse impacts are anticipated and it is therefore to be considered a 'no go’ area.

Management measures to be implemented to avoid and minimise impacts on terrestrial habitat and biodiversity due to vegetation clearing include (but are not limited to):

- Avoid locating towers in sensitive areas for biodiversity, such as critical habitat (e.g., for threatened species or of special significance for endemic or restricted-range flora and fauna). Locations that may trigger Category A impacts as defined under ADB Safeguard Requirements are considered 'no go' areas. This includes, but is not limited to, PNG Protected Areas, Alliance for Zero Extinction (AZE) sites and locations in close proximity to wetlands. Assessment is to be undertaken of any proposed sites located in natural habitat or Key Biodiversity Areas (KBAs) to assess potential risks to natural and critical habitat and whether additional management measures are required or the site is be avoided to comply with ADB Safeguard Requirements (MM001).
- Preferentially locate tower sites in areas with existing towers and road access, and where land is unused, minimally used or degraded rather than forests and land used for agriculture (MM002).
- Minimise the area disturbed around each tower site and along access roads to that required for safe construction activities (MM003).
- Consider the routing of any new access roads and install locked gates to avoid induced impacts such as increased access for hunting and vegetation removal (MM004).
- Clearly demarcate the works, including the extent of the site to be disturbed. Train construction workers in environmental management requirements (MM005).
- Where tree removal is necessary for road construction, limit damage to surrounding habitats by felling trees away from existing stands where practicable. Consider bird nesting seasons when scheduling tree removal (MM006).
- Limit work vehicles and machinery to designated access and work site areas (MM007).
- Limit the road surface width to 4 m and cut and fill batters to the minimum area required (MM008).
- Where practicable, stockpile cleared vegetation in a manner that facilitates respreading or salvaging, e.g., place on one side of cleared areas (MM009).
- Undertake site reinstatement promptly and progressively as works are staged and as soon as practicable after disturbance (MM010).
- Revegetate disturbed areas using native species, where required (MM011).

5.3.1.2 Introduction or Spread of Invasive Alien Species

Importing and transporting personnel, materials, equipment or machinery has the potential to introduce new, or contribute to the spread of existing invasive alien weed species. Areas of environmental disturbance (such as cleared sites) provide optimal conditions for the establishment of most invasive alien weed species. Mismanagement of waste (such as food waste at construction camps) can attract vermin fauna species and contribute to their population

growth. The potential for introduction and spread of invasive alien species will be greatest during mobilisation of equipment and personnel during early construction.

Management measures to minimise impacts on terrestrial biodiversity due to introduction or spread of invasive alien species include:

- Inspect equipment arriving on site to ensure that it is clean and free from soil or vegetative matter (MM012).
- Train and induct Project personnel in identifying invasive alien species and relevant control measures (MM013).
- Inspect regularly for the presence of weeds around the camp site and, when encountered, use appropriate control measures (hand pulling, spraying) (MM014).
- Construction contractor to develop and implement effective waste management procedures (MM015).

5.3.1.3 Electromagnetic Field Radiation

Electromagnetic fields (EMF) are areas of energy (or radiation) associated with the use of electrical power. This is a low frequency non-ionising radiation type which is generally regarded as harmless due to its lack of potency. Radio waves and microwaves emitted by transmitting antennae of base transceiver stations are also a form of electromagnetic energy at the lower end of the non-ionising radiation spectrum. The ecological impacts of electromagnetic field radiation is an emerging field of study, and impacts are as yet unclear (Redlarski et al. 2015). No clear dose-response relationship for ecological impacts has been established at environmentally relevant exposure levels (such as those emitted by towers). However, the International Commission on Non-Ionizing Radiation Protection (ICNIRP) has created reference levels for safe exposure of humans, which have been adopted by the IFC (see Section 2.3.4). Health effects from EMF to human communities are addressed in Section 5.3.2.9.

5.3.1.4 Noise Disturbance to Fauna

Noise disturbances may displace taxa that communicate acoustically, including birds, bats and frogs (Parris, 2015).

Construction noise will be generated from land clearing and earth moving equipment, from vehicle movements and in some locations, from helicopters. All of these activities will occur over a short period of time, depending on the tower size and access requirements.

Operational noise will primarily come from the operation of the diesel-powered generators at facilities not connected to mains power (which will operate for approximately 16 hours per day between battery runtime), or where backup power is required, and the occasional movement of vehicles transporting maintenance staff or equipment. Most of the increase in noise disturbance will be localised in areas that are already subject to this form of disturbance from nearby existing towers.

Management measures to minimise disturbance of fauna due to noise from Project activities and facilities include:

- Restrict construction activities to daylight hours (MM017).
- Monitor noise levels to make sure noise from construction activities are within relevant limits (MM018).
- Consider installing solar panels to minimise generator use and associated noise and emissions (MM019).
- Maintain construction vehicles and equipment in order to limit emissions (including noise) and remove from service any equipment from which emissions are visibly excessive (MM020).
- House generators in noise reduction panelling walls with noise dampening insulation (MM021).
- Preferentially use fuel-efficient diesel generators (MM022).

5.3.1.5 Harm to Avifauna due to Tower Bird Strikes

Communication towers are a significant cause of global avian disturbance and population loss. Approximately 6.8 million birds in the U.S and Canada are killed each year from entanglement in guy wires and, to a lesser extent, collisions with towers (Longcore et al., 2012a). Artificial light on towers appears to be a key attractant for birds. Artificial lights can disrupt avian internal navigation systems, causing them to circle towers continuously and eventually become entangled in the guy wires or collide with the tower or other birds (Longcore et al., 2012b). This issue is exacerbated in foggy conditions or along migration routes that have a high volume of birds (Manville, 2005). The number of bird kills has a strong positive association with tower height (i.e., taller towers kill more birds) (Manville, 2005). Longcore et al. (2012a) found that towers taller than 300 m accounted for over two-thirds of estimated mortality, while only accounting for 1.6% of total towers.

The transmission towers to be installed for the Project are much shorter than those typically associated with high rates of bird strike, with the majority of towers being less than 50 m high (see Table 3.1). No towers will be constructed using guy wires. Towers will also not be lit (apart from security lighting at ground level) unless required by PNG Civil Aviation Rules (CASA, 2017) due to their proximity to airports. Where lights are required, these will be flashing lights rather than steady state, which can reduce bird collisions by up to 70% (Longcore et al., 2012a). Avian migration patterns in PNG are poorly understood, although the largest aggregations of migrants occur near wetlands, coasts or estuaries. As shown in Figure 3.2, most sites are situated in inland areas and locating of sites near wetlands and important biodiversity areas, including protected areas, is to be avoided.

Management measures to minimise harm to avifauna due to tower bird strikes include:

- Avoid locating towers and any new access roads in sensitive areas for biodiversity, such as critical habitat (e.g., for threatened species or of special significance for endemic or restricted-range flora and fauna). Locations that may trigger Category A project categorisation under ADB Safeguard Requirements are considered 'no go' areas. This includes, but is not limited to, PNG Protected Areas, Alliance for Zero Extinction (AZE) sites and locations in close proximity to wetlands. Assessment is to be undertaken of any proposed sites located in natural habitat or Key Biodiversity Areas (KBAs) to assess

potential risks to natural and critical habitat and whether additional management measures are required or the site is be avoided to comply with ADB Safeguard Requirements (MM001).

- No towers are to be constructed using permanent guy wires (MM023).
- Minimise number of towers by co-locating antennae on existing towers or other fixed structures where practicable, designing new towers to accommodate future users, and removing towers no longer in use (MM024).
- Avoid the use of lights on towers unless required by PNG law for aviation safety. When required, lights should be flashing rather than steady state. Steady state security lights, if required, will be installed at <8 m height, and directed downwards, to reduce attraction to birds (MM025).

5.3.1.6 Alteration of Aquatic Habitats

Vegetation clearing and spoil stockpiling will be required for tower site preparation works. The majority of towers will have a base system that provides self-standing, self-supporting, rapid-deployable features and eliminates the need for a permanent foundation for the tower. The steel base requires the removal of 0.5 to 1 m of topsoil, which will then be reused to backfill the base.

Vegetation clearing and earth disturbance will also occur where new access roads are required to access tower sites. Existing access roads may also need upgrading to improve access. Stream crossings may be required for some access roads which potentially may alter aquatic habitat and create a barrier to fish movements.

Cleared areas (such as tower sites and access roads) and spoil stockpiles are more susceptible to erosion from rainfall. The exposure and disturbance of soil and stockpiling of spoil may lead to soil being eroded and mobilised to nearby surface water bodies. This could lead to a deterioration of aquatic habitat due to sedimentation and a decline in water quality through increased levels of suspended sediment and turbidity if disturbed areas are not appropriately managed.

Water quality of surface streams may also potentially be impacted by accidental spills or leaks of hydrocarbons, particularly from handling and storage of diesel and lubricants required for generators. Management measures to mitigate impacts due to accidental spills or leaks of hazardous materials, resulting in soil, groundwater or surface water contamination, are described in Section 5.3.1.7. Greenfield towers sites in rural areas will be situated on ridge lines and hill tops to optimise signal transmission range, hence will not be in close proximity to watercourses. Impacts on surface water streams due to any accidental spills of leaks during handling and storage of hydrocarbons at tower sites are therefore expected to be minimal.

Wastes generated by Project activities, if poorly managed, also have the potential to result in contamination of surface waters. As described in Section 3.3.2, the construction contractor is responsible for removing all waste materials generated during tower construction from the site for disposal or recycling as appropriate. Temporary accommodation camps required for construction shall have appropriate toilet facilities, usually consisting of simple pit latrines.

Waste from facility operation, including filters and used oil from generators, and BTS components replaced during maintenance and repair, is also to be removed from site and disposed at approved facilities.

Management measures to minimise the alteration of aquatic habitats and impacts to aquatic fauna include (but are not limited to):

- Avoid locating towers and any new access roads in sensitive areas for biodiversity, such as critical habitat (e.g., for threatened species or of special significance for endemic or restricted-range flora and fauna). Locations that may trigger Category A project categorisation under ADB Safeguard Requirements are considered 'no go' areas. This includes but is not limited to PNG Protected Areas, Alliance for Zero Extinction (AZE) sites and locations in close proximity to wetlands. Assessment is to be undertaken of any proposed sites located in natural habitat or Key Biodiversity Areas (KBAs) to assess potential risks to natural and critical habitat and whether additional management measures are required or the site is be avoided to comply with ADB Safeguard Requirements (MM001).
- Preferentially locate tower sites in areas with existing towers and road access, and where land is unused, minimally used or degraded rather than forests and land used for agriculture (MM002).
- Avoid the selection of sites close to water bodies (creeks/rivers, floodplains, wetlands, coastal areas) and maintain a minimum buffer zone from such features where practicable (e.g., except where stream crossings are required for new access roads) (MM076).
- Minimise the area disturbed around each tower site and along access roads to that required for safe construction activities (MM003).
- Limit gradients of access roads to reduce runoff-induced erosion (MM026).
- Install temporary and permanent erosion and sediment control measures, slope stabilisation measures, and subsidence control and minimisation measures at all construction sites, as necessary (MM027).
- Maintain fish access when road crossings of watercourses are unavoidable by utilising clearspan bridges, open-bottom culverts, or other approved methods (MM028).
- Minimise clearing and disruption to riparian vegetation (MM029).
- Undertake site reinstatement promptly and progressively as works are staged and as soon as practicable after disturbance (MM010).
- Provide portable toilets or appropriately constructed pit latrines at temporary construction camps that are appropriately located away from groundwater and surface waterbodies (MM030).
- Domestic and industrial waste materials generated during site construction, operations and decommissioning are to be recycled where possible or disposed at appropriate

landfill facilities (in accordance with DEC Environment Code of Practice for Sanitary Landfill Sites, DEC 2000) (MM031).

- No temporary camp domestic or industrial wastewater is to be discharged into the environment without CEPA approval (MM126).

5.3.1.7 Accidental Spills and Leaks of Hazardous Materials

During construction, the Project will require the transportation of fuels and other hazardous materials (e.g., lubricating oils, hydraulic fluids, coolants, solvents, cleaning agents, batteries) to sites to use during construction to operate machinery and equipment. For sites where connection to the electricity grid is unavailable, diesel-powered generators (gensets) will be used to power towers. Depending on the site location and ease of access, diesel for gensets will be stored in 600 L tanks, but using 1,000 L or 2,000 L tanks at some sites (see Section 3.3.3.1), in secure surrounds. The fuel tanks will be refilled every two to three months in remote locations and more frequently in urban areas.

Accidentals spills and leaks of fuel, oil or chemicals may contaminate soil, groundwater and/or surface waters if not prevented or contained. Such contamination may have impacts on terrestrial and aquatic fauna and flora and present a health risk to local communities.

Management measures to minimise or prevent impacts due to accidental spills or leaks of hazardous materials include:

- Avoid or minimise use of hazardous materials (MM032).
- Ban the use of chemicals and hazardous materials subject to international bans or phase-outs (MM033).
- Provide secondary containment, drip trays or other overflow or containment measures for hazardous material containers at connection points or other possible overflow points (MM034).
- Clearly label vessels with name or description of hazardous material and have accessible relevant safety data sheets (MM035).
- Regularly inspect integrity of all storage tanks and bunds for leaks and flaws (MM036).
- Spill kits appropriate to the spill risk are to be available at each work site and vehicles as necessary. All fuel tankers and vehicles transporting hazardous materials shall carry appropriate spill kits (MM037).
- Train personnel in the handling, transportation and storage of hazardous materials, and spill response procedures, including conduct of drills (MM038).
- Prohibit wash-down or fuel handling near streams (MM039).
- During site decommissioning, examine soil for any evidence of hydrocarbon contamination, and remove/treat soil as appropriate (MM040).

- Ensure temporary fuel storage tanks are bunded according to specifications in *Australian Standards–AS 1940* (MM127).
- Store hazardous materials in accordance with manufacturer's recommendations MM128).
- Ensure temporary workshop activities and fuel storage facilities comply with minimum requirements in *DEC Environmental Code of Practice for Vehicle/Machinery & Petroleum (Hydrocarbons) Storage/Resale/Usage Site, DEC 2000* (MM129).
- Ensure waste oil and other potentially hazardous materials are adequately treated and disposed of at an approved industrial waste facility (MM130).

5.3.1.8 Reduced Air Quality

The Project has the potential to impact human health, amenity and vegetation from the emission to the atmosphere of gaseous and particulate matter generated by the operation of machinery and equipment (e.g., vegetation clearing and roadworks), materials and personnel transport, and fuel and energy consumption for telecommunication network operation.

The main sources of emissions to air will be the operation of diesel generators at towers not connected to mains power or powered by solar, and vehicle and machinery movements during construction and maintenance of facilities. Emissions from generators and vehicles include carbon monoxide (CO), carbon dioxide (CO_2) and oxides of nitrogen (NO_x). Emissions of CO, CO_2, and NO_x can adversely impact human health by irritating the airways of the lungs, also aggravating asthma and other existing respiratory illnesses, and increasing the incidence of acute respiratory illness in children.

These emissions are also greenhouse gases (GHGs) that are a primary driver of climate change (through enhancement of the greenhouse effect). Potential impacts of climate change include increased risk of drought, flooding and fire, increased risk of natural hazards, change in ecosystem processes including vegetation and species assembly, and increased illness from vector-borne diseases and heat stress. The Project's GHG emissions will contribute to PNG's national emissions and global anthropogenic greenhouse gas emissions and will impact on the PNG government's ability to comply with its National Climate Compatible Development Management Policy (CCDA, 2014) and to meet its international obligations under the 2016 Paris Climate Change Agreement.

Dust may also be generated during construction of tower sites and access roads and by vehicles movements for tower maintenance in dryer regions and times of the year. Fugitive dust can settle on leaves, blocking sunlight and disrupting photosynthetic and respiratory processes, thereby damaging nearby vegetation. However, impacts from dust deposition are usually temporary, and washed away during rainfall events, which are a frequent occurrence in PNG.

Management measures to minimise the reduction in air quality due to emissions from construction machinery, diesel-powered generators and vehicle fleet, or fugitive dust emissions include:

- Ensure air emissions comply with Project criteria (see Section 2.3.4) (MM041).
- Preferentially use fuel-efficient diesel generators (MM022).

- Consider installing solar panels to minimise generator use and associated noise and emissions (MM019).
- Regularly service diesel powered equipment, including generators, and use low-sulfur diesel where practicable (MM042).
- Maintain construction vehicles and equipment in order to limit emissions (including noise) and remove from service any equipment from which emissions are visibly excessive (MM020).
- Use cleared vegetation where practicable for dust control and reinstatement (MM043).

5.3.1.9 Energy Use and Waste Generation

In addition to the gases described in Section 5.3.1.8, the Project will also contribute to PNG's national GHG emissions through electricity use. The Project will consume electricity in offices and from powering transmission towers and fixed equipment at sites on the electricity grid. The Project will also generate office wastes from consumption of resources, such as water, paper and plastics. Wastes can increase PNG's GHG emissions from methane in landfills (for biodegradable wastes) and from indirect emissions associated with waste processing and transport. Waste from transmission tower operation, including filters and used oil from generators, and BTS components replaced during maintenance and repair will also require appropriate management.

Management measures to minimise the Project's electricity use and waste generation consider the waste management hierarchy of reduce, reuse, recycle, recover and dispose, and include:

- Develop procedures for energy usage reduction in office buildings, such as:
  - Switching off lights when not in use.
  - Using energy efficient light bulbs in offices (e.g., LED bulbs).
  - Consider energy efficiency when purchasing new equipment.
  - Performing regular maintenance of office cooling systems (MM044).
- Design buildings to minimise the need for artificial lighting and insulate buildings where practicable (MM045).
- Monitor energy use to identify areas of inefficiency or high consumption (MM046).
- Raise awareness of employees and contractors of opportunities and benefits of energy saving and the impacts of climate change (MM047).
- Develop procedures incorporating waste minimisation principals (reduce, reuse/recycle, treatment and disposal) to minimise waste generation and disposal, such as:
  - Adopting paperless technology, where practicable.
  - Segregating wastes for reuse, recycling and disposal.
  - Conducting regular audits of waste generation (MM048).

- Domestic and industrial waste materials generated during site construction, operations and decommissioning are to be recycled where possible or disposed at appropriate landfill facilities (in accordance with DEC Environment Code of Practice for Sanitary Landfill Sites, DEC 2000) (MM031).

5.3.2 Socio-economic and Cultural

5.3.2.1 Change of Land Use and Loss of Community Access to Land

Where possible, towers will be co-located on land with existing telecommunications infrastructure rather than on greenfield (i.e., previously undeveloped) sites. This is to preferentially avoid as much as possible any adverse impacts on Indigenous Peoples.

Land use changes are therefore applicable only to greenfield towers constructed on customary land which has not already been leased for development of telecommunications or similar infrastructure. The main land type that will be converted to telecommunications use is ridgeline supporting grassland with scattered trees. Other land types that are affected to a lesser degree are cultivation and plantations.

As described in Section 3.1.2, each greenfield tower site will require less than 1,000 m^2 (0.1 ha) for the tower site and 2,000 m^2, on average, if an access road is required to be constructed (assuming a 500 m long road of 4 m width). During construction only, additional land may be temporarily required at each site to provide a laydown area and to establish a small workforce camp. Less than 1,000 m^2 of ground is temporarily required for this purpose.

A long-term change in land use and a potential loss of community access to land will result from land use transfer for tower construction and access roads. A temporary change in land use will result from the temporary storage of tower components and facility equipment and a temporary workforce camp, where required.

Management measures to minimise the impacts of a change in land use include:

- Preferentially locate tower sites in areas with existing towers and road access, and where land is unused, minimally used or degraded rather than forests and land used for agriculture (MM002).
- Implement the ‘Site Selection and Acquisition Procedure’ to ensure consultation is undertaken with affected communities and change in land use is supported (MM049).
- Prior to any site works, document the state of the land/premises and adjoining area, including photographs of the existing condition of the land (MM050).
- Limit the road surface width to 4 m and cut and fill batters to the minimum area required (MM008).
- Minimise the area disturbed around each tower site to that required for safe construction activities (MM003).
- Clearly demarcate the works, including the extent of the site to be disturbed (MM040).

- Preference the installation of smaller (18 to 30 m high, infill) towers in populated and coastal areas, and larger (>60 m high) towers in remote, less populated areas, minimising the land required in populated areas (MM051).
- Support capacity building programs aimed at enhancing national and local government capacity to foster diversified economic growth and their capacity to deliver local public services (MM052).

5.3.2.2 Increased Revenue, Employment and On-job Training Opportunities

Local communities (including Indigenous Peoples) and businesses will benefit from the Project by receiving revenue from lease payments for the use of land or rooftop space. There will also be employment opportunities for local communities through short-term construction jobs and training, and longer-term employment opportunities for PNG nationals in ICT technology, retail, business administration, human resources and project management (as examples), with 761 positions to be filled in Year 1 (see Table 3.3).

Tower construction typically takes from four to six weeks for small to medium-size towers (up to 45 m high) and up to three to four months for taller towers over 60 m high in remote areas where new access roads and or helipads are required. The construction crew typically comprises up to 10 skilled workers (site engineer/supervisor and riggers), and an additional 10 to 20 unskilled workers, recruited from local communities to assist with ground clearing, security and other general labour as required. This will provide Papua New Guineans, including people from local communities with short-term employment and on-job training opportunities, such as undertaking safe work practices and implementing basic environmental management protocols. Local communities may also be able to provide services such as accommodation (where available) to the Project workforce (employees and contractors) and there may also be an increase in local sales of garden produce, betel nut and cooked foods during construction.

During operations, there will be fewer employment local opportunities; however, site maintenance tasks such as grass-cutting, access road maintenance and security will provide some ongoing income over the tower life for people living in rural areas in particular. Revenue from lease payments and compensation will continue throughout operations.

Business and building owners in urban areas will benefit from lease payments made over the life of Project to host the telecommunications infrastructure and for office space in Port Moresby.

The expansion of PNG's telecommunications network can also support increased economic growth and development and help to reduce poverty. For example, a study of mobile telephony and data from 113 countries over a 20-year period, showed that a 1% increase in the telecommunications penetration rate leads to a 0.03% increase in GDP (Torero and von Braun, 2006).

Without management interventions, employment opportunities for women and Indigenous Peoples from rural communities where greenfield towers are located may be limited due to existing cultural gender norms and inequalities and lack of training.

Management and beneficial measures to support increased revenue, employment and on-job training for Papua New Guineans include:

- Undertake engagement and consultation with customary landowners[6] to negotiate and agree terms of customary land lease in accordance to legal requirements (MM053).
- Where land ownership is unknown, prepare a Land Investigation Report (LIR) to establish land ownership before proceeding with leasing negotiations (MM054).
- Map customary land assets (including natural resources, i.e., trees, crops) for compensation under the Valuer Generals Compensation Schedule 2013 (MM055).
- Engage with building/landowners to negotiate and agree terms of rooftop or land lease (MM056).
- Where possible, procure goods and services from local suppliers, including Incorporated Landowner Groups (ILGs) (MM057).
- Maximise the employment of people from local communities surrounding tower locations during construction and operations/maintenance, including the adoption of recruitment targets for women and Indigenous Peoples (MM058).
- Establish and maintain national content targets to maximise the employment and contracting of national citizens over the life of Project (MM059).
- Develop and deliver internships and/or training opportunities with the Project or its contractors specifically focusing on transferable, nationally recognised trade skill development (MM060).
- Provide local community representatives with basic training in site maintenance (cutting grass) and in monitoring security of the site (reporting alarms) during operations (MM061).
- Provide local community labourers with basic training in safe work practices and environmental management protocols during construction (MM062).
- Implement Company policies and the Company Code of Conduct that provide for equality in employment and appropriate workplace behaviour towards women and minority groups (MM063).
- Incorporate measures in supplier contracts and inductions to protect the rights of women and children, particularly in local Indigenous communities (MM064).
- Identify employment or other sustainable business opportunities for women from local communities in consultation with women's groups and potentially NGOs (MM065).

6 Company will enter negotiated agreements only with customary landowners who can demonstrate legal title to land and there is no ownership dispute.

5.3.2.3 Loss or Damage to Archaeological or Cultural Heritage Values

The Project has the potential to inadvertently impact tangible cultural heritage values through land clearing and associated damage to any archaeological materials disturbed during construction, and a change in land use leading to a loss of community access.

Management measures to minimise Project impacts on tangible cultural heritage include:

- Undertake engagement and consultation with customary landowners to identify local heritage sites and values (MM066).
- Implement the 'Site Selection and Acquisition Procedure' to avoid the selection of sites identified by customary landowners as having cultural heritage values or significance that may trigger Category A project categorisation under ADB Safeguard Requirements requiring additional assessment, approval and management, and to avoid impacts on areas of cultural heritage significance more generally (MM067).
- Avoid the selection of sites identified by customary landowners or the DLPP as having cultural heritage values or significance that may trigger Category A project categorisation under ADB Safeguard Requirements requiring additional assessment, approval and management (MM068).
- At new greenfield sites (i.e., those not co-located with existing ICT infrastructure), and based on an assessment of risk, consider liaising with the PNG National Museum and Art Gallery (NMAG) to inform site selection (MM069).
- Develop and implement a Chance Finds Procedure which includes measures for dealing with any skeletal material encountered during site disturbance activities (MM070).
- Develop and implement training for construction workers in Cultural Heritage identification and the Chance Finds Procedure before disturbance activities commence (MM071).

5.3.2.4 Decline in Intangible Heritage Values

Interactions with the construction workforce, Company representatives during the Project lifetime and leaders from neighbouring clans can contribute to a gradual and ongoing decline in intangible heritage, such as use of local language (and increased use of *Tok Pisin*), traditional knowledge and practices (such as use of traditional spirit sites, use of traditional medicine etc). This may be further exacerbated if in-migration results from the prospects of employment during tower construction.

Management and beneficial measures to minimise Project impacts on, and support the maintenance of, intangible cultural heritage include:

- Discourage Project workforce interactions with local communities during construction and operations by implementing community interaction protocols (MM072).
- Support local intangible heritage programs (e.g., providing financial or other assistance to support local cultural festivals) (MM073).

5.3.2.5 Economic Displacement Resulting from Loss of Subsistence Resources or Income

There is the potential for construction activities to temporarily disrupt income-generating activities or access to subsistence resources. For example, if not appropriately managed, construction traffic could temporarily block access to the markets on market day, resulting in a loss of income for stall holders.

In rural settings, gardens, plantations and wild foods are important resources for livelihoods and subsistence and may be adversely impacted by land clearing and a change in land use. Economic displacement may result where there is a loss of income or livelihood resulting from land acquisition or construction activities.

Most communities in PNG do not have access to piped domestic water, and rely on local rivers or streams, rainwater collection or groundwater. If the Project adversely impacts on fresh water supplies, this could also cause economic displacement and contribute to WASH-related health issues (see Section 4.3.6.1). As such, impacts on fresh water supplies and water bodies will be avoided.

Management and beneficial measures to minimise economic displacement and support sustainable economic development include:

- Implement the 'Site Selection and Acquisition Procedure' to ensure consultation is undertaken with customary landowners, businesses and local communities to identify economic activities and subsistence resources relevant to each tower site (MM074).
- Manage construction activities to avoid disruption of identified income-generating and subsistence activities and resources (MM075).
- Avoid the selection of sites close to water bodies (creeks/rivers, floodplains, wetlands, coastal areas) and maintain a minimum buffer zone from such features where practicable (e.g., except where stream crossings are required for new access roads) (MM076).
- Map customary land assets (including natural resources, i.e., trees, crops) for compensation under the Valuer-General Compensation Schedule 2013 (MM055).
- Deliver sustainable development and economic empowerment programs in locations identified as in need of additional support for livelihood maintenance (e.g., fresh water supply, agri-business training and development, etc.) (MM077).

5.3.2.6 Reduction in Visual Amenity due to Towers and Landscape Changes

Visual amenity is subjective, as it represents an individual's perception of the new structure and the aesthetic value of a landscape in which it is located. In most greenfield locations, towers will be co-located with existing telecommunications infrastructure, where the landscape and visual amenity will change only minimally. In other locations, new sites will need to be cleared and the existing land use will change. The installation of a visible tower, particularly if it is within an otherwise largely 'natural' landscape (i.e., one containing few or no other built structures) and located on a ridgeline to maximise signal coverage, could be perceived by some viewers as having a negative visual impact.

Where towers are located in urban or semi-urban areas and form part of a broader built landscape, the aesthetic value of that landscape may be perceived as lower and the impact of an additional structure is likely to have a minimal or negligible visual impact, at least on a landscape scale. There may be perceived visual impacts at an individual scale, as residents and businesses may have a changed view from a window or from the street view.

Management measures to minimise visual impacts include:

- Preferentially locate tower sites in areas with existing towers and road access, and where land is unused, minimally used or degraded rather than forests and land used for agriculture (MM002).
- Minimise the area disturbed around each tower site to that required for safe construction activities (MM003).
- Preference the installation of smaller (18 to 30 m high, infill) towers in populated and coastal areas, and larger (>60 m high) towers in remote, less populated areas, minimising the land required in populated areas (MM051).
- Undertake engagement and consultation with customary landowners, local communities and businesses to identify low-use sites and discuss the potential changes to visual amenity (MM078).
- Use muted colours (e.g., grey) on towers and infrastructure to support blending with their surroundings (except if required for aircraft or water safety reasons) (MM079).
- Consider installation of camouflage towers in visually sensitive locations (MM080).

5.3.2.7 Reduction in Amenity from Noise Emissions

Construction noise will be generated from land clearing and earth moving equipment, vehicular traffic movements, tower construction and, in some locations, helicopters. All of these activities will occur over a short period of time (see Section 5.3.2.2), depending on the tower size, location and access requirements.

Most towers will be powered by the main electricity grid, or by lithium batteries and diesel generators (gensets) at off-grid sites (see Section 3.1.2). Operational noise will primarily come from the operation of the gensets at facilities not connected to mains power (which operate for approximately 16 hours per day between battery runtime, including periods at night), or where backup power is required, and the occasional movement of vehicles transporting maintenance staff or equipment.

In urban environments, construction noise is unlikely to have an impact on amenity, given the ambient (or background) noise associated with cities and towns. Amenity may be more affected in rural locations where ambient noise is minimal and involves natural sounds and people, rather than machinery.

Management measures to minimise noise emissions include:

- Undertake engagement and consultation with local communities and businesses about construction timing and expected noise levels (MM081).

- Restrict construction activities to daylight hours (MM017).
- Preferentially locate tower sites with diesel generators away from sensitive receptors (e.g., houses) (MM016).
- Consider installing solar panels to minimise generator use and associated noise and emissions (MM019).
- House generators in noise reduction panelling walls with noise dampening insulation (MM021).
- Use diesel generators that emit low noise levels (MM082).
- Monitor noise levels to make sure construction activities and tower operations are within relevant limits (MM018).

5.3.2.8 Risks to Community and Workforce Health and Safety

The Project has the potential to generate health and safety issues for local communities, as well as the Project workforce (employees and contractors), which will include members of local communities.

Key risks to community health and safety include construction traffic, the use of heavy machinery and the potential for unauthorised access to cause accidents and injury. Health and safety risks for the Project workforce include working with heavy materials and equipment, excavation and confined spaces, working at heights, working in remote areas, snake bites, working with electrical equipment, working in close proximity to EMF (see Section 5.3.2.9), hot works, the use of power tools, presence of asbestos and working in and around moving vehicles. In some rural locations, the use of helicopters will also be a hazard.

There is also potential for communities and the Project workforce to be exposed to hazardous materials, such as hydrocarbons or waste (such as sewage). Fuels will be transported to and stored on site in most locations (see Section 3.3.3). There is potential for community exposure to these materials if there were an unplanned event such as a spill, which could impact local drinking water or food sources. In rural locations, waste from the construction camps will include general refuse (plastics, cardboard etc), food waste and sewage, and from the facilities, used oil, construction waste (equipment package and unused materials). Unmanaged waste has the potential to enter the environment, causing soil or water contamination (see Section 5.3.1.7 for hazardous wastes) and to attract pests or mosquitoes.

Malaria, a vector-borne disease, may also increase in prevalence where construction sites are allowed to contain standing water, which offers breeding habitat for mosquitoes. This is more likely during the construction period, when existing breeding or harbourage sites are disturbed or new ones are created (e.g., pooling water in poorly drained hardstands).

Close living arrangements within construction camps, and the proximity of these camps to local communities have the potential to result in increased incidence of communicable diseases, such as tuberculosis (TB) or sexually transmitted diseases (STDs). Women may also be at risk of sexual violence if workers are allowed to congregate in or close to local villages. There is also

potential for the Project workforce, where they are travelling from the capital or regional centres, to spread COVID-19 to areas previously free of the virus.

Management measures to minimise impacts on community and workforce health and safety include:

- Require the Project workforce, including contractors, to comply with the Company occupational health and safety (OHS) management plans and procedures (MM083).
- Provide Project workforce training and awareness to support understanding and compliance with health and safety procedures (MM084).
- Incorporate measures in supplier contracts and inductions to protect the rights of women and children, particularly in local Indigenous communities (MM064).
- Require the Project workforce, including contractors, to wear personal protective equipment (PPE) at all times while on site (MM085).
- Ensure that all employees and contractors required to work at heights, in confined spaces or with specialised machinery or equipment are appropriately trained and certified and operate in accordance with best practice guidelines and Company OHS plans and standard operating procedures (MM086).
- Equip towers with safety infrastructure, including railings and safe work platforms (MM087).
- Limit community access to tower locations, through installation of fencing and signage, and implementation of security patrols during construction (across all sites) and during operations for greenfield locations (MM088).
- Avoid siting towers within 4 km of airports or airfields and along known flight path envelopes (MM089).
- Consult regulatory air traffic authorities (i.e., CASA) prior to tower installation, in accordance with air traffic safety regulations (MM090).
- Discourage Project workforce interactions with local communities during construction and operations by providing separate accommodation for the construction workforce and implementing community interaction protocols (MM072).
- Design infrastructure including construction camps, to minimise vector harbourage (e.g., minimise pooling water, proper waste disposal) and human exposure (e.g., screening of doors and windows) to minimize spread of disease (MM091).
- Provide temporary toilet facilities for construction workers, (i.e., portable toilets or simple pit latrines) and ensure the location is agreed to by affected communities, is rehabilitated and waste is appropriately disposed of at workforce demobilisation (MM092).
- Remove all construction waste and waste generated from maintenance and repair activities from site following the completion of works (MM093).

- Maintain fire controls and buffers 5 to 10 m away from security fences (MM094).
- Develop and regularly test the emergency preparedness and response procedure (MM095).
- Manage hazardous materials and waste in accordance with relevant legislation, good industry practice and the Waste and Hazardous Material Management Plan (MM096).
- Provide community awareness programs on community health, wellness and safety (MM098).
- Encourage provincial health service providers to utilise mobile phone services for communication between health workers and between health workers and remote communities (MM099).
- Manage grievances or complaints to identify potential health and safety issues and trends that require management action across the program of works (MM100).
- Implement traffic management protocols during construction, including maintain separation between people and heavy machinery, implementing speed limits and road closures, where required (MM101).

5.3.2.9 Risks to Community and Workforce Health from EMF

Electromagnetic fields (EMF) are areas of energy (or radiation) associated with the use of electrical power. This is a low frequency non-ionising radiation type which is generally regarded as harmless due to its lack of potency. Radio waves and microwaves emitted by transmitting antennae of base transceiver stations are also a form of electromagnetic energy at the lower end of the non-ionising radiation spectrum.

There is some community concern over the potential health effects of EMF, particularly with long-term exposure, which according to some, can affect the body's nervous system and damage cells, causing cancer (DHHS, 2014). However, whether EMF causes negative health outcomes is a controversial issue, with no conclusive evidence demonstrating adverse health effects from community exposure to typical EMF levels from power transmission lines and telecommunications equipment, including transmission towers and mobile phones (IFC, 2007). However, while the evidence of adverse health risks is weak, it is still sufficient to warrant limited concern, and IFC (2007) recommends limiting EMF exposure where possible.

Management measures to minimise the perceived or actual impacts of EMF include:

- Comply with requirements for the management of potential health and safety risks associated with EMF described in Vodafone Global Policy Radiofrequency Electromagnetic Fields – Risk Management (MM123).
- Evaluate potential community exposure against the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and maintain average and peak exposure levels below the ICNIRP recommendation for General Public Exposure (MM102).

- Undertake engagement and consultation with local communities and businesses on EMF issues during the site selection process, including access to credible and current information on health risks (MM103).
- Restrict community access to tower locations, through installation of fencing and signage, and implementation of security patrols (MM104).
- Adopt good engineering practice in the siting and installation of directional links (e.g., microwave links), to avoid building structures (MM105).

5.3.2.10 Workplace Discrimination and Exclusion of Minorities and Women

The Project will require a distributed network of direct (Company and contractor employees), and indirect (i.e., supply chain) workers over the life of Project. The Project workforce will incorporate ongoing employees based in Port Moresby and overseas, contracted construction crews, suppliers (i.e., of materials, services etc) and local maintenance crews. Further, the workforce will comprise people from various cultural and ethnic backgrounds, and with varying experience working in cross cultural and gender-diverse workplaces. With such a diverse and distributed workforce, there is potential for discrimination and exclusion to occur, particularly against those who identify as a minority ethnic group, or against women, who are afforded fewer opportunities for education, employment and economic advancement than men.

Management and beneficial measures to minimise workplace discrimination and exclusion include:

- Comply with PNG laws applicable to non-discrimination in employment and enforce compliance (through contractual obligation) of contractors and the supply chain workforce (MM106).
- Provide employment opportunities that are transparent, open to all and free of discrimination (MM107).
- Maximise the employment of people from local communities surrounding tower locations during construction and operations/maintenance, including the adoption of recruitment targets for women and Indigenous Peoples (MM058).
- Establish and maintain national content targets to maximise the employment and contracting of national citizens over the life of Project (MM059).
- Develop and deliver internships and/or training opportunities with the Project or its contractors specifically focusing on transferable, nationally recognised trade skill development (MM060).
- Provide local community representatives with basic training in site maintenance (cutting grass) and in monitoring security of the site (reporting alarms) during operations (MM061).
- Implement Company policies and the Company Code of Conduct that provide for equality in employment and appropriate workplace behaviour towards women and minority groups (MM063).

- Incorporate measures in supplier contracts and inductions to protect the rights of women and children, particularly in local Indigenous communities (MM064).
- Deliver compliance and business ethics training for Project workers and contractors (MM109).
- Implement, maintain and communicate an employee grievance mechanism (MM110).
- Provide women's development and leadership programs for women at all levels within the workforce (MM111).

5.3.2.11 Reduction in Community Cohesion

Social cohesion refers to the social relationships or 'sense of belonging' that bind people together. Strong social cohesion depends on economic wellbeing (including income levels and distribution, health, sense of security and government responses to issues of poverty and disadvantage), political participation and socio-cultural agreement (AHRC, 2015).

The transfer of customary land to Vodafone PNG and the corresponding increase in wealth of some people in local communities has the potential to weaken social cohesion, through causing or contributing to disputes over land ownership and the distribution of associated lease payments or compensation. An increase in disposable income in local communities can also increase the use of alcohol, betel nut or drugs (i.e., marijuana), increasing the incidence of fighting, domestic violence or other anti-social behaviour (particularly toward or involving women and children).

Where the opportunity for economic benefit exists, this may increase in-migration/influx of outsiders into local communities. Many rural PNG communities report that migrants threaten community cohesion through partaking in drug and alcohol abuse, causing conflict over natural resource access and use and compromising traditional leadership, which is important for maintaining strong cohesion and managing disputes.

In urban settings with high youth unemployment rates, the potential for employment could contribute to localised unrest if employment and recruitment processes are not appropriately managed.

Management and beneficial measures to minimise impacts on, and strengthen, community cohesion include:

- Preferentially locate tower sites in areas with existing towers and road access, and where land is unused, minimally used or degraded rather than forests and land used for agriculture (MM002).
- Implement the 'Site Selection and Acquisition Procedure' to ensure consultation is undertaken with affected communities and change in land use is supported (MM049).
- Undertake engagement and consultation with customary landowners to negotiate and agree terms of customary land lease in accordance to legal requirements (MM112).
- Map customary land assets (including natural resources, i.e., trees, crops) for compensation under the Valuer Generals Compensation Schedule 2013 (MM055).

- Where possible, procure goods and services from local suppliers, including Incorporated Landowner Groups (ILGs) (MM057).
- Discourage Project workforce interactions with local communities during construction and operations by implementing community interaction protocols (MM072).
- Comply with PNG laws applicable to non-discrimination in employment and enforce compliance (through contractual obligation) of contractors and the supply chain workforce (MM106).
- Provide employment opportunities that are transparent, open to all and free of discrimination (MM107).
- Maximise the employment of people from local communities surrounding tower locations during construction and operations/maintenance, including the adoption of recruitment targets for women and Indigenous Peoples (MM058).
- Establish and maintain national content targets to maximise the employment and contracting of national citizens over the life of Project (MM059).
- Incorporate measures in supplier contracts and inductions to protect the rights of women and children, particularly in local Indigenous communities (MM064)
- Support sustainable initiatives to strengthen village law and order organisations (e.g., village courts, local police and churches) (MM114).

5.3.2.12 Increased Access to Telecommunications Services

Prior to 2008, access to information and communications technology (ICT) infrastructure in PNG was one of the lowest in the world (see Section 4.3.7.5). Increasing people's access to ICT (i.e., mobile and internet) in PNG can support economic growth through empowerment and income generation, and improving access to health, education and other social services. For example, May and Adera (2013) cites studies that found mobile phones assist businesses in the informal economy by helping them attract additional business, benefiting both producers and consumers through improved information and better functioning markets; and that internet access can help increase security and government accountability.

However, there are still inequalities in access to ICT, even when it is available. May and Adera (2013) refer to studies that suggest those with higher incomes and better education are more likely to take up access opportunities, whereas rural communities and women were significantly less likely (by up to 50%) to have access to ICT than their urban or male counterparts.

Less than 15% of the PNG population has access to reliable electricity (Highet et al., 2019). This is particularly relevant to people living in rural and remote areas of PNG and is a significant barrier to ICT use. Women in particular cited a lack of affordability, cultural norms, safety concerns and low digital literacy as barriers to greater mobile use uptake (Highet et al., 2019).

Management measures to support increased access to telecommunications services and the associated benefits include:

- Identify locations where local communities (in particular women and Indigenous Peoples) do not have access to electricity and collaboratively develop solutions to support access to mobile technology (e.g., provide solar chargers, access to generators, etc) (MM115).
- Provide free or subsidised mobile devices (handsets or tablets) and mobile internet plans to low-income affected communities, particularly of Indigenous Peoples in rural and remote areas surrounding greenfield towers (MM116).
- Establish mobile applications and information services that will provide help and assistance to women on aspects of health, safety, and assistance to tackle and address gender-based violence concerns (MM117).
- Develop and deliver culturally appropriate education and awareness programs (e.g., free SMS services) aimed particularly at rural/remote communities and Indigenous Peoples to help harness the benefits of increased access to ICT (MM118).
- Deliver digital literacy programs focusing on women, youth and Indigenous communities in rural and remote areas surrounding greenfield towers (MM119).
- Support the creation of local technology hubs to provide access to working spaces and affordable internet services for entrepreneurial projects registered women and youth groups (MM120).
- Provide access to affordable mobile handsets to communities and reliable internet speeds to all areas covered by the telecommunications rollout (MM124).
- Implement 'Mobile Money Services' to enable community use of the telecommunications network as a means to receive income for providing services or selling produce and goods (MM125).

5.3.3 Beneficial Measures

Table 5.2 highlights the beneficial measures associated with the Project that are captured and further described in the Vodafone PNG CSR Plan (Appendix 4).

Table 5.2 – Beneficial Measures

Activity/Aspect	Potential Impact or Benefit	Beneficial Measures
Consumption of energy and resources	Energy use and waste generation	• Raise awareness of employees and contractors of opportunities and benefits of energy saving and the impacts of climate change (MM047).
Land access	Change of land use and loss of community access to land	• Support capacity building programs aimed at enhancing national and local government capacity to foster diversified economic growth and their capacity to deliver local public services (MM052)

Table 5.2 – Beneficial Measures (cont'd)

Activity/Aspect	Potential Impact or Benefit	Beneficial Measures
Land access; Project employment and procurement	Increased revenue, employment and on-job training opportunities	• Identify employment or other sustainable business opportunities for women from local communities in consultation with women's groups and potentially NGOs (MM065). • Develop and deliver internships and/or training opportunities with the Project or its contractors specifically focusing on transferable, nationally recognised trade skill development (MM060).
Land access; Construction of towers and supporting infrastructure; Equipment maintenance	Loss or damage to archaeological or cultural heritage values. Decline in intangible heritage values	• Support local intangible heritage programs (e.g., providing financial or other assistance to support local cultural festivals) (MM073).
Land access; Construction of towers and supporting infrastructure; Transport, storage, use and disposal of hazardous materials	Economic displacement resulting from loss of subsistence resources	• Deliver sustainable development and economic empowerment programs in locations identified as in need of additional support for livelihood maintenance (e.g., fresh water supply, agri-business training and development etc) (MM077).
Construction of towers and supporting infrastructure; Transport, storage, use and disposal of hazardous materials, operation of towers	Risks to community and workforce health and safety	• Provide community awareness programs on community health, wellness and safety (MM098). • Encourage provincial health service providers to utilise mobile phone services for communication between health workers and between health workers and remote communities (MM099).
Project employment and procurement	Workplace discrimination and exclusion of minorities and women	• Deliver compliance and business ethics training for Project workers and contractors (MM109). • Provide women's development and leadership programs for women at all levels within the workforce (MM111).
Land access; Project employment and procurement; Workforce (fly camps); Construction of towers and supporting infrastructure	Reduction in community cohesion	• Support sustainable initiatives to strengthen village law and order organisations (e.g., village courts, local police and churches) (MM114).
Operation of towers	Increased access to telecommunications services, and associated economic, health and education benefits for local communities	• Identify locations where local communities (in particular women and Indigenous Peoples) do not have access to electricity and collaboratively develop solutions to support access to mobile technology (e.g., provide solar chargers, access to generators etc) (MM115). • Provide free or subsidised mobile devices (handsets or tablets) and mobile internet plans to low-income affected communities, particularly of Indigenous Peoples in rural and remote areas surrounding greenfield towers (MM116).

Table 5.2 – Beneficial Measures (cont'd)

Activity/Aspect	Potential Impact or Benefit	Beneficial Measures
Operation of towers (cont'd)	Increased access to telecommunications services, and associated economic, health and education benefits for local communities (cont'd)	• Establish mobile applications and information services that will provide help and assistance to women on aspects of health, safety, and assistance to tackle and address gender-based violence concerns (MM117). • Develop and deliver culturally appropriate education and awareness programs (e.g., free SMS services) aimed particularly at rural/remote communities and Indigenous Peoples to help harness the benefits of increased access to ICT (MM118). • Deliver digital literacy programs focusing on women, youth and Indigenous communities in rural and remote areas surrounding greenfield towers (MM119). • Support the creation of local technology hubs to provide access to working spaces and affordable internet services for entrepreneurial projects registered women and youth groups (MM120). • Provide access to affordable mobile handsets to communities and reliable internet speeds to all areas covered by the telecommunications rollout (MM124).

5.3.4 Major Hazards

Major hazards or risks associated with accidental or abnormal events may cause injury, loss of life, significant environmental harm, asset loss and reputational damage. These incidents, which can occur due to either natural events or human activity, typically have a low likelihood of occurring. The primary major hazards associated with the Project include:

- Naturally generated major seismic activity (e.g., earthquakes, mass movement) resulting in injury/loss of life to Project personnel, damage to Project property/infrastructure and/or loss of containment of fuel and other hazardous materials through failure or damage to equipment.
- Wildfire from a natural or third-party source (e.g., lightning strike or human source) causing injury/loss of life to Project personnel, damage to Project property/infrastructure and/or loss of containment of fuel and other hazardous materials through failure or damage to equipment.
- Flooding and/or high winds resulting in injury/loss of life to Project personnel, damage to Project property/infrastructure and/or loss of containment of fuel and other hazardous materials through failure or damage to equipment.

The management of potential impacts from major hazards is through proactive measures in the design of the Project. The risk of major hazards occurring will be regularly reviewed throughout the Project life.

In a broader context, the Project will extend and improve the telecommunications network across PNG and thereby provide the benefit of improved response to emergency events occurring as a result of natural disasters

Management measures to minimise the risk from, and improve response to, major hazards include:

- Consider the locations of geohazards and flood and high wind risk in site selection and tower construction (MM121).
- Develop and regularly test the emergency preparedness and response procedure (MM095).

6. Analysis of Alternatives

Chapter 3 presents the current optimised configuration proposed for the Project, which has been developed based on Vodafone Fiji's experience of operating a similar network in Fiji, and in consideration of PNG-specific constraints and opportunities. This chapter provides an overview of the alternatives and the process used to define the Project that is the basis of this IEE.

The Project is subject to a range of constraints and opportunities, which include:

- Technological – towers service people, so need to be located near cities, urban centres and on ridgelines in rural areas where signals will have maximum reach. They need access to power and must be accessible for regular maintenance. Where existing ICT infrastructure exists, there are opportunities to co-locate towers.
- Environmental – the existing environmental values (e.g., high conservation areas, water bodies, suitable terrain etc).
- Social – the values, expectations and concerns of affected communities, businesses and other stakeholders with an interest in the Project, including land ownership and ease of acquisition.
- Cultural heritage – the cultural heritage of the landowners and communities across PNG that host the towers and other infrastructure that comprise the Project.
- Economic – the Project must be commercially viable and represent value-for-money for investors. Market drivers and trends (e.g., rate of uptake, existing operators, government or investor incentives, etc.) must also be taken into account.
- Governance/compliance – the Project must satisfy industry regulations, government legislation and financier requirements.

These constraints and opportunities have been considered through the stages of Project development; concept design, pre-feasibility and feasibility, and will continue to influence the decisions made throughout Project implementation.

6.1 Market Opportunity

The benefits of ICT development include increased gross domestic product (GDP), through the creation of jobs and support for business transactions, and improved access to education and health services (see Chapter 4). Since the arrival of international competition in 2007, the adoption and use of ICT in PNG has increased significantly. The penetration of mobile phone usage grew from approximately 4.7% in 2007 to 47% in 2015 (Galgal, 2017). However, PNG's mobile penetration rate is still one of the lowest in the South Pacific region, and affordability is still an issue. While Kemp (2020) estimates around 12% of the population is now online, and the World Bank suggests that the rate of uptake is the highest in the region, the percentage of people online is still the lowest in the region (Galgal, 2017).

Operators in PNG include Digicel (a private operator), the PNG Government-run Telikom PNG Limited (Telikom) and a public-private partnership between Telikom and bmobile. The existing network is comprised of microwave radio, satellite (domestic and international) and optical fibre transmission systems. The PNG telecom market presents a compelling opportunity for Vodafone PNG based on the country's positive economic outlook, the low penetration of services and the quasi-monopoly position of Digicel. PNG has one of the lowest mobile penetration rates in the world, and although there are two operators in the market, Digicel, the dominant mobile network operator, is not currently being competitively challenged and has retained a 90% market-share since it launched in PNG more than 12 years ago.

Through the Project, Vodafone PNG seeks to increase access to ICT infrastructure and services across PNG, filling gaps in network coverage, providing greater choice and driving affordability across the market.

6.2 Alternatives Considered

Vodafone PNG has considered the most commercially, socially and environmentally viable Project design and location options. Specifically, the alternatives considered include:

- Tower co-location with other providers.
- Technology options.
- Tower site selection.
- Workforce configuration.
- Tower type.
- Project versus no Project option.

The following sections outline the alternatives considered and selected as a result of this process, and the reasons the current Project configuration was selected.

6.2.1 Tower Co-location

Vodafone PNG assessed the feasibility of co-locating its towers with existing operator infrastructure, which is a common practice for ICT operators (although not in PNG currently) and provides economic, social and environmental advantages and often a quicker deployment than standalone towers.

Where possible, Vodafone will locate greenfield transmission towers at locations that already have mobile communication towers, as these strategic locations are known transmission sites where; the land use and ownership has already been converted; local communities are used to the structures; visual amenity will be least impacted; access is available (for construction and maintenance crews); and towers have existing benchmark lease rates.

Tower co-location was balanced with the operational advantages of having direct control over towers and supporting infrastructure, and the need to expand the existing network, which by definition requires new towers to be built in greenfield (and often remote) locations.

6.2.2 Technology Options

The technology and design of the networks and physical infrastructure was influenced by the spectrum available in PNG and what could be allocated by NICTA and the proven Fiji technology model.

The technology selected for the Project replicates the proven Fiji technology model. This significantly reduces risk, leveraging on existing vendor-supplier relationships to obtain technology support and procure technology at best prices and operating costs, and reduces complexity through a homogenous network architecture across Fiji and PNG.

6.2.3 Tower Site Selection

The locations for new towers are selected based on demand, i.e., proximity to populations and commercial viability and gaps in the existing network. The location of towers also considers connectivity to adjacent tower sites and provision of adequate wireless signal to the community intended to receive mobile coverage.

A detailed procedure has been established under the Vodafone PNG ESMS to guide the selection and acquisition of suitable tower sites, both in urban and rural areas. This procedure is provided in Appendix 1. Some of the key principles that underpin site selection to minimise social and environmental impacts are:

- Preference is given to sites in areas with existing towers and road access, and where land is unused, minimally used or degraded rather than forests and land used for agriculture.
- Sites will be avoided where land ownership is under dispute.
- Sites will be avoided which have been identified as sensitive areas for biodiversity, such as critical habitat (e.g., for threatened species or of special significance for endemic or restricted-range flora and fauna)
- Sites with cultural heritage significance will be avoided.

Site selection has not been completed for the tower locations proposed over the life of the Project, and the options for tower sites will continue to be reviewed and interrogated as the Project is implemented.

6.2.4 Workforce Configuration

Vodafone PNG considered several options for recruiting an experienced, well-trained and flexible workforce, that also includes as many skilled and unskilled positions for Papua New Guineans.

A proportion of the Project's workforce will be initially leveraged from Vodafone Fiji, to ensure there is the transfer of knowledge and skills available to the PNG team, while reducing risks, costs and timelines associated with hiring an all-PNG team. This strategy provides Vodafone PNG with the ability to mentor, coach and develop Papua New Guinean teams in the early years of Project implementation, with a view to rolling back the involvement of Fiji staff over time.

The tower construction is undertaken by specialist contractor companies. The construction crew typically comprises up to 10 skilled workers, and a further 10 to 20 unskilled workers recruited from local communities to assist with ground clearing, security and other general labour (see Chapter 3). Specialist construction companies hire local workers and provide all necessary training to ensure compliance to construction standards and safety requirements.

This configuration, incorporating international specialist contractor companies, (with which Vodafone already have established procurement relationships), a mixture of international and Papua New Guinean skilled crews and unskilled workers from the communities near where towers are being constructed is considered to be the optimal workforce configuration as it:

- Maximises employment opportunities for Papua New Guineans, and particularly people from local communities.
- Increases the engagement of local communities with Vodafone PNG, via ongoing maintenance and security work.
- Ensures that the teams have access to industry knowledge and experience.
- Leverages on existing supplier relationships, increasing the speed of deployment and reducing risk of engaging unknown contractors.

6.2.5 Tower Type

As described in Chapter 3, a BTS facility typically consists of a small parcel of leased land (around 400 m^2), a tower or mast, a microwave antenna and RF antenna mounted on the tower, switch gear at the base of the tower, a power system, security fencing and an access road.

There are a variety of tower structures available, including RDS, grillage/lattice, monopole, camouflage and rooftop tower designs, and the type selected depends on the presence of existing ICT infrastructure and/or suitable buildings/rooftops, ease of access, signal strength required, structural integrity of the base (building or soil/landform), and the potential visual impact (i.e., number of people who can see the tower and how intrusive it may perceived to be). All towers must be designed to conform with Australia/New Zealand Structural Engineering Standards – AS/NZS 1170-0-2002 , AS 3995-1994.

Solar panels will be deployed for sites that are more remote, such as those that require helicopter to reach. The configurations selected for each site will be based on the power load requirements of the technology deployed at the site and the availability of grid power. Vodafone PNG has also undertaken a power technology study to review options to address base station outages due to generator problems.

6.2.6 No Project Option

Not proceeding with the Project would mean that any potential adverse environmental and social impacts would not eventuate as a direct consequence. However, it will also result in the more substantial Project benefits not being realised, which include:

- Socio-economic benefits associated with increased coverage and competition (e.g., reduced costs of mobile calls and text and increased internet access for small

businesses; improved access to health and education information and emergency services).

- Direct benefits to government, business and legally recognised landowners through tax payments, lease revenue or compensation, in addition to dividends to shareholders.
- Projected employment and training opportunities during Project construction and operation.
- The social investment and capacity-building programs described in Chapter 5.

7. Information Disclosure, Consultation and Participation

7.1 Engagement with Customary Landowners

Vodafone PNG's approach to information disclosure, consultation and participation of customary landowners is captured within the Community Consultation Procedure Involving Customary Land, which has been prepared as part of the 'Site Selection and Acquisition Procedure' (Appendix 1). These procedures are included within the Vodafone PNG ESMS and require that:

- Meaningful community consultation is undertaken in a culture of informed consultation and participation (ICP), with consultation commencing in the planning phases (i.e., site screening and selection) and carried out on an ongoing basis throughout the Project cycle (project design, implementation and completion).
- The consultation is voluntary and without external interference or coercion.
- Community members are given prior information on the intent and scope of the Project, including the uses of the land and the possible environmental and social impacts and benefits of the works to be constructed on the land. This is to include access to credible and current information on health risks, such as impacts of electromagnetic field (EMF) radiation from transmissions during operations.
- Information is provided to community members in a manner, form and language that will be appropriate, understandable and accessible to the community members.
- Sufficient time is provided to community members to undertake internal decision-making.
- Community members are made aware that they have an option to consent to or refuse to accept the land use arrangements.
- Land use arrangements involving customary land are finalised only when there is a documented evidence of broad community support. Ways in which broad community support are assessed include:
  - The existence of consensus supporting the Project.
  - The formal support from the leaders of the land-owning community.
  - The support of a considerable majority of the land-owning community.
  - Lack of opposition to the Project, including documentation of opposing views and how these have been addressed.
  - Approval from the registered customary land group, i.e., Incorporated Land Group (ILG).

- Where it is necessary to construct access roads, consultations with all/relevant affected community members will be undertaken.
- Participants of community consultations will be representative of the customary land-owning community and include community leaders identified by the community members themselves.
- Consultations with customary land-owning communities will include vulnerable groups and be gender sensitive. Women will be included in consultations especially as they rely on land for making gardens. Gender-specific consultation forums (e.g., women-only discussions, women-led discussions) will be employed to encourage and support the inclusion of women in consultation. In addition, consultations that include women will occur at a time in the day when women do not have other family and social obligations.
- All consultations with customary land-owning communities will be documented with the following information recorded:
  - Name of land-owning group and names of participants.
  - Date and place of consultation.
  - Photographs or videos taken of consultation with consent from the community.
  - Demographic summary of participants (number of women, elderly, youth, community leaders, etc.), including identification of people disproportionately affected because of their disadvantaged or vulnerable status.
  - Summary of how and by whom the consultation was prepared.
  - Issues/questions/concerns raised by the community and responses provided.
  - Summary of how outstanding issues and opposing views have been addressed.
  - Summary of agreements reached with communities.
- Where there are disagreements in relation to the Project, negotiations are undertaken in good faith to resolve differences and disagreements.
- Outcomes from consultation are communicated back to affected communities (e.g., through a follow-up forum or meeting), and issues, questions and concerns are addressed through Project design, management measures and/or further communication and engagement.

Consultation with affected communities during site screening and selection focuses primarily on explaining the design and functioning of the proposed facility, answering questions and discussing suitable sites and the potential impacts and benefits of these. Once a site is selected and land use agreements are in place, engagement topics focus on construction timing, employment, safety and the management of any issues identified. During operations, the level of engagement is less frequent and consists of updates provided where an issue arises, or the management of grievances (see Chapter 8).

7.2 Stakeholder Engagement

7.2.1 Stakeholder Engagement Procedure

Vodafone PNG's broader stakeholder consultation process is described in its Stakeholder Engagement Procedure under the Vodafone PNG ESMS. The Stakeholder Engagement Procedure sets out the processes for strategically identifying, analysing (i.e., according to their interest and influence) and engaging Project stakeholders, and recording, monitoring and reporting on engagement outcomes. All engagements are recorded in a stakeholder database, which helps Vodafone PNG assess and address issues raised by stakeholders, track engagement, monitor trends and identify areas for improvement.

7.2.2 Community Engagement

Across all stages of development, a range of approaches are utilised for broader community consultation beyond customary landowners (see Section 7.1), depending upon the level of interest and impact. This engagement is described in the Stakeholder Engagement Procedure and includes:

- Information sharing: making relevant information available in an accessible format. This may include information sessions, information posted in local newspapers or on the website or the circulation of awareness materials such as posters of 'frequently asked questions' or newsletters.
- Dialogue and participation: consulting with and listening to understand perceptions or views to better incorporate these into decision-making processes. This may include focus group discussions or key informant interviews, including women-only group discussions, or involving community members in activities such as impact identification or joint planning sessions (e.g., implementing livelihood projects).
- Negotiation: reaching agreement on a specific issue (e.g., compensation rates or on access to land), which may involve meetings with landowners/lessors and regulatory agencies.
- Grievance management: recording and addressing community or broader stakeholder concerns and grievances.

8. Grievance Redress Mechanism

8.1 Community Grievances

A grievance is a concern or complaint, raised by individuals or groups within communities affected by Project operations. Grievances relate mainly to perceived or observed misconduct by company or contractor personnel during construction and operation. A grievance is submitted in confidence (i.e., they are not made public) with an expectation of corrective action or compensation.

A grievance redress mechanism is the process by which grievances are received, recorded and managed through to resolution. The process must be proportional (to the nature and scale of Project impacts), culturally appropriate, fair, accessible, transparent and properly documented. Vodafone PNG has developed a Grievance Procedure under its ESMS, which includes a flowchart for grievance redress. The purpose of this procedure is to ensure affected communities' expectations and concerns about Vodafone PNG's operations are recognised and addressed in a timely manner. All contractors are also required to implement this procedure, and to report grievances and dispute resolution to Vodafone PNG.

The procedure:

- Identifies the steps to be taken to receive, process, promptly manage and respond to grievances from local communities.
- Identifies responsible parties including contractors.
- Includes a process to deal with complaints from other nearby villages or families.
- Includes a dispute resolution mechanism.
- Includes a monitoring and evaluation framework to support continual improvement.

Grievances can be received both verbally and in writing. A copy of the form used to record the grievance will be provided to the person raising the grievance either at the time of raising the grievance or within seven (7) days of receipt of the grievance.

Once recorded, all grievances are registered in a centralised grievance-tracking database. Tracking and analysis of grievances enables Vodafone PNG to develop corrective actions with the intent to reduce incidences of grievances and improve performance. Depending on the nature of the grievance, it is assigned to the appropriate Company department or Contractor representative for response and resolution. This may involve incorporating community feedback or concerns raised within the grievance into Project design or implementation. Within a month of the response being provided to the person raising the grievance, Vodafone PNG personnel will verify that the situation has been resolved to the satisfaction of all involved, and close out the grievance including feedback to all persons involved.

The grievance process forms part of Vodafone PNG's stakeholder engagement process and is communicated to all potentially affected persons and organisations. Disclosure will use a method and language appropriate to each community to ensure the process is understood.

8.2 Employee Grievances

Vodafone PNG supports and expects open communication with its employees which includes proactively addressing issues, either directly work-related or of a personal nature, and managing grievances. All employees are encouraged to discuss any aspects of their work in an open, positive and constructive manner, Vodafone PNG is committed to creating and sustaining an environment in which all employees feel comfortable in doing this.

Vodafone PNG maintains an employee handbook, which details the process for grievance management, which is summarised in the following five steps:

1. Notification – Where possible, employees should try to resolve grievances directly with the person with whom they have the grievance. It may also involve the employee discussing the grievance with their supervisor to seek their advice on how to proceed. If an employee cannot settle a grievance themselves, the grievance is reported to their supervisor, or their Product Manager or Human Resources (HR) who will be responsible for investigating the grievance. A grievance may be reported orally or in writing.

2. Clarification and Assignment – The person handling the grievance will clarify and record all aspects of the grievance with the grievant and determine, with the grievant, the best way to resolve it. This could include actions by the grievant with support and counselling, action by the supervisor or HR, or referral of the matter to senior management. The person handing the grievance must not proceed to act without the consent of the grievant, unless there is an issue of occupational health or safety, legislative responsibility or liability or possible serious misconduct, such as theft, fraud or assault.

3. Investigation – The person handling the grievance will fully document all stages of the investigation, interview relevant people while keeping the matter confidential, and provide support and/or counselling to employees as required.

4. Substantiation – If the person handling the grievance concludes that the grievance is substantiated, all parties are advised of the determination, appropriate steps are taken to prevent the grievance reoccurring (where practicable) and disciplinary actions may be taken, where necessary. If a grievance is not substantiated, all parties are advised of the determination and the person handling the grievance notifies the grievant, who may refer the grievance to the next level of management and ultimately to the Regional Chief Executive Officer for review.

5. Resolution – Where a grievance is successfully resolved, this is communicated to all parties and agreement reached about a follow-up with the grievant at a later date to review their progress. The records relating to the investigation of the grievance are filed. Where a grievance is not successfully resolved, the person handling the grievance should attempt to resolve the grievance by counselling all parties individually.

9. Environmental and Social Management Plan

This chapter outlines the framework for environmental and social management, monitoring and reporting under which the potential Project impacts and benefits, identified in Chapter 5, will be avoided, mitigated or realised.

9.1 Management System Implementation Arrangement

The Project's environmental and social impacts will be managed under the governance of the Vodafone PNG ESMS, which is driven by Vodafone PNG's overarching social, health, safety, environment and security policies. The Vodafone PNG ESMS aims to communicate to Company and Contractors the environmental and social management requirements and mitigation measures pertaining to the rollout, operation and decommissioning of its mobile telecommunications network.

Vodafone PNG's objectives in implementing the ESMS are to:

- Describe the specific management and mitigation measures required to implement good industry practice conditions stipulated by the PNG Government and applicable International Finance Institution (IFI) requirements.
- Describe the roles and responsibilities of its environmental and social management organisation.
- Communicate its environmental and social expectations throughout Company.
- Establish the framework and minimum requirements for Contractors' ESMP documents.
- Keep stakeholders informed of Company's processes and practices towards being responsible towards the environment and social structures in PNG.

Development of the Vodafone PNG ESMS has considered the requirements of the ADB Safeguard Policy Statement (ADB, 2009), ADB Policy on Gender and Development (ADB, 1998), ADB Social Protection Strategy (ADB, 2001) and ADB Access to Information Policy (ADB, 2019) to ensure that environmental, workforce and community health and safety, involuntary resettlement, indigenous peoples, gender and development, labour and corporate social responsibilities are adequately addressed. The ESMS has also been developed considering practical guidance provided by the IFC ESMS Implementation Handbook (IFC, 2015a) and IFC ESMS Toolkit (IFC, 2015b).

9.1.1 Management of Environmental and Social Impacts

The Vodafone PNG ESMS provides a series of aspect-specific management plans, each of which detail objectives, targets, compliance requirements, management measures, performance indicators, roles and responsibilities and monitoring and reporting regimes. The aspect-specific

management plans incorporated under the ESMS, which collectively represent the Project Environmental and Social Management Plan (ESMP), include:

- Air and Noise Emissions, Cleaner Production and Energy Efficiency Management Plan.
- Waste and Hazardous Material Management Plan.
- Biodiversity Management Plan.
- Electromagnetic Fields Management Plan.
- Erosion and Sediment Control Management Plan.
- OHS Risk Management Plan.
- Labour and Working Conditions Management Plan.
- Community Health and Safety Management Plan.
- Social Management Plan.

These plans have been developed considering potential Project impacts and proposed management measures to mitigate impacts and realise benefits (see Chapter 5). Potential impacts from various Project activities, and management measures to mitigate these impacts, are itemised in tabular form in aspects-specific management plans in Section 9.2. These tables include performance indicators and monitoring to evaluate the effectiveness of the management measures.

In addition to the aspect-specific management plans, Vodafone PNG has also developed a series of procedures under its ESMS to guide the environmental and social management of its mobile communication network rollout and operation. These procedures describe Company's standardised operating processes, including specific work instructions, flowcharts, checklists and forms, including:

- Environmental and social risk assessment procedure.
- Site selection and acquisition procedure (provided in Appendix 1), including
  - Community consultation procedure involving customary land
  - Site selection environmental and social screening checklist
  - Site acquisition report template.
  - Land investigation report form
  - Site handover checklist
  - ESMP checklist.
- Stakeholder engagement procedure and checklist.
- Grievance procedure.
- Tower construction and camp management checklist.

- Template for contractor environmental and social reporting to Vodafone PNG.
- Chance find procedure.
- Incident reporting form.
- Standard operating procedure for OHS management.
- Emergency preparedness and response procedure.
- Training and awareness procedure.
- Management of change procedure.
- Monitoring and measurement procedure.
- Template for biannual reporting to ADB.
- Environmental and social legal compliance register.

9.1.2 Beneficial Measures

The Vodafone PNG Foundation[7] will oversee the delivery of the beneficial measures identified in Chapter 5 and described in the Vodafone PNG CSR Plan (Appendix 4). The PNG Foundation will provide funding, identify and negotiate appropriate delivery partners and undertake program monitoring and reporting. To facilitate effective implementation of programs, a governance board will be developed to help coordinate and integrate programs with existing health and education programs and to provide the support needed by partners to meet the program objectives. A governance board will oversee the allocation of Vodafone PNG Foundation funds and the acquittal of funding grants to charities.

9.2 Aspect-specific Management Plans

9.2.1 Impacts and Mitigation Measures

Aspect-specific management plans, which identify potential environmental and social impacts from Project activities and management measures to mitigate these impacts are itemised in tabular form in Tables 9.1 to 9.9. These management plans have been developed from the impact assessment described in Chapter 5 and will be assimilated under the Vodafone PNG ESMS.

9.2.2 Performance Indicators and Monitoring

Performance indicators and monitoring parameters are described in the aspect-specific management plans to establish whether stated objectives of the plans are being achieved. A ‘Monitoring and Measurement Procedure’ is included within the Vodafone PNG ESMS to provide details on what will be monitored and when and by whom the monitoring will be carried out.

The frequency and methods by which Vodafone PNG’s activities and performance are monitored, measured and evaluated is determined and informed by:

[7] Vodafone PNG is establishing the Vodafone PNG Foundation (the PNG Foundation) as a charitable trust to enable Vodafone PNG to invest some of its profits back into the communities and the environment in which it operates.

- Regulatory and lender compliance requirements and obligations and stakeholder requirements.
- Vodafone PNG policy commitments and objectives.
- Level of risk and types of control measures.
- Performance and audit results.
- Trends in non-conformities or corrective actions.
- Outcome of stakeholder/community interviews and grievances.

Monitoring records will be kept for management review and reporting. All monitoring results will be documented and reviewed to provide for continual improvement of environmental and social performance and consideration of unanticipated impacts.

9.2.3 CEPA Requirements

A waste management plan and environmental management monitoring program (EMMP) covering the whole project is required to be submitted to CEPA as a condition of the Environment Permit. The EMMP is to be regularly updated (where necessary) and submitted to CEPA for approval, including 12 months after commencement of construction, prior to operations and every five years thereafter or when there is a material change to project operation or management of its environmental impacts.

Table 9.1 – Air and Noise Emissions, Cleaner Production and Energy Efficiency Management Plan

Activity/Aspect	Potential Impact	Management Objective	Management Measures	Performance Indicator	Monitoring	Responsibility
Project traffic; Construction of towers and supporting infrastructure; Operation of towers	Reduced air quality	Minimise the impacts of fugitive dust and fuel combustion emissions on human health, amenity and the environment	• Ensure air emissions comply with Project criteria (MM041). • Preferentially use fuel-efficient diesel generators (MM022). • Consider installing solar panels to minimise generator use and associated noise and emissions (MM019). • Regularly service diesel powered equipment, including generators, and use low-sulfur diesel where practicable (MM042). • Maintain construction vehicles and equipment in order to limit emissions (including noise) and remove from service any equipment from which emissions are visibly excessive (MM020). • Use cleared vegetation where practicable for dust control and reinstatement (MM043).	• Air emissions remain within relevant criteria. • No Project-related air quality or dust complaints received.	• Monitor air quality for compliance with relevant criteria, as needed. • Visual monitoring of dust emissions during construction activities such as earthworks and traffic movements. • Monitor community grievances. • Verify implementation of management measures.	Company, Contractor
Project traffic; Construction of towers and supporting infrastructure; Operation of towers	Reduction in amenity from noise emissions See Biodiversity Management Plan regarding noise disturbance to fauna	Limit the effects of noise on local communities during construction	• Undertake engagement and consultation with local communities and businesses about construction timing and expected noise levels (MM081). • Restrict construction activities to daylight hours (MM017). • Preferentially locate tower sites with diesel generators away from sensitive receptors (e.g., houses) (MM016). • Maintain construction vehicles and equipment in order to limit emissions (including noise) and remove from service any equipment from which emissions are visibly excessive (MM020). • Consider installing solar panels to minimise generator use and associated noise and emissions (MM019). • House generators in noise reduction panelling walls with noise dampening insulation (MM021). • Use diesel generators that emit low noise levels (MM082). • Monitor noise levels to make sure construction activities and tower operations are within relevant limits (MM018).	• Noise and emissions levels remain within relevant criteria. • Number of installations of solar panels and fuel-efficient diesel generators which emit maximum noise level of 45 decibels. • No Project-related noise complaints received.	• Monitor noise levels for compliance with relevant criteria, as needed. • Monitor community grievances. • Verify implementation of management measures.	Company, Contractor
Consumption of energy	Energy use	Minimise the contribution to PNG's national GHG emissions	• Develop procedures for energy usage reduction in office buildings, such as: – Switching off lights when not in use. – Using energy efficient light bulbs in offices (e.g., LED bulbs). – Consider energy efficiency when purchasing new equipment. – Performing regular maintenance of office cooling systems (MM044). • Design buildings to minimise the need for artificial lighting and insulate buildings where practicable (MM045). • Monitor energy use to identify areas of inefficiency or high consumption (MM046). • Raise awareness of employees and contractors of opportunities and benefits of energy saving and the impacts of climate change (MM047).	• Identification of areas of inefficiency or high consumption.	• Record energy usage. • Compliance with energy usage procedures and design standards.	Company, Contractor

Table 9.2 – Waste and Hazardous Material Management Plan

Activity/Aspect	Potential Impact	Management Objective	Management Measures	Performance Indicator	Monitoring	Responsibility
Workforce (fly camps)	Alteration of aquatic habitats due to temporary camp waste discharges	Maintain the quality of groundwater and surface water	• Provide portable toilets or appropriately constructed pit latrines at temporary construction camps that are appropriately located away from groundwater and surface waterbodies (MM030). • No temporary camp domestic or industrial wastewater is to be discharged into the environment without CEPA approval (MM126).	• No pit latrines located near groundwater or surface waterbodies.	• Pit latrine locations.	Contractor
Construction of towers and supporting infrastructure; Transport, storage, use and disposal of hazardous materials; Waste disposal	Accidental spills or leaks of hazardous materials	Prevent accidental spills or leaks of hazardous materials	• Avoid or minimise use of hazardous materials (MM032). • Ban the use of chemicals and hazardous materials subject to international bans or phase-outs (MM033). • Provide secondary containment, drip trays or other overflow or containment measures for hazardous material containers at connection points or other possible overflow points (MM034). • Ensure temporary fuel storage tanks are bunded according to specifications in *Australian Standards–AS 1940* (MM127). • Clearly label vessels with name or description of hazardous material and have accessible relevant safety data sheets (MM035). • Store hazardous materials in accordance with manufacturer's recommendations MM128). • Regularly inspect integrity of all storage tanks and bunds for leaks and flaws (MM036). • Ensure temporary workshop activities and fuel storage facilities comply with minimum requirements in *DEC Environmental Code of Practice for Vehicle/Machinery & Petroleum (Hydrocarbons) Storage/Resale/Usage Site, DEC 2000* (MM129). • Ensure waste oil and other potentially hazardous materials are adequately treated and disposed of at an approved industrial waste facility (MM130). • Spill kits appropriate to the spill risk are to be available at each work site and vehicles as necessary. All fuel tankers and vehicles transporting hazardous materials shall carry appropriate spill kits (MM037). • Train personnel in the handling, transportation and storage of hazardous materials, and spill response procedures (MM038). • Prohibit wash-down or fuel handling near streams (MM039). • During site decommissioning, examine soil for any evidence of hydrocarbon contamination, and remove/treat soil as appropriate (MM040).	• No spills or leaks of hazardous materials. • Environmental audits showing no non-compliances to spill prevention, response and control mitigations.	• Records of hazardous material spills and leaks. • Verify implementation of management measures.	Company, Contractor
Construction of towers and supporting infrastructure; Consumption of energy and resources	Waste generation	Minimise waste generation and dispose of appropriately	• Develop procedures incorporating waste minimisation principals (reduce, reuse/recycle, treatment and disposal) to minimise waste generation and disposal, such as: – Adopting paperless technology, where practicable. – Segregating wastes for reuse, recycling and disposal. – Conducting regular audits of waste generation (MM048). • Domestic and industrial waste materials generated during site construction, operations and decommissioning are to be recycled where possible or disposed at appropriate landfill facilities (in accordance with DEC Environment Code of Practice for Sanitary Landfill Sites, DEC 2000) (MM031).	• Procedures for reduced waste generation and disposal are implemented. • All waste materials generated on site are disposed of at approved facilities.	• Records of: – Tonnes of waste generated. – Types of waste generated. – Locations where waste is disposed. • Verify implementation of management measures.	Company, Contractor

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Table 9.3 – Biodiversity Management Plan

Activity/Aspect	Potential Impact	Management Objective	Management Measures	Performance Indicator	Monitoring	Responsibility
Site clearance; Construction of roads	Terrestrial habitat loss or degradation and associated loss of biodiversity	Avoid or minimise habitat loss, disturbance and fragmentation	• Avoid locating towers and any new access roads in sensitive areas for biodiversity, such as critical habitat (e.g., for threatened species or of special significance for endemic or restricted-range flora and fauna). Locations that may trigger Category A project categorisation under ADB Safeguard Requirements are considered 'no go' areas. This includes but is not limited to PNG Protected Areas, Alliance for Zero Extinction (AZE) sites and locations in close proximity to wetlands. Assessment is to be undertaken of any proposed sites located in natural habitat or Key Biodiversity Areas (KBAs) to assess potential risks to natural and critical habitat and whether additional management measures are required or the site is be avoided to comply with ADB Safeguard Requirements (MM001). • Preferentially locate tower sites in areas with existing towers and road access, and where land is unused, minimally used or degraded rather than forests and land used for agriculture (MM002). • Minimise the area disturbed around each tower site and along access roads to that required for safe construction activities (MM003). • Consider the routing of any new access roads to avoid induced impacts such as increased access for hunting (MM004). • Clearly demarcate the works, including the extent of the site to be disturbed. Train construction workers in environmental management requirements (MM005). • Where tree removal is necessary for road construction, limit damage to surrounding habitats by felling trees away from existing stands where practicable. Consider bird nesting seasons when scheduling tree removal (MM006). • Limit work vehicles and machinery to designated access and work site areas (MM007). • Limit the road surface width to 4 m and cut and fill batters to the minimum area required (MM008). • Where practicable, stockpile cleared vegetation in a manner that facilitates respreading or salvaging, e.g., place on one side of cleared areas (MM009). • Undertake site reinstatement promptly and progressively as works are staged and as soon as practicable after disturbance (MM010). • Revegetate disturbed areas using native species, where required (MM011).	• No towers located in 'no go' areas (per the SAQ Procedure, e.g.., that may trigger Category A project categorisation under ADB Safeguard Requirements). • No vegetation clearing and disturbance beyond predefined boundaries.	• Check proposed tower locations with regard to 'no go' areas in SAQ Procedure. • Routine inspections to verify the extent of disturbance. • Verify implementation of management measures.	Company, Contractor
Site clearance; construction of towers and supporting infrastructure; Project traffic	Introduction or spread of invasive species	Prevent invasive alien species from entering, spreading or becoming established in the Project areas	• Inspect equipment arriving on site to ensure that it is clean and free from soil or vegetative matter (MM012). • Train and induct Project personnel in identifying invasive alien species and relevant control measures (MM013). • Inspect regularly for the presence of weeds around the camp site and, when encountered, use appropriate control measures (hand pulling, spraying) (MM014). • Construction contractor to develop and implement effective waste management procedures (MM015).	• No new weed, pathogen and pest incursions as a result of Project activities.	• Routine inspections of Project sites and surrounding areas for invasive alien species. • Verify implementation of management measures.	Company, Contractor
Construction of towers and supporting infrastructure; Operation of towers	Noise disturbance to fauna	Avoid or minimise impacts of Project noise on fauna	• Restrict construction activities to daylight hours (MM017). • Monitor noise levels to make sure noise from construction activities are within relevant limits (MM018). • Consider installing solar panels to minimise generator use and associated noise and emissions (MM019).	• Noise levels remain within relevant criteria.	• Monitor noise levels for compliance with relevant criteria, as needed. • Verify implementation of management measures.	Company, Contractor

Activity/Aspect	Potential Impact	Management Objective	Management Measures	Performance Indicator	Monitoring	Responsibility
			• Maintain construction vehicles and equipment in order to limit emissions (including noise) and remove from service any equipment from which emissions are visibly excessive (MM020). • House generators in noise reduction panelling walls with noise dampening insulation (MM021). • Preferentially use fuel-efficient diesel generators (MM022).			
Operation of towers	Harm to birds due to tower strikes	Avoid or minimise impacts to fauna	• Avoid locating towers and any new access roads in sensitive areas for biodiversity, such as critical habitat (e.g., for threatened species or of special significance for endemic or restricted-range flora and fauna). Locations that may trigger Category A project categorisation under ADB Safeguard Requirements are considered 'no go' areas. This includes but is not limited to PNG Protected Areas, Alliance for Zero Extinction (AZE) sites and locations in close proximity to wetlands. Assessment is to be undertaken of any proposed sites located in natural habitat or Key Biodiversity Areas (KBAs) to assess potential risks to natural and critical habitat and whether additional management measures are required or the site is be avoided to comply with ADB Safeguard Requirements (MM001). • No towers are to be constructed using permanent guy wires (MM023). • Minimise number of towers by co-locating antennae on existing towers or other fixed structures where practicable, designing new towers to accommodate future users, and removing towers no longer in use (MM024). • Avoid the use of lights on towers unless required by PNG law for aviation safety. When required, lights should be flashing rather than steady state. Steady state security lights, if required, will be installed at <8 m height, and directed downwards, to reduce attraction to birds (MM025).	• No towers located in 'no go' areas (per the SAQ Procedure, e.g.., that may trigger Category A project categorisation under ADB Safeguard Requirements). • No towers constructed using guy wires.	• Check proposed tower locations with regard to 'no go' areas.. • Verify implementation of management measures.	Company
Site clearance; construction of towers and supporting infrastructure;	Alteration of aquatic habitats	Avoid or minimise impacts to aquatic habitat and fauna	• Avoid locating towers and any new access roads in sensitive areas for biodiversity, such as critical habitat (e.g., for threatened, rare and endemic flora and fauna). Locations that may trigger Category A project categorisation under ADB Safeguard Requirements are considered 'no go' areas. This includes but is not limited to PNG Protected Areas, Alliance for Zero Extinction (AZE) sites and locations in close proximity to wetlands. Assessment is to be undertaken of any proposed sites located in natural habitat or Key Biodiversity Areas (KBAs) to assess potential risks to natural and critical habitat and whether additional management measures are required or the site is be avoided to comply with ADB Safeguard Requirements (MM001). • Preferentially locate tower sites in areas with existing towers and road access, and where land is unused, minimally used or degraded rather than forests and land used for agriculture (MM002). • Avoid the selection of sites close to water bodies (creeks/rivers, floodplains, wetlands, coastal areas) where practicable (MM076). • Minimise the area disturbed around each tower site and along access roads to that required for safe construction activities (MM003). • Limit gradients of access roads to reduce runoff-induced erosion (MM026). • Install temporary and permanent erosion and sediment control measures, slope stabilisation measures, and subsidence control and minimisation measures at all construction sites, as necessary (MM027).	• No towers located in 'no go' areas (i.e., that may trigger Category A project categorisation under ADB Safeguard Requirements). • Erosion and sediment control measures are implemented and effective. • No vegetation clearing and disturbance beyond predefined boundaries.	• Check proposed tower locations with regard to 'no go' areas in SAQ Procedure. • Visual monitoring of the effectiveness of installed erosion and sediment controls as needed, particularly during and after storm events. • Routine inspections to verify the extent of disturbance. • Verify implementation of management measures.	Company, Contractor

Activity/Aspect	Potential Impact	Management Objective	Management Measures	Performance Indicator	Monitoring	Responsibility
			• Maintain fish access when road crossings of watercourses are unavoidable by utilising clearspan bridges, open-bottom culverts, or other approved methods (MM028). • Minimise clearing and disruption to riparian vegetation (MM029). • Undertake site reinstatement promptly and progressively as works are staged and as soon as practicable after disturbance (MM010). • Provide portable toilets or appropriately constructed pit latrines at temporary construction camps that are appropriately located away from groundwater and surface waterbodies (MM030). • Domestic and industrial waste materials generated during site construction, operations and decommissioning are to be recycled where possible or disposed at appropriate landfill facilities (in accordance with DEC Environment Code of Practice for Sanitary Landfill Sites, DEC 2000) (MM031). • No temporary camp domestic or industrial wastewater is to be discharged into the environment without CEPA approval (MM126).			

Table 9.4 – Electromagnetic Fields Management Plan

Activity/Aspect	Potential Impact	Management Objective	Management Measures	Performance Indicator	Monitoring	Responsibility
Operation of towers	Reduction in workforce and community health from EMF	Avoid impacts, or perception of harm, to people from EMF	• Comply with requirements for the management of potential health and safety risks associated with EMF described in Vodafone Global Policy Radiofrequency Electromagnetic Fields – Risk Management (MM123). • Evaluate potential community exposure against the International Commission on Non-ionizing Radiation Protection (ICNIRP) and maintain average and peak exposure levels below the ICNIRP recommendation for General Public Exposure (MM102). • Undertake engagement and consultation with local communities and businesses on EMF issues during the site selection process, including access to credible and current information on health risks (MM103). • Restrict community access to tower locations, through installation of fencing and signage, and implementation of security patrols (MM104). • Adopt good engineering practice in the siting and installation of directional links (e.g., microwave links), to avoid building structures (MM105).	• Average and peak exposure levels remain below the ICNIRP recommendation for General Public Exposure. • 100% of Project-affected Indigenous Peoples' communities provided access to reputable information on effects of EMF.	• Monitor average and peak exposure levels. • Verify implementation of management measures.	Company

Table 9.5 – Erosion and Sediment Control Management Plan

Activity/Aspect	Potential Impact	Management Objective	Management Measures	Performance Indicator	Monitoring	Responsibility
Site clearance; Construction of towers and supporting infrastructure	Alteration of aquatic habitats	• Maintain surface water quality. • Maintain existing hydrological regimes.	• Avoid locating towers and any new access roads in sensitive areas for biodiversity, such as critical habitat (e.g., for threatened species or of special significance for endemic or restricted-range flora and fauna). Locations that may trigger Category A project categorisation under ADB Safeguard Requirements are considered 'no go' areas. This includes but is not limited to PNG Protected Areas, Alliance for Zero Extinction (AZE) sites and locations in close proximity to wetlands. Assessment is to be undertaken of any proposed sites located in natural habitat or Key Biodiversity Areas (KBAs) to assess potential risks to natural and critical habitat and whether additional management measures are required or the site is be avoided to comply with ADB Safeguard Requirements (MM001). • Preferentially locate tower sites in areas with existing towers and road access, and where land is unused, minimally used or degraded rather than forests and land used for agriculture (MM002). • Minimise the area disturbed around each tower site and along access roads to that required for safe construction activities (MM003). • Limit gradients of access roads to reduce runoff-induced erosion (MM026). • Install temporary and permanent erosion and sediment control measures, slope stabilisation measures, and subsidence control and minimisation measures at all construction sites, as necessary (MM027). • Maintain fish access when road crossings of watercourses are unavoidable by utilising clearspan bridges, open-bottom culverts, or other approved methods (MM028). • Minimise clearing and disruption to riparian vegetation (MM029). • Undertake site reinstatement promptly and progressively as works are staged and as soon as practicable after disturbance (MM010).	• Erosion and sediment control measures are implemented and effective.	• Visual monitoring of the effectiveness of installed erosion and sediment controls as needed, particularly during and after storm events. • Verify implementation of management measures.	Company, Contractor

Table 9.6 – OHS Risk Management Plan

Activity/Aspect	Potential Impact	Management Objective	Management Measures	Performance Indicator	Monitoring	Responsibility
Transport, storage, use and disposal of hazardous materials; Project traffic; Workforce (fly camps); Site access and security; Operation of towers	Risks to workforce health and safety including: • Increased accidents and injuries • Increased incidence of communicable diseases or malaria • Exposure to hazardous materials or waste • Exposure to/spread of COVID-19	Avoid risks to workforce health as a result of accidents or transmission of disease	• Require the Project workforce, including contractors, to comply with the Company occupational health and safety (OHS) management plans and procedures (MM083). • Provide Project workforce training and awareness to support understanding and compliance with health and safety procedures (MM084). • Require the Project workforce, including contractors, to wear personal protective equipment (PPE) at all times while on site (MM085). Ensure that all employees and contractors required to work at heights, in confined spaces or with specialised machinery or equipment are appropriately trained and certified and operate in accordance with best practice guidelines and Company OHS plans and standard operating procedures (MM086). • Equip towers with safety infrastructure, including railings and safe work platforms (MM087). • Discourage Project workforce interactions with local communities during construction and operations by providing separate accommodation for the construction workforce and implementing community interaction protocols (MM072). • Design infrastructure including construction camps, to minimise vector harbourage (e.g., minimise pooling water, proper waste disposal) and human exposure (e.g., screening of doors and windows) to minimise spread of disease (MM091). • Provide temporary toilet facilities for construction workers, (i.e., portable toilets or simple pit latrines) and ensure the location is agreed to by affected communities, is rehabilitated and waste is appropriately disposed of at workforce demobilisation (MM092). • Remove all construction waste and waste generated from maintenance and repair activities from site following the completion of works (MM093). • Maintain fire controls and buffers 5 to 10 m away from security fences (MM094). • Develop and regularly test the emergency preparedness and response procedure (MM095). • Manage hazardous materials and waste in accordance with relevant legislation, good industry practice and the Waste and Hazardous Material Management Plan (MM096). • Manage grievances or complaints to identify potential health and safety issues and trends that require management action across the program of works (MM100). • Implement traffic management protocols during construction, including maintain separation between people and heavy machinery, implementing speed limits and road closures, where required (MM101).	• Number of accidents or injuries of Project workers. • No cases of COVID-19 linked to the Project construction workforce. • All relevant employees have required training (e.g., health and safety procedures, working at heights procedures). • Traffic management protocols are implemented.	• Monitor workplace accidents and injuries • Verify implementation of management measures.	Company, Contractor

Table 9.7 – Labour and Working Conditions Management Plan

Activity/Aspect	Potential Impact	Management Objective	Management Measures	Performance Indicator	Monitoring	Responsibility
Project employment and procurement	Workplace discrimination, exploitation and exclusion of minorities and women	Prevent workplace discrimination, exploitation and exclusion of minorities and women	• Comply with PNG laws applicable to non-discrimination in employment and enforce compliance (through contractual obligation) of contractors and the supply chain workforce (MM106). • Provide employment opportunities that are transparent, open to all and free of discrimination (MM107). • Maximise the employment of people from local communities surrounding tower locations during construction and operations/maintenance, including the adoption of recruitment targets for women and Indigenous Peoples (MM058). • Establish and maintain national content targets to maximise the employment and contracting of national citizens over the life of Project (MM059). • Develop and deliver internships and/or training opportunities with the Project or its contractors specifically focusing on transferable, nationally recognised trade skill development (MM060). • Provide local community representatives with basic training in site maintenance (cutting grass) and in monitoring security of the site (reporting alarms) during operations (MM061). • Implement Company policies and the Company Code of Conduct that provide for equality in employment and appropriate workplace behaviour towards women and minority groups (MM063). • Incorporate measures in supplier contracts and inductions to protect the rights of women and children, particularly in local Indigenous communities (MM064). • Deliver compliance and business ethics training for Project workers and contractors (MM109). • Implement, maintain and communicate an employee grievance mechanism (MM110). • Provide women's development and leadership programs for women at all levels within the workforce (MM111).	• Number of women hired during construction and operations. • Number of local Indigenous Peoples hired during construction and operations. • Incidences of discrimination and/or workplace grievances lodged.	• Monitor: – Number of women hired during construction and operations. – Employee grievance mechanism. • Verify implementation of management measures.	Company, Contractor

Table 9.8 – Community Health and Safety Management Plan

Activity/Aspect	Potential Impact	Management Objective	Management Measures	Performance Indicator	Monitoring	Responsibility
Transport, storage, use and disposal of hazardous materials; Project traffic; Workforce (fly camps); Site access and security; Operation of towers	Risks to community and workforce health and safety including: • Increased accidents and injuries. • Increased incidence of communicable diseases or malaria. • Exposure to hazardous materials or waste. • Exposure to/spread of COVID-19. See 'Electromagnetic Fields Management Plan' regarding impacts on community health from EMF	Avoid a reduction in community health as a result of accidents or transmission of disease	• Incorporate measures in supplier contracts and inductions to protect the rights of women and children, particularly in local Indigenous communities (MM064). • Limit community access to tower locations, through installation of fencing and signage, and implementation of security patrols during construction (across all sites) and during operations for greenfield locations (MM088). • Avoid siting towers within 4 km of airports or airfields and along known flight path envelopes (MM089). • Consult regulatory air traffic authorities (i.e., CASA) prior to tower installation, in accordance with air traffic safety regulations (MM090). • Discourage Project workforce interactions with local communities during construction and operations by providing separate accommodation for the construction workforce and implementing community interaction protocols (MM072). • Remove all construction waste and waste generated from maintenance and repair activities from site following the completion of works (MM093). • Maintain fire controls and buffers 5 to 10 m away from security fences (MM094). • Manage hazardous materials and waste in accordance with relevant legislation, good industry practice and the Waste and Hazardous Material Management Plan (MM096). • Provide community awareness programs on community health, wellness and safety (MM098). • Encourage provincial health service providers to utilise mobile phone services for communication between health workers and between health workers and remote communities (MM099). • Manage grievances or complaints to identify potential health and safety issues and trends that require management action across the program of works (MM100). • Implement traffic management protocols during construction, including maintain separation between people and heavy machinery, implementing speed limits and road closures, where required (MM101).	• Number of accidents or injuries of community members (e.g., associated with construction, traffic or unauthorised access). • No cases of COVID-19 linked to the Project construction workforce. • No increased incidences of communicable diseases in Indigenous Peoples' communities as a result of the Project workforce. • No community exposure to Project-related hazardous materials.	• Monitor COVID cases and accidents or injuries involving community members. • Verify implementation of management measures.	Company, Contractor

Table 9.9 – Social Management Plan

Activity/Aspect	Potential Impact	Management Objective	Management Measures	Performance Indicator	Monitoring	Responsibility
Land access	Change of land use and loss of community access to land	Avoid or minimise land use changes	• Preferentially locate tower sites in areas with existing towers and road access, and where land is unused, minimally used or degraded rather than forests and land used for agriculture (MM002). • Implement the 'Site Selection and Acquisition Procedure' to ensure consultation is undertaken with affected communities and change in land use is supported (MM049). • Prior to any site works, document the state of the land/premises and adjoining area, including photographs of the existing condition of the land (MM050). • Limit the road surface width to 4 m and cut and fill batters to the minimum area required (MM008). • Minimise the area disturbed around each tower site to that required for safe construction activities (MM003). • Clearly demarcate the works, including the extent of the site to be disturbed (MM040). • Preference the installation of smaller (18 to 30 m high, infill) towers in populated and coastal areas, and larger (>60 m high) towers in remote, less populated areas, minimising the land required in populated areas (MM051). • Support capacity building programs aimed at enhancing national and local government capacity to foster diversified economic growth and their capacity to deliver local public services (MM052).	• No vegetation clearing and disturbance beyond predefined boundaries.	• Routine inspections to verify the extent of disturbance. • Verify implementation of management measures.	Company, Contractor
Land access; Construction of towers and supporting infrastructure	Loss or damage to archaeological or cultural heritage values	Avoid disturbance or damage to tangible heritage values	• Undertake engagement and consultation with customary landowners to identify local heritage sites and values (MM066). • Implement the 'Site Selection and Acquisition Procedure' to avoid the selection of sites identified by customary landowners as having cultural heritage values or significance that may trigger Category A project categorisation under ADB Safeguard Requirements requiring additional assessment, approval and management, and to avoid impacts on areas of cultural heritage significance more generally (MM067). • Avoid the selection of sites identified by customary landowners or the DLPP as having cultural heritage values or significance that may trigger Category A project categorisation under ADB Safeguard Requirements requiring additional assessment, approval and management (MM068). • At new greenfield sites (i.e., those not co-located with existing ICT infrastructure), and based on an assessment of risk, consider liaising with the PNG National Museum and Art Gallery (NMAG) to inform site selection (MM069). • Develop and implement a Chance Finds Procedure which includes measures for dealing with any skeletal material encountered during site disturbance activities (MM070). • Develop and implement training for construction workers in Cultural Heritage identification and the Chance Finds Procedure before disturbance activities commence (MM071).	• 100% of sites appropriately managed (i.e., no disturbance to heritage sites and values).	• Monitor: – Records of site clearance agreements with NMAG for identified sites. – Marking of identified sites during ground disturbance. • Verify implementation of management measures.	Company, Contractor
Land access; Construction of towers and supporting infrastructure; Operation of towers	Decline in intangible heritage values (e.g., local languages, traditional knowledge and practices)	Minimise Project contribution to loss of intangible heritage values	• Discourage Project workforce interactions with local communities during construction and operations by providing separate accommodation for the construction workforce and implementing community interaction protocols (MM072).	• No change in traditional language use and cultural practices.	• Monitor traditional language use and cultural practices. • Verify implementation of management measures.	Company, Contractor

Activity/Aspect	Potential Impact	Management Objective	Management Measures	Performance Indicator	Monitoring	Responsibility
			• Support local intangible heritage programs (e.g., providing financial or other assistance to support local cultural festivals) (MM073).			
Land access; Construction of towers and supporting infrastructure; Transport, storage, use and disposal of hazardous materials	Economic displacement resulting from loss of subsistence resources or income	Avoid or minimise loss of livelihoods	• Implement the 'Site Selection and Acquisition Procedure' to ensure consultation is undertaken with customary landowners, businesses and local communities to identify economic activities and subsistence resources relevant to each tower site (MM074). • Manage construction activities to avoid disruption of identified income-generating and subsistence activities and resources (MM075). • Avoid the selection of sites close to water bodies (creeks/rivers, floodplains, wetlands, coastal areas) where practicable (MM076). • Map customary land assets (including natural resources, i.e., trees, crops) for compensation under the Valuer-General Compensation Schedule 2013 (MM055). • Deliver sustainable development and economic empowerment programs in locations identified as in need of additional support for livelihood maintenance (e.g., fresh water supply, agri-business training and development, etc.) (MM077).	• Compensation or benefits awarded to customary landowners (in PGK per annum). • No net changes in subsistence practices resulting from Project activities. • No net changes in Indigenous People's income.	• Monitor compensation or benefits awarded to customary landowners. • Verify implementation of management measures.	Company, Contractor
Construction of towers and supporting infrastructure	Reduction in visual amenity due to towers and landscape changes	Avoid or minimise the impacts on amenity	• Preferentially locate tower sites in areas with existing towers and road access, and where land is unused, minimally used or degraded rather than forests and land used for agriculture (MM002). • Minimise the area disturbed around each tower site to that required for safe construction activities (MM003). • Preference the installation of smaller (18 to 30 m high, infill) towers in populated and coastal areas, and larger (>60 m high) towers in remote, less populated areas, minimising the land required in populated areas (MM051). • Undertake engagement and consultation with customary landowners, local communities and businesses to identify low-use sites and discuss the potential changes to visual amenity (MM078). • Use muted colours (e.g., grey) on towers and infrastructure to support blending with their surroundings (except if required for aircraft or water safety reasons) (MM079). • Consider installation of camouflage towers in visually sensitive locations (MM080).	• Number of community complaints regarding visual amenity.	• Monitor community grievances. • Verify implementation of management measures.	Company, Contractor
Land access; Project employment and procurement; Workforce (fly camps), Construction of towers and supporting infrastructure	Reduction in community cohesion resulting from: • Lease benefits distribution • Landowners or local communities not being properly consulted • In-migration/influx of people looking for employment opportunities • Increased use of alcohol and drugs and associated anti-social behaviour	Avoid adverse impacts to community cohesion and governance as a result of Project activities	• Preferentially locate tower sites in areas with existing towers and road access, and where land is unused, minimally used or degraded rather than forests and land used for agriculture (MM002). • Implement the 'Site Selection and Acquisition Procedure' to ensure consultation is undertaken with affected communities and change in land use is supported (MM049). • Undertake engagement and consultation with customary landowners to negotiate and agree terms of customary land lease in accordance to legal requirements (MM112). • Map customary land assets (including natural resources, i.e., trees, crops) for compensation under the Valuer Generals Compensation Schedule 2013 (MM055). • Where possible, procure goods and services from local suppliers, including Incorporated Landowner Groups (ILGs) (MM057).	• No Project-induced in-migration. • Number of local Indigenous Peoples hired during construction and operations. • No increase in use of alcohol and drugs and associated anti-social behaviour.	• Monitor: – Local Indigenous Peoples hired during construction and operations. – Project-induced in migration. • Verify implementation of management measures.	Company, Contractor

Activity/Aspect	Potential Impact	Management Objective	Management Measures	Performance Indicator	Monitoring	Responsibility
			• Discourage Project workforce interactions with local communities during construction and operations by providing separate accommodation for the construction workforce and implementing community interaction protocols (MM072). • Comply with PNG laws applicable to non-discrimination in employment and enforce compliance (through contractual obligation) of contractors and the supply chain workforce (MM106). • Provide employment opportunities that are transparent, open to all and free of discrimination (MM107). • Maximise the employment of people from local communities surrounding tower locations during construction and operations/maintenance, including the adoption of recruitment targets for women and Indigenous Peoples (MM058). • Establish and maintain national content targets to maximise the employment and contracting of national citizens over the life of Project (MM059). • Incorporate measures in supplier contracts and inductions to protect the rights of women and children, particularly in local Indigenous communities (MM064). • Support sustainable initiatives to strengthen village law and order organisations (e.g., village courts, local police and churches) (MM114).			

9.2.4 Auditing

9.2.4.1 Internal Audit

Vodafone PNG will undertake regular internal audits to assess the effectiveness and implementation of environmental and social management across Company operations, and to ensure compliance with regulatory requirements. These audits will be supported by additional routine inspections at tower sites to ensure management measures are effectively implemented. Inspections will be undertaken during construction of each tower using checklists addressing environmental and social requirements for tower construction and camp management.

9.2.4.2 External Audit

Vodafone PNG will appoint an independent and suitably qualified environmental and social consultant to undertake an audit of ESMS performance and prepare a corrective action plan for submission to Company and the ADB 12 months after network launch. The purpose of this audit is to ensure compliance with the ESMS, national regulations and ADB Safeguard Policy Statement requirements.

9.2.5 Reporting

9.2.5.1 Internal Reporting

Internal reporting will be undertaken to communicate environmental performance and incidents within the framework of the ESMS. Key reporting initiatives include:

- Regular reporting against Corporate environmental and social objectives to the Company Board and Executive.
- Regular departmental reporting on environmental and social performance against key performance indicators in the environmental and social management plans.
- Close-out report to be provided by Contractor for each tower site following completion of construction, describing compliance with ESMS and associated management plans and procedures and regulatory requirements, and identifying any complaints received and actions to resolve. Company shall review site close-out reports and reporting of engagement with local communities, identifying any lessons learned and corrective actions to be implemented.
- Incident reporting.
- Ongoing site reporting as part of routine maintenance and management during operations.
- Site decommissioning and closure reporting at the end of tower life, including close-out reporting by Contractor and sign-off thereof by project-affected communities to confirm closure works have been undertaken to community satisfaction.

9.2.4.2 External Reporting

The external reporting schedule comprises:

- Bi-annual provision of an environmental and social performance report to ADB detailing compliance with the ESMS and associated environmental and social management plans. Reporting will include employment information of Company and Contractors including numbers of local people and women employed, adherence with national labour laws and international standards, and non-engagement of child labour or forced labour. It will also include a summary of close-out reports provided by Contractor for each tower site completed during the previous six months, identifying any lessons learned and corrective actions to be implemented.
- Provision of external audit report to ADB 12 months after network launch to ensure compliance with the ESMS, national regulations and ADB Safeguard Policy Statement Requirements.
- Provision of Environmental Performance Report to CEPA at the end of each calendar year, that reports on compliance with conditions of the Environment Permit.
- Reporting to CEPA all significant environment incidents in accordance with regulations.

9.3 Roles and Responsibilities

Vodafone PNG is ultimately responsible for the implementation of management measures outlined in this IEE and ESMP. Table 9.10 sets out the key roles and responsibilities of Company and Contractor personnel in planning and implementation of the suite of environmental and social management measures identified in this document.

Vodafone PNG will work with its stakeholders to implement the measures within this IEE, ESMP and CSR Plan. In particular, as a Project equity investment partner, the ADB will review annual operating plans and budget allocations, Project implementation and compliance with its investment funding agreement.

Table 9.10 – Company and Contractor Roles and Responsibilities

Role	Responsibilities
Company	
Board	• Approves annual budget allocations.
Chief Executive Officer	• Has overall responsibility for the design, implementation, monitoring and reporting of environmental and social management measures. • Ensures that environmental and social management measures are communicated to all employees, contractors, stakeholders and the public. • Defines, documents and communicates environmental and social management roles and responsibilities. • Ensures sufficient human and financial resources are allocated on an ongoing basis to achieve effective implementation of environmental and social management measures, including provision of awareness and skills training programs. • Manages key relationships with delivery partners, including the Vodafone PNG Foundation, ADB, non-governmental organisations and the PNG government.

(This information has been removed as it falls within the exceptions to disclose specified in para 17(2) of ADB's Access to Information Policy.)

Table 9.10 – Company and Contractor Roles and Responsibilities (cont'd)

Role	Responsibilities
Manager Human Resources	• Provides Company personnel with environmental and social leadership and guidance regarding the implementation of, and compliance with, the ESMS. • Ensures the development and ongoing improvement of the ESMS and its associated plans and procedures and ensure its implementation during operations. • Defines job specifications for all new personnel. • Organises Company environmental and social related training and maintain linkages between the ESMS and human resources management systems, as necessary. • Evaluates adequacy and effectiveness of awareness and skills training programmes pertinent to environmental and social management. • Ensures compliance with the ADB safeguards relating to labour and working conditions, and indigenous peoples.
OHS and Quality Specialist	• Ensures all personnel are aware of their environmental and social responsibilities and have completed inductions. • Maintains risk register and current status of risk mitigation plans. • Confirms necessary authorisations (licences/permits) have been obtained for construction and operational phases. • Confirms compliance with legal requirements and other obligations pertaining to environmental and social management. • Commits contractors and suppliers to meeting relevant environmental and social obligations by means of specific conditions in their contracts of appointment. • Prepares bi-annual environmental and social performance report for submission to ADB.
Environment Specialist(s) / Social Development Specialist(s)	• Ensures compliance with the ADB safeguards and relevant legislation. • Responsible for the management of environmental and social impacts from Company's activities. • Responsible to execute rollout activities including site survey, site preparation, equipment implementation, site documentation, integration and acceptance. • Ensures Contractor employees are inducted and made aware of all environmental and social requirements, management plans and procedures.
Chief Technical Officer	• Establishes technical standards framework and ensures adherence to Vodafone Group, ADB safeguard requirements and industry standards. • Manages key aspects of network rollout strategies, stakeholder engagements and liaison.
Site Acquisition (SAQ) Manager	• Ensures compliance to company policies and procedures in related to site acquisition. • Tracks and reports site acquisition self-performance and preparation of timely payment requisition for landowners. • Identifies SAQ contractors, prepares documentation for approval and appointment of contractors and monitors contractor performance against relevant procedures. • Liaises with Project landowners, affected communities, government agencies, other stakeholders and the public, including response to grievances.
SAQ Officer(s)	• Identifies candidates for specific land leases based on technical set criteria, business direction, and land use regulations. • Negotiates lease acquisitions and lease amendments for mobile communications installations. • Assists in tracking and reporting site acquisition self-performance and preparation of timely payment requisition for landowners. • Undertakes quality control, data entry and tracking of site acquisition and leasing documentation. • Coordinates, orders and track titles, survey reports, environmental and social reports, structural analyses, regulatory reports and construction plans and drawings. • Prepares and updates site status reports/databases, site close-out packages, and attends client meetings or deployment calls as required. • Liaises with community and government agencies and implements the grievance mechanism.

Table 9.10 – Company and Contractor Roles and Responsibilities (cont'd)

Role	Responsibilities
Project Management Unit	• Oversees project administration, implementation management and financial management • Coordinates with implementing agencies on project activity planning and delivery. • Manages the contract with ADB. • Monitor and provide support to ensure compliance with ADB safeguards requirements during project implementation. • Ensures collection and synthesis of project monitoring data. • Prepares project reports in accordance with ADB requirements. • Assists in preparation of project financial statements in accordance with ADB requirements.
Contractors	
SAQ Contractor	• Implements the Site Selection and Acquisition Procedure (Appendix 1), including providing direction and delivering relevant training to Contractor employees. • Implements other Company procedures and management plans as directed. • Ensures compliance with relevant legislation and good industry practice when delivering specified works. • Provides regular monitoring, audits and review of compliance with environmental and social requirements and routinely identifies and acts on opportunities for improvement. • Investigates and reports any non-conformances, complaints, incidents, emergencies or breach of approval conditions to Company. • Liaises with community and other stakeholders and reports grievances to Company.
Site Project Manager(s)	• Implements Company procedures and management plans as directed. • Ensures compliance with relevant legislation and good industry practice when delivering specified works. • Provides direction to Contractor employees in relation to implementing environmental and social management measures, including delivering relevant training. • Provides regular monitoring, audits and review of compliance with environmental and social requirements and routinely identifies and acts on opportunities for improvement. • Investigates and reports any non-conformances, complaints, incidents, emergencies or breach of approval conditions to Company. • Liaises with community and other stakeholders and reports grievances to Company.
All Personnel	
	• Complete a health, safety and environment induction. • Report any hazards and/or incidents to Site Project Manager. • Comply with the ESMS, including associated management plans and procedures, for all work activities. • Understand risks applicable to their role. Effectively and efficiently minimise risk to themselves, their colleagues, suppliers, clients and the group. Raise risk management concerns to the attention of their line manager.

9.4 Budget and Financing

The management measures identified in this IEE (see Section 9.2) to mitigate adverse Project impacts are integrated into the overall budget for Project rollout and network operations and will begin implementation in Yr 0. These costs relate to capital (construction) costs, staff and contractor employment, implementation of operating procedures, training and awareness, community and stakeholder engagement, and monitoring, evaluation and reporting.

Budgets for CSR initiatives are developed and approved by the PNG Foundation and are then tabled in February each year for Vodafone PNG board approval by March.

10. Conclusion

The Project comprises the development and operation of a new telecommunications network in PNG. The main components of the US$ 400 million venture by Vodafone PNG include the company headquarters and data centre in Port Moresby, support facilities and retail stores, and the network towers across the country.

In accordance with ADB's Safeguard Policy Statement 2009 (ADB, 2009), ADB has classified the Project as Category B for Environment and Indigenous Peoples safeguard categories, given that potential environmental impacts are likely to be site-specific, mostly reversible and readily managed and there will be greenfield sites located on Indigenous Peoples/customary owned land. No involuntary land acquisition will occur.

This IEE has identified and described the potential environmental and social impacts of the Project. The Project is expected to result in impacts that are site-specific, mostly reversible and readily managed. Only a small area of land (around 400 m^2) is required to install each tower, and these will be constructed only on sites where landowners enter voluntary lease agreements. Culturally appropriate consultation and negotiation will be undertaken leasing sites on customary-owned land. Sites will be avoided in sensitive areas for biodiversity, such as critical habitat (e.g., for threatened species or of special significance for endemic or restricted-range flora and fauna). In particular, sites that may trigger Category A project categorisation under ADB Safeguard Requirements (due to biodiversity or cultural heritage considerations) will be considered 'no go' areas that are screened out during the site selection process. Potential impacts are primarily related to construction activities such as soil erosion from ground disturbance to construct tower sites and new access roads (where required), workplace health and safety, waste management, risks from accidental spill or leaks of fuel, and emissions from generators required for base stations during operations. Construction of new access roads, where required, also has the potential to have impacts on biodiversity by increasing access for hunting and vegetation removal.

Management measures will be implemented to avoid and minimise environmental and social impacts from Project activities which are integrated into aspect-specific management plans under the Project ESMS. These plans also provide monitoring and performance targets which determine whether management measures have been implemented and assess the efficacy of mitigating potential impacts.

With application of the proposed management measures, the impact of the Project will be highly beneficial for Papua New Guineans. The establishment of Vodafone PNG will introduce improvement and variety of mobile communications services in PNG. It will improve mobile service in areas of the country where it is currently limited, particularly remote and low-income parts of the country, and increase competition in other areas, resulting in lower costs and better service.

Access to affordable mobile telecommunications technology provides access to information on socio-economic opportunities and public services, especially to the poor and vulnerable population living in rural, mountainous, and hard to reach areas. This will increase domestic and regional connectivity of rural and urban communities and provides a powerful tool for customers

(This information has been removed as it falls within the exceptions to disclose specified in para 17(2) of ADB's Access to Information Policy.)

to access health and education services, support agriculture activities and undertake mobile banking and money transfers. Papua New Guineans living in both rural and urban areas will also benefit from the employment and livelihood opportunities in the construction of towers and operation of Vodafone PNG's administration and technology support services, retail stores and call centres. Economic empowerment of women will also be increased through greater employment opportunities and improved access to telecommunications.

Establishment of Vodafone PNG expands regional investment in the ICT sector between Pacific countries by ATH IV and will improve PNG's digital connectivity to match that of other countries in the region. The private sector development will also improve PNG's business environment, including governance and business practices, and lift investor confidence in the telecommunications sector.

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(This information has been removed as it falls within the exceptions to disclose specified in para 17(2) of ADB's Access to Information Policy.)

Appendix 1.
Site Selection and Acquisition Procedure

Appendix 2. Environmental and Social Legal Compliance Register

Appendix 3. Design Drawings for 30-m-high Grillage RDS

Appendix 4.
Vodafone PNG Corporate Social Responsibility Plan