KOLOSORI NICKEL PROJECT

Environmental and Social Impact Assessment

30 September 2021

Prepared for:

Pacific Nickel Mines Limited

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ACRONYMS

ACOM	Anglican Church of Melanisia
AIDS	Acquired Immuno Deficiency Syndrome
AP	Affected Person
ASL	above sea level
ASX	Australian Stock Exchange
BMP	Building Materials Permit
BP	before present
BYO	Be Your Own
CHMP	Cultural Heritage Management Plant
CITES	Convention on International Trade on Endangered Species
CLO	Community Liaison Officer
cm	centimetres
CPCe	Coral Point Count with Excel Extension
DEM	Digital Elevation Model
ECD	Environment Conservation Division
EIA	Environment Impact Assessment
EIS	Environment Impact Statement
EIS	Environmental Impact Statement
EMP	Environment Management Plan
ESIA	Environment Social Impact Assessment
ESIA	environmental and social impact assessment
ESO	Environment Safety Officer
GIS	Geographic Information System
GPS	Global Positioning System
GRM	Grievance Redress Mechanism

HIV Human Immuno Virus

ICMM International Council on Mining and Minerals

IFC International Finance Corporation

Ind. ha^{-1} Individual Per Hectare

IUCN International Union for Conservation of Nature

JBIC Japan Bank for International Cooperation

KTA Kolosori Tenement Area

LMMA Locally Managed Marine Areas

LSA Local Study Area

m metres

MAI Mining Area of Influence

MBSA Marine Baseline Study Area

MD Mine's Division

MECDM Ministry of Environment, Climate Change, Disaster Management and Meteorology

MFMR Ministry of Fisheries and Marine Resources

mg/L milligrams per litre

MIA Mining Area of Influence

MID Ministry of Infrastructure Development

ML Mining License

mm millimetres

MMERE Ministry of Mines Energy Rural Electrification

n.d. no date

NAPA National Adaptation Plan of Action

NDF Non-Detrimental Findings

NDS National Development Strategy

NEMS National Environment Management Strategy

NGO Non-Governmental Organisation

NWMPCS Waste Management and Pollution Control Strategy

PER Public Environment Report

PGA Provincial Government Act

PL Prospecting License

PNM Pacific Nickel Mines

PNML Pacific Nickel Mines Limited

RSA Regional Study Area

RSIPF	Royal Solomon Islands Police Force
SIG	Solomon Islands Government
SINDS	Solomon Islands National Development Strategy 2011-2020
SINP	Solomon Islands Nickel Project
SIRC	Solomon Islands Resources Company
SIRCL	Solomon Islands Resource Company Limited
SMM	Tsumitomo Metal Mining
SOP	Standard Operating Procedures
SS	Sampling Station
SSR	Special Site Right
STA	San Jorge Tenement Area
TPI	topographic position index
TTA	Takata Tenement Area
UPT	Underwater Photographic Sampling with Transect
UVS	Underwater Visual Census Survey
UXO	Unexploded Ordinance
WHO	World Health Organisation

1 INTRODUCTION

1.1 *Background and Overview*

Pacific Nickel Mines Kolosori Limited ("PNMKL" or the "Company") is incorporated under the laws of the Solomon Islands and is based in Honiara, Solomon Islands.

The Company is the holder of PL 05/19 and has lodged an application for a mining lease over the entire PL area. PL05/19 is on the south-eastern end of Isabel Island, Solomon Islands.

PNMKL is owned 80% by Pacific Nickel Mines (SI) Limited and 20% by local landowners.

Pacific Nickel Mines (SI) Limited is the wholly owned Solomon Islands subsidiary of ASX listed Pacific Nickel Mines Ltd ("Pacific Nickel"), who will fund and develop the Kolosori Nickel Project within PL 05/19.

PL 05/19 was recently transferred from Kolosori Nickel (SI) Limited ("KNSI") to PNMKL under the same terms and conditions as the original agreement between Pacific Nickel and KNSI.

The purpose of the Company is the exploration and development of mineral resources within PL 05/19.

The Company proposes to mine nickel laterite ore deposits with PL 05/19 (the Kolosori Nickel Project).

Pacific Nickel has carried out a commercial report and feasibility study on the Kolosori Project.

Pacific Nickel is currently funding the development exploration on PL 05/19 using local geologists, drillers and assistants under the supervision of a local chief geologist.

The Company has recently completed an exploration program with over 150 holes being drilled at the project site this year and will carry on with this drilling as part of the project development program.

The feasibility study for the project demonstrated that the development of the Kolosori Project will be beneficial to the landowners, the Isabel provincial government and the National Government at a time when COVID 19 has severely impacted the economy of the Solomon Islands,

1.2 *The Proponent*

The proponent of this project is Pacific Nickel Mines Kolosori Limited (PNMKL) which is a locally registered company. ASX listed company, Pacific Nickel Mines Limited (Pacific Nickel), has an 80% interest in the Kolosori nickel tenement. The local landowners retain a 20% share in the Company. The Proponent or Developer contact details are as follows:

Mr. Pawel Misiec / Commercial Manager

Pacific Nickel Mines (SI) Limited

P.O. Box 2115 Honiara Solomon Islands

Tel. 677 781 36 11 Email: pawelmisiec@gmail.com

1.3 Prepararion of the ESIA

This ESIA was prepared by a group of consultant who have wide experience in environmental impact assessment in the Asia Pacific region including the Solomon Islands. The ecological studies for marine and terrestrial ecosystems were undertaken by Ecological Solutions (Solomon Islands). The baseline water sampling was undertaken by Solomon Islands based Quantum 7 Limited.

1.3.1 Objective of the ESIA

The main objective of this assessment is to establish the baseline information, identify the potential environmental and social impacts of the mining to facilitate the construction of an Environmental Management Plan to ensure the proposed mining takes into consideration appropriate measures to mitigate any adverse impacts during construction, operation and decommissioning.

The assessment was undertaken in full compliance with the Solomon Islands environment impact assessment guideline. Appropriate sectorial legal provisions relevant to such mining project have also been referred to for the necessary considerations during the construction, operation and decommissioning of the mining.

Specific objectives of the study include the following:

- Comply with Solomon Islands legal requirements for the formulation of an Environment Impact Statement under the Environment Act 1998 since the proposed mining is a prescribed development under schedule 2 (section 16);
- Define the environmental social baseline conditions of the tenement area and review available information and data related to the mining project;
- Identify areas for environmental and social concerns as well as the anticipated impacts associated with the mining project;
- Establish a comprehensive environmental social management plan for the construction, operation and decommissioning phases of the mining project before commencement of operations; and
- Preparation of an ESIA and submission for approval.

1.3.2 Environmental Impact Analysis

Impacts on the following environmental values physical and natural environment were assessed:

- Physical assets including soils and landforms;
- Forestry;
- Fisheries;
- Water supply, availability and quality;

- Terrestrial and freshwater ecosystems; and
- Marine ecosystem..

1.3.3 Social Impact Analysis

Impacts on the following social values were assessed:

- Cultural heritage;
- Health, safety and well-being;
- Social organisation;
- Local customs and way of life;
- Employment;
- Education; and
- Livelihood.

1.3.4 Assessment Process

The south of Santa Isabel Island has been extensively studied during preparation of the EIS for Sumitomo Metal Mining's (SMM 2012) proposed development of Isabel tenements D and E; and the Solomon Islands Resouce Company (SIRC) proposed development on the Takata tenement. These tenements are adjacent to the Kolosori Tenement and share similar geology, soils, ecology, geography, climate and social fabric.

The assessment process comprised literature review for the ESIA components, and field-based assessment for Terrestrial and Freshwater ecosystems, marine ecosystems, baseline surface water establishment, and social-economics of the existing communities within the tenement area.

1.4 Project area

The project is located within the south eastern part of Isabel province as shown in Figure 1-1.

The mineral license PL 05/19 includes the Havihua and Vara villages in Santa Isabel Island. The Kolosori Nickel Project is located in the Isabel Province, Solomon Islands, approximately 170km from Honiara.

The topography is mountainous with high open hills and ridges. The study area falls within a land-type being an area that is uniform with respect to terrain form, soil patterns and climate. The area is described as moderate-arable medium potential grazing land.

The area has been subjected to some logging activity that was not rehabilitated and consequently environment impacts had already cover much of the study area. Most of the disturbed areas have been re-colonised by vegetation. Although bare patches of exposed substrate are evident, there are many small trees and shrubs recolonising through the area. The vegetation within the disturbed areas is however considered secondary in nature.

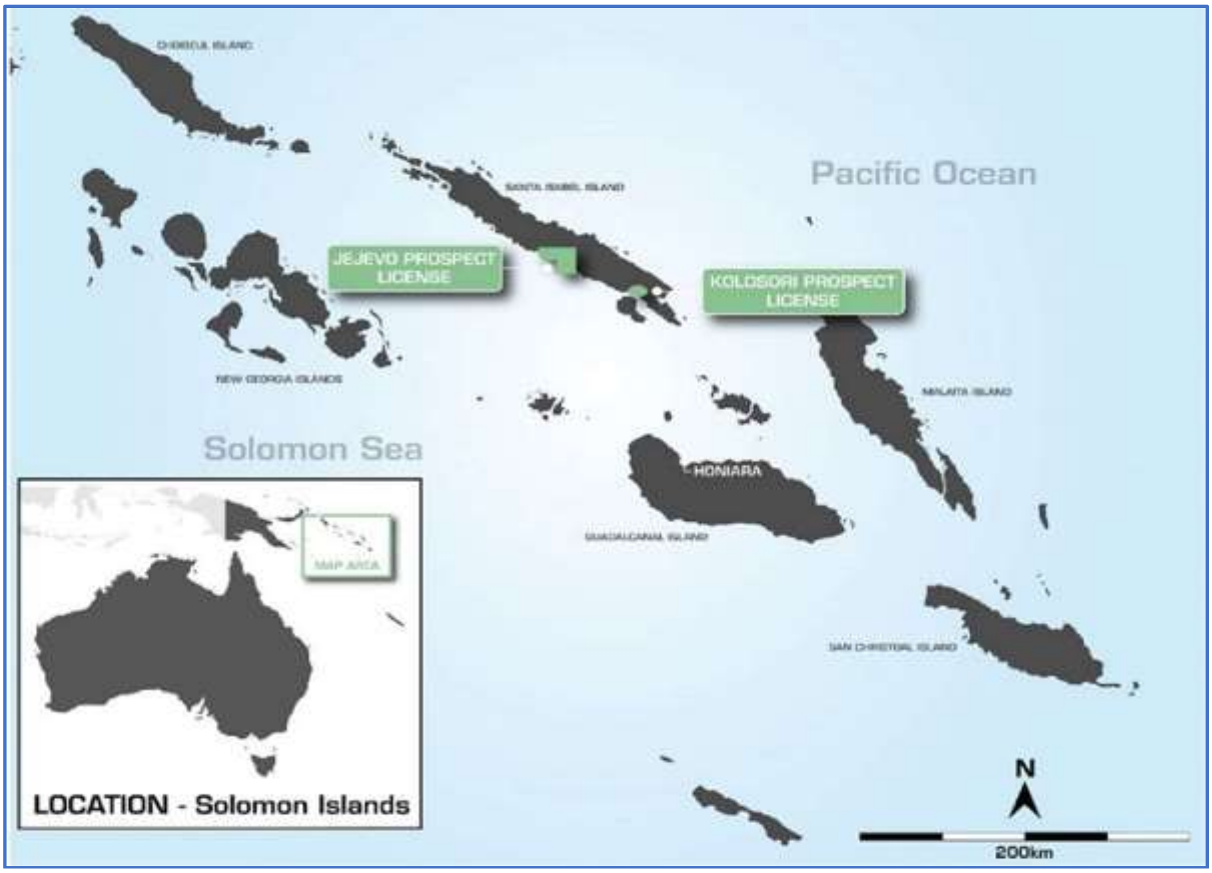


Figure 1-1: Project Location

There is the potential that some faunal species of conservation concern may occur within the study area.

The study site hosts active water sources for domesic use by the community in the area. In general water quality in the area is within the international standards for domestic use. Sedimen discharge is observable in esturine areas.

Mining and exploration related activities exist in the area to the north (Takata project) and west (San Jorge project) of the project area. The undulating nature of the terrain within the proposed mining area however limits the extent of visual intrusions. The area has already been disturbed by previous logging and exploration activity resulting in a landscape of open fern lands on the ridges and adjoining slopes fringed by denser forestation of the gulles and streams draining the ridgelines. The vegetation in the southern and central part of the lease is dominated by open fern and forest vegetation on ultramafic soils and denser forests in the northern part of the lease.

1.5 Project summary

The Company has determined an economic resource for the Kolosori Project and has submitted an economic discovery and a mining lease application which includes a feasibility study. The Company has currently defined a resource of around 6 million tonnes at 1.55% Nickel.

This ESIA is for the proposed mining of the nickel laterite deposits located within the Kolosori tenement.

Two types of nickel ores, which are common to all known nickel deposits and reserves on Santa Isabel will be mined from the mining areas: limonite ore and saprolite ore. The ores will be mined and stockpiled separately. Both ores will not be processed locally but will be sent elsewhere for processing purposes. The main target of the project is the higher grade saprolite ore.

The mine is expected to operate for at least 6 years. As in all normal mining operations, the project will involve construction, operations, decommissioning and closure phases. The construction phase of the project is expected to take up the first 1 year of the project life. Further exploration will be carried out to extend the current mine life.

The construction phase will include site clearances and establishment of project infrastructure. The operations phase will include excavation and extraction, hauling, stockpiling and trans-shipment of the ores. It will also involve many site activities to support the project. The decommissioning and closure phases will involve the decommissioning of all site infrastructures, although progressive rehabilitation will be implemented throughout the lifetime of the project where possible. Final rehabilitation will be designed to be carried out at the completion of all project operations.

The tenement has additional prospective areas with the potential for economic nickel reserves not identified by previous prospecting, and these will also be targeted as part of the prospecting stage. These additional resources have the potential to extend the mine life significantly.

The most important employer in the area is the logging and private sectors including mineral exploration.

1.5.1 Project Components

When it is developed, the project will comprise of the following basic components:

- Mining areas;
- Mine haulage roads;
- Mining equipment;
- Ore stockpile area;
- Jetty and relevant marine terminals;
- Accommodation camp;
- Mining work force;
- Mine administration buildings;
- Power systems;
- Water supply systems;
- Waste Management facilities; and
- Trans-shipment mooring.

1.5.2 Project Objectives

The project will establish a fully developed and operating nickel mine under the current tenement (PL 05/19) in the southern Isabel province. The development will hence establish active and operational mine sites, relevant camps, road networks including haulage roads, stockpile and storage areas, jetty's and relevant marine terminals for transport and shipping purposes.

2 LEGISLATION AND REGULATORY FRAMEWORK

2.1 Legislation

The development and operation of the Kolosori Nickel Project is subject to the following legislation.

2.1.1 The Constitution 1978

The Preamble of the 1978 Constitution of the Solomon Islands states that the natural resources of Solomon Islands are vested in the people and the government. It recognises customary land ownership and the right to compensation, with protections from the deprivation of property. However, it allows for the acquisition of property under certain conditions.

2.1.2 Mines and Minerals Act (Amendment) 2008

The Mines and Minerals Act 1990 [Cap 42] (Mines Act) vests the government with the exclusive right to develop mineral resources and deals with the legal, regulatory and contractual aspects of reconnaissance, prospecting, mining and closure.

The provisions relating to prospecting are provided in Part IV of the Mines Act. A 'baseline' environmental study detailing the environmental impact of the prospecting must be submitted with the application. The Director must refuse the application if the area subject to the application overlaps with an existing prospecting license or mining lease area. Furthermore, the Director must refuse the application if the applicant is currently holding three or more prospecting licenses over other areas, and it has not applied for a mining lease or commenced mining in at least one area.

Mining lease provisions are set out in Part V of the Mines Act. An applicant for a mining lease must hold a current prospecting license over the area it proposes to mine, and it must have made a commercial discovery and have in place a domestically incorporated company.

Although the principal purpose of the Mines Act and the Mines Regulations is to regulate the grant of reconnaissance, prospecting and mining rights, they also contain provisions for the protection of the environment. Section 6 of the Mines Act empowers the Minister for Mines to make regulations for conservation and to minimise damage to the environment. For implementing Section 6 of the Mines Act, Section 18 of the Mines and Minerals Regulation 1996 (Mines Regulations) requires mining companies to:

- conserve and avoid the waste of the mineral deposits of Solomon Islands;
- result in minimum ecological damage or destruction;
- control the flow and prevent the escape of contaminants, tailings and other matters produced in the course of such operations;
- prevent avoidable damage to trees, crops, buildings and other structures;

- avoid any action which could endanger the health and safety of persons; and
- avoid harm to fresh and marine waters, and animal life.

As environmental conservation and protection are clearly criteria for a company to maintain its legal license to operate, it is in the developer's interest to ensure that its entire operation is compliant with the relevant environmental provisions in the Mines Act and the Mines Regulation.

2.1.3 Environment Act 1998 and Environment Regulations 2008

The Environment Act 1998 (Environment Act) came into force in 2003 and is the first comprehensive environmental legislation in the Solomon Islands. The Environment Regulations was promulgated in 2008. This is the principal legislation the Solomon Islands Government uses to regulate the conduct of an EIS and monitor developer obligations.

It established the Environment and Conservation Division (ECD) within the Ministry of Environment, Climate Change, Disaster Management and Meteorology. It also established the position of the Director of the ECD and inspectors and the power of the Minister. The functions of the ECD include protecting the quality of the environment, developing national standards to promote sustainable development and promoting the participation of the community in environmental decision making (Price et al. 2015).

Section 4 (1) of the Environment Act states "[i]n the event of any conflict between the provisions of this Act and the provisions of any other Act, the provisions of this Act shall, to the extent of inconsistency prevail." This provision gives overriding power over other legislation with the exception of provisions within the National Constitution.

The Environment Act introduced a requirement for developers to obtain an approval called 'development consent' from the Director of the ECD before commencing certain 'prescribed developments' set out under the Second Schedule to the Act. Prescribed developments have to complete either a Public Environment Report or an Environment Impact Assessment to the satisfaction of the Director in accordance with the requirements set down in the Act. Mining is a prescribed development and requires compliance with the requirements of Section 23 of the Act. These requirements have been met, and the section where they are addressed is provided in Table 2-1; Contents requirements summary of this ESIA.

Table 2-1; Contents requirements summary of this ESIA

Requirement	**Chapter / Section**
Contain a full description of the objectives of the prescribed development	Chapter 4
Analyse the need for the prescribed development	Chapter 3
Indicate the consequences of not implementing or carrying out the prescribed development	Chapter 3
Include adequate information and technical data adequate to allow assessment of the impact of the prescribed development on the environment	Chapter 4, Chapters 6 to 14
Examine any reasonable alternatives to the prescribed development, including alternative sites for it	Chapter 3

Requirement	Chapter / Section
Describe the environment that is or is likely to be affected by the prescribed development and by any reasonable alternatives to it	Chapters 5 to 12
Assess the actual or potential impact on the environment of the prescribed development and of any reasonable alternatives to it, including the primary, secondary, short-term, long-term, adverse and beneficial impacts on the environment	Chapters 6 to 12
Outline the reasons for the choice of the prescribed development	Chapter 3 and 4
Estimate the time period of any expected impacts	Chapters 4
State the methods of predicting and assessing each impact from the construction, operational and where relevant, the de-commissioning phase of an implemented development and for each alternative presented	Chapter 1, 4, 6-12
Justify the prescribed development in terms of environmental, economic, culture and social considerations	Chapter 3, 4, 7-12
Identify and analyse all likely impacts or consequences of implementing the prescribed development, including implications for the use and conservation of energy	Chapter 4, 6-11
Describe measures to prevent or reduce significant adverse impacts and enhance beneficial effects and an account of their likely success with estimated costs as appropriate	Chapters 4 6 to 11
Describe residual impacts which cannot be mitigated or can only be mitigated partially	Chapters 6 to 11
Describe proposed monitoring and reporting schemes with estimated costs as appropriate	Chapters 6 to 12
Describe and assess the estimated cost-effectiveness of any safeguards or standards for the protection of the environment to be adopted or applied including its implementation, monitoring or reporting	Chapter 4, 6 to 12
Give an account of the impact on the environment of any of a series or programme of similar development (whether implemented or not) over a period of time	TBA
Give any sources and references of information relied on and outline any consultations with any persons made during the preparation of the report	Chapter 17
Include a site survey report concerning National Heritage items or traditional artefacts as specified by the Director	Chapter 14
Address any further matters as the Director specifies	Not Applicable
Give a clear and concise summary printed on a separate page	TBA

Once the EIS is in a form acceptable to the Director, notice is given for interested parties to lodge any submissions with regard to the granting of development consent. Upon examination of the objections, the Director either grants the Development Consent or refuses it (Price et al. 2015). Conditions for the development are set out in the Development Consent which the Director uses to regulate the development.

Any person who disagrees with the decision of the Director may within 30 days of the decision being published appeal to the Advisory Committee. A further 30 days is given for an appeal from the Advisory Committee to the Minister of Environment. Part IV of the Environment Act makes provision for the control of pollution from premises and standards to meet where waste is discharged from an operator's premises.

2.1.4 Land and Titles Act [Chapter 133]

Ownership, use and dispossession of rights to land in Solomon Islands are regulated under the Land and Titles Act first introduced in 1969 but now contained in Chapter 133 of the Solomon Islands Revised Edition 1996 (Price et al. 2015). Unregistered land, also commonly known as customary land, is regulated under the customs and practices of each region and differs from place to place. Where customary land is required for development, access rights are acquired through purchase or lease pursuant to Part V Division I of the Act or through compulsory acquisition pursuant to Part V Division II of the Act.

Mining rights as discussed in Section 2.1.2 above depend on having access to the surface of the land in what has been referred to as Surface Access Rights. Having access to the land is essential for reconnaissance, prospecting and mining. Where rights to surface access of the land have been obtained through Part V, Division I and II, the operator can proceed to deal with mining rights. Where only a surface access agreement has been used for operations during prospecting, the applicant would need to apply for a more permanent and longer term right, such as a mining lease to underpin the mining rights. The Land and Titles Act makes provisions for the various land rights and interests as well as the obligations that go with these.

2.1.5 Wildlife Protection and Management Act 2010

The Wildlife Protection and Management Act 2010 provides for the conservation, management and protection of wild flora and fauna in the country. It regulates the export and import of wildlife ensuring compliance to obligations set under the Convention on International Trade in Endangered Species (CITES). The Solomon Islands is a refuge for many species of wildlife (that includes rare and endemic). Therefore it needs to protect and manage these endangered and unique species effectively. The act prohibits the poaching of wild fauna and flora as well as harvesting of protected species. With this, SIRC shall ensure its workers are frequently informed not to undertake poaching of flora and/or fauna. This shall be prohibited under the company’s policy as well.

2.1.6 Protected Areas Act 2010

The Protected Area Act 2010 was developed with the objective of establishing protected areas to conserve biological diversity. In order for an area to become a protected area (PA), a community or organization will prepare an application to the Director of Environment for their site to be declared as a protected area. The application will need to include a PA management plan and scientific studies to show that the area is of significance to biological diversity and to the community in terms of natural resources. The application will also include an estimated budget for the PA and evidence of agreement by all customary landowners, map showing the boundary and size of the site. The director upon receiving the application will review the application and make recommendation to the Minister if the application have merits and should be declared a PA. The basic requirements for considerations by the minister include;

- (a)the conservation objectives of the protected area are identified and are in accordance with sound conservation practices;
- (b) the boundaries of the area are accurately identified, or otherwise demarcated and surveyed; (c) the consent and approval are obtained from persons having rights or interests in the area;
- (d) an appropriate conservation, protection or management plan is developed for the area to ensure that the conservation objectives of the protected area will be achieved.

Meanwhile, there are no protected areas declared under the Act within the Tenement.

2.1.7 Rivers and Waters Act 1996

The Rivers and Waters Act was enacted to administer and control developments that would impact on a river, however the Act only applies to rivers that have been designated under the Act. The River waters Act which was firstly enacted on 30th December 1964 and recently revised in 1996 is an important Act that is aimed at regulating the proper use, protection and management of waterways. It was made clear in the Act that it is an offence to create a ditch, drain, channel, pipe or any other means whatsoever diverts any water from rivers, felling of trees so that it falls into a river or river bed is also an offence, damages or interferences with the banks of any river is also an offence. Unless carefully following legal procedures, doing this activities are not acceptable. With this, it is important that prescribed developments must be cautious with respect to watercourse ways as far as this Act is concerned.

2.1.8 Waters Resource Bill

The Bill has been prepared to go through parliament and if approved and passed by parliament and gazetted, it will supersede the Rivers Waters Act 1996. The purpose of the proposed Bill is to:

- Provide for the integrated water resource management of Solomon Islands;
- To promote the most efficient, fair and beneficial use of natural water;
- To ensure the natural water resources are available for the sustainable use for the benefit of all present and future Solomon Islanders;
- To provide for the protection of natural watercourses and water catchments; and
- To provide for the control of activities occurring over or beside waterways or watercourses6.

A Water Resources Advisory Board is required under the River and Waters Act, whose function is to advise the Minister on matters pertaining to the Act and consult with the Director of Water Resources on technical matters. The Director with his/her staff shall administer, manage and implement the Act accordingly so as to achieve the above goals.

The Bill covers all water bodies, rivers, streams whether in a registered or non-registered, public or private or customary land in the Solomon Islands. The Ministry has the authority to control the use and development of all water catchments and riverbanks. Logging, mining, sands and gravel extraction in water catchments, riverbanks and river beds may be restricted by the responsible Minister according to the requirements of the catchment management and conservation. Section 21 of the River and Waters Act provides for the Ministry to recommend to the Board to declare a water body such as a catchment, groundwater or flood control zone as a Water Control Area. If approved by the Minister and gazetted, mining, and sand and gravel extraction will be prohibited. This also includes any contraction, altering, removing or in any way impede or be likely to impede flow or movement of surface water. This is very important as it may have direct impact to mining in the future if the current activities are not managed sustainably. The Bill clearly states that a development must not obstruct, divert or dam the river, if so it must make application to the Minister who upon receiving the request will assess and if agrees will issue a license accordingly.

2.1.9 Custom Recognition Act 2000

The Custom Recognition Act 2000 provides recognition to the existence of any customary law and the nature of such customary law in relation to a matter, and its application in or relevance to any particular circumstances, shall be ascertained as though they were matters of fact . However, the existence shall be provided in proof as required under section 5 of the act.

2.1.10 Shipping Act 1998

The Shipping Act 1998 was purposed for protecting (ensuring safety and health) the shipping industry. The Act gives effect to the International Maritime Organization (IMO) to manage risk, dangers and cleanliness in the marine environment.8 Part IV mentions the responsibility to respect the safety of all equipment, off and on load the vessel including human beings which applies to safe disposal of wastes (pollutants) to the ocean causing dangers/hazardous to the marine environment and habitat. It is possible that larger vessels coming in to the country to load bulk bauxite soils can cause pollution. Therefore the Act is important to ensure safety in loading of nickel ore.

2.1.11 Shipping (Marine Pollution) Regulation 2011

The shipping regulation was amended into the Shipping Act, which has special emphasis on pollution of the marine environment. The regulation has provisions for and links Solomon Islands to rectifying the IMO. It catered for safety and security of shipping and prevention of marine pollution by ships and MARPHOL. Under this Regulation, no pollution and or harmful substances are to be discharged from vessels, platform or land into the Solomon Islands waters or from a Solomon Islands vessel into any waters. If a person contravene with the provisions and standards, the person is liable/guilty to pay fine or serve imprisonment. The enforcement also includes meeting the immediate cost of restoration, rehabilitation and cleaning up within a set timeframe.

The regulation prohibits the discharge of ballast water that contains non-indigenous aquatic organisms (invasive organisms) or microorganism (pathogens) in the Solomon Islands waters. If any harmful and/or hazardous substance discharged to the marine environment in Solomon Islands waters is found to be a health risk, the person in command of the vessel must report to the Principle Surveyor (an officer appointed under the Act). This is also applicable to MPAs or Local Marine Management Area (taboo areas) declared under the Protected Acts 2010. The Director of Marine and the Permanent Secretary responsible for Disaster Management had to be informed of any discharge.

2.1.12 Ports Act 1990

Section VI of the Act makes provision for discharge of waste, etc. into and other pollution of the port. It states that no person shall cause, suffer or permit any refuse, gas, petroleum oil, bilge water, ballast water or other offensive substance whatsoever its nature to be discharged, pumped or cast into or onto any waters or land within the limits of a port without the prior written permission of the SI Ports Authority. This is only relevant for vessels coming to port at the Point Cruz wharf and the Noro Township Port and may not necessarily relevant to this proposed mining.

2.1.13 Agricultural Quarantine Order 1985

The Order of 1985 provides for preventing the introduction of disease into Solomon Islands through the importation or landing of animals, plants and other things, and preventing the introduction of pests and undesirable plants; for requiring vessels and aircrafts to give notice of their arrival in Solomon Islands; and for connected purposes. This Act grants regulation-making powers to the Minister in respect of the introduction or importation of plants and animals and substances or other material that may be the carrier of plant or animal pests and diseases. The Act further provides for the appointment of inspectors and defines their powers

and prescribed list offences. An Order of the Minister may prohibit or regulate the importation or landing of: (a) animals and animal products; (b) plants; (c) earth; and (d) other things by, or by means of, which it appears to the Minister that any disease or pest might be introduced. The First Schedule sets out the matters which may be dealt with by Order made under this Act. This is important for this proposed development as most of the larger vessels will be coming from overseas especially Asia and that Quarantine will be paramount to ensure no diseases are brought in by those vessels.

2.1.14 Forestry and Timber Utilization Act 1979

The timber rights agreement under this act is a legally binding contract made under the Form 4 and has clear conditions attached to it. These conditions include pollution prevention measure, all oil, fuel, chemicals and other pollutants shall be stored at a safe distance (buffered zone away from any river or water course in secure conditions with safeguards against accidental contamination of water).15 It clearly stated that no refuse, sewage, rubbish, oil, fuel or other pollutants may be discharged into any river, pond, and stream or water source by the Company or any of its employees or sub-contractors. This Act is specifically for logging development whereby loggable trees will be exploited for economic purposes. The processes stipulated in the Act may be required to be followed by the Company if and whenever, economical trees cleared from the tenement need to be exported overseas. There are economical trees in the tenement and before the actual mining, some of these economical trees will be exploited and there may be a need for these trees be sold overseas. Should the need arise, specific processes according to the Forestry and Timber Utilization Act will be adhered to.

2.1.15 The Provincial Government Act 1997

The Provincial Government Act 1997 gives substantial power to the provinces to pass their own legislation, including matters pertaining to the environment and conservation. Their areas of jurisdiction extend three nautical miles (Nm) from the water line and the assemblies can pass regulations that will affect the Project regarding:

- Transport, coastal and lagoon shipping, construction, maintenance and improvement of harbours, roads and bridges.
- Cultural and environment – protection of wildlife, historical remains, local crafts.
- Agriculture and fishing – protection, improvement and maintenance of freshwater and reef fisheries.
- Land and land use – codification and amendment of existing customary laws about land. Registration of customary rights in respect of land including customary fishing rights.
- Business licenses – while the central government abandoned the foreign investment authorisation process, provinces are permitted to issue authorisation to trade and conduct business, giving the province effective control over foreign investment and activity in their jurisdiction.
- Physical planning except within a local planning area (developed under the Town and Country Planning Act 1982).
- Local matters like fire services, waste disposal, parks building standards, use of water, pollution, water supply.

The *Provincial Government Act 1997* also delegates legislative authority to complement national legislation governing road and traffic, compulsory land acquisition, forestry activities, rivers and water regulations. Those powers are exercised by the provincial governments under separate Provincial Ordinances. Provincial Ordinances relevant to the Project activities are described briefly below.

2.1.16 Provincial Ordinance

The provincial government is being given power under the Provincial Government Act to pass by-laws that are important to protect and perhaps improve the wellbeing of people. With that, the Isabel Provincial Government was known to have gazette the Conservation Area Ordinance which provide guidance towards conservation of certain areas including the Arnavon Islands and other conservation or protected areas on the Island.

2.1.17 Unexploded Ordinance (UXO)

Technically WWII ordnance found in the Pacific Islands can be defined as either unexploded (UXO) or abandoned (AXO). Unexploded ordnance is defined as explosive ordnance that has been primed, fused, armed or otherwise prepared for use in armed conflict but has failed to explode. Abandoned explosive ordnance is defined as explosive ordnance unused during an armed conflict and subsequently abandoned or left behind. UXO and AXO are defined collectively as Explosive Remnants of War (ERW)18.

Solomon Islands was the scene of bitter fighting during World War II. While this was over 60 years ago, unexploded (UXO) may still be found around our islands including Isabel Island. Should UXO be discovered, the contractor is to immediately cordon off the area, arrange the evacuation of nearby residences and inform the police of the find. Currently all UXO finds are reported to the police who arrange the pickup, transport, storage and ultimate disposal of the finds. It is possible that during the mine construction and operation phase of the mine UXOs could be found. In such case, a chance find procedure for handling the UXOs during the mine construction and operation phase. This will be the responsibility of the mining company. Ultimately, there is a need the whole tenement is cleared of UXOs before the actual mining begins.

2.1.18 National Development Strategy (NDS)

The National Development Strategy is a policy document that strategizes ways in order to achieve the development aspirations of the country. Using the 17 Sustainable Development Goals (SDGs), "Transforming our World: the 2030 Agenda for Sustainable Development” as a reference, the NDS highlight five important long-term development goals. Mining for instance aligns with objective one of the NDS “Sustained and inclusive economic growth”. Proposed mining will contribute significant revenues directly to the SIG. It is anticipated that a proportion of taxes and royalty benefits will be used for local social infrastructure and social development such as education, healthcare and among others long term community projects in southern part of Isabel Province. Not only that, more local people in the area and elsewhere in the country will be employed during the construction phase and operation phase of the mine.

2.1.19 Climate Change Policy

The Solomon Islands Government through the MECDM launched the Climate Change Policy, highlighting steps the SIG would take in aiding the country and its people to exist and adapt to present imminent climate change and its impact. The Policy aims to integrate climate considerations within the framework of national policies, and guiding the government and its partners to ensure the people, natural environment and economy of the country are resilient and able to adapt to the predicted impacts of climate change. To enable the local community become climate change resilient, the company will be embarking on replanting economical trees on mined over areas so that carbon sinks are replenished despite the original vegetation may be changed.

2.1.20 National Environment Management Strategy

The primary document for environment policy in the country is the 1993 National Environment Management Strategy (NEMS), although outdated; it is an import document at the present time in the absence of an environment policy. It ensures, that the physical and social environment are protected and sustainable development is achieved.

2.1.21 National Waste Management and Pollution Control Strategy

The formulation of the National Waste Management and Pollution Control Strategy (NWMPCS) 2016-2024 is part of the ongoing efforts in the country to address the issue of waste and pollution as the country enters a period of rapid social and economic change. The objectives are:

- The development of our natural resources does not compromise the wellbeing of natural environment, ecosystems and wellbeing.
- Ensure that existing legislations, strategies and guidelines on waste management and pollution control are effectively implemented and enforced.
- Support, Encourage 4Rs and where relevant regulate waste minimization for solid wastes noting that organic waste form a large component of wastes produced in the country.
- Develop institutional capacity and train waste and pollution experts for the country.
- The government through MECDM, provincial government and Ministry of Infrastructure Development (MID) ensure that all provincial centres have in place proper landfills or waste disposal sites and a functioning waste collection system.
- All Solomon Islanders are aware of the issue of waste and pollution and are taking appropriate actions address it.
- Waste management and pollution control activities are undertaken based on accurate data and research, update information, new innovation and technology
- Encourage public-private partnership and investment in waste management and pollution control.
- There is in place a long financial mechanism in place at the national level to manage waste and address pollution issues.
- International guests and tourist are able enjoy and enjoy the natural beauty and aesthetic value of the country.
- Waste management and pollution control is fully addressed in responding to climate change and natural disasters.

One of the highlights of the strategy is the management of e wastes such as solar batteries. It is important all waste collection and disposal associated with the mining development are in line with the strategy. As part of its commitment to reducing waste, the company will prepare a Waste Management Plan that will be implemented during the mining operation on Isabel Island.

2.1.22 Additional relevant legislation

Additional relevant legislation ncludes the following Acts and Ordinances

Acts

- National Park Act 1978
- Fisheries Act 1998
- Forest and Timber (Amendment) Act 1984,
- Forests Act 1999, Forests Bill 2004
- Town and Country Planning Act 1982 and Amendment 2017
- Environmental Health Act 1980 [Cap 99]
- Petroleum Act 1987

Ordinances

- Isabel Province Draft Resource Management and Environment Protection Ordinance 2006
- Isabel Province Conservation Area Ordinance 1993
- National Minerals Policy 2017-2021
- Penal Code Amendment (Sexual Offences)
- National Policy on Gender Equality and Women's Development 2016-2020
- National Youth Policy 2017-2030
- National Policy to Eliminate Violence against Women and Girls 2016-2020
- National Children's Policy 2010-2015
- Minerals Policy
- Solomon Island National Waste Management and pollution control strategy
-

3 PROJECT JUSTIFICATION AND ALTERNATIVES

3.1 Background

3.1.1 Nickel market

There are many industrial nickel articles issues this year (2021) that supports the ongoing development of nickel ore mining and shipment to large established smelters with an increasing demand.

The opportunity to sell directly to offtakers particularly in China has been investigated by PNM with plans currently underway to engage in discussions with major Chinese Smelters.

The following article is one example for reference from Forbes, 2021 where the traditional used such as stainless steel remain a major factor, however also new emerging technology markets are contributing to the demand and the increasing Ni ore price.

"Nickel Soars and Could Keep Flying as Demand Rises and Supply Falls"

(Source: Forbes, 14 January 2021. https://www.forbes.com/sites/timtreadgold/2021/01/14)

Demand up. Supply down. Price heading for a 10-year high. It doesn't get much better for nickel—except for the potential to get a lot better for a metal which has a well-earned reputation for extreme highs (and lows).

Since suffering a Covid-19 collapse last March when the price fell to $10,800 a ton, nickel has been on a largely uninterrupted rise to last sales at $18,244/t, up almost 70% in 10 months.

Next target for nickel, which is a critical ingredient in high quality stainless steel and the batteries used in most electric vehicles (EVs) is $20,000/t, a level reached in the early 2012.

But, if a move back to levels seen in the last commodities boom sounds unlikely, then get ready for a rise to the great nickel rush of 2007, when the metal hit an all-time high of $50,000/t—before plunging to $9,200/t just two years later.

What sent nickel through the ceiling 14 years ago was a combination of supply shortages and strong demand for stainless steel.

EVs Emerge As A Nickel Driver

This time around, nickel has a new price driver, EVs, a mode of transport which was not even a blip on commodity investors radar screens in 2007.

Mercurial in the extreme, nickel has been the subject of repeated booms (and busts), mainly because of supply shortages caused by labour disputes in big Canadian mines, or in the current situation from a labour dispute in a mine on the Pacific Island of New Caledonia.

A dispute between management of Eramet, a French mining company, and the workforce at the company's mines and a metal smelter on the island, is one of the causes of concern about a nickel shortage developing, with another supply issue being a ban on mining nickel ore on an island in the Philippines.

3.1.2 Economy of the Solomon Islands

The economy of the Solomon Islands is largely centred on forestry and agriculture, which makes it vulnerable to changing climate and market forces. In 2011, the government established alternative export industries to compensate for the expected decline of the forestry industry; these industries include mining, tourism and fishing (The Economist Intelligence Unit 2017).

The Solomon Islands is considered a lower middle income country, with a 1.551 billion USD GDP in 2020. It is currently ranked 180th out of 196 countries by the World Bank. Close to one quarter of the population was living under the poverty line in 2015.

The nickel mined from the Kolosori deposit will be exported in a raw (unrefined) state, and processed overseas. This reduces the potential for adverse environmental impacts from the project on the Solomon Islands, but also means that the mining output is not economically tied to a particular smelter or company for processing, and can be traded on the open market.

3.2 Project justification

3.2.1 Economic benefits

It is estimated that the project will contribute significant revenues directly to the Solomon Islands Government, over the life of the project, subject to depending on the market price of nickel, over the life of the project. Financial returns will continue to grow as the project proceeds

A proportion of taxes and royalty benefits is anticipated will flow onto Santa Isabel Province where it can be used for local social infrastructure and social development such as education, healthcare, roads, communication and other long term community projects in southern Isabel Province.

Employment

The estimated construction workforce is 300 and the estimated operations workforce is around 200. It is expected that the construction workforce will peak within four months of commencement and reduce as the project infrastructure is completed (9 months) and the operations phase commences. The Company's priority is to employ personnel from local communities as much as possible. Most personnel will be transported to and from the island via sea. There also will be additional increase in employment opportunities for supply of goods and services as the project proceeds.

The project will generate a significant increase in employment and training for many locals, which in turn will result in an increase overall skills and income base in Santa Isabel Province.

Due to their ownership of twenty percent share in the project, the local landowners of tenement area and nearby communities will definitely benefit from this mining operation as there has never been any such mining operation where landowners are joint or part owners of the company. Further to these ownership issues, the local population will have opportunities for employment and spinoff activities as service providers in some aspects of the operation. In terms of socio-economic impacts therefore, this operation will have major positive impacts to the landowners, the communities nearby, the province and the national at large.

In terms of vulnerable groups, it is hoped that specific programs will be designed to target these groups especially in terms of employment opportunities or support in income generating activities or other social development programmes. Normal standard mining practice will be observed and implemented in terms of vulnerable groups in relation to other aspects of the operation. The main objective will be to ensure that the vulnerable groups do not get left behind but also participate and enjoy in the benefits accrued from the mining operation. Pacific Nickel is committed to observing and implementing good mining practice and will endeavor to promote positive socio-economic impacts for the local communities and all stakeholders in its mining operations. This project has the real and ideal opportunity of increasing employment in the country and thus benefits to local Solomon Islanders and increasing positive contributions to the national economy.

The project will indirectly contribute to the Solomon Islands economy through the purchase of goods and services from local suppliers, both in Isabel Province and other parts of the country. This will increase gross domestic product in the Solomon Islands over the life of the project.

Employing and training local people in construction and project infrastructure, increases the skill set of each person and these skills can be directly applied to their home village. These skills may be used to construct, develop and/or repair and maintain homes and village infrastructure.

The project will provide an economic benefit locally to Santa Isabel Island, as well as nationally to the Solomon Islands. The development of the project will reduce the Solomon Islands' reliance on forestry and agriculture exports, and help to diversify the economy.

Pacific Nickel holds further prospecting licences in Santa Isabel province at Jejevo. Development of the Kolosori and Jejevo deposits will allow Pacific Nickel to invest further in the Solomon Islands through the exploration and development of these tenements.

3.3 Alternatives

3.3.1 Not proceeding with the project

If the project does not go ahead, and the resource is in-situ, the economic benefits described above will not be realised. These include foregone tax revenue for the government and training, employment, community development funds and local spending for southern Isabel Province.

3.3.2 Alternative location

The main ore bodies are on the tops of ridges within the Kolosori Tenement. The location of the ore bodies is a fixed geological phenomenon and mining the nickel has to involve these areas.

The proposed location of the mine represents the best option for the project as it comprises ore bodies which are close to the ocean, have some existing infrastructure and have been previously explored.

Construction of processing facilities on Santa Isabel Island is not economically feasible at this stage due to the proposed short initial period of mining. Therefore, ore processing will be in alternative locations such as Australia or other facilities where Pacific Nickel's clients will be located. Further, offshore processing reduces the potential for adverse environmental impacts at Kolosori from the project.

3.3.3 Alternative mining method

Open cut strip mining is the only mining option as the resource is shallow and there is relatively high in situ soil moisture content (30% to 40%).

Top down mining, commencing mining at the top of a slope rather than at the base, is the preferred method.

3.3.4 Alternative infrastructure

Pacific Nickel proposes to use existing infrastructure where possible such as roads and tracks to minimise the disturbance areas.

Transfer to ship

The proposed barge mooring facility for transferring ore from shore to barge by drive-on/drive-off facility located in a sheltered harbour that is protected from the ocean currents. The ore will be transferred to ship from the barges

Other than via a long, expensive and possibly environmentally disruptive loading jetty, it would not be possible to load the ore ships at the ore handling facility as the inshore areas will be too shallow to accommodate the type of ship likely to transport the ore. Therefore, this option was dismissed.

The land around the Kolosori wharfing facility is a relatively flat area and near the deposits and the deeper water of Thousand Ships Bay. There is no alternative location.

Shipping

Pacific Nickel proposes to construct the deep water mooring in Thousand Ships Bay. This location provides water of a sufficient depth.

4 PROJECT DESCRIPTION

The Kolosori laterite nickel deposits are located at a relatively shallow depth (less than 15 m). The deposits will be strip mined with low grade and overburden placed in separate waste dumps. The nickel ore will be partially dried in stockpiles and then trucked to a barge loading facility ready for shipment. Barges will transport the ore to ocean going vessels who will then deliver the ore to international processing facilities within the region.

4.1 Construction

The infrastructure to be developed includes;

1) Mining Pits and Overburden Stockpiles.

2) Mining & operations facilities to support the Project and the mining development.

3) Access & Haul Roads linking all facilities.

4) Barge Jetty for the loading and export of nickel ore as well as logistics support.

5) Port facilities to support the Barging Contractor and Company Port operations personnel. This includes the initial temporary facilities established to commence the works.

6) Port Stockpile for ore drying and preparation for shipment.

7) Camp to accommodate the workforce.

8) Environmental, drainage and sediment control systems to maintain the integrity of the local flora, fauna, waterways and marine waters and the ecosystems they support.

Construction cargo such as equipment and materials will be sourced locally as much as possible. If this is not possible then it will be shipped from overseas to Honiara for customs clearance. Cargo will be loaded onto barges and transported to the project site. Erosion and sediment controls (ESCs) will be installed across the project area in accordance with an erosion and sedimentation control plan (ESCP) that will be prepared prior to construction. Once the controls are in place, required vegetation will be cleared. Trees that can be used by the project or community will be marked and temporarily placed separately to other cleared vegetation.

Areas disturbed for construction, but not required for operations, will be rehabilitated and revegetated as soon as practicable.

The indicative project layout is provided in Figure 4-1.

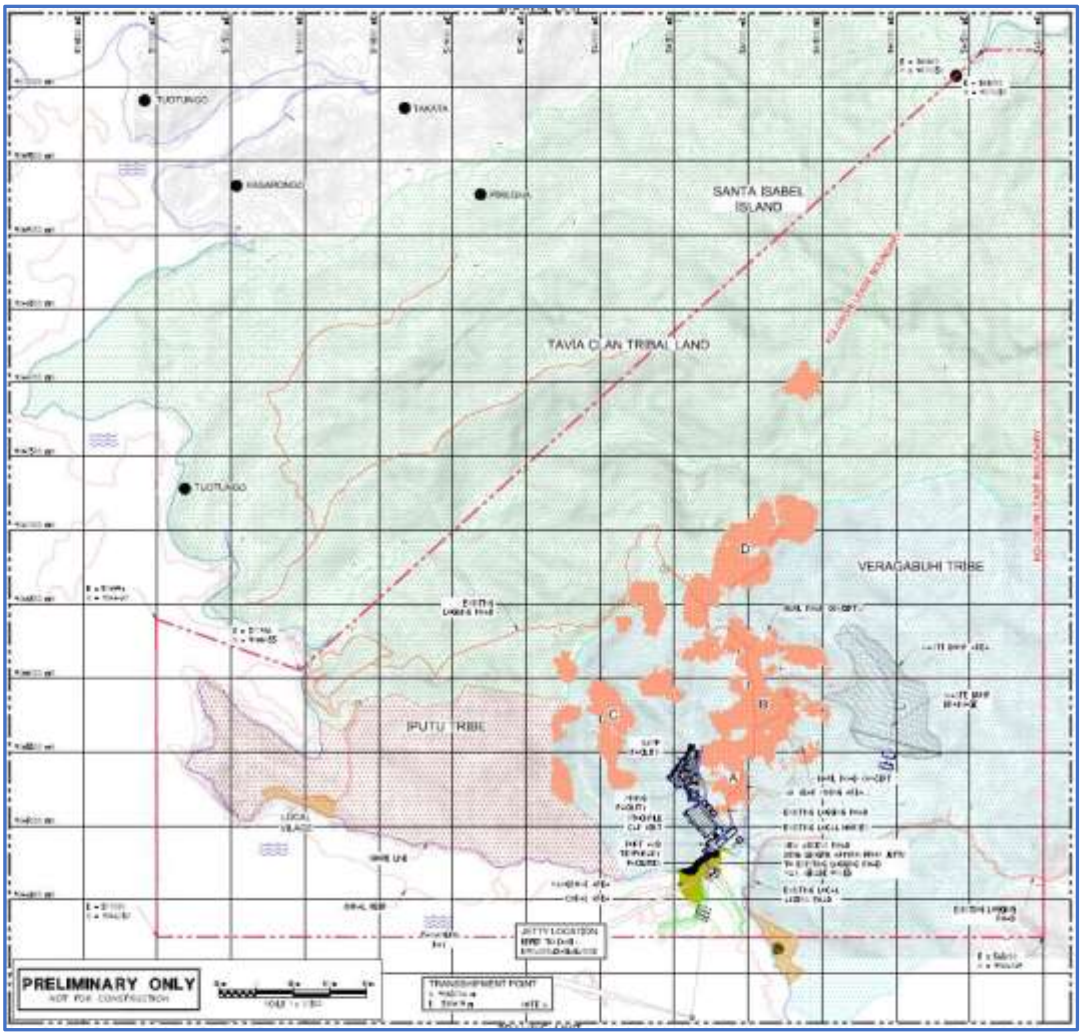


Figure 4-1 Overview of Lease Boundary and Development Areas

4.2 Operations

Operations will generally occur progressively in the following sequence:

- installation and maintenance of erosion and sediment control measures;
- construction of access roads;
- vegetation clearing and grubbing where necessary, with stockpiling of topsoil and overburden for re-spreading during rehabilitation;
- progressive mining of laterite nickel ore from the mining areas and transport of ore to temporary stockpiles, either directly to the ore handling facility or interim stockpiles;
- drying in stockpiles;
- loading of ore by trucks onto barges for transfer to ocean going vessels;

- progressive placement of overburden and waste rock into completed mining areas for rehabilitation; and
- progressive revegetation.

The proposed facilities area is shown below in Figure 4-2.

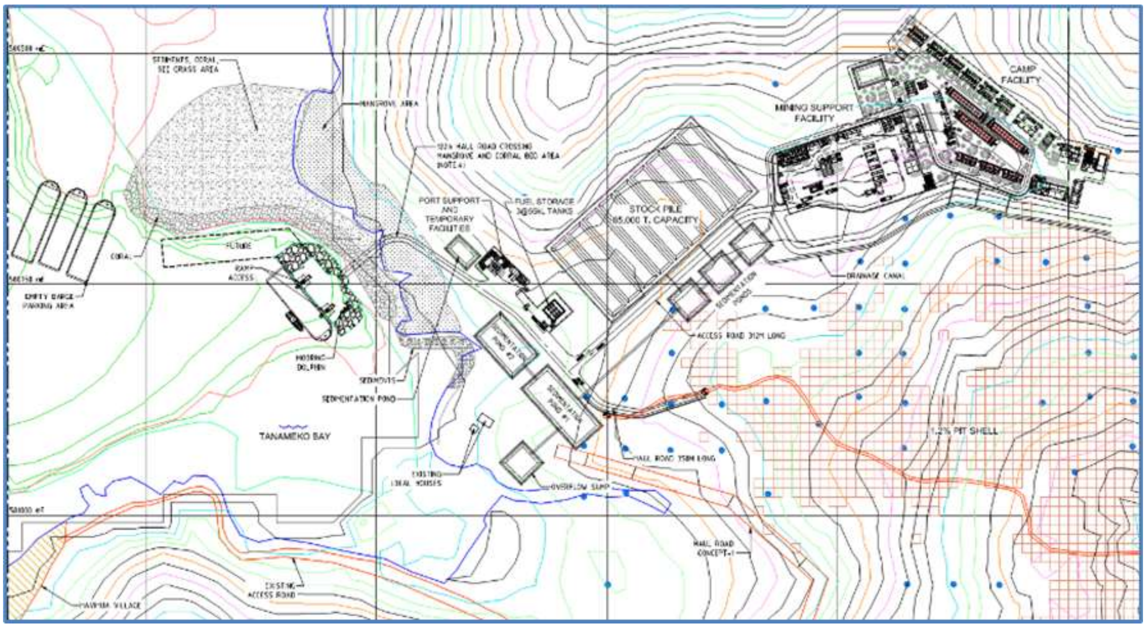


Figure 4-2: Overview of the Facilities Areas

4.3 Nickel resource

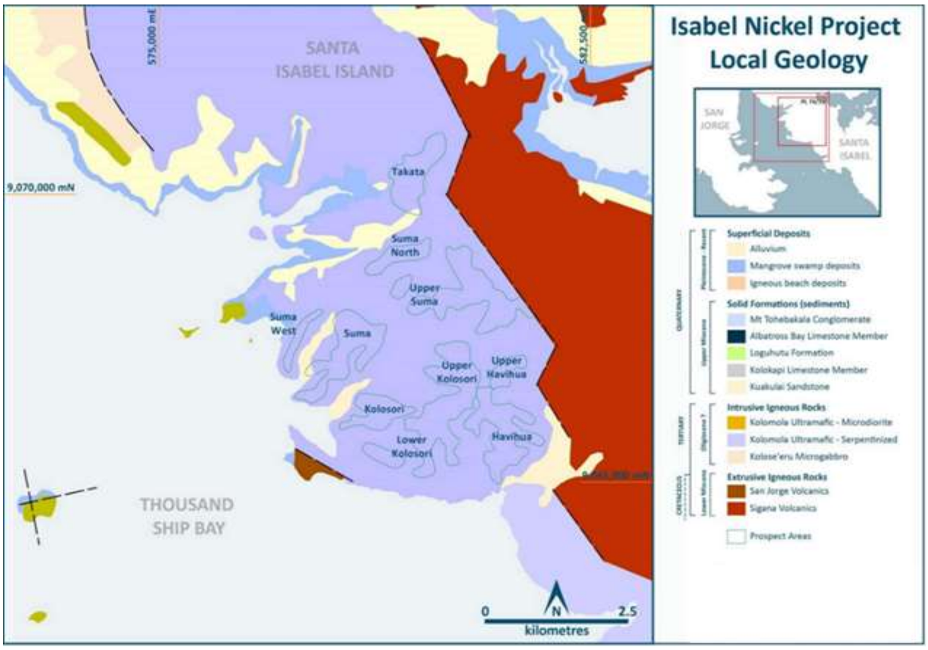
4.3.1 Nickel resource geology

The Solomon Islands archipelago is a linear NW-SE trending chain of islands located at the boundary of the Australian and Pacific continental plates. The boundary comprises three geologic zones, known as the Pacific Province (Cretaceous unmetamorphosed Ontong Java Plateau basement, overlain by pelagic sediments), Central Province (Mesozoic metamorphosed basalts and intruded gabbros) and the Volcanic Province (Pliocene to Holocene volcanoes).

The collision between the Ontong Java Plateau (OJP) and the Old Solomon Arc of the Central Province resulted in the uplift and obduction of ultramafic rocks, marine volcaniclastic sediments and limestone fades. It is in this region where the Isabel Island formed.

4.3.2 Nickel laterite deposits

The nickel laterite deposits of the Solomon Islands have developed under tropical conditions by weathering and decomposition of the ultramafic host rocks. These processes lead to residual and supergene enrichment of nickel within the laterite profile.



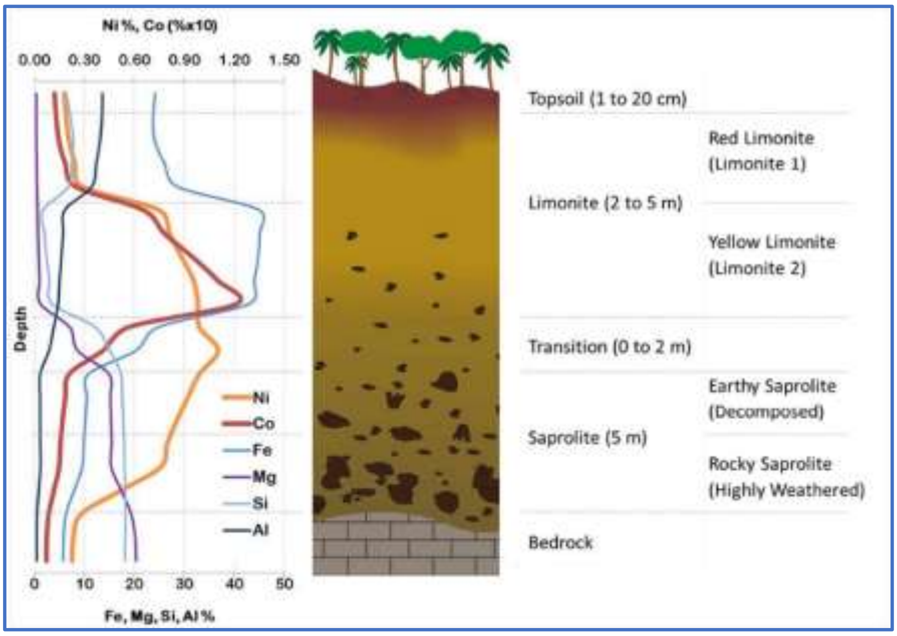
Source SI Government Geological Mapping

Figure 4-3: Local Geology

The laterite profile in Kolosori tenement overlies ultramafic rocks and can be divided into two distinct zones as illustrated in Figure 4-3. The lower zone consists of saprolitic rock, rocky saprolite and saprolite. The upper oxide zone consists of ferruginous saprolite, limonite, ferruginous zone and soil types (Sumitomo ESIA Report 2014).

The lower saprolite zone consists of boulders of the bedrock in a soft, earthy matrix. The boulders generally have fresh cores and partially oxidised rims. Highly serpentinized rocks may have more pervasive oxidation and the boulders may be friable and lack a tough core. The matrix contains a high proportion of iron-oxides that are a product of weathering, but bedrock textures are usually still recognisable.

Iron grades increase rapidly upwards across the saprolite-limonite contact, reflecting the displacement of silicate minerals by iron oxides (goethite) as the dominant component. Bedrock textures are not readily recognisable and although relict bedrock boulders do occur, they tend to be more isolated and less abundant than in the underlying saprolite.



Source Sumitomo ESIA Report 2014

Figure 4-4: Basic Soil Structure of the Tenement Area

The Saprolite zone consists of the Decomposed and Highly Weathered lithologies, including boulders of bedrock in a soft, earthy matrix. The boulders may have fresh cores and partially oxidised rims. Highly serpentinised rocks may have more pervasive oxidation and the boulders may be friable and lack a tough core. The matrix contains a high proportion of iron oxides that are a product of weathering, but bedrock textures are usually still recognisable.

In the matrix material, nickel, cobalt and iron grades are higher than in the bedrock, but magnesium and silicon grades are generally lower. Silica may be concentrated above bedrock levels because of localised accumulations of platy, chalcedonic silica, particularly in fractures. However, massive accretions of silica (chert) are not recorded at either project indicating sufficient flushing of meteoric waters.

Potentially ore grades of nickel are usually developed in the upper part of the saprolite zone. The nickel occurs in a number of mineral associations; with partially oxidised bedrock minerals, newly developed iron oxides and garnierite, a family of bright apple-green nickel-silicates. Cobalt grades in the saprolite are generally too low to be of economic interest, but isolated concentrations may occur in the upper levels of the saprolite.

The transitional zone lies between the saprolite and limonite zone. It consists of a mixture of these two zones.

The Limonite Zone consists of the Limonite 2 and Limonite 3 lithologies. Limonite is characteristically soft and earthy with a high proportion of the minerals present which are very fine grained. Iron grades increase rapidly upwards across the saprolite-limonite contact, reflecting the displacement of silicate minerals by iron oxides (goethite) as the dominant component. Bedrock textures are not readily recognisable and although bedrock boulders do occur, they tend to be more isolated and less abundant than in the underlying saprolite.

Nickel grades are generally lower and locally less variable in the limonite than in the saprolite. Although much of the nickel in the limonite is incorporated into iron oxide minerals, a proportion is associated with manganese oxides. Nickel grades decrease progressively upwards and the upper levels of the limonite may be classed as overburden.

Cobalt grades in the lower and middle sections of the limonite are commonly of economic interest, though grades decrease towards the ground surface. Cobalt usually occurs with manganese-oxide minerals.

Colours range from mid-brown (goethite) at the base of the limonite to deep red-brown (goethite-hematite) near ground surface. The red-brown limonite has a more sandy texture, lower water content and a higher load bearing capacity than the underlying brown limonite. As a consequence, roads constructed upon the natural surface require less paving than those constructed on deeper levels of exposed limonite.

A thin top soil lithology which is highly weathered with high iron grades and nutrient content makes up the overburden zone.

4.3.3 Resource

Mining One has completed an initial JORC (2012) mineral resource estimate for Prospecting Licence PL 05/19 (Kolosori tenement) on Isabel Island, Solomon Islands. The results are provided in Table 4-1 and Table 4-2. The Mineral Resource estimate is classified in accordance with the 2012 JORC guidelines. Pacific Nickel has previously submitted a commercial discovery report for the Kolosori Project to the MMRE. This report was prepared by Mining One Consultants.

Table 4-1 Kolosori JORC(2012) Resource Estimate Cut off grade 1.2% Ni

KOLOSORI JORC MINERAL RESOURCES > 1.2 % Ni				
LITHOLOGY	RESOURCE CATEGORY	Kt ('000)	Ni %	Co %
TRANSITIONAL	MEASURED	104	1.79	0.08
	INDICATED	559	1.63	0.05
	INFERRED	1,178	1.6	0.05
	SUB TOTAL	**1,842**	**1.62**	**0.05**
SAPROLITE	MEASURED	549	1.72	0.03
	INDICATED	1,136	1.54	0.02
	INFERRED	2,359	1.46	0.02
	SUB TOTAL	4,045	1.52	0.02
TOTAL (M+I+I)		**5,887**	**1.55**	**0.03**

Table 4-2 Kolosori JORC(2012) Resource Estimate Cut- off grade 1.0% Ni

KOLOSORI JORC MINERAL RESOURCES > 1.0 % Ni				
LITHOLOGY	RESOURCE CATEGORY	Kt ('000)	Ni %	Co %
TRANSITIONAL	MEASURED	107	1.77	0.08
	INDICATED	631	1.57	0.05
	INFERRED	1,504	1.49	0.06
	SUB TOTAL	2,242	1.53	0.06
SAPROLITE	MEASURED	575	1.69	0.03
	INDICATED	1,399	1.46	0.02
	INFERRED	3,061	1.37	0.02
	SUB TOTAL	5,035	1.43	0.02
TOTAL (M+I+I)		**7,277**	**1.46**	**0.03**

4.3.4 Mining method

The Company is proposing to mine within the Kolosori tenement to extract the limonite, transitional and saprolite nickel ores through conventional strip-mining techniques. The ore will be available for direct shipping and upgrading if possible. The mining area will be developed progressively, with progressive rehabilitation of the mined area completed as soon as practical after mining has been completed. Based on the resource delineated at present the operation is anticipated to have a five to six year mine life. The Company will carry out further exploration during mining to increase the mine life where possible.

The conventional method of strip-mining, using excavator and truck haul fleets has been based on a number of parameters including:

- The shallow and variable thickness of the ore deposit. A thin overburden layer lies directly underneath the topsoil, followed by a thin layer of limonite nickel ore zone (minor volumes). The transition nickel ore zone separates the limonite ore zone (where present) from the underlying saprolite nickel ore zone. The saprolite nickel ore zone extends to a defined depth below the transitional material.
- Mining operations will have challenges during the tropical wet season months. Mining methods are proposed to allow for multiple mining benches (faces) to ensure access and maintenance of the mining locations, including surrounding areas.
- The indicated and assumed earth moisture content (30-60%) presents issues for heavy earthmoving equipment and mining movements.

- The low dry bulk density of the transitional and saprolite (approximately 1.2 t/m^3 including a swell factor of 1.3) impact the capacity of the mine haul trucks. Selective utilisation of articulated and rigid dump trucks will be required.

Mining will be conducted along benches ranging from 10 to 50 metres in width, horizontally defined at a height of 2.5 metres, being subdivided into blocks defined within the ore resource geological model.

Mine access roads will service the areas and feed into a primary haul road system. Initial mining areas will be adjacent to the port, stockpile pad and camp locations. This will allow for a short haulage distance for initial ore stockpiles and assist with materials for port and camp civil works. Material extraction from mining areas close to operational facilities will allow for early rehabilitation to commence. Stabilization of the areas nearest to the port will be an environmental priority.

Mining methodologies will be applied to minimise erosion from water run-off and maximise ore extraction. Bench strip-mining and backfilling methodologies will take advantage of the natural land surface. Minimising the exposure of disturbed areas as mining progresses will assist in minimizing the risk of sediment run-off.

Mine boundary and active pit areas will have safety bunds placed along the highest elevations to divert surface water run-off from entering the mining precinct and to minimise the possibility of personal injury from falling into a pit. Diversion drains will be used where necessary to take excess water to sediment ponds.

The plan is to mine benches closest to the primary haul road first and then extend out to the pit boundaries. The mining operations will use survey and geological controls to maximise ore extraction and maintain strict sediment erosion controls.

It is expected that more than one bench will be mined at a time. The use of multiple benches will allow for better ground water management, while maximising ore extraction requirements. Accelerated completion of mining benches is based on a leapfrog technique (higher to lower elevations) which will provide areas for efficient backfilling and rehabilitation as mining progresses.

The process for bench mining is as follows:

a) Review area and setup mine access safety requirements.

b) Inspection for any Flora and Fauna concerns.

c) Implement water diversion, erosion and sediment controls.

d) Define and construct equipment and vehicle access to mining areas.

e) Clearing and stockpiling of topsoil, timber and vegetation waste.

f) Overburden removal. Used as backfill or overburden stockpile placement.

g) Selective mining of transitional nickel ores to stockpiles. (Kolosori - minimal limonite)

h) Selective mining of saprolite nickel ores to stockpiles.

i) Mining along the strike of the ore zones with precision selection of the contact surfaces to minimise dilution.

j) Backfill with overburden and contour mined areas.

k) Rehabilitation using stockpiled topsoil and vegetation waste and re-seeding as required.

4.3.5 Mining fleet and equipment

The vehicles used to develop a laterite nickel operation are considerable. The ancillary fleet is required to construct roads, sediment control structures and to provide support to the primary excavation equipment. The type and indicative number of primary mining fleet and ancillary plant are presented in Table 4-3.

Table 4-3 Equipment Fleet Numbers

Equipment	Number
Excavators	
40 tonne Excavator	1
30 tonne Excavator	2
20 tonne Excavator	2
Sub-Total	5
Trucks	
40 tonne (6wd) Articulated Trucks	7
20 tonne Rigid truck	10
Water truck (8x4)	1
Fuel/lube truck (service)	1
Crane truck	1
Firetruck	1
Sub-Total	21
Dozers	
Track Dozers	3
Grader (16H)	1
Sub-Total	4
Front end Loaders	
Front end loader (Cat 988H Equivalent)	1
Sub-Total	1
Auxillary Equipment	
Compactors	2
Crawler crane	1

Equipment	Number
Telehandler	1
Forklift	1
Ambulance	1
Light Vehicles (4WD)	10
Lighting plant	6
Water fill pump + Pontoon	2
Welders	2
Rock breaker- Altas Copco	1
Compressors	
Compressors	2
Gensets	4
Sub-Total	33

4.4 Project infrastructure

The Project infrastructure is designed to support mine operations for the export of nickel ore, through the provision of operations and maintenance facilities, power, water, logistics, administration and other necessary support services.

The infrastructure is designed for a minimal effect to the local environment and would be undertaken with consultation with all stakeholders. The project areas including mine pits and support facilities would be developed in strict accordance to mining regulations for good mine practices with the best approach for water management and environmental protection.

The project infrastructure is summarised as follows:

1) Mining & Operations Facility comprising:
   a) Operations Office
   b) Laboratory
   c) Heavy & Light Vehicle Equipment Workshops
   d) Warehouses
   e) Water & waste water systems
2) Port facility comprising:
   a) Jetty with mooring for ore barges, tug refuelling, personnel speedboat access
   b) Office and warehouse to manage direct port operations
   c) Diesel Fuel Storage & dispensing system delivered by pipeline from the Jetty
   d) Temporary facilities for construction; later used for barge operations & port team including:
      i. Accommodation & kitchen
      ii. First Aid Station
      iii. Meal's area
      iv. Showers & ablutions
3) Operations camp comprising:

   a) Accommodation for the Project workforce
   b) Mess hall and laundry
   c) Medical facilities: Clinic
   d) Water & waste water treatment & management
   e) Muster point
4) Quarry for road-base and aggregates
5) Other services;
   a) Site wide drainage & containment systems
   b) Roads for haulage, access and logistics
   c) Distributed diesel generating sets & power distribution system
6) Firefighting systems
7) Communications system
8) Security sitewide

4.4.1 Power and communications

Due to the remote nature of the site, no general services or utilities are currently available.

Diesel gensets will be provided at each facility on a distributed approach. Power will be distributed at each facility via overhead lines which will also enable fibre optic cables to be run to key facility areas and link to the overall communications system.

4.4.2 Mine infrastructure area

The following will be provided at mine infrastructure area:

- maintenance workshop for marine and heavy/light land vehicles, supplies storage and electrical and carpentry services. Day to day service, maintenance and change out activities will take place in the workshop, however, major repairs will be carried out off site;
- bunded and fenced fuel storage and fuelling facility;
- heavy and light vehicle washdown facility using water from a local supply, including an oil/water separator and sediment pit with collected wastes disposed at the project landfill;
- administration and personnel service buildings, including first aid room, geotechnical and environmental laboratory, offices, training rooms, lunch room, and wash rooms. These facilities will also be used as a cyclone refuge if personnel cannot be evacuated in advance ofthe onset of cyclones; and
- utilities such as power, communications, water and sewerage. Water infrastructure is likely to comprise a raw water supply, water management system, waste water treatment plant, sewage treatment plant and fire fighting system.

- All fuels, oils, lubricants and chemicals will be stored in bunded areas.
- waste water/sewage will be treated to a standard suitable for discharge.
- Sludge from the waste water/sewage plants will be disposed at the project landfill.
- Diesel and petrol will be the main fuels used by land and water based vehicles and generators. The tanks will be installed and maintained in accordance with Solomon Islands and international standards.
- Water will be directed to sediment ponds via open channels.
- Water which does not seep into the ground will either be used for dust suppression throughout the project area or diverted into the water management system.
- ESCs at the stockpiles and roads leading to the mine infrastructure areas, for example trenches, will direct runoff to the sediment pond in accordance with the ESCP.

4.4.3 Water supply

The project has significant water requirements for mining, processing, camp and other general uses. The main water requirements are:

1) Raw water
2) Domestic Water (filtered raw water)
3) Potable water for consumption

Water for raw waters services and domestic use will be sourced from existing rain run-off and natural springs sourced. If required bores or deep wells will be provided. The water will be directed or pumped to a storage pond then via a pipeline for distribution to the mine and camp facilities and the water treatment plant. In addition, water carts will operate to distribute to remote areas (Port, Mine Pits) and along roads for the control of dust. Sediment and stormwater ponds will further augment the water supplies as necessary.

4.5 Waste management

A Waste Management Plan (WMP) will be prepared that considers prevention, reduction, reuse, recovery, recycling, removal and finally disposal of wastes.

4.5.1 Solid waste

Solid waste from construction and operations will be contained, transported, handled and disposed of in such a manner as to reduce potential impacts on human health and the environment. The following options will be considered for the disposal of all solid wastes:

- landfill;
- composting, incineration and recovery (landscaping); and
- capture and removal to approved facilities.

Hazardous waste will be stored in a secure and bunded location for collection and disposal at an accredited and registered waste disposal facility.

4.5.2 Waste water

Waste water will mostly be generated from domestic sources such as the accommodation camp; however, small quantities may be generated by activities at the mine infrastructure area. The plant may be required to treat water via screening, aerobic, anaerobic and disinfection processes and can be disposed of via the following options:

- Sub-surface release; and
- Recycled for non-potable use, such as dust suppression.

4.6 Transport

Transport within the tenement will predominantly be by 4WD light vehicles with small boats also available for transfer to surrounding areas by water. Vessels for transportation of equipment and supplies from Honiara and surrounding areas will depend on the cargo type but will vary from open boats with outboard motors to large barges and tugs.

4.7 Workforce

Initial manning is based on the Project operations workforce including contractors and handover from construction to operations. The camp housing is summarised in Table 4-4.

Table 4-4 Permanent - Camp Accommodation

No.	Type	Number of Unit	Total Operations
1	Non- staff Accommodation	3 units @ approx.. 80 persons/building, Bunk beds, incl. 1 spare capacity	240 persons
2	Junior Staff Accommodation	2 units @ 20 persons/ building, incl. 1 spare capacity	40 persons
3	Senior Staff Accommodation	4 units @ 10 persons/ building, incl. 1 spare capacity	40 persons
4	Manager Accommodation	3 units @ 4 persons/ building, incl. 1 spare capacity	12 persons
5	Guest House		Included above
6		Total Capacity (Beds)	332

The estimated construction workforce is 300 and the estimated operations workforce is around 200. It is expected that the construction workforce will peak within four months of commencement and reduce as the project infrastructure is completed (9 months) and the operations phase commences. The Company's priority is to employ personnel from local communities as much as possible. Most personnel will be transported to and from the island via sea.

The induction program will address the protocols for the construction and mining program to ensure that all personnel on-site are aware of:

- the environmental and socio-economic context of the site and surrounds;
- the potential environmental and community impacts associated with the work they are undertaking and how to undertake appropriate mitigation measures;
- roles and responsibilities of employees, contractors and visitors;
- environmental operating practices;
- incident management;
- health and safety requirements; and
- complaints management.

4.8 Rehabilitation and closure plan

The Closure Planning commences prior to commencement of mining so that all materials movement such as topsoil and overburden extraction and stockpiled is designed for closure. Wherever possible overburden will be progressively backfilled to mined out areas and stockpiling will be minimalised through the mine life. Progressive reclamation forms part of the Mine Plan.

Rehabilitation and closure for the Project comprises:

- Progressive rehabilitation of the mine area up to completion of mining. This includes backfill, grading, landscaping and revegetation of areas where ore resources have been removed. Stabilisation of landform including erosion and sediment control, topsoil and growth medium spreading and revegetation as per landform design.
- Project closure including decommissioning of the mine site, removal of structures and final rehabilitation of mine areas. Infrastructures, Port, workshops, landing areas, laydown areas, fuel storage, Mine administration, decommissioning and removal where surplus to site requirements. Stabilise landform with sediment and erosion control. The site is made safe for humans and endemic and domestic animals.
- Post closure retain sufficient staff to continue monitoring and maintenance work for rehabilitated areas.

The Mine Rehabilitation and Closure Plan and Mine Monitoring and Maintenance Plan will detail the closure and decommissioning phase of the Kolosori Nickel operation.

Rehabilitation and decommissioning areas disturbed by the Project: the following objectives will be used:

- the mine site will be safe to humans and fauna
- mining and rehabilitation will aim to create a landform that is stable and with similar land use capabilities and/or suitability that existed prior to the disturbance, unless other beneficial end uses are pre-determined and agreed
- mine wastes and disturbed land will be rehabilitated so that they are non-polluting and self-sustaining or to a condition where the maintenance requirements are consistent with an agree post-mining land use
- surface and ground waters leaving the Project area will not be degraded compared to their condition prior to the commencement of mining operations. Current and future water quality will be maintained at levels that are acceptable for users downstream of the site and meet environmental needs
- potential acid mine drainage will be determined and management measure implemented (e.g. encapsulation of sulphides or treatment systems), if required
- vegetation cover will be established to reduce rates of erosion and sediment loss to that in surrounding, comparable undisturbed landscapes
- soil suitability for use in rehabilitation will be assessed and soils will be enhanced as required
- following final rehabilitation there will be limited need for ongoing maintenance of rehabilitated areas.

Prior to the cessation of operations decommissioning must such that ongoing environmental harm is minimised and is made a safe site for humans and animals at the completion of rehabilitation and becomes a stable landform that minimises erosion impacts.

Decommissioning and closure of the mine is best achieved by progressive rehabilitation.

4.9 Expected project schedule

The mine construction phase is planned to start in 2022. The mine will initially operate for at least five or six years. Exploration will continue and it is expected that sufficient ore will be mapped to allow mining to continue for longer than initially planned. The completion of all mining will be followed by a decommissioning and closure period of one to three years. This will be described in the mine rehabilitation plan. Current projections indicate that the mine will export the first shipment of ore within 12 months of the development consent and mining lease being granted.

5 PHYSICAL SETTING

5.1 Location and topography

The Kolosori lease is located at the southern end of Santa Isabel Province (see Figure 5-1 and Figure 5-2). The Santa Isabel Island is characterised by moderately steep to steep narrow to broad ridges with average elevations of 250 m to 400 m. The ridges are generally aligned parallel to the orientation of Santa Isabel Island. The ridges are surficial expressions of the resource and the underlying folded ultramafic sequence and the relation of these deposits with the thrust fault system of the island. The ridges are incised by narrow river channels with nearly absent river terraces due to thick vegetation cover. The rivers also lack distinct flood plains. The ridges abruptly terminate to the coastal flat areas but the boundaries are indistinct due to the vegetation cover.

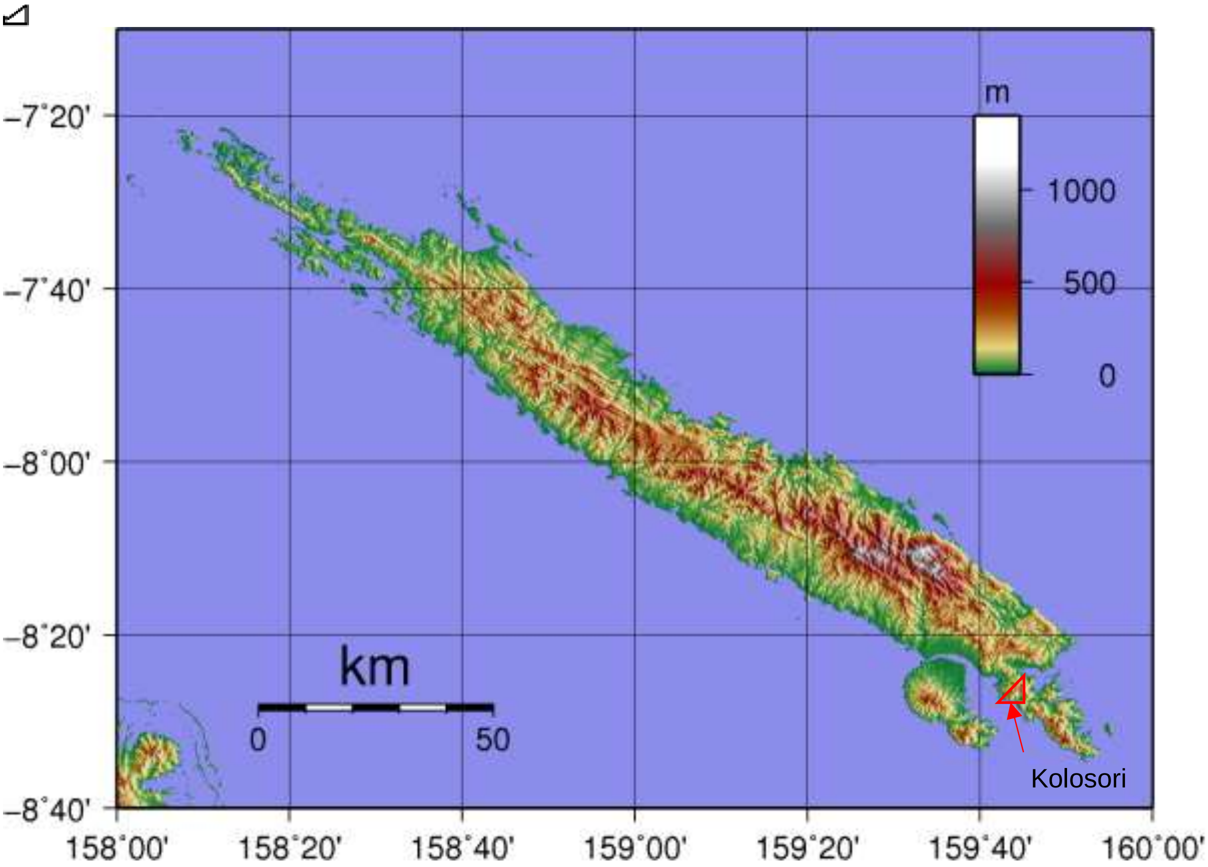


Figure 5-1: Santa Isabel topographic relief map

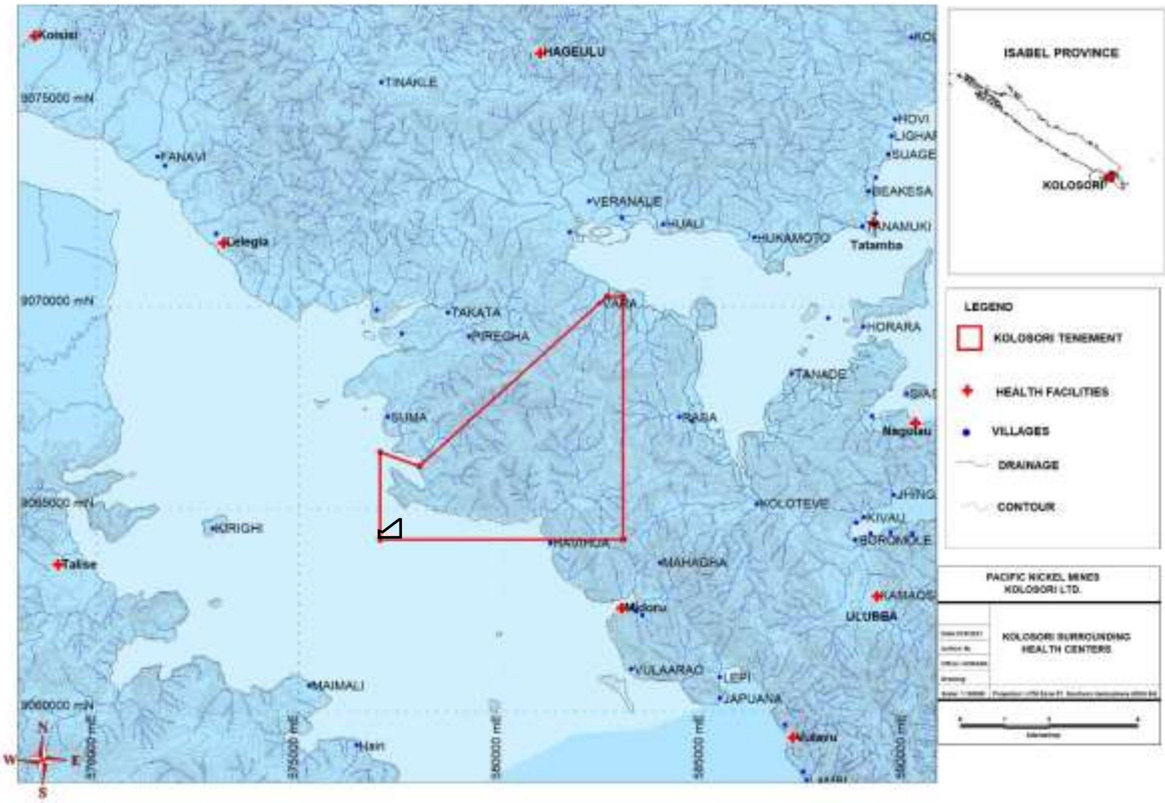


Figure 5-2: Kolosori Tenement location plan

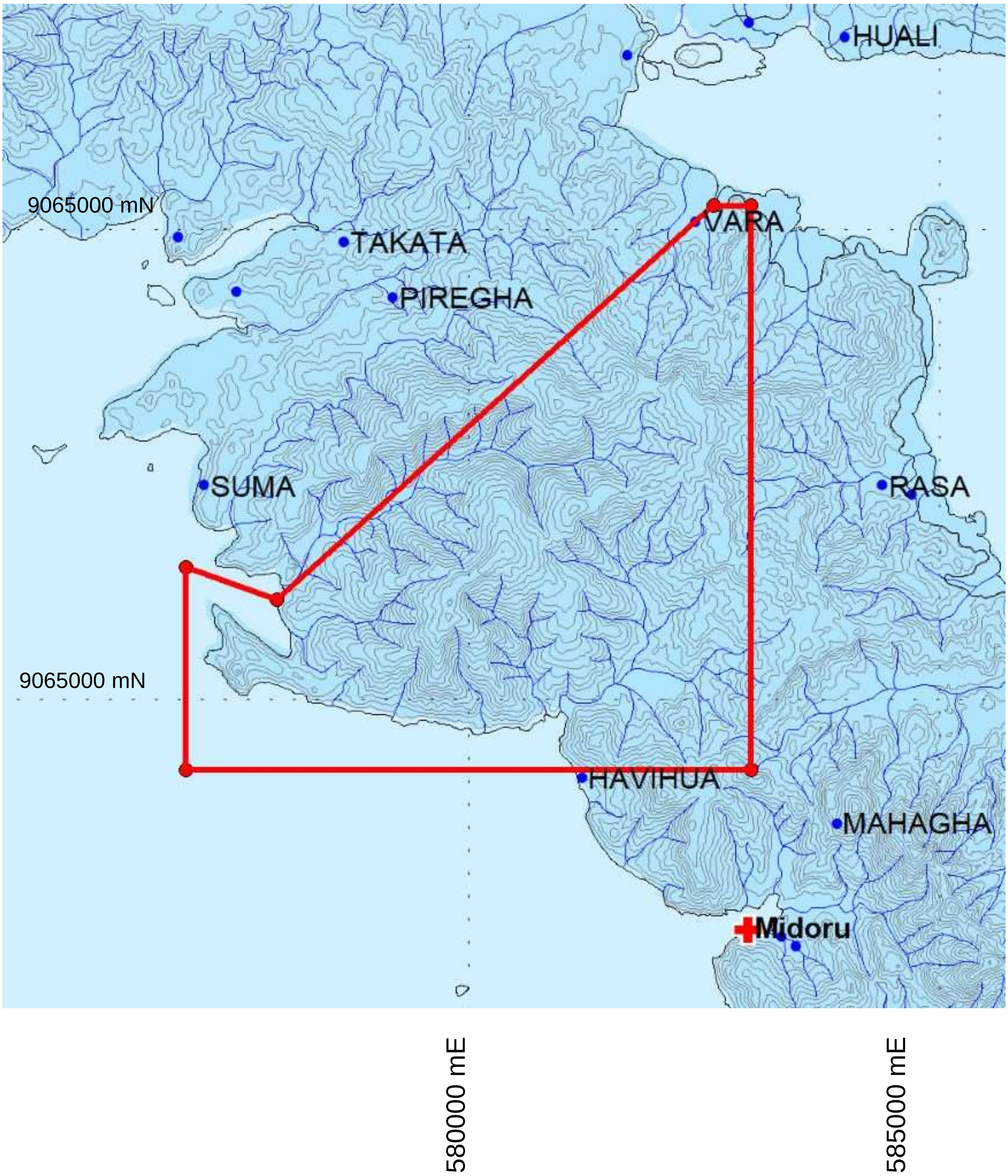


Figure 5-3: Kolosori Project area topographic map

5.2 The Climate of Solomon Islands

Solomon Islands experiences an equatorial monsoon climate. The climate of the region is controlled by the islands proximity to the equator and the mixture of land and sea surfaces. The combination of sea and land and the mountainous character of the islands create a large variety of local climates, mainly depending on elevation and exposure to the monsoons. Temperature and humidity are high, with little variation throughout the year. The west to northwest monsoon (December to March) brings a large part of the total annual rainfall. Southeast trade winds (May to October) may also bring heavy rainfall.

The weather and climate of the region can be explained largely by the seasonal movement and development of the equatorial trough; a belt of low pressure that migrates between hemispheres following the apparent movement of the sun, and the subtropical ridge of the southern hemisphere (a belt of high pressure typically located at about latitude 30 to 35 degrees south).

From about January to March the equatorial trough is usually found close to, or south of the Solomons, and this is a period of West to North-westerly monsoonal winds. The heaviest rainfall at most places also occurs at this time. The equatorial trough is in the Northern hemisphere from May to October and the Islands then lie within the region of the Southeast trade winds; the trades being the stronger and more persistent winds blowing out from the subtropical ridge towards the equatorial trough. These winds are moisture bearing, having had a long path over the ocean and heavy rainfall can also occur during the South-easterly season, especially on the windward side of the Islands. The transition months between the two seasons are marked by a greater frequency of calm winds.

Because of the low latitude of the Solomons, atmospheric pressure has only a small variation from month to month and, unlike places in temperate latitudes, records little change from day to day except when a tropical cyclone is in the area. The lowest mean monthly pressure (for Honiara, for example) at 9 a.m. is 1007.6 hpa in January, when the equatorial trough is in the vicinity, and the highest 1010.9 hpa in August. The decrease of pressure from 9 a.m. to 3 p.m. is part of an atmospheric tidal effect caused largely by the alternate heating and cooling every 24 hours.

SMM set up a weather stations on their Isabel E tenement as part of the baseline environmental data collection. It comprised 3 stations IWS01, IWS02 and IWSo3 immediately northe of the Kolosori tenement. These data were reviewed and supplement publicly available weather data from the Solomon Islands Meteorological Service (SIMS). The data from SMM and SIM weather stations are summarised in Table 5-1, Table 5-5, Table 5-6 and Figure 5-5.

5.2.1 Atmospheric Circulation

At the centre of the tropical atmospheric circulation is an area dominated by low surface pressure, rising air movement and convergence of air masses known as the Intertropical Convergence Zone (ITCZ) or equatorial trough (McGregor and Nieuwolt 1998). The ITCZ is a persistent band of cloudiness around the equator. The highest rainfall occurs in Solomon Islands during December to March when the ITCZ is close to or just south of the islands.

From May to October the ITCZ moves into the northern hemisphere and the trade winds dominate regionally. The trade winds are low level constant winds from the southeast. The southeast trade winds result in rainfall particularly on the windward (southeast) side of the islands.

5.2.2 Rainfall

Measured average annual rainfall across the islands is generally in the range of 3,000 mm and 5,000 mm. Rainfall is seasonal with most rainfall occurring between December and March during the northwest monsoon. Locations on the southern sides of larger islands tend to also have rainfall maximums between June and September (Solomon Islands Meteorological Service 2013a).

The Solomon Islands, situated close to the equator, has a climate that is typical of most tropical areas, with uniform temperature and humidity and abundant rainfall in most months. Rainfall distribution is affected by topography and can vary considerably from one location to another.

The following data are predominantly sourced from the Solomon Islands Ministry of Environment, Conservation, Disaster Management and Meteorology (MECDM), SSM (2012), and SIRC (2021).

Rainfall occurs as a result of convection, convergence or orographic processes. Warm and humid air masses prevail over the region needing little uplifting to produce rainfall. Convectional rainfall occurs as a result of heating of land or sea surfaces. Convergence of air masses occurs with rainfall related to the presence of the ITCZ. Orographic processes occur due to the uplifting of moist air over land masses.

It is expected that average annual total rainfalls will be higher as elevation increases; however, there are no long term rainfall stations at elevation in Solomon Islands (Solomon Islands Meteorological Service 2013a). The Solomon Islands Meteorological Service (SIMS) estimates that it is possible the heaviest average yearly rainfall could reach 9,000 mm at some elevated sites (Solomon Islands Meteorological Service 2013a).

Thunderstorms are relatively frequent on large and more mountainous islands and are more likely to occur in the afternoon. Over the ocean, storms are more likely to occur at night.

Dry periods are rarely prolonged, except during exceptionally dry years which appear to be related to the El Niño-Southern Oscillation (ENSO) phenomena.

Annual rainfall distribution data (Table 5-1) show that there is no single pattern for rainfall distribution for the Solomon Islands. Regional factors such as prevailing winds and topography significantly influence rainfall occurrence across the Solomon Islands. Global factors such as El Niño or La Niña events also impact on rainfall in the Solomon Islands (MECDM, 2021).

5.2.3 Wind

East to southeast winds are prevalent from May to October and, although not usually as strong as in other Pacific regions further south or east, still have a large degree of constancy. The typical speed of the winds over the sea, free from the influence of the mountainous islands of the region, is about 30 km/hr. Stronger southeast winds occur at times, possibly blowing at more than 40 km/hr for several days, when the subtropical high pressure belt is stronger than usual in the south (MECDM, 2021).

West to northwest winds from about November to April are usually lighter than the southeast trade winds and much less persistent. In addition to the seasonal winds, there is also a strong diurnal wind pattern caused by the islands themselves, and several factors contribute to this effect. The wind speed tends to increase over land areas during the morning, reaching a maximum during the afternoon at about the time of the maximum temperature, and then dying away at night to become light, variable or calm. In coastal areas, the greater heating of the land during the day allows a flow of air from over a slightly cooler sea. The strength of this sea breeze is typically 20 to 30 km/hr. Conversely, at night a land breeze may occur because of the rapid cooling of the land. The offshore land breeze is much weaker than the sea breeze. Where there is hilly or mountainous terrain, cool and relatively dense air can flow downhill at night as a katabatic wind. If this reaches the coast, it can combine with the land breeze effect to give an offshore wind as strong as 20 km/hr in the early morning. All of these effects are important in determining the daily wind pattern at any particular location in the Solomon Islands (MECDM, 2021).

The averaged annual rainfall for south Santa Isabel is provided in Table 5-1.

Table 5-1 Average Annual Rainfall Solomon Islands

Province	Station	Elevation mASL	Rainfall (mm)		
			2009	2010	Mean Annual
Choiseul	Taro	2	3,525	3,205	3,320
	Sikura	57	4,687	3,912	4,300
Santa Isabel	IWS01	57	3,415	3,655	3,540
New Georgia	Munda	2.7	4,090	3,940	3,580
Guadalcanal	Honiara	55	2,495	2,170	2,025
	Henderson Airport	8	2,515	2,115	1,870
Malaita	Auki	11.3	3,240	3,250	3,165
Makira	Kirakira	5.5	3,876	-	3,530
Santa Cruz	Lata	22.8	5,010	4,205	4360

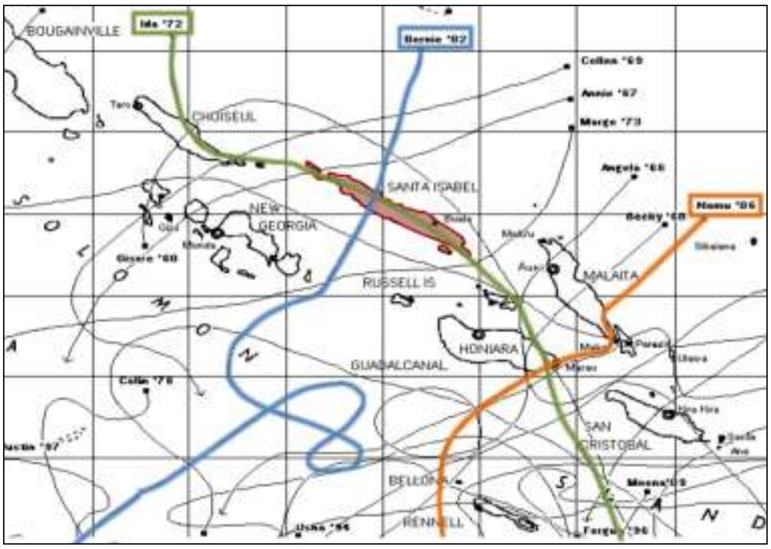
5.2.4 Tropical Cyclones

A number of tropical low pressure systems occur each year over the Solomon Islands at times when the equatorial trough is in the vicinity, but few of these develop into tropical cyclones associated, by definition, with winds of at least gale force - 34kts). The average frequency of cyclone occurrence is between one and two per year, tending to increase southward. Because the cyclones that do affect the Solomon Islands are usually in the early stage of their life cycle, they are relatively small. Nevertheless, they can cause serious damage to structures, crops, forests and local water supplies and have caused loss of life in the past. (MECDM, 2021).

On average, one to two tropical cyclones occur in Solomon Islands each year between November and April; increasing in frequency to the south. Tropical cyclones occur as a result of horizontal convergence of moist air in an area of low pressure. Due to the geographical location of Solomon Islands, cyclones that do occur are often in their early stage of development, and are generally less severe than in other

South Pacific Island groups. However, intense tropical cyclones do occur and have in the past resulted in flooding and wind damage in Solomon Islands. Severe floods on Guadalcanal, Malaita, Makira and Santa Isabel islands in recent years have resulted in loss of life and severe damages to agriculture and infrastructure (Solomon Islands Meteorological Service 2013a).

In the past 40 years, two cyclones have crossed Santa Isabel Island (Table 5-2); Cyclones Bernie (April 1982) and Ida (May 1972). Cyclone Bernie crossed the island from north to south; its greatest intensity was reached within 24 hours, and winds of 126 km/h were recorded (Australian Government Bureau of Meteorology 2013a). Local flooding as well as crop and property damage occurred.



Source: Solomon Islands Meteorological Service 2013c

Figure 5-4: Historical Cyclone Paths

Cyclone Namu (May 1986) is considered the most serious natural disaster recorded in Solomon Islands. The cyclone slowly passed through Malaita and Guadalcanal islands over four days and brought persistent heavy rain and mud slides. There were 103 recorded fatalities and 99,000 were left homeless (Solomon Islands Meteorological Service 2013b). It is estimated Namu had winds of 93 km/h (Australian Government Bureau of Meteorology 2013b).

Table 5-2 lists the 10 cyclones that have passed within 200km of the Project area since 1969.

Table 5-2 Cyclone and Seasons within 200km from the mining tenement area

Season	Number of Cyclones	Names of Cyclones
1969/1970	1	ISA
1971/1972	2	CARLOTTA and IDA
1972/1973	1	MADGE
1981/1982	1	BERNIE
1985/1986	1	NAMU
1990/1991	1	JOY
1993/1994	1	REWA
1996/1997	1	CYRIL

Season	Number of Cyclones	Names of Cyclones
2014/2015	1	RAQUEL
2017/2018	1	LINDA

Source: SIMS (2021); SIRC (2021)

5.2.5 El Niño-Southern Oscillation

The consistent way in which changes in the El Niño-Southern Oscillation (ENSO) system influence inter- annual climate variability means forecasts of ENSO states can predict above or below average rainfall conditions. The ENSO is the oscillation between periods of El Niño and La Niña. Fluctuations are observed through changes in the Southern Oscillation Index (SOI) which is a measure of the air pressure difference between the east and west Pacific. Sustained positive values of the SOI are indicative of La Niña conditions which are generally associated with above average rainfall conditions in Solomon Islands. Conversely, sustained negative values of the SOI are indicative of El Niño conditions which are associated with below average rainfall conditions.

5.2.6 Temperature

The main feature of temperature in the Solomon Islands is its uniformity, with seasonal variation extremely small, and little variation with latitude evident. (MECDM, 2021).

The range of average maximum temperature is approximately 2º C throughout the year (in the range of 30 to 32º C). The mean daily range of temperature (or diurnal variation) is approximately 7º C (MECDM 2021).

MECDM report that a decrease of mean monthly temperature (calculated as the average of monthly maximum and minimum temperatures) of about 2º C for each 300 m of elevation has been recorded in many areas of the Solomon Islands. The diurnal range of temperature tends to be greater at an elevated station than at locations near the coast (MECDM, 2021).

5.2.7 Relative Humidity

Relative humidity is generally high and, like temperature, shows little seasonal variation but exhibits marked diurnal fluctuation. The lowest humidity is generally recorded when temperatures are highest (MECDM, 2021).

5.2.8 Electrical Storms

Thunderstorms occur frequently over the large and more mountainous islands, building up inland in the afternoons and, if winds are favourable, moving towards coastal areas. Over the ocean, storms are likely to occur in the night or early morning. There is less thunderstorm activity during the south-easterly season and more storm activity from around December to March (MECDM, 2021).

5.3 Weather stations

In the absence of long term data records for the Project area, data collected by SMM Solomon regionally and by the SIMS on Guadalcanal and Malaita Islands has also been reviewed for this EIA. Data from six climate/rainfall stations have been included in this report (Table 5-3):

- 3 stations maintained by SIMS (Honiara Henderson Airport on Guadacanal, and Auki on Malaita
- 3 stations established by SMM immediately north of Kolosori Project area: IWS01, IWS03 and IWS02 . IWS01 climate station is located in the Lelegia area, Immediately north of Kolosori tenement area.

Table 5-3 Climate Stations location

Station ID	Owner	Island	Distance to Kolosori [km]	UTM	Easting (m)	Northing (m)	Elevation (m)
IWS01	SMM	Santa Isabel	7	57 L	577207	9072261	195
IWS02	SMM	Santa Isabel	15	57 L	568212	9081016	425
IWS03	SMM	Santa Isabel	20	57 L	573778	9076670	347
Henderson	SIMS	Guadalcanal	120	57 L	615826	8957654	8
Honiara	SIMS	Guadalcanal	120	57 L	604112	8957423	55
Auki	SIMS	Malaita	135	57 L	690620	9028698	11

Mean annual rainfall from selected weather staions is summarised in Table 5-4.

Table 5-4 Mean Annual Rainfall for the Solomon Islands

Province	Station	Elevation mASL	Rainfall (mm)		
			2009	2010	Mean Annual
Choiseul	Taro	2	3,525	3,205	3,320
	Sikura	57	4,687	3,912	4,300
Santa Isabel	IWS01	57	3,415	3,655	3,540
New Georgia	Munda	2.7	4,090	3,940	3,580
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Malaita	Auki	11.3	3,240	3,250	3,165
Makira	Kirakira	5.5	3,876	-	3,530
Santa Cruz	Lata	22.8	5,010	4,205	4360

5.3.1 Climate Station – Southern Santa Isabel

Climate data are based on desktop analysis of existing climate data compiled by SIMS, SMM and SIRC.

Automatic Climate Monitoring stations will be established prior to commencement of the operation on both coastline locations and one station on the highest peak. Evaporation study will be conducted at all three climate stations

Humidity and Temperature

Data from weather station IWS01 for the period 2008- 2012, the minimum temperatures range from 20.39 °C to 23.35 °C while maximum temperatures ranged from 31.53 °C to 35.83 °C. The monthly average temperatures range from 25.51 °C to 26.92 °C. The weather station recorded that humidity data in IWS01 exhibit uniform trend throughout the year except from fluctuations in the minimum temperature (SIRC (2021). Data are summarised in Table 5-5.

Monthly areaage humidity data for 2008-2012 for IWS01 are tabulated in Table 5-6.

Table 5-5 IWS01 Temperature and Relative Humidity data for April to June 2020

Year - 2020	Temperature			Relative Humidity		
	Minimum	Maximum	Average	Minimum	Maximum	Average
April	0	31.44	24.16147	0	99.51	83.55729
May	0	33.24	26.42694	0	99.51	82.47849
June	23.05	34.25	27.0095	60.75	100	91.27702

Source SIRC (2021)

Table 5-6: Station IWS01 Monthly Relative Humidity for 2008-2012Source SMM, 2012

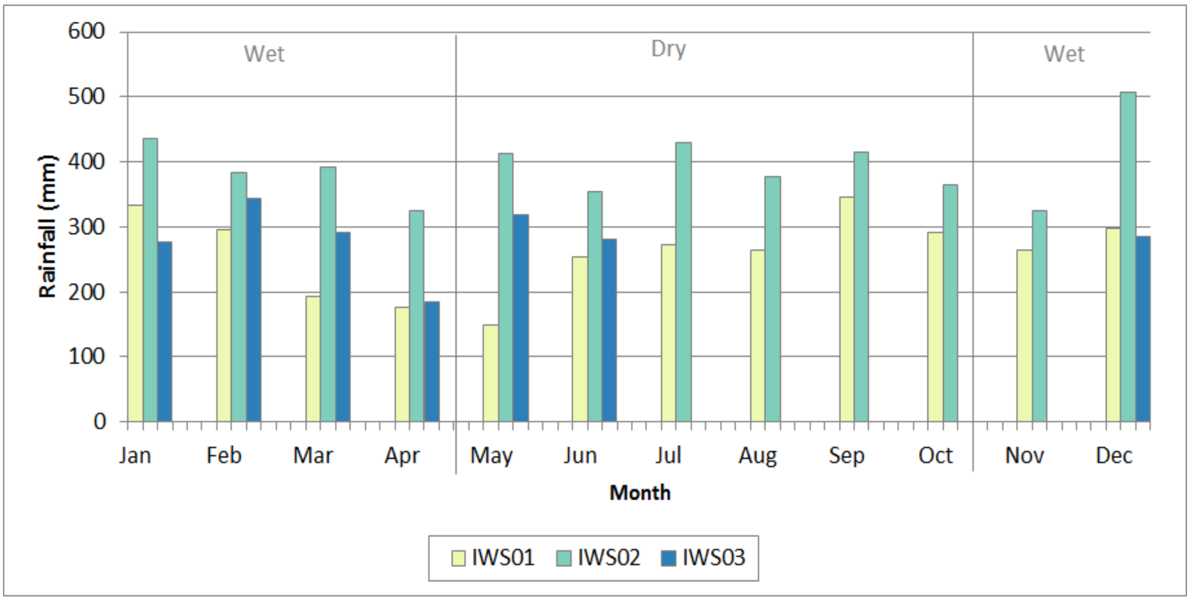
Month	2008	2009	2010	2011	2012
January	ND	315.0	643.5	247.0	291.5
February	ND	391.5	305.5	268.0	MD
March	MD	228.0	512.0	193.5	ND
April	217.5	161.5	205.0	189.5	ND
May	270.5	320.0	187.5	137.0	ND
June	222.5	166.0	106.0	254.0	ND
July	259.5	462.5	322.0	273.5	ND
August	284.0	287.0	309.5	295.5	ND
September	345.5	520.5	317.0	208.5	ND
October	295.0	279.0	205.5	399.0	ND
November	138.5	120.5	203.5	171.0	ND
December	243.0	160.5	339.0	271.0	ND

Note: ND - no data; MD – with missing data

Source: IWS01 weather station data

Rainfall

Rainfall data for the three regional sites located at the south of Santa Isabel Island (IWS01, IWS02 and IWS03) is provided in Figure 5-5. IWS02 consistently received more rainfall than the other stations; it is at the highest elevation. Across all stations, the average monthly wet season rainfall (306 mm) is slightly higher than the dry season rainfall (280 mm). It is expected that these sites receive high rainfall totals year round due to their elevation (orographic effects) and location on the southern side of the island (subjected to rainfall from the southeast trade winds as well as the northwest monsoon). Monthly rainfall data for period 2008 – 2012 is tabulated inFigure 5-5. Data were compiled from the IWS01 climate station.



Source SMM 2012

Figure 5-5   Station IWS01 Monthly Rainfall for 2008-2012

Month	2008	2009	2010	2011	2012
January	ND	315.0	643.5	247.0	291.5
February	ND	391.5	305.5	268.0	MD
March	MD	228.0	512.0	193.5	ND
April	217.5	161.5	205.0	189.5	ND
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November	138.5	120.5	203.5	171.0	ND
December	243.0	160.5	339.0	271.0	ND

Note: ND - no data; MD – with missing data

Source: IWS01 weather station data

5.3.2 Weather data summary for the Santa Isabel Island Kolosori Tenement

The SMM Solomon weather stations on Santa Isabel Island have provided continuous data for temperature, wind speed, humidity, rainfall and solar radiation since early 2008 to 2012 and summarised below.

The data for the SMM Solomon Isabel Island weather station indicates that:

- Maximum daily temperatures are in the 30ºC to 34ºC range.
- Minimum daily temperatures are in the 20ºC to 24ºC range.
- Relative humidity averages 84% and varies within the 40 to 97% range.
- Annual rainfall was 3,412 mm in 2009.
- Average monthly rainfall was 284.3 mm in 2009.
- Highest daily rainfall recorded was 118.5 mm on 20 January 2010.
- Rainfall patterns do not exhibit a clear wet and dry season.
- Solar radiation averages 16.9 MJ/m^2 and ranges from 2 to 28 MJ/m^2 due to the influence of cloudcover.
- The maximum wind speed recorded was 16.05 m/s (57 km/hr) in August 2008.
- Wind direction varies with the seasons, however typically between November and April the winds are predominantly from the west to northwest and between May and October the windsare from the east to southeast.

5.4 Climate Change

5.4.1 General observation

Solomon Islands has been identified as being one of the most vulnerable Small Island Developing States to the adverse effects of climate change due to the fact that the majority of the population lives in 1.5 km of the coast (World Bank Group 2011). Recent trends in the climate of Solomon Islands include warming in annual and seasonal mean air temperatures, sea-level rise (3.5 mm annually) and rise in sea surface temperature (0.6°C to 1°C since 1910 with the most change since 1970). The Pacific Climate Change Science Program (Australian Bureau of Meteorology and CSIRO 2011) predicts over the course of the 21st century that:

- surface air temperature and sea surface temperature are projected to increase
- annual and seasonal mean rainfall are projected to increase
- the intensity and frequency of days of extreme heat are projected to increase
- the intensity and frequency of days of extreme rainfall are projected to increase
- the incidence of drought is projected to decrease
- tropical cyclone numbers are projected to decline in the southwest Pacific Ocean (0°S - 40°S, 130°E - 170°E)

5.4.2 Sea Level

Monthly averages of the historical tide gauge, satellite (since 1993) and gridded sea-level (since 1950) data agree well after 1993 and indicate interannual variability in sea levels of about 31 cm (estimated 5–95% range) after removal of the seasonal cycle. The sea-level rise near Solomon Islands measured by satellite altimeters (Figure 5-6) since 1993 is mostly over 8 mm per year, larger than the global average of 3.2 ± 0.4 mm per year. This rise is partly linked to a pattern related to climate variability from year to year and decade to decade.

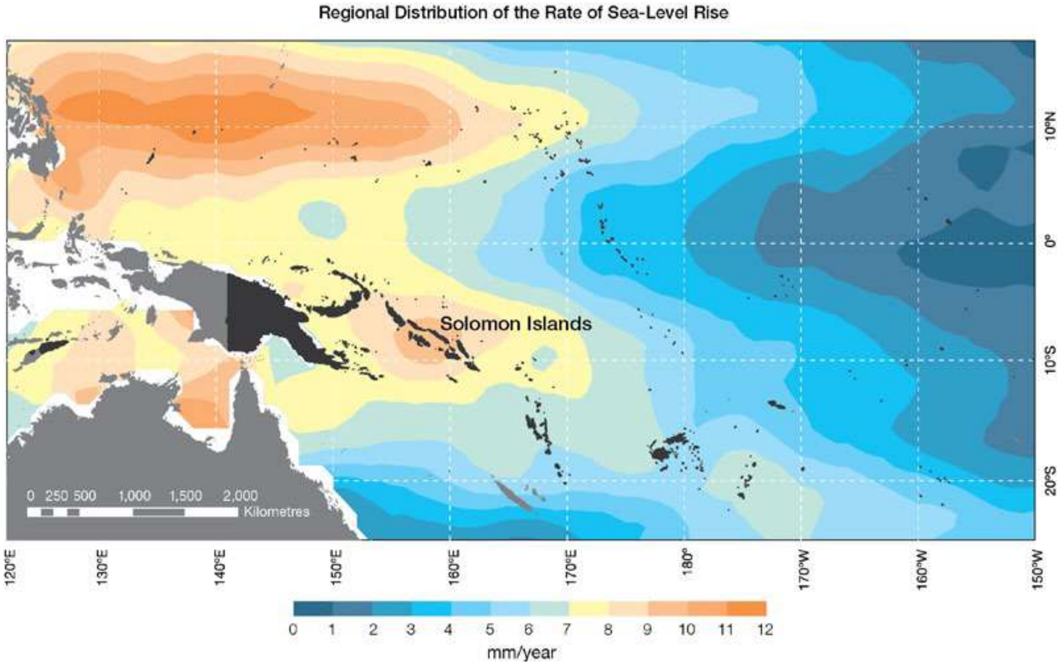


Figure 5-6: The regional distribution of the rate of sea-level rise measured by satellite altimeters from January 1993 to December 2010, with the location of Solomon Islands indicated.

Mean sea level is projected to continue to rise over the course of the 21st century. There is very high confidence in this direction of change because of the following conditions. Sea-level rise is a physically consistent response to increasing ocean and atmospheric temperatures, due to thermal expansion of the water and the melting of glaciers and ice caps. Globally, since the early 1990s, sea level has been rising.

5.4.3 Rainfall

Wet season (November-April), dry season (May-October) and annual average rainfall are projected to increase over the course of the 21st century.

5.4.4 Temperature

Surface air temperature and sea-surface temperature are projected to continue to increase over the course of the 21st century.

The intensity and frequency of days of extreme heat are projected to increase over the course of the 21st century.

5.4.5 Extreme Events

The tropical cyclone season in the Solomon Islands is between Novemberand April. Occurrences outside this period are rare. The tropical cyclone archive for the Southern Hemisphere indicates that between the 1969/70 and 2009/10 cyclone seasons, the centre of 41 tropical cyclones passed within approximately 400 km of Honiara. This represents an average of 10 cyclones per decade. Tropical cyclones were most frequent in El Niño years (13 cyclones per decade) and least frequent in La Niña years (six cyclones per decade). The ENSO-neutral average is nine cyclones per decade. The interannual variability in the number of tropical cyclones in the vicinity of Honiara is large, ranging from zero in some seasons to five in the 1971/72 season. This high variability makes it difficult to identify any long-term trends in frequency.

5.4.6 Extreme Weather Impacts

Tropical cyclones result in flooding and wind damage in the Solomon Islands. There have been severe floods on Guadalcanal, Malaita, Makira and Santa Isabel in recent years with a number of lives lost, and severe damage.

The camp and processing facility will be located well above the tidal flood plain with well-designed drainage systems, so flooding issues are expected to relate solely to flood events crossing of the mine haul road. Culverts and drains will be designed for reasonably anticipatable events. Cyclones and storm surges are recognised as extreme weather hazards and their patterns will be properly understood to guide the project design. Mitigating the hazard is a process of good design and contingency plans will be designed and implemented throughout the operational life of the project. Foreshore erosion can be a consequence of cyclones and storm surge and can be an issue at the bulk carrier wharf or the processing facility site. Foreshore erosion protection against storm surge will be designed and installed.

5.5 Mineralisation

The ultramafic rocks at Isabel and San Jorge Islands comprise highly serpentinised harzburgite with minor amount of variably serpentinised dunite, wehrlite and pyroxenite. Serpentinised harzburgites can be classified into foliated harzburgite interpreted as residual mantle material, and undeformed and layered rocks which may grade into more gabbroic lithology and interpreted as cumulates formed in a magma chamber.

The laterite formation wraps over the topography as this layers that comprise two principal zones overlying fresh and weathered rock that includes:

- The saprolite zone where weathered silicate minerals remain. This zone can include weathered to fresh remnant rocks and silicate clay minerals from the initial decomposition and weathering of the host ultramafic rocks. Residual enrichment is limited and nickel generally enriched within the saprolite by supergene processes.
- The limonite zone where silicate minerals are largely destroyed and removed leaving dominantly the iron rich oxides such as limonite (goethite) that can grade into higher alumina oxide mineral towards surface. Residual enrichment of iron, aluminium, manganese, cobalt and nickel occur from the compaction of the profiles from the intense leaching from tropical rainfall over time.

The intense serpentinisation of the ultramafics has resulted in a thin but consistent laterite profiles developed on ridge slopes at Santa Isabel and more rounded hill tops at San Jorge that has less precipitous terrain.

Iron rich caps over the limonite can occur in laterites but are not noted at Santa Isabel or San Jorge.

Structural preparation and layering within the ultramafic units are noted to be sub-horizontal and parallel to thrust orientation.

There is little available description of any previous mineralogical studies prior to Sagapoa et al (2011). Sagapoa et al (2011) describe the mineralogy of the Siruka laterites on Choiseul Island to the north of Isabel. They note that in the limonite nickel is within the goethite and manganese oxides. As these become unstable the Nickel is leached to the saprolite zone and precipitated as lizardite or mixed gels (garnierites). In contrast cobalt is enriched in the limonitic zone along with manganese oxides and is not supergene enriched in the saprolite.

The nickel laterite deposits of the Solomon Islands have developed under tropical conditions over ultramafic rocks. An expected nickel laterite profile for the site is presented in Figure 4-4. The laterite profile overlying the ultramafic rocks can be subdivided into six soil types that form two distinct zones. The lower silicate zone consists of saprolitic rock, rocky saprolite and saprolite. The upper oxide zone consists of ferruginous saprolite, limonite, ferruginous zone and soil types.

The presence of nickel in the oxide zone is due to the depletion of magnesium and silicon and the retention of iron, nickel and other insoluble elements. Nickel within the limonite zone is principally associated with goethite, where it can be adsorbed onto the surface of the particles.

However, nickel is readily leached by meteoric waters and can be transferred to lower parts of the laterite profile. Hematite hold no or very little nickel within its lattice, which makes the upper unit of the limonite zone that has associated hematite and maghemite nodules have lower nickel grade than the lower unit of the limonite and underlying saprolite.

Mineralisation in the saprolite zone has a sharp increase in magnesium and decrease in iron. The weathering of olivine to serpentine only marginally increases the nickel grade due to some loss of silicon, magnesium as well as mineral density. However, the nickel content of serpentine is highly variable (SMM ESIA Report 2014). Nickel in the meteoric water can be redeposited in the saprolite, substituting for magnesium in serpentine and forming minerals such as garnierite. Garnierite is a green hydrated nickel-magnesium silicate mineral and is thought to be the main nickel bearing mineral but may not be the primary source of the nickel.

5.6 Soils

5.6.1 Assessment objectives

Document existing soils present in the Kolosori tenement area that are likely to be disturbed by mining activity.

5.6.2 Assessment method

The assessment method comprised literature review. Extensive work in the souhern Isabel Province area has been compiled by INCO, Hatch (2010), SMM (2012), AXIOM (2016) and SIRC (2020).

5.6.3 Metal enrichment in ultramafic soils

SMM (2012) computed geo-accumulation indices for the soil samples to determine the background enrichment concentrations of major metals within the Isobel D and E tenement areas that cover ultramafic rocks north and south of the Kolosori tenement.. The following metals had reported results from the soil physicochemical laboratory analysis: pH, moisture content, exchangeable sodium percentage (ESP), ESP classification, sodium absorption ratio, exchange sodium, exchange potassium, exchange calcium, exchange magnesium, cation exchange capacity, bicarbonate alkalinity, sulphate, soluble major cations (calcium, magnesium, potassium), total major cation (magnesium), total metals (aluminium, cobalt, iron, manganese, molybdenum, selenium, arsenic, cadmium, chromium, copper, lead, nickel, zinc), total recoverable mercury, fluoride extractable phosphorous and organic matter.

Concentrations of cadmium, chromium, copper, and iron exceed the Average Shale Values. The rest of the metals including arsenic, nickel, and aluminium are within their respective normal crustal values. Consequently, the geo-accumulation indices of the metals include moderately polluted to extremely polluted categories, which indicates high crustal enrichment of the metals. Refer to Section 4.3.3 for standards applied in this assessment.

The soil profile of Santa Isabel Island is subdivided into three divisions, namely the laterite or limonitic zone, saprolitic zone, and basement rocks. The limonitic zone is further subdivided into three limonite types classified according to colour, texture, and grainsize. The limonitic zone is followed by the saprolitic zone with depths typically varying from 7 mbgs to 8 mbgs up to 11 mbgs to 12 mbgs. The basement rock, subdivided into the weathered zone and base rocks, underlies the saprolitic zone. Detailed descriptions of the horizons of the soil profile are shown in Table 5-7.

Table 5-7 Soil Profile and Leaching Effects

Division	Subdivision	Average depths (mbgs)	Description	Leaching Effects
Pedolith (Laterite)	Topsoil	0 to 0.1	Soil composed of plant roots, plant litter and organic materials	
	Red Limonite Zone (Limonite 1)	0.1 to 4	Reddish brown to dark brown silty to clayey heterogeneous limonitic laterite	Mg and Si leached; Fe, Cr and Al residually enriched

Division	Subdivision	Average depths (mbgs)	Description	Leaching Effects
	Limonite 2	1 to 5	Brown, silty limonitic laterite	
	Limonite 3	2 to 8	Yellow to yellowish brown heterogeneous silty limonitic laterite, sometimes with observable soil bandings (yellow, brown, dark)	Mg and Si leached; Ni, Co and Mn residually enriched
Regolith (Saprolitic Zone)	Transition Zone	7 to 8	Yellowish brown, sandy or clayey soil with highly weathered serpentinite fragments and intense garnierite stains	Ni enriched
	Decomposed Serpentine	7 to 12	Sandy or clayey soils with serpentinite fragments to fragmented ultramafics and intensively decomposed serpentinite	
Basement	Highly weathered zone	2 to 16	Highly weathered gabbro, ultramafics or serpentinite; May have cross-cut veining and garnierite-filled voids	Minimal to none
	Base rock	3 to 27	Fresh basement rock (gabbro, ultramafics, serpentinite)	

(modified from Hatch, 2010 and Sagapoa et al., 2011)

5.6.4 Topsoil

A thin top soil lithology which is highly weathered with high iron grades and nutrient content makes up the overburden zone.

5.6.5 Limonite Zone

The Limonite Zone consists of the Limonite 2 and Limonite 3 lithologies. Limonite is characteristically soft and earthy with a high proportion of the minerals present which are very fine grained. Iron grades increase rapidly upwards across the saprolite-limonite contact, reflecting the displacement of silicate minerals by iron oxides (goethite) as the dominant component. Bedrock textures are not readily recognisable and although bedrock boulders do occur, they tend to be more isolated and less abundant than in the underlying saprolite.

Nickel grades are generally lower and locally less variable in the limonite than in the saprolite. Although much of the nickel in the limonite is incorporated into iron oxide minerals, a proportion is associated with manganese oxides. Nickel grades decrease progressively upwards and the upper levels of the limonite may be classed as overburden.

Cobalt grades in the lower and middle sections of the limonite are commonly of economic interest, though grades decrease towards the ground surface. Cobalt usually occurs with manganese-oxide minerals.

Colours range from mid-brown (goethite) at the base of the limonite to deep red-brown (goethite-hematite) near ground surface. The red-brown limonite has a sandier texture, lower water content and a higher load bearing capacity than the underlying brown limonite. As a consequence, roads constructed upon the natural surface require less paving than those constructed on deeper levels of exposed limonite.

5.6.6 Transitional Zone

The transitional zone lies between the saprolite and limonite zone. It consists of a mixture of these two zones.

5.6.7 Saprolite Zone

The Saprolite zone consists of the Decomposed and Highly Weathered lithologies, including boulders of bedrock in a soft, earthy matrix. The boulders may have fresh cores and partially oxidised rims. Highly serpentinised rocks may have more pervasive oxidation and the boulders may be friable and lack a tough core. The matrix contains a high proportion of iron oxides that are a product of weathering, but bedrock textures are usually still recognisable.

In the matrix material, nickel, cobalt and iron grades are higher than in the bedrock, but magnesium and silicon grades are generally lower. Silica may be concentrated above bedrock levels because of localised accumulations of platy, chalcedonic silica, particularly in fractures. However, massive accretions of silica (chert) are not recorded at either project indicating sufficient flushing of meteoric waters.

Potentially ore grades of nickel are usually developed in the upper part of the saprolite zone. The nickel occurs in a number of mineral associations; with partially oxidised bedrock minerals, newly developed iron oxides and garnierite, a family of bright apple-green nickel-silicates. Cobalt grades in the saprolite are generally too low to be of economic interest, but isolated concentrations may occur in the upper levels of the saprolite.

Santa Isabel Island has 13 soil associations with five of these found in the tenement (shown in Figure 5-7). Two soil associations INJ and JLX dominate the soils that occur within the tenement. The soil associations are associated with the geology since the underlying rock types dictate the composition and characteristics of the soil. In terms of the USDA soil order, the majority of the soils within the tenement fall within the Dystropepts, Tropodults and Haplorthox group to the INJ, and Dystropepts, Haplorthox and Haplohumex group to the JIX soil associations.

Soil association EBF which consists of the soil great groups Sulfihemists, Tropaquents, and Sulfaquents are considered potentially acid sulfate soils and are found in the coastal areas of Huali Bay; exposure of these soils due to mining activity is likely to be limited as most of the activity will be within the southern part of the lease area.

The soil association units are summarised in Table 5-8.

In terms of land capability, the majority of the soil cover in the Santa Isabel tenement is unsuitable for agriculture and is restricted to forest land in terms of suitable usage. These soils are categorized under Class VI of the USDA Land Capability Classification scheme. Other soil associations found within the tenement have severe limitations that restrict the vegetation that can be supported or require special conservation practices.

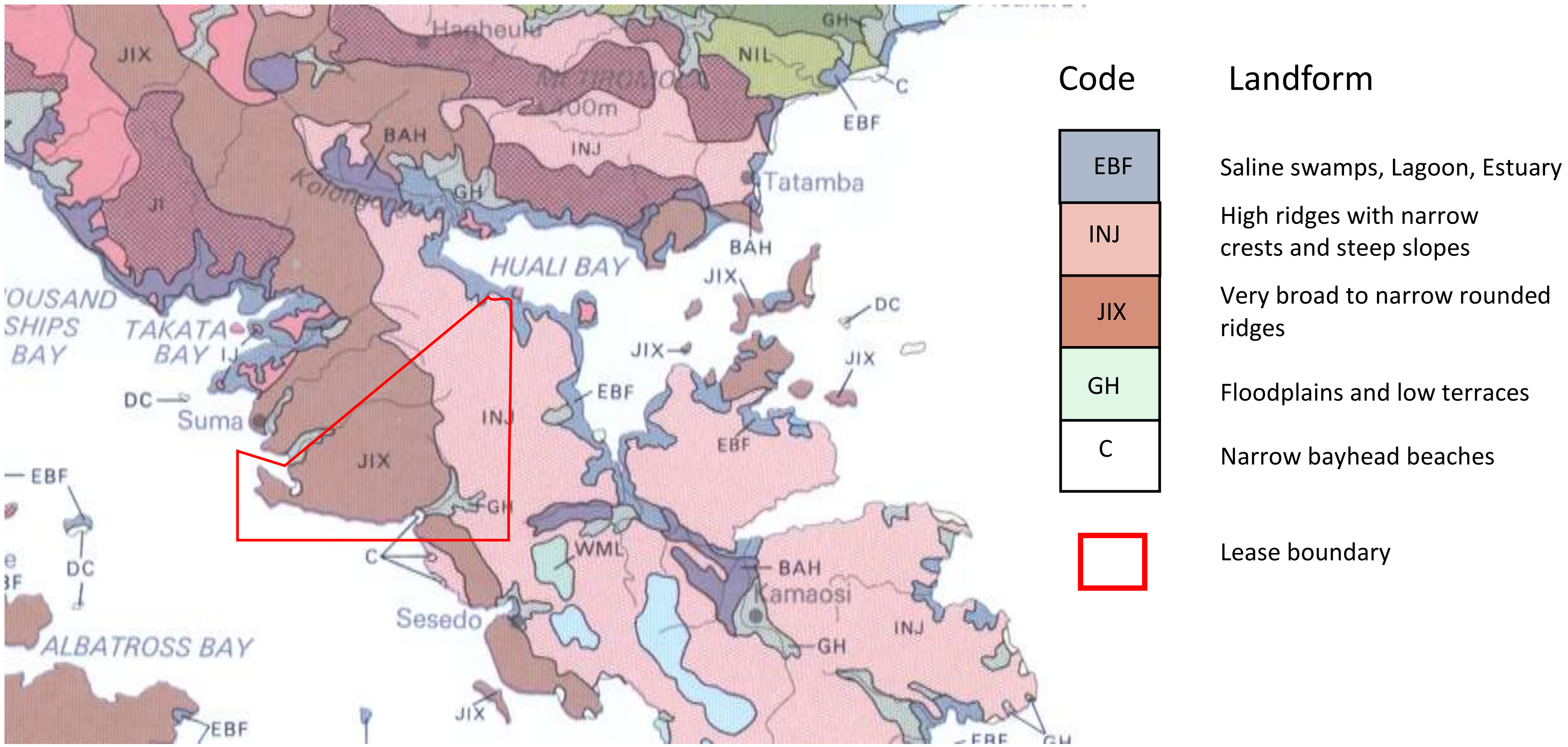


Figure 5-7 Kolosori Soil Associations

Table 5-8 Summary of soils present in the Kolosori tenement area

Soil Association	Soil Unit	Soil Description (and Classification)	Parent Material	Landform	Fertility
EBF	E	Deep to shallow, very poorly drained, saline, brown or reddish brown peat or muck (Sulfihemists)	Coastal and estuarine alluvium, and organic accumulations	Saline swamps, lagoons and estuaries	Partly humified, saline, base rich but possibly developing strongly acid sulphate properties if drained
	B	Moderately deep to deep, very poorly drained, grey to bluish green, locally mottled clay, (Tropaquents)			Unweathered, unleached, saline, base-rich
	F	Deep, very poorly drained, saline, pale or gleyed clays and loams with a thin surface peat layer (Sulfaquents)			Unweathered, saline, base-rich, possibly developing strongly acid-sulphate properties if drained
INJ	I	Deep to shallow , freely drained, brown, to yellowish brown clays and loams (Dystropepts)	Basaltic volcanics with thin limestone lenses	High ridges with narrow crests and steep slopes	Weakly weathered and leached, acid-base poor with low reserve nutrients except magnesium which is moderate
	N	Deep freely drained, yellowish red clay (Tropudox)			Strongly weathered and leached, acid, with low reserve and total nutrient
	J	Deep freely drained, yellowish red clay (Haplorthox)			Very strongly weathered and leached, acid, very low available and reserve nutrients
JIX	J	Deep freely drained, yellowish red clay (Haplorthox	Ultramafic and gabbroic intrusives	Very broad to narrow rounded ridges	Very strongly weathered and leached, acid with very low available and reserve nutrients, high heavy metal concentrations
	I	Deep to shallow , freely drained, brown, to yellowish brown clays and loams (Dystropepts)			Weakly weathered and leached, acid, base-poor with low reserve nutrients except magnesium which is moderate

Soil Association	Soil Unit	Soil Description (and Classification)	Parent Material	Landform	Fertility
	X	Deep, humus-rich, freely drained, yellowish red to red clay (Haplohumox)			Very strongly weathered and leached, with a surface humus layer containing most available nutrients. Below this layer, nutrient levels are low except for total magnesium
C	C	Deep to shallow, freely to excessively, drained, pale to dark loose sands (Tropopsamments)	Mineral grains derived from volcanic detritus	Narrow bay-head beaches	Unweathered, calcareous, low in available and reserve nutrients
GH	G	Deep to shallow , freely drained, brown, to dark brown clays and clay loams (Eutropepts)	Alluvium from mixed calcareous sediments, basalts and ultramafics	Floodplains and low terraces	Weakly weathered, weakly acid to neutral, base-rich with medium to high reserve nutrients except for potassium
	H	Deep to shallow, imperfectly drained, greyish mottled loams and clays (Tropofluvents)			Unweathered, weakly acid, base-rich with moderate to high reserve nutrients

6 TERRESTRIAL ECOLOGY

6.1 Assessment Objectives

This terrestrial ecology assessment and report is part of the desktop study of the Kolosori mining project (Pacific Nickel Mining) and was prepared by Ecological Solutions Solomon Islands (ESSI) for the Kolosori mining tenement area in the Hograno district of Isabel Province. This chapter focuses on the terrestrial environment and its various habitats, including the description of different forest types, their composition and structure, and the unique flora and fauna species that occupy habitats within the tenement site. There will be some focus on the potential impacts of the project on vegetation structure, native flora and fauna, and the overall landscape and biodiversity of the Kolosori tenement site. The impacts of known invasive species on the threatened native flora and fauna are also explored and lastly, the management options and measures on how to mitigate potential impacts to the surrounding environment within the project site.

The core objectives of this desktop review are to provide and deliver:

- A description of the existing ecological values such as flora and fauna of the terrestrial habitats within the Kolosori tenement site, by using information from existing literature, and field data and observations drawn and recorded from the surveys.
- A description of the potential impacts of the proposed project on the terrestrial ecological values and the whole biodiversity within the project area.
- A description of the actions, measures, and the possible solutions to avoid, minimize, and mitigate the potential impacts of the mining project within the tenement area.

6.2 Assessment method

The assessment method mainly comprised two components, a literature review, and a field/site inspection survey. Various literature sources have been consulted and reviewed, comprising important scientific (published) and unpublished (reports) information relevant to south Santa Isabel, and especially areas closer to or within the vicinity of Kolosori and Takata tenements. The major tribal land within the tenement site is the Vergabuhi land, and the other two landowning tribes located northwest and west of the Vergabuhi lands are Tavia clan land and Iputu land respectively (refer to Figure 6-1). The terrestrial field survey was conducted by Ecological Solutions Solomon Islands (ESSI) staff from 14th to 20th of June 2021. The on-site survey mainly involved the observation and description of various terrestrial habitats (habitat assessment) within the tenement boundary, including the list of known faunal species that occupy the different terrestrial habitats. A general assessment of the vegetation composition and structure of the project site was essential to provide baseline information important for the overall viability of the area and its ability to support various fauna.

In complementing intensive surveys, the general faunal survey methods employed during the field assessment include Visual Encounter Surveys (VES) in the form of randomized walks, acoustic surveys, and an overall general observation of the habitats within the tenement site.

Figure 6-1 Map depicting various land blocks representing landowning tribes within the tenement site.

The Vergabuhi land (in purple) covers a large central area in the project site including the coastal beach strand, the mangrove forest, the lowland, and the ultramafic forest (refer to Figure 6-2 for habitats located in the Kolosori Mining lease area). The Tavia clan land (light green) at the interior north-western end of the tenement site comprises a portion of the lowland forest, and the Iputu land (blue area) encompasses parts of the lowland forest, most parts of the mangrove forest, coastal beach forest, and a headland consisting of a clearly defined forest transition from the coast to the ultramafic forest and to the hill forest

6.3 Existing environment

Solomon Islands is well known for its rich biodiversity having unique species of flora and fauna occupying different ecosystems within the stratum double chain of mainly six (6) islands of which Santa Isabel Island is geographically part of (Pikacha, 2008; Secretariat of the Pacific Regional Environment Programme , 2019). Famously referred to as one of the most biologically rich archipelagos on earth, the Solomon Islands is a global hotspot of biological endemism and is among those countries comprising one of the most diverse species of terrestrial fauna and one of the most biodiverse countries in the south pacific region surpassed only by Papua New Guinea (Plant Conservation National Consultant Group, 2019; Pacific Horizon Consultancy Group, 2008; Pikacha, et al., 2008; Pauku & Lapo, 2009; Morrison, et al., 2007) straddling the northwest of Bougainville and ending further east at the Santa Cruz Islands (Pikacha, 2008; Pauku & Lapo, 2009). There are many reports that allude to Solomon Islands biodiversity being 'globally outstanding' with regards to its rainforests having ranked one of the highest, and being included in the global 200 list as part of the 1998 global assessment of biodiversity (Pacific Horizon Consultancy Group, 2008; SMM SOLOMON LIMITED, 2012) The status of Solomon Islands' biodiversity is further highlighted, updated, and confirmed in the NBSAP 2016-2020, with important fundamental and baseline references from Whitmore (1969), Whitmore (1998), Hancock & Henderson (1988), Hansel & Wall (1976), Lewis & Cribb (1991), McCoy (2006), Menzies (2006), and many others.

Often regarded as the 'Centre of Plant Diversity', the country has very high occurrences of plant species with a record of 4,500 plants of which 3,200 are known to be native or indigenous species (Ministry of Environment, climate Change, Disaster Management and Meteorology, 2016; SIRC, 2021). Various credible sources (Pikacha, 2008; Pikacha, et al., 2016; Whitmore, 1969; Hancock & Henderson, 1988; Bennett, 2000) have recognized and categorized major vegetation types in the Solomon Islands into five (5) or six (6) types however, present field observations and reports mainly focus more on six major forest types namely:

- Coastal forest or Beach strand
- Saline swamp and Mangrove forest
- Freshwater swamp, Marshes, and Riverine forest
- Lowland forest
- Uphill and Ridge top forest
- Montane or Cloud forest

The grassland forest or ecosystem is often included as a major type of forest however, only few areas in the Solomons do have large areas of grasslands for example areas on the northern leeward side of Guadalcanal Island (Lavery, et al., 2016). Smaller areas of grassland are also found on Ngella, Savo, San Jorge Island, Malaita, Choiseul, Gatokae, and Ghizo Island in the Western Province (Pikacha, 2008; Polhemeus, et al., 2008; Morrison, et al., 2007; Lavery, et al., 2016). In addition, some plant communities often grow together because they prefer areas with a certain rainfall, soil type, position in the landscape, and island size and usually changes between communities can be gradual and hard to notice or can be very obvious (for instance when a grassland is next to a forest) (Lavery, et al., 2016). A classic example of a gradual change between plant communities without the occurrence or presence of grassland ecosystems observed within the Kolosori tenement site are the fernlands *(Dicranopteris linearis)* located adjacent to ultramafic forests dominated by *Gymnostoma papuana*, a pine tree from the Casuarinaceae family (Ent, et al., 2015). The NBSAP 2016-2020 report compiled by MECDM (2016), Tyrone et al., (2016), and Solomon Islands Resources Company Limited (2021) stated six and seven forest types within the Solomon Islands with the inclusion of grassland forest, secondary forests, and the ultrabasic/ultramafic forest in which the latter is one of the main forest types found in the Kolosori tenement site.

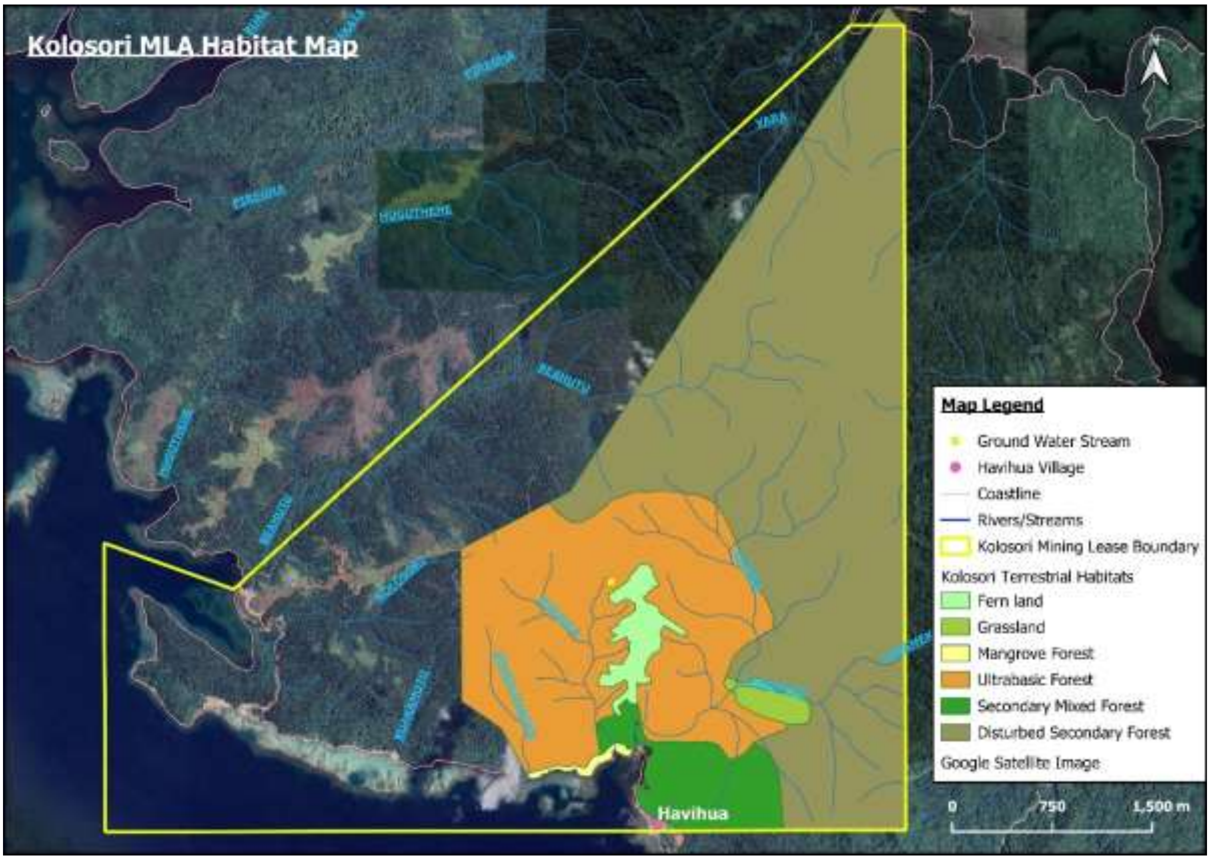


Figure 6-2 Map of various habitats found and recorded in the Kolosori tenement site.

Note that other areas to the western portion of the tenement (parts of Tavia clan land and Iputu land) were not surveyed by ESSI, but Figure 6-2 and Figure 6-3 and the results from SMM (2012) and SIRC (2021) reports, have provided a clear understanding of the general habitat types found in those areas. The area to the west of the land survey that comprises The western portion of the tenement is likely dominated by ultrabasic soils supporting ultrabasic forest and disturbed forests.

Based on the ESSI survey and summarised in Figure 6-2, the Kokoilovadhe, Vuavula, and Komika streams (blue lines) are seen traversing the central part of the tenement site with the main village (Havihua village) located on the banks of Vuavula stream next to the mangrove forest (tiny, squared boxes in orange area on the coast). The fern lands (visible open areas with green dots) are composed of the dominant False staghorn fern *(D. linearis)* as alluded to in the previous paragraph and the ultramafic/ultrabasic forests (yellow dots on edges of the fern lands) can be seen occupying a significant amount of area on the ridgeline that leads inland to the major lowland hilly forests in the interior of the project site. As seen in Figure 6-3 the lowland forest that fringes the Fern Land is still relatively intact but could be impacted by the proposed mining.

Some localities in the provinces like Santa Isabel (south-eastern side of the island which includes San Jorge and the adjacent mainland Isabel- Takata & Kolosori), Choiseul (south-eastern part of the island), Guadalcanal (Marau area) have nickel-rich laterite soils developed over ultramafic rock and their sedimentary and metamorphosed derivatives (Ent, et al., 2015; Visioli, et al., 2019). Under tropical climate conditions supergene deposits of Nickel (nickel laterite deposits) formed from the pervasive chemical and mechanical weathering of ultramafic rocks that occur within ophiolite complexes as harzburgite and dunite (Brand and others, 1998). the soil weathering process enhances the formation of laterite soils which are mainly developed over serpentinites, that are widespread, and when deeply leached result in the accumulation of iron oxides in the soil profile and the surface soils Ent, et al., 2015a; Visioli, et al., 2019; Chaudhury, et al., 2015; Ent, et al., 2015b). The constituent iron oxides and the nickelferous laterite geology influence and determine the vegetation type that is commonly known as ultrabasic/ultramafic forest (Aiba, et al., 2015; Ent, et al., 2015a) that is closely linked to the occurrence of nickel laterite in the Kolosori mining lease area.

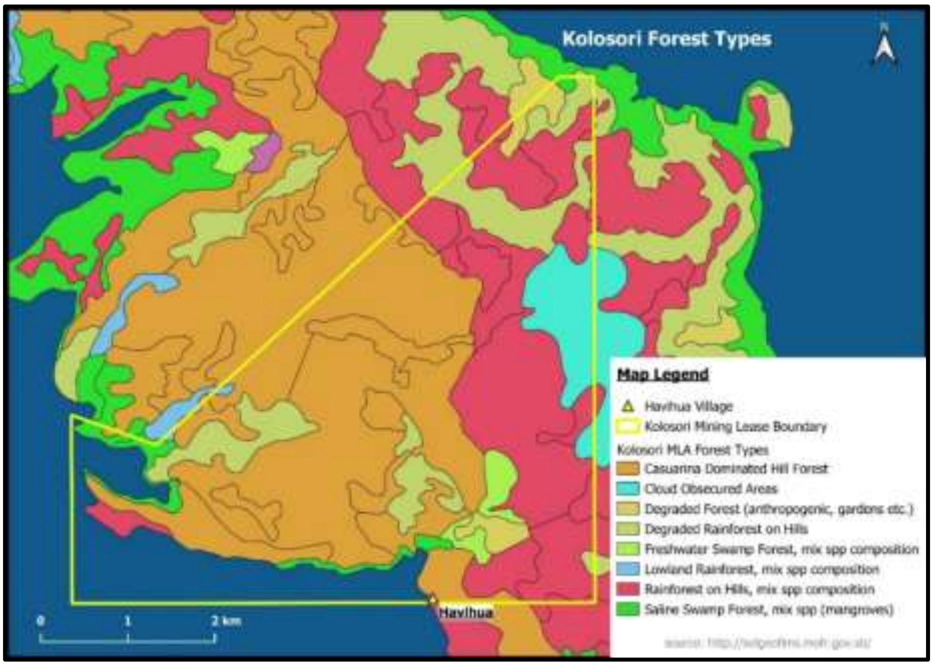


Figure 6-3 Map of different forest types found in the tenement site and surrounding lands.

There are a total of seven (7) forest types specifically found in the tenement site as depicted in Figure 6-3 namely Fresh swamp forest, Terminalia swamp forest, Casuarina dominated hill forest, Hilly rainforest, Degraded hilly rainforest with mix species, Degraded Forest (anthropogenic), and the Saline swamp forest with different mangrove species. These different forest or habitat types can be further grouped and merge into the main six categories. For example, the Sago swamp forest and the Terminalia swamp forest are mainly part of the freshwater swamp/riverine forest.

The Kolosori tenement site, as was previously surveyed by Sumitomo Mining Ltd (SMM Ltd) has produced interesting results and findings about the area and adjacent localities, which further contributed to the already available data for Solomon Island's flora and fauna and improve on the knowledge of Santa Isabel's flora and fauna as well as their conservation status. The results of the survey carried out by Solomon Islands Resource Company Limited (SIRC) in the same tenement area complemented the geological, physical, and biological characteristics of SMM's results and in that, most of the data that is produced in this report draws mainly from those two reports with other available references and supportive sources that have information about the same geology and ultramafic vegetation as the Kolosori tenement area. the area. Peterson et al., (2012), further stated that Santa Isabel Island supports a very high diversity of flora and fauna.

(Source: ESSI, 2021).

Figure 6-4 Depicts the central part of the tenement site dominated by fern lands and showing the extent of the ultramafic forest.

According to SMM Ltd (2012) and Peterson et al., (2012), there are about 162 vascular plant species in the Kolosori locality and adjacent areas with most of the plants growing on the ultramafic soils depending entirely on the serpentine bedrock and geology of The current and previous exploration activities are also visible in the area as depicted such as drilling sites, access roads, camp sites, and areas being cleared for survey.

6.4 Flora

The two major vegetation types observed in the tenement area during the survey are Lowland Forest and Ultramafic Forest. However, within those two major vegetation or forest types are found other habitats or smaller forest communities for example, the Ultramafic Forest have plant communities with different composition on hills as compared to those in the valleys. The habitats on the coast are categorized in either the coastal forest/beach strand or the mangrove forests, with both occurring in the tenement site. In the findings produced by SMM Ltd (2012), the dominant species as reported were the ironwood *(Xanthostemon melanoxylon)* which is locally known on Isabel as Tubi. However, the report by SIRC 2021 and the general observations made during the survey believed that the dominant species in the whole ultramafic forest is *G. papuana*. In the habitat assessment and results from SIRC 2021, *X. melanoxylon* is closely associated with *G. papuana*, and the two species thrive on ultramafic soils in various habitats in the hills, slopes, and on the edges of the fern lands (refer to Figure 6-4) within the tenement site. According to SMM Ltd (2012), other main canopy species that are abundant in the ultramafic soils are *Dacrydium sp* (later confirmed by ESSI survey), *Podocarpus sp*, and two species of palms namely *Hydriastele hombronii* and *Actinorhtyis calapparia*. The dominant understory or ground level species in most sites on ultramafic soils is *D. linearis* therefore, inhibiting and limiting the growth of other tree and shrub species except for ironwood trees *(X. melanoxylon)*. Visioli et al., (2019), stated that shrubs and trees that occur on open scrubland on serpentinite (ultramafic) soils tend to be dwarf and stunted in their growth from the ones growing in adjacent soils and the SMM 2012 report has also stated that small-statured trees of *X*. *melanoxylon* and *G. papuana* can be found in areas associated with the open fern lands and do have stunted growth (Figure 6-5).

(Source: ESSI, 2021).

Figure 6-5 *G. papuana* saplings freely intermixed with *D. linearis* (fern land habitat) (left) and stands of *G. papuana* and *X. melanoxylon* at the edge of hilly forest (right).

Historical records and past studies on plant diversity in the Solomon Islands have recorded 4,500 species, whereas other sources have estimated a total of 5,000 species (Hancock & Henderson, 1988; Whitmore, 1969) including 22 species of gymnosperms, 2,821 angiosperms and 367 pteridophytes (Hancock & Henderson, 1988). Although, the forest and floral communities on the whole of Santa Isabel Island and especially within the Kolosori tenement are under-studied and under-explored, the proportion and abundance of the native vegetation are anticipated to be well represented in the project area, as many of its forested areas are relatively intact.

The description of each forest type or habitat types found in the tenement site will begin from the coastal habitats and further inland to the ultramafic forests and the lowland hilly forests as set out below.

6.4.1 Coastal forest/Beach strand

Generally, coastal forests occur on the main islands in Solomon Islands (Pikacha, 2008; Lavery, et al., 2016; Pauku, 2009; Pikacha & Sirikolo, 2010). The coastal forests mainly offer protection for the lowland forests because they tend to be salt-tolerant and have adapted deep roots that can stabilize the coastal soils (Lavery, et al., 2016), and acting as buffers against strong winds, cyclones, and high storm surges (Pikacha, 2008). The vegetation communities on the coast are different from inland communities in that, they occupy a narrow area and typically exhibit zonation into several bands that run roughly parallel to the coastline (Whitmore, 1998; Whistler , 1992). The floral composition of the beach forest found in this site are quite typical of that found throughout the Indo-Pacific region and the Indo-Malesia region (Whistler , 1992; Whitmore, 1969; Lavery, et al., 2016).

Three of the most common coastal trees found in the Solomon Islands and are also present in the tenement site are: Alexandrian laurel or Beach mahogany *(Calophyllum inophyllum),* Tropical beach almond *(Terminalia catappa)* and the Fish poison tree or Box fruit *(Barringtonia asiatica)* (Solomon Islands Resources Company Limited , 2021; Kratter, et al., 2001). Other characteristic trees and shrubs recorded within the area are Beach cordia or Kerosene wood *(Cordia subcordata)*, Beach hibiscus tree *(Hibiscus tiliaceus)*, Sea mango *(Cerbera manghas)*, Casuarina *(Casuarina equisetifolia)*, Vesi *(Intsia bijuga),* Looking-glass tree *(Heritiera littolaris),* Tree heliotrope or Butterfly tree *(Tournefortia argentea),* Milo *(Thespesia populnea),* Sea randa *(Guettarda speciosa),* Grand devil's-claws *(Pisonia grandis),* Lantern tree *(Hernandia nymphaeifolia),* Buas buas *(Premna corymbosa)*, Beach vitex *(Vitex trifolia)*, Noni *(Morinda citrifolia)*, Half flower *(Scaevola taccada)* and *Neisosperma oppositifolium*. In secondary habitats nearby Vuavula village (settlement) are stands of Coconut palms *(Cocos nucifera),* Mango trees *(Magnifera indica),* Screw pine *(Pandanus tectorius)*, *Pandanus compressus*, and some invasive plants intermixed with most of the coastal strand natives. They occur due to human modification of the habitat (Lina Dorovolomo, pers.com, 2021).
(Source: pacificnickel.com)

Figure 6-6 Typical coastal beach habitat on Santa Isabel Island.
on the left depicts surveys carried out in the coastal area within the Kolosori tenement site and as seen in the background are Coconut and *P. tectorius* saplings and a *C. subcordata* tree. Depicted on the right of are a beach strand comprising of *S. taccada*, *P. tectorius*, *I. bijuga* and larger trees like *T. catappa* and *C. inophyllum* in the background.

Additionally, the sandy and rocky substrates in the eastern coast of the tenement comprised of mostly vines, herbs, and trailers such as the Beach morning glory *(Ipomoea pes-caprae)*, Beach bean *(Canavalia rosea)*, Beach pea *(Vigna marina)*, Beach daisy/sunflower *(Wollastonia biflora)*, Indian beech *(Millettia pinnata)*, *Bikkia tetrandra* and few grasses and sedges like the *Cyperus stoloniferus*, *Thuarea involuta*, *Scleria polycarpa*, *Lepturus repens*, and *Stenotaphrum micranthum*. Because of the habitat's common nature, the beach forest is identified as 'Native Forest that is not listed as threatened' (Solomon Islands Resources Company Limited , 2021).

6.4.2 Mangrove forest

The mangrove forest or mangrove swamp as it is often referred to as, instead of occupying narrow zones on the beach, tend to inhabit muddy, reef-protected areas that are periodically inundated by sea water (Hansel & Wall, 1976; Whistler , 1992). Most mangrove species have specialized adaptations that enable them to exist and thrive in the harsh habitat and environments such as, the toleration of sea water for growth and obtaining oxygen for their underground roots through knobby breathing roots called pneumatophores (Whitmore, 1998; Whistler, 1992). On Santa Isabel, they also commonly occur in rivers and stream deltas having marine influence or in the estuarine habitats (SIRC, 2021; SMM, 2012).

(Source: ESSI, 2021).

Figure 6-7 Aerial photo of the mangrove forest at the southern end of the Kolosori tenement site.

Observations made during the survey showed that the mangrove forest occupies much of western edge of the tenement site, and the two dominant mangrove species are *Rhizophora mangle* and *Brugueira gymnorrhiza*. The SIRC 2021 and SMM 2012 surveys also recorded *R. mangle* and *B.gymnorrhiza* as the two main types of species present in the tenement site as well as the dominant mangroves. Three other mangrove species present in the tenement site are *Rhizophora stylosa, Rhizophora apiculate*, and Teruntum merah *(Lumnitzera littorea)*.

Other important salt tolerant trees that form the intact canopy growing amongst *B. gymnorrhiza* are the Blinding tree *(Exoecaria agallocha)*, Puzzle nut *(Xylocarpus granatum)*, *Nypa fruticans*, *Heritiera littolaris* and *Inocarpus fagiferus (SIRC, 2021).* The Pond apple *(Annona glabra)* is regarded as an invasive species that has known to invade saline swamps and mangrove habitats (Pacific Invasives Initiative, 2010) and within the tenement site, its thicket-growth habit has caused it to spread and outcompete native understory species (especially germinating mangrove saplings and other coastal tree saplings) in saline and mangrove swamp forests. According to the field observations, the absence of Wedelia *(Sphagneticola trilobata)*, one of Pacific Island's worst invasive weed (Thaman, 2007) in the project site requires careful management and invasive control measures to be put into place. Wedelia is an imminent and potential threat to indigenous and native plants, and it should be controlled and eradicated from adjacent areas that have already been invaded (Pacific Invasives Initiative, 2010; Thaman, 2007), before it becomes a problem in the tenement site (Lina Dorovolomo, pers.com, 2021). As depicted in Figure 6-8 and Figure 6-9 the *R. mangle* species with other *Rhizophora spp* (smaller than *B. gymnorrhiza*) normally occupy sunny spaces in the seaward side (front) of the mangrove vegetation community.

(Source: San Jorge EIS report, 2017).

Figure 6-8 Typical close-up view of a mangrove forest that clearly shows the smaller *Rhizophora spp* in front, and the taller stands of *Brugueira spp* at the back.

The larger mangrove *(Bruguiera)* is found behind the *Rhizophora spp* and can grow up to heights of about 20 meters (SMM, 2012). *Brugueira* displaces the smaller Rhizophora spp as the vegetation matures and transitions from scrub to forest (Hancock & Henderson, 1988; Whistler , 1992; Pikacha, 2008).

Figure 6-9 shows a transitional habitat from *Rhizophora spp* to *Brugueira spp* and other taller trees like *X. granatum* referred to above.

(Source: ESSI, 2021).

Figure 6-9 Part of the mangrove forest within the tenement site.

The conservation status of the mangrove forest/habitat is 'Native Forest that is not listed as threatened (SMM, 2012). The mangrove forest is a very important ecosystem of its own that needs to be maintained when the mining is fully operational, as it will assist in the mitigation and prevention of sediment release onto the reef flats and the coral reefs.

6.4.3 Freshwater (Riparian) swamp forest/Riverine Forest

It is important to note that in this forest type the Sago swamp forest and *Terminalia* swamp forest are merged with the riparian forest and that also includes a few vegetation species that grows on ultramafic/serpentine soils.

In the tenement site, the riparian forests are restricted to small areas beside the Kokoilovadhe, Komika, Havihua, Komika, and the main Vuavula streams/rivers. In fact, Whitmore (1969) noted that, freshwater swamp forests/riverine forest in the Solomon Islands usually encompass small pockets of areas up to 1 km^2. As observed, the canopy of the freshwater forest is still intact, and the ground layer is filled with thick leaf litter with the understory consisting mainly of lianas and ferns that occur intermittent, and a sporadic occurrence of young *Pandanus spiralis* and germinating seedlings of trees that are common at the site such as *Terminalia calamansanai*, *Vitex coffasus, Vitex trifolia*, *Calophyllum vitiense*, *Eudia spp, Ficus spp*, and *Metroxylon solomonensis* (Sago palm). Although situated closer to streams, the freshwater swamp forests and riverine vegetation are often inundated during the rainy seasons which can influence the growth of trees such as the *Camnosperma brevipetiolatum* and the *Terminalia brassi* to a height of about 40 meters with higher value of commercial importance (Pauku, 2009; Pikacha, 2008; Whitmore , 1969; Ellison, 2008). Pikacha (2008) and Pikacha & Sirikolo (2010), stated that *C.*

brevipetiolatum and *T. brassi*, are mostly dominant species of freshwater swamp forests of the Western Solomon Islands, hence the proof to their little to no occurrence in the project site where it is replaced by *T. calamansanai*.

In areas on the slopes where there is presence of ultramafic soils, *G. papuana* trees are observed to be abundant with the understory covered with *Calamus spp*, Lawyer canes *(Calamus hollrungii)* *Freycinetia solomonensis*, *Freycinetia decipiens*, and the invasive vine (climber) *Merremia peltata*, which is a major havoc in the project site (SIRC, 2021). Due to some drilling sites and roads located within the riparian forest, the vegetation at the site is mainly secondary and is composed of tree and palm species like *Rhus taitensis*, *Macaranga spp, Syzygium spp*, *Heterospathe solomonensis* and *Bambusa spp.*

(Source: SIRC, 2021)

Figure 6-10 Depicts part of the freshwater swamp vegetation within the tenement site.

The *M. solomonensis, C. brevipatiolatum* saplings, *Alpinia spp* are recognisable with few other riparian species (Figure 6-10 and Figure 6-11).

Occasional landslides and landslips due to heavy rains have recently altered the vegetation in some areas and because the dominant soil type in the freshwater/riparian swamp forest is of clay, the habitat is prone to more erosion.

(Source: Melanesian Geo, 2016).

Figure 6-11 Typical freshwater/riverine habitat showing palm species like *H. solomonensis* (left), and freshwater ferns and *Freycinetia spp* climbing on trees (right).

Due to current small scale mining activities and threats of invasive species, especially from the dominant *M. peltata*, it is recommended that proper management plans be created that can include the possibility of establishing nature reserves specifically, riparian reserves.

6.4.4 Fernlands (Fern scrubland and woodland)

At the project site, the occurrence of fernlands, fern shrublands, and fern woodlands are on the ridges and slopes of hills in the centre of the tenement site (Figure 6-4, Figure 6-12 and Figure 6-13). In other localities in the Solomon Islands apart from the southeast side of Santa Isabel, the flora and vegetation composition and structure are mainly consistent and usually no floral variations are identified (Bennett, 2000; Pikacha, 2008; Pikacha, et al., 2008). However, in the slopes and ridges within the tenement site, the usual scenery is being replaced by fern scrublands of totally different vegetation composition due to the ultramafic peridotite bedrock (Kratter, et al., 2001; Echevarria, 2018). In the ridges that lead to the coastal forest, the groundlayer is mainly sparsely distributed with Stag's horn clubmoss *(Lycopodium cernum)*, the ground orchid *(Spathoglottis plicata)*, *Scleria polycarpa, Melastoma affine,* and limited areas covered with *D. linearis*.

(Source: ESSI, 2021).

Figure 6-12 The fern scrubland overlooking the central part of the tenement site towards San Jorge Island in the background.

Further inland in the direction of the lowland hilly forest and located adjacent to the dominant *G. papuana*, *X. melanoxylon* and *H. hombronii* is the dominant fernland habitat consisting of *D. linearis* (covering a very large area) as briefly described in the flora introduction part of this report. Few native tree species that are sporadically distributed across the fernland include *Dillenia crenata*, *Pandanus spiralis*, *Eudia hortensis*, and *Trema orientalis*. The dominant shrub as observed during the survey is *Myrtella beccarii.* According to Whitmore (1969), the fernland (which includes the fern scrubland and fern woodland) although poor in shrub species, is a very important habitat that needs to be preserved and protected because it is one of the only two localities in the Solomon Islands (the other being San Jorge Island) on ultramafic geology that has the Myrtaceous shrub *(M. beccarii)*. *M. beccarii* is absent on ultramafic forests and fernlands on Choiseul Island (Whitmore , 1969). One important point of the ecological importance of the fernland on ultramafic soils is that, the high soil pH (Alkaline soils) and the hyperaccumulation of metals such as Cobalt, Nickel, Chromium and Zinc (metal toxicity) have found depauperate termite assemblages. Termites are very important organisms known to have a major influence over decomposition, mineralization, the redistribution of organic matter, soil structure and soil quality (Jones, et al., 2010).

Due to the shallow, rocky, and exposed nature of the outcrops (Boyd, et al., 2009; Kolar, et al., 2012; Ent, et al., 2014), the species composition in the fernland is always influenced by fire and over time, the frequent deliberate fires have extended these plant communities in the tenement area and has now becoming the largest area of this vegetation type on Santa Isabel Island (SIRC, 2021).

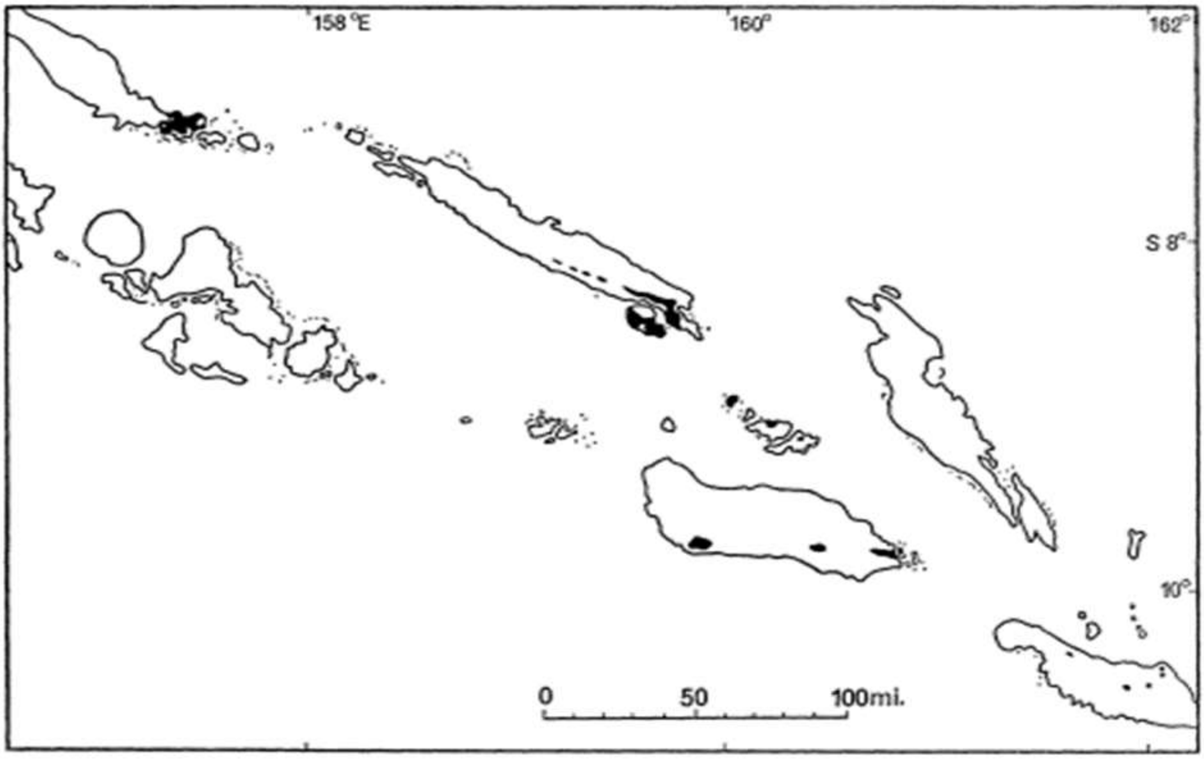
(Source: ESSI, 2021).

Figure 6-13 Fernland habitat dominated by *D.linearis* (left), and the fern scrubland/woodland with *D. linearis*, and the visible dominant *M. beccarii*.

The restricted species composition and diversity on the ultramafic soils like the occurrence of *M. beccarii*, *X. melanoxylon*, G*. papuana*, and *H. hombronii* suggests that careful management measures are established to protect these rare species on one of the most important environments within the Kolosori tenement site. The human induced fernland is not considered threatened as stated in the SIRC 2021 report.

6.4.5 Ultramafic/Ultrabasic Forest

Ultramafic vegetation is composed of dense humid forests and of an array of sclerophyllous formations composed of bushy shrubby and ligno-herbaceous plants locally called ‘mining maquis’ (i.e mining scrubland) (Ent, et al., 2015b), and because of its hyperccumulation of nickel, sparks mining interests globally, and in the Solomon Islands. The most distinctive variant of lowland rain forest is found on the areas of ultramafic rocks which outcrop principally on southern Santa Isabel and adjacent San Jorge, and southern Choiseul, with additional smaller areas on Guadalcanal (Marau Sound and Wanderer Bay), San Cristobal and Florida Islands (Small and Big Ngella with several small outcrops each) (Whitmore , 1969; Lavery, et al, 2016) as shown in Figure 6-14.



(Source: Whitmore, 1969).

Figure 6-14 Map showing outcrops of ultramafic rocks (serpentinite soils) and its distribution in the Solomon Islands, represented by the black-shaded areas on each island.

There are two different vegetation composition of the ultramafic forest occurring in the Kolosori project site on the ultramafic (serpentinite) soils where the dominant vegetation is represented. Firstly, on the slopes and ridges on the central locality of the tenement site where there is good soil drainage (deep free draining), the dominant upper canopy tree species is *G. papuana* and the dominant emergent tree species is the *H. hombronii*. The ironwood tree *(X. melanoxylon)* is considered an associate of *G. papuana* on the ridges and slopes reaching elevations of up to 200 meters in highly leached soils (Tutua, 2018) at the project site (see Figure 6-15 and Figure 6-16). On other islands in Tropical Philippines and areas in Malaysia, most of the *Gymnostoma spp* are also found on elevations around 200 meters and have even occupied areas up to 1400 meters (Ent, et al., 2015a; Aiba, et al., 2015). Secondly, because of *G. papuana's* ability to adapt to other soil conditions in lower elevations mainly in valleys adjacent riparian forest, the dominant tree species could be found growing with other species like *Callophylum vitiense*, *Calophyllum spp*, *Dysoxylum excelsum,* and *Canarium spp* (SIRC, 2021; SMM, 2012).

(Source: ESSI, 2021)

Figure 6-15 *Gymnostoma papuana* and *Xanthostemon melanoxylon* freely intermixed on ridges in the project site.

Many sources have stated that the ultramafic forests assemblages in the Solomon Islands are the most distinctive, and are even more distinctive than those found in South East Asia and in the temperate regions of New Zealand (SMM, 2012; Whitmore (1969), Ent et al., (2015a), Ent et al., (2015b), Ent et al., (2014), Jones et al., (2010), Visioli et al., (2019), and Aiba et al., (2015), noted that the variation in ultramafic forests in the tropics (Solomon Islands included) was as a result of low concentrations of nitrogen, potassium, and phosphorus and not so much on the higher concentrations (hyperaccumulation) of nickel, cobalt, and chromium. This resulted in the reduced height in trees (approx 15-25 meters) in the tenement site, responsible for the stunted growth in some species, and also explains the low species diversity and restricted species range in the project site. Furthermore, Galey et al., (2017), stated that the absence of important soil nutrients like magnesium has also proven to lower tree species diversity with the vegetation having a simplified forest structure. Currently, the conservation status of the ultramafic forest is ‘Native forest that is not threatened’, however, because of the relatively arge numbers of endemic species, ecotypes, and rare species, the ultramafic forests and the related vegetative communities on serpentinite soils are referred to as high priority areas for biodiversity conservation (Galey, et al., 2017).

(Source: ESSI, 2021).

Figure 6-16 Shows the clear aerial view of the intermixed association of *G. papuana* and *X. melanoxylon* on a ridge at the margin of the fernland habitat on the eastern side of the tenement area.

6.4.6 Lowland Forest (including hilly forest)

The lowland forest described here are forests that are without the presence of ultramafic vegetation or in other words, where the vegetation grows on adjacent non-ultramafic soils. Although lowland forests are generally found on level land, they can also be found on lowland ridges and hills (Bennett, 2000; Pikacha, 2008; Pikacha, et al., 2008).

Lowland forest can be regarded as one of the most species diverse of all vegetation communities and in the Solomon Islands, these forests are more floristically like that of the Indo-Malayan archipelago (Lewis & Cribb, 1991; Pikacha, 2008; Lavery, et al., 2016; Whitmore, 1969) with approximately sixty (60) generally large trees by which 12 of those species can often reach the forest canopy. Generally, the frequent canopy species include *Calophyllum kajewski, C. vitiense, C. brevipatiolatum, Dillenia salomonensis, Elaeocarpus sphaericus, Endospermum medullosum, Gmelina moluccana, Maranthes corymbosa, Parinari salomonensis, Pometia pinnata, Schizomeria serrata,* and *T. calamansai* (Whitmore, 1969; Whitmore, 1998; Pikacha, 2008; Thomson & Thaman, 2006; Pauku, 2009). The lowland forest of the Kolosori tenement site has a distinct feature which is very different from the species composition of the ultrabasic/ultramafic Forest (SIRC, 2021). The commonly occurring species of the lowland forest within the tenement site are *Astronidium sp*., *Finschia sp., Dysoxylum excelsum,*

Calophylum spp, *Diospyros insularis (Ebony), Trema orientalis, C. vitiense, T. calamansanai, Vitex coffasus, Ficus spp., Eudia spp., Syzygium spp.*, *Heterosphate solomonensis* and *Cannarium spp*.
As observed high emergent within the habitats include *T. calamansai* and the *Ficus spp*, and the presence of *V. cofassus* and *Canarium spp,* indicated that the area subjected to past disturbances or might be an abandoned old village site (Pikacha, 2008; Katovai, 2018). The understory is thick with the presence of mainly palms, vines, epiphytes, gingers *(Alpinia spp)*, large leaved herbs and ferns which are all abundant in the areas they occur. According to the SIRC and SMM reports, the dominant epiphytes in the area are *Asplenium, Hydnophytum, and Myrmecodia (SIRC, 2021, SMM, 2012)*. In addition, the forest does not have *G. papuana* and *X. melanoxylon* which are mainly species restricted to the ultramafic soils.

(Source: Pacifika Environews, 2019)

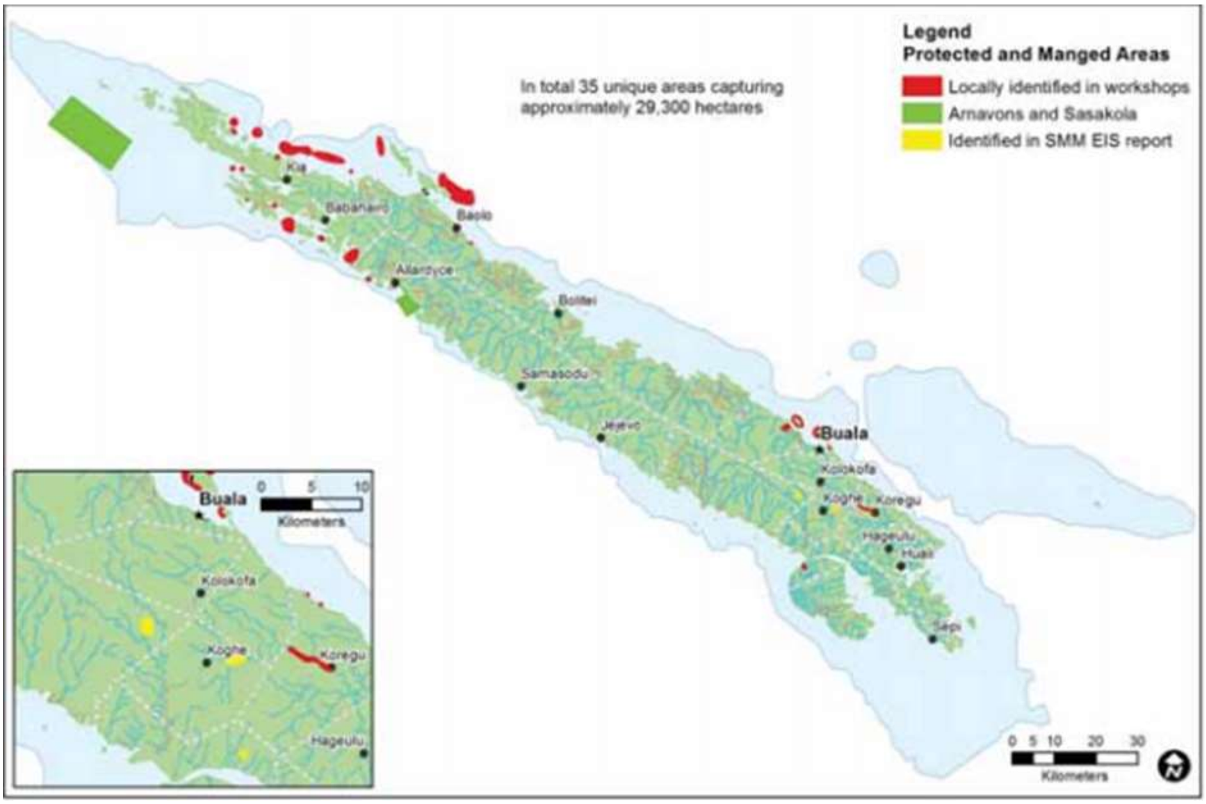
Figure 6-17 Typical lowland forests of the Solomon Islands.
As seen in Figure 6-17, the leaf litter is also abundant and normally filters through the thick canopy and thick vegetation density with leaves of plants growing near the forest floor tend to be comparatively bigger than those of the canopy, due to the competition for sunlight (Pikacha, 2008). In the immediate future when the mining operates, the lowland forests in this tenement site will become highly threatened. As stated in Lavery et al., (2016), the increase in mining industry in the Solomon Islands has already posed threats to the lowland forest tree species and its adjacent habitats. Pikacha (2008) noted that the lowland forests are probably the most threatened terrestrial ecosystem (habitat) in the Solomon Islands.

6.5 Flora species of conservation significance

There are two species identified during the survey namely Diospyros insularis and Callophylum obscurum which are listed in the IUCN Red List of Threatened Species 2013 (SMM, 2012; SIRC, 2021). There are a total 27 plant species listed as Threatened species under the IUCN Red List of Threatened Species (refer to Table 6-1), as reported by the SMM EIS report of 2012. That survey was a decade ago which means that an updated assessment on the status of the overall forest types within the tenement site is highly recommended before more development (forest clearance etc) is taken place, so that decisions can be made on which tree species are to be felled and which ones are not. Out of the 27 plant species listed in Table 6-1, some species are found and recorded in the tenement site while others are possible to have occurred on the island of Isabel. Important tree species like Ironwood (Intsia bijuga); Ebony (Diospyros spp.); Ngali Nuts (Canarium indicum), Noni (Morinda citrifolia), Screw pine (Pandanus tectorius) and other edible fruit trees that are found in the area, are listed as protected species under Schedule 1 of the Forest Resources and Timber Utilization Act (SIRC, 2021).

Additionally, as according to Pauku (2009), the potential of these native species being commercialised and traded for export is already evident, for example, *C. indicum, M. citrifolia*, and *Calamus hollrungii* (lawyer cane). The need to develop these native species with commercial potential should be seriously considered by the government as an option for the diversification of income-generating opportunities for resource owners from the three tribal lands of the Kolosori proposed mining project (Pauku, 2009). Most of the tree species in the lowland forest like the sought-after *Terminalia spp*, *Vitex cofassus*, *Dysoxylum excelsum*, and *Calophyllum spp*, for their timber and other medicinal uses are not yet threatened with overharvesting since the disturbance is small-scale but in the immediate future when adjacent habitats are impacted, they could be potentially listed as threatened under the IUCN Red List of Threatened Species.

The mangrove forest found in the area is undisturbed and still intact and would need some sort of management or protection under a marine reserve or Locally Marine Managed Areas (LMMA's). Mangroves however are not listed as threatened but it is important that the mangrove forest be reserved as it will help to mitigate sedimentation and siltation run-offs from the mining operation sites. Not only that, but the *Xanthostemon melanoxylon* is an endemic and native tree species of the Solomon Islands (Tutua, 2018, MECDM, 2016) that is abundant in the area that requires some level of protection as well. It is very important to note that not all forested areas will be cleared by the mining operation, however, pockets of soils will be mined, which means strands of forests located on a particular pocket will be cleared prior to excavations. As there are no formal protected areas or proposed protected areas that could be affected by the mining excavations, the informal protection of many small natural sites called "Tambu" sites, should be provided and demarcated by the local population from the landowning tribes to protect these important significant cultural areas in a traditional manner.



(Source: The Nature Conservancy, 2012).

Figure 6-18 Map of Santa Isabel Province showing existing marine and terrestrial protected and locally managed areas.

As depicted in Figure 6-18, there is only one locally managed area on the northern side of San Jorge area, but no formal protected area or local conservation area in the adjacent tenement sites of Takata and Kolosori. Some areas (in yellow shade) have been successfully identified by the Sumitomo Metal Mining group EIS report which are located closer to the Kolosori tenement site. It is therefore recommended that the tribal owners learn from the achievements of other areas on the island so that a potential forest reserve be set aside and created within the Kolosori tenement boundary.

Table 6-1 Flora species of conservation significance and their potential to occur on Santa Isabel Island

Species	Distribution Record	Habitat Preference	Potential to Occur on Santa Isabel Island
Agathis macrophylla (Lindl.) Mast	Occurs in Solomon Islands (Sta. Cruz)	Lowland forest	Unlikely but still possible
Aglaia brasii Merr & Perry	Solomons, Southeast Asia, Northern Australia and the Pacific	Lowland forest	Possible
Aglaia flavida Merr & Perry	Solomons, Southeast Asia, Northern Australia and the Pacific	Lowland forest	Possible
Aglaia parksii A.C. Sm.	Solomons, Southeast Asia, Northern Australia and the Pacific	Lowland forest	Possible
Aglaia parviflora C. DC	Moluccas, New Guinea, Solomon Islands	Lowland forest	Possible

Species	Distribution Record	Habitat Preference	Potential to Occur on Santa Isabel Island
Aglaia rubrivenia Merr & Perry	Endemic to Solomon Islands	Lowland forest	Possible
Aglaia saltatorum A.C. Sm	Solomon Islands (Sta. Cruz)	Lowland forest	Unlikely but still possible
Aglaia samoensis A. Gray	Solomon Islands (Sta. Cruz)	Lowland forest	Unlikely but still possible
Aglaia silvestris (M. Roem.) Merr.	Solomon Islands	Lowland forest	Possible
Archidendron oblongum (Hemsl.) de Wit	Endemic to Solomon Islands	Lowland forest (alluvial valleys)	Possible
Burckella sorei Royen	Bougainville and Guadalcanal	Lowland forest	Unlikely but still possible
Calophyllum confusum P.F. Stevens	Solomon Islands (New Georgia)	Lowland forest	Unlikely but still possible
Calophyllum obscurum Stevens	Solomon Islands (Choiseul, Santa Isabel and Malaita)	Lowland forest (ridges and coral platforms)	Recorded
Cycas bouganivilleana	Solomon Islands, Bougainville, New Britain Islands	Coastal beach forest	Unlikely but still possible
Diospyros insularis Bakh.	Solomon Islands and New Ireland	Lowland forest	Recorded
Gonystylus macrophyllus (Miq.) A Shaw	Solomon islands (Choiseul and New Georgia)	Lowland forest up to 1,500 m asl	Recorded
Intsia bijuga (Colebr.) Kuntze	Madagascar, Indian Ocean Islands, tropical Asia through Malesia to Northern Australia, Melanesia and Micronesia	Inland from coastal forest	Possible
Livistona woodfordii Ridl.	Solomon Islands (Nggela Island)	Lowland and swamp forests	Unlikely but still possible
Mangifera altissima Blanco	Philippines, Sulawesi, Lesser Sunda Isls, Moluccas, New Guinea, Solomon Islands (Guadalcanal)	Lowland forest	Possible
Mastixiodendron stoddardii Merr. & Perry	New Britain and Solomon Islands	Lowland forest	Possible
Myristica globosa Warb.	Solomon Islands	Lowland forest up to 1,200 m asl	Possible
Myristica guadalcanalensis Sinclair	Solomon Islands (Guadalcanal, Renell, Malaita)	Lowland forest	Unlikely but still possible
Myristica petiolata A.C. Sm.	Solomon Islands (Santa Isabel and Big Nggela Island)	Lowland forest	Possible
Myristica xylocarpa W.J. de Wilde	Solomon Islands (Santa Isabel Island, San Cristobal and Guadalcanal)	Lowland forest	Possible
Podocarpus glaucus Foxw.	Data deficient	Data deficient	Data deficient
Pterocarpus indicus Willd.	Myanmar, Thailand, Cambodia, Ryukyus, Philippines, along Bismarck Archipelago, Vanuatu, Solomon Islands, Caroline Islands	Lowland forest	Possible
Terminalia rerei Coode	Solomon Islands (San Cristobal and Guadalcanal)	Lowland forest	Unlikely but still possible

(Source: SMM, 2012).

6.6 Forestry

The identified forest timber trees of high commercial value in the tenement site are *Terminalia brassi*, *Vitex cofassus*, *Diospyros insularis, Callophylum obscurum, Calophyllum vitiense, Gmelina moluccana, Terminalia calamansai, Pometia pinnata, Dillenia salomonensis* and *Dysoxylum excelsum*. The logging industry is a major export industry in Solomon Islands where most round logs are directly exported overseas. According to the Central Bank of Solomon Islands (2012), logging exports out of the Solomon Islands accounted for roughly 46% of all the exports in 2011, and there was a significant increase from 1.4 million cubic meters (volume of exports) in 2010 to 1.9 million cubic meters in 2010. The reason was due to high international demand for logs and increased log prices (Central Bank of Solomon Islands, 2012). At that time, Isabel Province is the leading log producer in the Solomon Islands and contributes 35% of total production (Central Bank of Solomon Islands, 2012; Peterson, et al., 2012). In 2019, CBSI issued 922 specific authorities to export to round log exporters. This was a decrease of 0.2% from the previous year of 924 specific authorities (Central Bank of Solomon Islands, 2020). The log production or the volume of export is gradually decreasing from 3.156 million cubic meters to 2.822 million cubic meters, and 2.717 million cubic meters for the years 2017, 2018, and 2019 respectively (Central Bank of Solomon Islands, 2020). The decrease has been the result of covid 19 affecting the global economy, however, since logging industry is a legitimate business for economic development, more trees will be logged into the future.

It is important to note that there was no previous logging activity recorded in the area, but should it happen, the combined effects with the mining operations will have significant impacts to the native vegetation and the forests within the tenement site.

6.7 Fauna

Due to limitations of time for the survey, most the faunal species that were expected to be observed within the project site were not sighted. However, constant bird and insect sounds can be heard from beside the riparian forests and along the coast. There were few skinks observed in sunny patches beside the streams and running up on trees and on logs. No mammals, frogs, and larger reptiles were observed.

According to published literature and various sources, there are at least 389 terrestrial fauna species known from the Solomon Islands (McCoy, 2006; Menzies, 2006; Pikacha, 2008). Out of the 389 species, 153 species are endemic (39%) and 39 species are listed as threatened on the IUCN Redlist of Threatened species (including 2 amphibian species, 2 reptiles, 17 birds and 18 mammals) (SMM, 2012). The fauna of the Solomon Islands has key international significance as noted in Pikacha (2008). He further stated that, apart from the island of New Guinea, the Solomon Islands have greater diversity of animal species and the endemism is remarkable and disntinctive than any other Pacific Island country, yet there is little knowledge about the ecology of each fauna species. According to the report by SMM (2012), Santa Isabel Island has at least 211 terrestrial vertebrate fauna consisting of 23 amphibians (frogs), 38 reptiles, 126 birds, and 24 mammals. The SMM 2012 has provided a thorough baseline terrestrial data for the adjacent Takata tenement and most of the areas at the western boundary of the Kolosori tenement site where much of the lowland forests are found.

(Source: ESSI, 2018).

Figure 6-19 An insect found in a lowland forest on one of the past survey sites on Kolosita locality, eastern side of Santa Isabel.

Despite being part of the terrestrial fauna, the data produced in this report does not include insects as observations were mainly focused on vertebrate species.

The survey undertaken by SMM Ltd in 2010 and 2011 has recorded a total of 93 species of terrestrial fauna which accounts for 24% of all known terrestrial vertebrate species for the entire Solomon Islands and about 44% of known vertebrate species for the whole of Santa Isabel Island. Of the 211 recorded fauna species for Santa Isabel, three species are endemic to Santa Isabel, eight are confirmed threatened by the IUCN Red List of Threatened Species, six are considered threatened and that are very likely to occur in the tenement site, and three are threatened species that are highly likely present in the project site (SMM, 2012). Part of the data was produced on the possibilty of each species to occur depending on their range and habitat.

6.7.1 Amphibians (Frogs)

Amphibians are commonly surveyed using the Visual Encounter Survey (VES) method at night which is the best time for frogging. The survey was done mostly during daytime hence, no frogs were encountered the other reason is that ultramafic areas are hostile environments with limited fauna diversity (Galey, et al., 2017; Visioli, et al., 2019). Frogs are the only representatives of amphibians in the Solomon Islands (Pikacha, et al., 2008) and on the island of Santa Isabel, the frog diversity is very high compared to other islands in the Solomon Islands. The frog data in Pikacha et al., (2008), noted a total of 23 frog species recorded for Solomon Islands (with only two endemics namely *Cornufer malukuna* and *Cornufer desticans*) and 18 frog species for Santa Isabel Island, and over the years as a result of more biodisversity surveys and scientific research, the Island is currently known to have 22 species of frogs (SMM, 2012). The other remaining 21 frog species are also found in Bougainville which is politically part of Papua New Guinea (Pikacha, et al., 2008).

The study by Brown & Richards (2008), noted the discovery of two new frog species namely, the Squeaking ground frog *(Cornufer desticans)*, and *Cornufer parilis*, both formely known as *Platymantis desticans* and *Platymantis parilis* respectively. The recent survey of the Kubonitu-Sasari massif (Varanitu land) in 2018 recorded four (4) possibly new species of *Cornufer* frogs at an elevation greater than 1000 meters (>1000 m) in the mossy cloud forest. The scientists proposed these 4 frog species are likely to repesent undescribed species (or possibly range extensions of species that were previously only known from the mountains of Bouganiville Island in Papua New Guinea) (Brady, et al., 2018). In addition, it is important to note that two vulnerable frog species (assessed under the IUCN Red list of Threatened species) are also found on the island namely, Solomon Island palm frog (*Cornufer heffernani*, formely *Palmatorappia solomonis*), and the Solomon Islands tree frog *(Litoria lutea* Figure 6-20*)*. The main reason for the two species being vulnerable is, loss of habitat due to their forest being threatened and deforested in an uncontrollable manner (Menzies, 2006; Pikacha, et al., 2008). Other important frog species that are very likely to be found in the lowland forest and the riparian forest within the tenement site include; Solomons wrinkled ground frog *(Cornufer solomonis)*, Webers wrinkled ground frog *(Cornufer weberi,* Figure 6-21*),* Treasury Island tree frog *(Litorea thesaurensis)*, Giant webbed frog *(Cornufer guppyi)*, Solomon Island giant tree frog *(Cornufer hedigeri,* Figure 6-21*)*, Neckers wrinkled ground frog *(Cornufer neckeri)*, San Cristobal frog *(Papurana kreffti)*, Torakino sticky-toed frog *(Cornufer trossulus)*, Fauro sticky-toed frog *(Cornufer vertebralis)*, and Solomon Island eye-lash frog *(Cornufer guentheri (*Figure 6-20*).*

(Source: ESSI, 2018).

Figure 6-20 *Cornufer guentheri* (left), and the vulnerable *Litoria lutea* (right) recorded on Santa Isabel (Kolosita locality), in 2018.

(Source: ESSI, 2018).

Figure 6-21 *Cornufer weberi* (left), and *Cornufer hedigeri* (right).

6.7.2 Birds (Avifauna)

The Solomon Islands, despite a rich history of exploration focused on the archipelago's birds (Mayr & Diamond, 2001), are still characterized as ''poor'' with regards to the knowledge of the native avifauna (BirdLife International, 2015; Decicco, et al., 2020). Recent fieldwork and scientific research surveys have documented new populations of birds and other land vertebrates (Lavery & Judge, 2017; Decicco, et al., 2019; Guo, et al., 2021) which underscore that the knowledge of basic bird distributional data are likely incomplete in this archipelago (Dutson, 2011). One classic example of a new documentation of a species once thought of as could be extinct on Santa Isabel but now becoming rare, is the re-discovery of the Island leaf warbler *(Phylloscopus maforensis)* near the summit of Mt Sasari in mossy cloud forest above 1000 m within the Kubonitu-Sasari massif in 2018 (Decicco, et al., 2019). The bird was first discovered on Santa Isabel in 1927 in the same locality (Beck, 1927; Drowne, 1927). Although the Solomon Islands is known to have high species diversity, the actual total species count for the whole country is still unknown and yet to be confirmed. Several results obtained from past and recent field studies in the country produced different numbers concerning species occurrences across the Solomon Islands. A recent survey by Avibase (2011), reported 289 species whereby 59 are endemic species and 26 species are globally threatened.

According to SMM report 2012, a total of our 17 bird species are listed as threatened under the 2011 IUCN Red list of Threatened Species (SMM, 2012). Around three (3) of the threatened bird species are recorded on Santa Isabel Island. These birds are Solomons sea eagle *(Haliaeetus sanfordi),* Imitator Goshawk *(Accipiter imitator)* and the Fearful owl *(Nesasio Solomonensis)*. The three birds are endemic to the Solomon Islands including Santa Isabel and together with other bird species found on Santa Isabel Island, are categorized into 40 families (SMM Ltd EIS, 2012). Thirty-one (31) species of shorebirds are represented within eight families and canopy, or above canopy species are represented by seven families with 14 species (Solomon Islands Resources Company Limited , 2021). The rest of the bird species are obviously understorey species. On Santa Isabel, the rare and elusive *A. imitator* was reported to occur up to 1000m in the Kubonitu-Sasari massif (Decicco, et al., 2019; Debus, et al.,

2019) and Kratter et al., (2001) considered the species uncommon in the lowlands of Hograno District in the areas opposite San Jorge Island. Hence, *A. imitator* is unlikely to be encountered in the lowland forests at the project site. The bird is listed as Vulnerable (BirdLife International, 2018) on the IUCN Red List of Threatened Species and both Dutson (2011) and (Gregory, 2017) considered it rare and poorly known. Due to the intactness of the canopy and the existence of large areas of riparian, freshwater swamp, and lowland forests, the tenement area most likely has high diversity of bird species.

Some bird species that are very likely to be present in the tenement site include the Black-faced pitta *(Pitta anerythra,* Figure 6-22*)*, Solomons nightjar *(Eurostopodus nigripennis),* Solomons sea eagle *(Haliaeetus sanfordi),* Fearful owl *(Nesasio Solomonensis)*, Eclectus parrot *(Eclectus roratus),* Solomons cockatoo *(Cacatua ducorpsii)*, Rufous fantail *(Rhipidura rufifrons,* Figure 6-22*)*, Oriole whistler *(Pachycephala orioloides,* Figure 6-23*)*, Brown-winged starling *(Aplonis grandis)*, Long-tailed myna *(Mino kreffti),* Stephen's ground dove *(Chalcophaps stephani),* Brahminy Kite *(Haliastur indus),* and the Superb fruit dove *(Ptilinopus superbus).*

(Source: ESSI, 2018).

Figure 6-22 *Rhipidura rufifrons* (left), and *Pitta anerythra*, two of the bird species that are likely present in the Kolosori tenement site.

It is important to note that *H. sanfordi*, *E. nigripennis* (Guo, et al., 2021) and *P. anerythra*, are three of the seven endemic species in the Solomon Islands to have been protected under the Wildlife Protection and Management Act 1998. The protection status is because of their restricted range within Solomon Islands, small distribution, and a declining population in their habitats due to habitat loss and increased deforestation (Brady, et al., 2018; Pikacha, 2008; SIRC, 2021; Alabai, et al., 2019).


(Source: ESSI, 2018).

Figure 6-23 *Pachycephala orioloides* (left), and a North Solomons dwarf kingfisher *(Ceyx meeki)* on the right.

6.8 Mammals

During the survey, none of the large mammals and small mammals were observed due to the limited time taken to carry out the assessment, and the survey was done entirely during daytime. According to Flannery (1995), there are a total of 52 mammal species recorded in the Solomon Islands. Those species are representative of three orders (Diprotondontia with one species, Rodentia with 10 species, and Chiroptera with 41 species) (SIRC, 2021). The Rodents (rats) include six species of giant rats of the genus *Solomys* and *Uromys*, as well as three species of the introduced (invasive) rats such as the Black rat *(Rattus rattus)*, Norwegian rat *(Rattus Norvegicus)*, and the Pacific rat *(Rattus exulans),* and a *Melomys*. The Melomys species is known as *Melomys bougainville*, found only in Choiseul province and Bougainville Island (PNG) but geographically part of the Solomon Islands archipelago (Flannery, 1995; Pikacha, et al., 2008).

The 41 species of Chiroptera include 23 species of fruit bats, and 18 species of insectivorous bats (Insect-eating bats). Flannery (1995) stated that 27 species of mammals are endemic to Solomon Islands and 17 species of the 27 endemic species are vulnerable and threatened species (IUCN, 2011; SMM, 2012). As noted in SMM (2012), four of the seventeen threatened mammal species occur on Santa Isabel Island inhabiting different areas of the forests. The four threatened mammals are Isabel Giant Rat *(Solomys sapientis)*, Guadalcanal monkey-faced bat *(Pteralopex atrata)*, Greater monkey-faced bat *(Pteralopex flanneryi)* and Sanborn's flying fox *(Pteropus mahaganus).* According to the IUCN (2013), *S. sapientis* is endangered because of a noticeable population decline and the degradation of forest habitats. Flannery (1995) further stated that though *S. sapientis* is moderately common within its habitat, it may also be threatened due to people hunting them for food. Furthermore, *P. flanneryi* is listed as critically endangered by the IUCN (2013), as it is estimated that its population declined more than 80% from 1997 to 2007. The species is mainly threatened by hunting for bushmeat and habitat destruction (IUCN Red List of Threatened Species, 2013; Lavery, 2017).

Noteworthy mammal species that are very likely present in the tenement site include the Rousette bat *(Rousettus amplexicaudatus),* Solomon's flying fox *(Pteropus rayneri),* Island Tube-nosed bat *(Nyctimene major),* Solomons Tube-nosed bat *(Nyctimene bougainville)*, Sanborn's flying fox *(P. mahaganus),* Diadem horse-shoe *bat (Hipposideros diadema),* Fawn horse-shoe bat *(Hipposideros cervinus),* Isabel Giant Rat *(Solomys sapientis)*, Solomons bare-backed fruit bat *(Dobsonia inermis)*, Guadalcanal monkey-faced bat *(Pteralopex atrata)*, and the Northern blossom bat *(Macroglossus minimus)*.

The more widely distributed Solomons bare-backed fruit bat *(Dobsonia inermis)*, and Woodford's blossom bat *(Melonycteris woodfordi)* are listed as protected species under the Wildlife Protection and Management Act 1998 (SMM, 2012).

Table 6-2 is included in this report to compare the species recorded at San Jorge Island with the possibility of these species occurring in the Kolosori tenement site.

Table 6-2 Mammal species recorded at the project tenement site at San Jorge Island.

Common Name	Scientific Name	Status	Habitat Requirements
Bougainville Monkey-faced Bat	*Pteralopex anceps*	EN	Flannery (1995) suggests that this species inhabits mature tropical forest (preferentially high elevation mossy forest).
Guadalcanal Monkey-faced Bat	*Pteralopex atrata*	EN	Flannery (1995) observed animals feeding upon unripe mangos in an old garden. The species is probably dependent on undisturbed, old growth forests, and seems to roost in tree hollows.
Greater Monkey-faced Bat	Pteralopex flanneryi	CR	This species appears to be entirely dependent on old-growth, lowland forest. It probably roosts solitarily in foliage, though it might also utilize hollows or cavities of large Ficus trees.
Sanborn's Flying Fox	Pteropus mahaganus	VU	This species is found in coastal lowlands in coconut plantations and lowland tropical forest.
Dwarf Flying Fox	Pteropus woodfordi	VU	Has been recorded from lowland gardens, mature forests
Bougainville Giant Rat	Solomys salebrosus	EN	Has been collected in nests of leaves within trees presumably within tropical moist forest.
Isabel Giant Rat	Solomys sapientis	EN	This species is associated with tropical moist forest. It is reportedly arboreal, and may rely on large forest trees for nesting sites.

(Source: EMM, 2016)

As depicted in Mamamal species recorded at the project tenement site at San Jorge Island, two of the species recorded namely Bougainville monkey-faced bat *(Pteralopex anceps),* and Bougainville giant rat *(Solomys salebrosus)* are only found on the island of Bougainville, and Choiseul in the Solomon Islands (Flannery, 1995). Both *P. anceps* and *S. salebrosus* are listed as Endangered on the IUCN Red List of Threatened Species and are both endemic and require good forest cover (SMM, 2012). Although the potential of the two species to occur on Santa Isabel Island is 'very likely' for *P. anceps*, and 'possible' for *S. salebrosus*, to date, there were no available literature or credible source (s) confirming their occurrence on Santa Isabel and nearby San Jorge Island as according to SMM (2012). In addition, the Dwarf flying fox *(Pteropus woodfordi),* which is commonly found throughout the western and southern parts of the Solomon Islands (the New Georgia group, Florida Islands, Guadalcanal, and Malaita) (Flannery, 1995), was absent on Santa Isabel but as stated in SMM (2012), it is possible that the species could be found in the Kolosori tenement area. As noted in Pauku & Lapo (2009), 56% of all the mammal species in Solomon Island can be found on Santa Isabel and Choiseul alone (high endemism), however species from the *Solomys* genus (Giant rats) are becoming increasingly rarely encountered in their habitat range due to habitat destruction/loss caused mainly by extensive logging activities on those two large islands in the Solomon Islands (Lavery & Judge, 2017; Pauku, 2009; Pikacha, 2008).

Figure 6-24 Depicts an Isabel giant rat *(Solomys sapientis).*

(Source: Flannery, 1995; ESSI, 2018).

Figure 6-25 Island Tube-nosed bat *(Nyctimene major)*, The Tube-nosed bat *(Nyctimene major,* Figure 6-25*)* is one of the widely distributed Tube-nosed species in the Solomon Islands.

6.9 Reptiles

With 83 species of reptiles currently recorded from Solomon Islands, of which at least 39 are found nowhere else in the world, this rich reptile fauna is a key element in understanding and conserving the Pacific's rich island biodiversity (McCoy, 2015; Morrison, et al., 2007; McCoy, 2006). It is a fauna that is becoming increasingly threatened by logging activities; collection, and illegal export of selected reptile species to Europe and North America; the impacts of invasive species such as cane toads and rats; and the uncertain future impacts of local and global changes in climate (Bennett, 2000; Secretariat of the Pacific Regional Environment Programme , 2019; McCoy, 2015). Most sources have stated that the reptile diversity, with its range and distribution may not be well studied in the Solomon Islands (Morrison, et al., 2007; McCoy, 2015; McCoy, 2006), and would require more field studies and surveys to produce data that well represent the overall diversity of reptiles in the Solomon Islands.

The discovery of the Bougainville coral snake *(Parapistocalamus hedigeri)* at Hakama area in 2017 approximately 20 meters above sea level on Small Ngella Island in Central province, was probably one of the most important and noteworthy findings from a distributional perspective, as this represents a new country record for the reptile fauna of the Solomon Islands (Andersen, et al., 2017). This species was unknown from the Solomon Islands until the only individual was found on Ngella Island by field biologists and scientists from the Universities of Kansas and New Mexico, and Ecological Solutions Solomon Islands (ESSI). *P hedigeri* represents a monotypic genus of venomous elapid snake that is only known from Bougainville Island (Papua New Guinea) which was first discovered in 1934 by Roux (Williams & Parker, 1964). The species is one the least studied reptiles and almost nothing is known about the ecology or evolutionary affinities of this small and secretive elapid species (Andersen, et al., 2017; McCoy, 2015). The now disjunct distribution of this species (Bougainville and Ngella) suggests that it may also occur on Santa Isabel and Choiseul as these islands were all connected during periods of lower sea levels in the Pleistocene (Andersen, et al., 2017; Polhemeus, et al., 2008; Morrison, et al., 2007).

According to McCoy (2006) and Heatwole (1975), 78% of reptile species belong to the four known lizard families (Agamidae, Gekkonidae, Scincidae, and Varanidae) are known to be found and recorded in the Solomon Islands. As noted in SMM (2012), 38 species of the 83 recorded reptile species in the Solomons are found on Santa Isabel Island. Furthermore, the study by SMM Ltd 2012 has identified and recorded 25 reptile species in the adjacent Takata tenement and within specific areas in the Kolosori tenement site, by which nine (9) of those 25 species are endemics. It is important to note that the findings and results produced by SMM Ltd represents 33% of reptile species for the entire Solomon Islands and 66% of known species on Isabel Island (SMM, 2012).

(Source: McCoy, 2015).

Figure 6-26 *Cyrtodactylus salomonensis* (left), and *Tribolonotus blanchardi* (right).

One finding that stated the Solomons ring-tailed gecko *(Cyrtodactylus salomonensis,* Figure 6-26*)* was first discovered in the Solomon Islands as a new species by SMM limited in 2011 as referenced to SIRC (2021) in the tenements of Takata and Kolosori, was quite misleading and might be an error since the species is widespread and was also found in other islands of Shortlands, the New Georgia Group, and Malaita (McCoy, 2006; McCoy, 2015) prior to the SMM survey in 2011, and was recently documented as a new distributional record (Island record) for Ngella in 2017 (Andersen, et al., 2017).

According to the IUCN Red List of Threatened Species, the Blanchard's crocodile skink *(Tribolonotus blanchardi)* (refer to Figure 6-26) is listed as Vulnerable and is quite common on Santa Isabel Island and Ngella in the Central Islands (McCoy, 2015) where it can be found in heavily shaded areas in the forest especially under thick leaf litter on the forest floor (McCoy, 2006; McCoy, 2015). The species was also recorded during the survey by SMM (2012). A total of seven reptile species consisting of the Brown-tailed copper-striped skink *(Emoia cyanura)*, Solomons forest skink *(Sphenomorphus solomonis),* White-banded sheen skink *(Eugongylus albofasciolatus),* Prehensile-tailed skink or the Solomons monkey-tailed skink *(Corucia zebrata),* Sago gecko *(Gekko vittatus)* and the South Pacific tree boa *(Candoia bibroni)* are listed as protected species under the Wildlife Protection and Management Act 1998. One of the protected species namely *C. zebrata* although previously common, despite traditional human predation (the skink is a prized food item for many rural Solomon Islanders), many populations of Corucia are now threatened by habitat destruction resulting from logging and forest clearing for subsistence gardens (McCoy, 2015). Also, gross over-collecting of *Corucia* in the Solomons by several animal dealers supplying the foreign pet trade, has necessitated its CITES Appendix II status (McCoy, 2015; Hagen, et al., 2012). McCoy (2015) stated that thousands of these slow-breeding lizards were exported from the Solomons annually from the mid-1980s until 2002 when trade in the species was stopped following its Appendix II listing.

In addition, during the survey by ESSI, larger reptiles like the Saltwater crocodile *(Crocodylus porosus)* were not sighted however, are inhabitants of mangrove and estuarine areas and are very likely present in the tenement site.

Table 6-3 depicts the list of reptile species as part of the noteworthy fauna species recorded by SMM 2012 in the survey sites, which included Takata and parts of Kolosori tenement site.

Table 6-3 List of reptile species as part of the noteworthy fauna species recorded by SMM 2012

Reptiles				
	Scientific Name	Common Name	Observation (SMM EIS)	Occurence
1	*Emoia pseudocyanura*	Solomons blue-tailed skink	All fauna survey sites	Restricted range: endemic to Solomon Islands Relatively immobile species
2	*Emoia flavigularis*	Yellow-throated skink	All fauna survey sites	Restricted range: endemic to Solomon Islands Relatively immobile species
3	*Tribolonotus blanchardi*	Blanchard's helmet skink	Recorded from previous and/or historical studies	Restricted range: Bougainville, Choiseul, Santa Isabel and Nggela Globally threatened species Relatively immobile species
4	*Corucia zebrata*	Prehensile-tailed skink	All fauna survey sites except sites 8 and 9	Restricted range: endemic to Solomon Islands Globally threatened species Relatively immobile species
5	*Sphenomorphus concinnatus*	Elegant forest skink	All fauna survey sites	Restricted range: endemic to Solomon Islands Relatively immobile species
6	*Sphenomorphus woodfordi*	Woodford's skink	All fauna survey sites	Restricted range: endemic to Solomon Islands Relatively immobile species
7	*Cyrtodactylus solomonensis*	Not available	All fauna survey sites	Restricted range: endemic to Solomon Islands Relatively immobile species
8	*Loveridgelaps elapoides*	Solomons black-banded krait	All fauna survey sites except site 2	Restricted range: endemic to Solomon Islands Relatively immobile species
9	*Parapistocalamus hedigeri*	Hediger's snake	Fauna survey sites 2 to 9	Restricted range: endemic to Solomon Islands Relatively immobile species
10	*Salomonelaps par*	Solomons red krait	All fauna survey sites	Restricted range: endemic to Solomon Islands Relatively immobile species

As depicted in Table 6-3, out of the 10 noteworthy species, the Bougainville coral snake/Hediger's snake was said to be present and was recorded in the survey sites by SMM in 2011. These data require confirmation as according to previous studies and records, the only first sighting in the Solomon Islands was in 2017 on Ngella Island (Hakama locality on Small Ngella) as mentioned earlier in the reptile section.

Other important reptile species worth mentioning and are very likely to occur in the Kolosori tenement site are the skinks such as the Green-blooded skink *(Prasinohaema virens)*, Emerald tree skink *(Lamprolepis smaragdina)*, the rare Poncelet's crocodile skink *(Tribolonotus ponceleti),* Crane's skink *(Sphenomorphus cranei)*, Elegant forest skink *(Sphenomorphus concinnatus)*, Pacific blue-tailed skink *(Emoia caeruleocauda),* Pacific black skink *(Emoia nigra),* Reef skink *(Emoia atrocostata)*, Greenbellied tree skink *(Emoia cyanogaster)*, White-banded sheen skink *(Eugongylus albofasciolatus)* and the Moth skink *(Lipinia noctua)*.

Gecko species may include Sago gecko *(Gekko vittatus),* Oceanic gecko *(Gehyra oceanica),* Mourning gecko *(Lepidodactylus lugubris),* Solomons slender-toed gecko *(Nactus multicarinatus)* and Guppy's gecko *(Lepidodactylus guppyi)*.

Snake species may include Solomons ground boa *(Candoia paulsoni),* Brown tree snake *(Boiga irregularis)*, Flowerpot blind snake *(Indotyphlops braminus),* Solomons tree snake *(Dendrelaphis calligaster),* and the Blind snake *Ramphotyphlops depressus*.

It is also very important to mention the Pacific monitor *(Varanus indicus)* and the Isabel monitor *(Varanus spinulosus)* from the Varanidae family, and the Solomons tree dragon *(Hypsilurus macroplepis)* an Agamid from the Agamidae family that are also very likely present in the tenement but were not observed during the ESSI survey, due to limited time constraints.

Source, ESSI, 2018.

Figure 6-27 Solomons black-banded krait *(Loveridgelaps elapoides)* (left), and the Solomons tree dragon *(Hypsilurus macrolepis)* (right).

(Source: McCoy, 2015).

Figure 6-28 *Corucia zebrata* (left), and *Emoia caeruleocauda* (right).

6.10 Fauna species of conservation significance

As alluded to in the introductory paragraphs about the fauna of Santa Isabel and the Solomon Islands, there are a total 39 vertebrate fauna species that are listed under the IUCN Red List of Threatened Species. In the study by SMM (2012), 9 threatened species were recorded on Santa Isabel and 2 species were present in their area of study which covered the Takata and Kolosori tenements.

Table 6-4 lists species of conservation significance that have been identified as present in Santa Isabel and have been included in this report as they may potentially be present in the Kolosori tenement area.

Table 6-4 Fauna species of conservation significance and their potential to occur on Santa Isabel Island.

Scientific Names		Common Names	Distribution Record	Habitat Preference	IUCN 2011 Status	Potential to Occur on Santa Isabel Island
Amphibians						
1	*Litoria lutea*	Solomon Islands tree frog	Northern Solomon Islands from Buka to New Georgia	Arboreal utilizing lowland tropical rainforest	Vulnerable	Very likely
2	*Palmatorappia solomonis*	Solomon Islands palm frog	Buka, Bougainville, Choiseul and Santa Isabel	Arboreal utilizing lowland tropical rainforest	Vulnerable	Recorded *
Reptiles						
3	*Emoia isolata*	Bellona skink	Endemic to Bellona Island, Solomon Islands	Very common in both forested and semi-cleared areas	Vulnerable	Very unlikely

Scientific Names		Common Names	Distribution Record	Habitat Preference	IUCN 2011 Status	Potential to Occur on Santa Isabel Island
				with some form of canopy		
4	*Tribolonotus blanchardi*	Blanchard's helmet skink	Bougainville, Choiseul, Santa Isabel and Nggela	Requires very moist conditions in river valleys or under stones and piles of dead leaves and other debris in wet stream beds. In Bougainville, it requires montane habitat	Vulnerable	Recorded**
Birds						
5	*Accipiter imitator*	Imitator sparrowhawk	Bougainville, Choiseul and Santa Isabel	Prefers lowland forest and forest edges up to 1,000 m asl	Vulnerable	Recorded**
6	*Actenoides bougainvillei*	Moustached kingfisher	A.b.bougainvillea in Bougainville and A.b. excelsa in Guadalcanal	Requires mature forested areas from 900 to 1,000 m asl	Vulnerable	Very unlikely
7	*Aplonis brunneicapillus*	White-eye starling	Bougainville, Choiseul, Rendova and Guadalcanal	Prefers lowland swamp forest and hill forest	Endangered	Very likely
8	*Charmosyna palmarum*	Palm lorikeet	Endemic to Santa Cruz Islands and Vanuatu	Requires montane habitat (>1,000 m asl)	Vulnerable	Very unlikely
9	*Clytorhynchus santaecrusis*	Santa Cruz shrikebill	Endemic to Nendo in the Santa Cruz Islands	Requires forested area	Vulnerable	Very unlikely
10	*Columba pallidiceps*	Yellow-legged pigeon	Bismarck Archipelago, Bougainville, Choiseul, Guadalcanal and San Cristobal	Recorded in both old growth forest and mature secondary forest	Vulnerable	Very likely
11	*Ducula brenchleyi*	Chesnut-bellied imperial pigeon	Guadalcanal, San Cristobal and Malaita	Requires old growth forest	Vulnerable	Very unlikely
12	*Gallicolumba sanctaecrucis*	Santa Cruz ground-dove	Santa Cruz Islands	Inhabits forested areas and patches of remnant forest	Endangered	Very unlikely
13	*Gallinula silvestris*	Makira moorhen	San Cristobal. Last recorded in 1953.	Lowland forested areas	Critically Endangered	Very unlikely

Scientific Names		Common Names	Distribution Record	Habitat Preference	IUCN 2011 Status	Potential to Occur on Santa Isabel Island
14	*Haliaeetus sanfordi*	Solomon sea-eagle	All major islands of the Solomon Islands	In coastal areas, and inshore waters and tidal flats to montane forests	Vulnerable	Very likely
15	*Nesasio solomonensis*	Fearful owl	Bougainville, Choiseul, Santa Isabel and Santa Cruz	Lowland old growth forest and mature secondary forest	Vulnerable	Recorded *
16	*Numenius tahitiensis*	Bristle-thighed curlew	Migratory species to Santa Cruz	Coastal areas, tidal flats, sand bars, offshore islands and grasslands	Vulnerable	Possible
17	*Phylloscopus amoenus*	Sombre leaf-warbler	Endemic to Kulambangara Island	Montane forest at >1,000 m asl	Vulnerable	Very unlikely
18	*Pitta anerythra*	Black faced pitta	Bougainville, Choiseul, Santa Isabel and Santa Cruz	Forested areas in valleys and alluvial plains, regrowth thickets and forest remnants	Vulnerable	Recorded**
19	*Rhipidura malaitae*	Malaita fantail	Endemic to Malaita	Montane forest above 900 m asl.	Vulnerable	Very unlikely
20	*Zoothera turipavae*	Guadalcanal thrush	Guadalcanal	Montane to mossy forest at elevation range of 1,450 to 1,500 m asl	Vulnerable	Very unlikely
21	*Zosterops luteirostris*	Splendid white-eye	Endemic to Ghizo	Mature secondary forest	Endangered	Very unlikely
Mammals						
22	*Hipposideros demissus*	Makira leaf-nosed bat	San Cristobal	Requires caves as roosting area	Vulnerable	Very unlikely
23	*Pteralopex anceps*	Bougainville monkey-faced bat	Buka, Bougainville and Choiseul	There is no data regarding diet, habitat and reproduction.	Endangered	Very likely
24	*Pteralopex atrata*	Guadalcanal monkey-faced bat	New Georgia, Santa Isabel and Guadalcanal	Possibly dependent on old growth forest and tree hollows	Endangered	Recorded**
25	*Pteralopex flanneryi*	Greater monkey-faced bat	No available information	Old growth forest in the lowland	Critically Endangered	Cannot be determined
26	*Pteralopex pulchra*	Montane monkey-faced bat	Known from a single specimen from Guadalcanal	Requires primary mossy to montane forest	Critically Endangered	Very unlikely

Scientific Names		Common Names	Distribution Record	Habitat Preference	IUCN 2011 Status	Potential to Occur on Santa Isabel Island
27	*Pteralopex taki*	New Georgia monkey-faced bat	New Georgia and Vangunu Islands	Moist mature lowland forest	Endangered	Very unlikely
28	*Pteropus cognatus*	Makira flying fox	San Cristobal	Habitat unknown.	Endangered	Very unlikely
29	*Pteropus mahaganus*	Sanborn's flying fox	Bougainville and Santa Isabel	From coconut plantation to lowland forest	Vulnerable	Recorded**
30	*Pteropus nitendiensis*	Temotu flying fox	Nendo and Tomotu Neo	Roosts in mangrove areas and forages in old growth and mature secondary forest	Endangered	Very unlikely
31	*Pteropus rennelli*	Rennell flying fox	Rennell Island. Poorly known	Habitat unknown	Vulnerable	Very unlikely
32	*Pteropus tuberculatus*	Vanikoro flying fox	Vanikoro in the Santa Cruz Islands	Habitat unknown	Critically Endangered	Very unlikely
33	*Pteropus woodfordi*	Dwarf flying fox	Malaita, Guadalcanal, Florida, Russell, Vella Lavella, Kolumbangara, New Georgia and Vangunu	Coconut plantation, lowland gardens and mature forest stands		Possible
34	*Solomys ponceleti*	Poncelet's giant rat	Bougainville and Choiseul	Possibly swamp forest	Vulnerable	Very likely
35	*Solomys salebrosus*	Bougainville giant rat	Bougainville and Choiseul	Tropical moist forest	Endangered	Possible
36	*Solomys sapientis*	Isabel giant rat	Endemic to Santa Isabel	Tropical moist forest	Endangered	Recorded**
37	*Uromys imperator*	Emperor rat	Last recorded in 1888 from Guadalcanal	Lowland forest near the coast	Critically Endangered	Very unlikely
38	*Uromys porculus*	Guadalcanal rat	Last recorded in 1888 from Guadalcanal	Cave dwelling. Vegetation type preferred unknown	Critically Endangered	Very unlikely
39	*Uromys rex*	King rat	Endemic to Guadalcanal	Tropical moist forest	Endangered	Very unlikely

(Source: SMM, 2012).

Although the survey by ESSI yielded limited data, the diversity of terrestrial flora and fauna within the tenement as identified by past and recent surveys and in various literatures, implies and indicates the importance of environmental protection in the area.

6.11 Mitigation of Potential Impacts

Pacific Nickel has adopted a proactive management for the Kolosori Nickel project that involves environmental management planning coupled with progressive rehabilitation to limit soil erosion and discharge of sediment to streams and the receiving marine environment.

The proposed mining project will subject to the following Environmental Management Plans which will be developed prior to the commencement of operation. These plans include:

- Sediment and erosion management plan
- Hydrocarbons spill management plan
- Vegetation clearing management plan
- Watrer management Plan
- Rehabiltation management plan
- Waste management Plan
- Water quality monitoring program

A Management Plan for Terrestrial Flora and Fauna will be developed prior to commencement of operation. Leading International Industry Practice (LIIP) will be adopted and applied, along with the proposed mitigation measures and management procedures in the management plan. The focus will be to minimise potential negative impacts to the terrestrial environment and the species inhabiting the various habitats and ecosystems that are proximal and adjoining the mine site..

7 FRESH WATER ENVIRONMENT

7.1 Assessment objectives

The freshwater assessment is part of the desktop study of the Kolosori mining project (Pacific Nickel Mining) and was prepared by Ecological Solutions Solomon Islands (ESSI) for the Kolosori mining tenement area in the Hograno district of Isabel Province. This chapter focuses on freshwater habitat assessment which mainly includes the description of the areas surrounding the freshwater catchments within the project boundary including the list of some known freshwater species that occupy streams and freshwater habitats.

The core objective of the assessment was to provide a habitat description and overview of the freshwater environment by using information from existing literature and field observations recorded during the surveys.

7.2 Assessment method

The assessment method comprised of a literature review which began by consulting relevant information and sources about the freshwater environment and a field/site inspection survey which includes the description of the freshwater habitat. ESSI field staff have involved in the freshwater survey of the project tenement area from 14th to 20th of June 2021.

The assessment further described the present existing environment including the climate, soils, and the vegetation that are found in ultramafic/ultrabasic forest within the tenement area. Figure 7-1 shows an aerial view of the proposed mining areafacing south and, south-east.

(Source: ESSI, 2021)

Figure 7-1 Aerial view of part of the Kolosori tenement site overlooking the ocean

The road cuts through the fern land (lighter yellow green patches dominated by *Dicranopteris linearis*), with ultramafic forest dominated by *Gymnostoma papuana* on either side of the road where the fern land meets the forest stands. One of the campsites is visible, and the hill forest right at the background transitions through to the coastal beach strand with patches of mangrove forests thriving on the coast. Figure 7-2 shows the location Kolosori tenement and project site in relation to other rural villages, and its location on Santa Isabel Island (top right insert marked yellow) and in Solomon Islands (bottom insert).

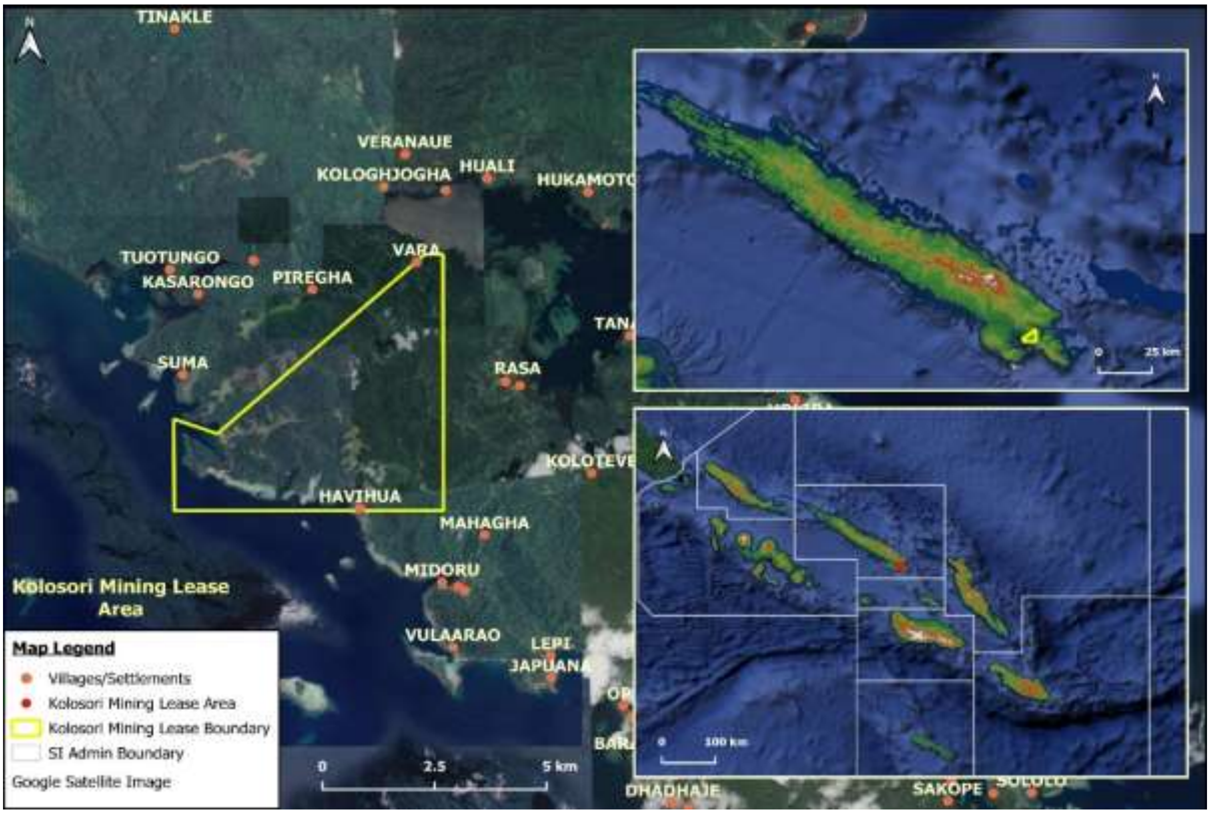


Figure 7-2 Kolosori tenement location

7.3 *Existing Environment*

7.3.1 Climate

Solomon Islands' location in the tropical bioregion means that there exist warm to high temperatures, high humidity, and abundant rainfall in most months of the year with average annual rainfall ranging between 3,000 to 5,000 mm (Hiriasia & Tahani, 2014). Generally, Solomon Islands has a relatively constant temperature all throughout the year showing very little seasonal variation which is closely linked to sea surface temperatures (Pacific Climate Change Science Program, 2011; Hiriasia & Tahani, 2014) and across the Solomon Islands, temperatures are strongly tied to changes in the surrounding ocean temperature with the country having a wet season from November to April, and a dry season from May to October (Pacific Climate Change Science Program, 2011). The geographic variation in rainfall and seasonality are largely dependent upon the effects of the local topography (for instance, mountains creating a rain shadow) determining and influencing the south-easterly trade winds and the north-west monsoons (Filardi, et al., 2007; Whitmore, 1969). The northwest monsoon is associated with cyclone season between November and April and has significantly proven to influence variation in vegetation and forest structure and composition, (Whitmore, The Vegetation of the Solomon Islands, 1969; Secretariat of the Pacific Regional Environment Programme, 2019).

According to Hiriasia and Tahani (2014), although the Solomon Islands normally experience abundant rainfall and high humidity in most months, the western part has a marked wet season from November to April and the eastern provinces including Isabel province usually receive more constant rainfall during the year, averaging between 3,500 on lowland areas to more than 6,000 mm in mountainous areas (higher peaks) (Peterson, et al., 2012; Solomon Islands Resources Company Limited, 2021). As noted in SMM (2012) for the years 2008-2012, the average monthly rainfall that was recorded indicated sporadic data with no defined wet and dry seasonal patterns for Santa Isabel. However, the IWS01 weather station on Santa Isabel recorded a maximum monthly rainfall of 643.5 mm in January 2010 and a minimum monthly rainfall of 106.0 mm in April of the same year (SMM, 2012). Recently, the rainfall data that was produced by SIRC (2021) reported extremely higher periods of rainfall especially in April and May of 2020. This was due to the low pressure system in the country during these months (SIRC, 2021) nevertheless, there were similar trends in rainfall patterns throughout the year (SIRC, 2021). Furthermore, the Island's mountainous terrain situated towards the south western end of the island (Pacific Climate Change Science Program, 2011; Peterson, et al., 2012; Decicco, et al., 2019) has influenced rainfall on Santa Isabel Island.

The Solomon Islands, though situated at the nothern limit for cyclone prevalence, typically experiences between one and two tropical cyclones annually and for the record, Isabel Island has not been experiencing severe natural disasters in the last 30 years (Peterson, et al., 2012; SIRC, 2021).

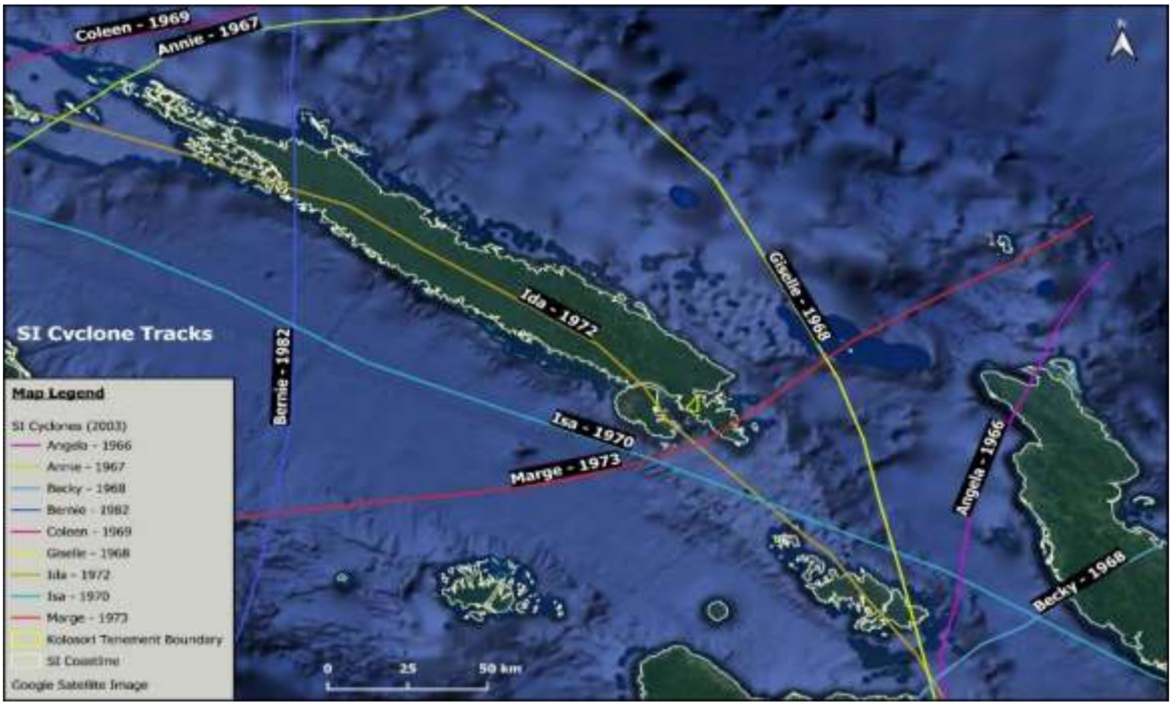


Figure 7-3 Map showing cyclone path/track data up till 2003

Note that the last cyclone recorded in the Solomon Islands is cyclone Marge back in 1973. Past records for the Takata tenement area adjacent to the Kolosori tenement reported a total of 11 cylcones occurring within 200 km from the tenement area within the last 60 years (Solomon Islands Resources Company Limited, 2021) as shown in Figure 7-3. Therefore, the probability of a cyclone occuring near the Kolosori tenement in the future is possible (low confidence).

7.3.2 Vegetation and Soils

Small streams and rivers between and below the valleys within the project boundary that are part of the seven (7) major catchments in the tenement site, support the growth of native vegetation and are habitats for many freshwater flora. Despite the area being previously exposed to two (2) mining companies namely Axiom and Sumitomo, there are still patches of forests near the Vuavula, Kokoilovadhe, Havihua, and Komika streams/rivers and areas deep within the Tavia clan land towards the north of the tenement boundary and the headwaters, that have good forest cover (refer to Kolosori tenement habitat map and Kolosori tenement map) providing shade for numerous understory plant species and shade tolerant plants, and maintaining river ecosystem and stream health. The current mining actvities that have taken place in the tenement can be clearly seen in few areas above the Kokoilovadhe stream, below the Havihua stream on the eastern side where a major road is located (refer to Kolosori tenement habitat map), adjacent the Vuavula stream closer to Havihua village where there are presence of secondary forests and fruit trees and on the fern lands, in which into the future, the impacts of the project could affect the freshwater habitat including the vegetation and soils (Figure 7-4 and Figure 7-5).

(source: ESSI, 2021)

Figure 7-4 Image of the vegetation and soils within the Kolosori tenement area.

The topsoil is mostly clay, having high water retention capacities, but highly vulnerable to landslides and erosion.

The southern part of Santa Isabel Island is part of the Central Solomon Terrane in which the terrane is more recent for islands like the Florida Islands (44 and 35 mya), however, the southern part of Isabel dates back to the paleocene age (60-55 mya) with basement rocks that are dated up to 120 my in age (Decicco, et al., 2019; Polhemus, et al., 2008; Ent, et al., 2015). According to (Polhemus, et al., 2008), the rocks have been subaerially exposed following the geological emplacement resulting in the production of potentially economically important mineralization. The weathering of these geological assemblage mostly composed of peridotites resulted in the formation of ultramafic soils (Pillon, et al., 2010; Mengoni, et al., 2010; Martin, et al., 2007).

The chemical composition of the soil is the same in most tropical countries including Santa Isabel Island, and specifically within the Kolosori tenement; however, vegetation composition differs from the lowland areas to the upper montane forests (Ent, et al., 2015).

(Source: Ent, et al., 2015).

Figure 7-5 Depicts the vegetation and soils (ultramafic landscape) in New Caledonia (left) and Sabah, Malaysia (right).

Soils derived from the ultramafic bedrock pose several edaphic challenges for plant growth including metal toxicity, nutrient imbalances and deficiencies and in some cases water stresses (Ent V. A., et al., 2015). Water stresses often occur as a result of the shallow and exposed nature of the rocky outcrops(Boyd, et al., 2009). Ultramafic soils which are also commonly known as serpentine soils, are found in almost every continent, containing high concentrations of heavy metals such as chromium (Cr), iron (Fe), cobalt (Co), and nickel (Ni) (Boyd, et al., 2009; Mengoni, et al., 2010), but with low levels of nitrogen (N), phosphorus (P), potassium (K), and calcium (Ca) (Mengoni, et al., 2010; Sabaris, et al., 2020; Ent, et al., 2015). The chemical composition of the ultramafic soils are unsuitable for most plant species and because of the characteristic thin soil layers, and nutrients which are mostly distributed in the upper soil horizons (Sabaras et al, 2020) and the high macro-nutrient deficiency (N, P, K, Ca), resulted in low organic matter content, low plant (crop) productivity, and stressful environment for plant establishment and growth (Ent, et al., 2015; Mengoni, et al., 2010; Sabaris, et al., 2020).

In a non-ultramafic freshwater environment, the vegetation composition would comprise dominant species such as *Terminalia brassi, Dillenia sp, Metroxylon sagu* and often *Campnosperma brevipetiolatum* (Pikacha , 2008; Whitmore, 1998; Pauku, 2009; Lavery, et al., 2016). However, the field survey/study yielded obervations describing the environment as dominated by secondary forests (refer to Figure 7-6) with few *Macaranga spp*, *Rhus taitensis,* Coconut saplings *(Cocos nucifera),* other native palms and lawyer canes and bamboo thickets *(Bambusa spp.)*.

(Source: ESSI, 2021).

Figure 7-6 Typical vegetation composition that might be representative of a small stream being part of the lower zone watercourse.

In addition, exposed soils on the ridges closer to the streams are mainly clay soils that would have high levels of erodibility (subjected to high soil erosion and landslides) and could further erode into the rivers and streams once more and more vegetation are cut and cleared during the pre-construction stage and operational stage.

7.3.3 Watercourses

There are at least seven (7) major water catchments within the Kolosori mining tenement site and several other smaller catchements which can be clearly depicted in the Water catchment map produced for the site (refer to Figure 7-7). According to the observations and the field assessment, current water quality in the catchment does not appear to be a limiting factor for aquatic life, given the low level of pollution currently and the low turbidity. The project tenement area encompasses smaller catchments near the coast towards the eastern boundary with three (3) other major catchments (in the centre and western end of the tenement) draining out into the ocean. The lower reaches of the water courses are mixed with brackish water and are characterized by beach strand vegetation, estuaries, and mangroves respectively. Generally, river hydrology and geomorphology of typical rivers and streams in the Solomon Islands are different from the continental rivers such as Australia (Polhemus, et al., 2008; Pikacha, et al., 2016) because they are relatively short (<100 km), straight (not very meandering), having steeper channels, with small narrow catchments and few tributaries (Pikacha, et al., 2016; Giano, 2021). Polhemus, et al., (2008) also stated that Solomon Islands, due to its long geological history and diverse terrain, contain a wide array of freshwater and mixohaline ecosystems with rivers normally 30-40 km long. Santa Isabel is the fourth largest island in Solomon Islands with knife-like ridges and deep canyons (Decicco, et al., 2019; Peterson, et al., 2012) hence, having characteristic rocky upland streams and rivers that smaller island atolls are lacking (Pikacha, et al, 2016).

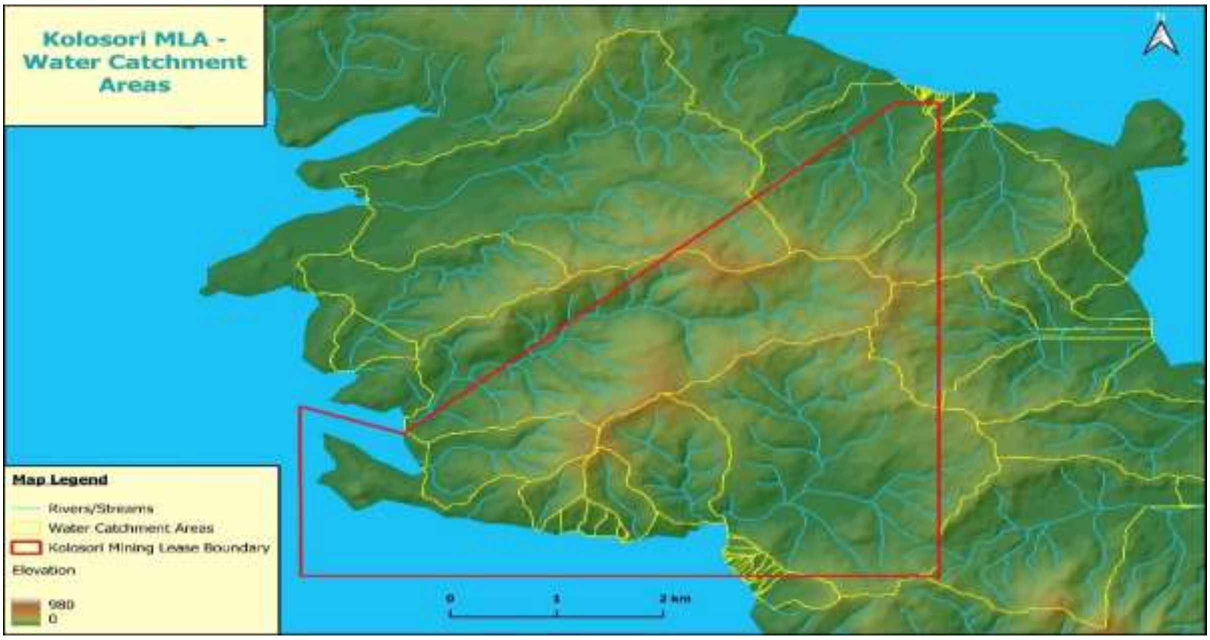


Figure 7-7 Map of Kolosori tenemement water catchment areas.

The seven major catchment boundaries can be clearly seen within the Kolosori tenement (area inside the red boundary) and the largest catchment in the tenement being located in the center of the project site with Havihua village situated on the mouth of the lower zone section of the main river of the catchment.

The water courses and their locations in the project site can be divided into three (3) courses/sections namely the lower reach, the middle reach, and the upper reach. These three zones or courses are defined according to the slope, the average current velocity, and the size of the substrate (Pikacha & Boseto, 2016). Numerous sources and literature have specific names for these zones and some have used ‘course’ instead of ‘reach’, however having same descriptions and similar meaning (Keith, et al., 2010; Pikacha, et al., 2016).

The water courses and their locations in the project site can be divided into three (3) courses/sections namely the lower reach, the middle reach, and the upper reach. These three zones or courses are defined according to the slope, the average current velocity, and the size of the substrate (Pikacha & Boseto, 2016). Numerous sources and literature have specific names for these zones and some have used ‘course’ instead of ‘reach’, however having same descriptions and similar meaning (Keith, et al., 2010; Pikacha, et al., 2016).

The lower reach areas (Figure 7-8) are mainly locations from the river entrance to the first major obstacle in which it could be a small waterfall or cascade, a culvert, or a weir (Pikacha, et al., 2016; Giano, 2021). Currently in the project site, an obstacle would refer to small waterfalls cascading closer to the middle course section. Having a coastal stream in the project site means that the section can be distinguished into the estuary (under marine influence) and the upstream part, which is the area of water where the conductivity is very low (Pikacha & Boseto, 2016). Estuaries are habitats that contain mixture of salt and freshwater or in simple terms, where the freshwater freely meets the ocean (Pikacha, et al., 2016; Giano, 2021; Polhemus, et al., 2008).

(Source: EMM, 2018).

Figure 7-8 An example of a lower reach watercourse or river in a typical San Jorge freshwater ecosystem having the same ultramafic soils.

The middle reach sections comprise pure freshwater on a slightly moderate slope or a low incline that usually consist of runs, riffles, and the development of pools which offer great microhabitats for freshwater fauna as shown in Figure 7-9 and described in Pikacha, et al., 2016; Pikacha & Boseto, 2016. Pikacha & Boseto (2016), described the middle reach as having an average slope of less than 10% with the riverbed covered in pebbles and rocks, and often sandy bottoms in areas where the current is slow moving. In addition, the length of the middle courses depend entirely on the geological origins of the catchment area or the island (Polhemus, et al., 2008).

(Source: Golder Associates, 2014).

Figure 7-9 A typical middle reach section of a river system or watercourse.

The photos were captured from the freshwater ecology baseline report for the Jejevo river on Santa Isabel.

The upper reach areas are generally characterized by steep gradients or slopes (steep gradient headwater areas) where the water velocity is high and well oxygenated (Pikacha & Boseto, 2016; Keith, 2018; Boseto, et al., 2007) as shown in Figure 7-10.

(Source: Kolombangara Island Biodiversity Association, 2013).

Figure 7-10 Typical example of an upper reach watercourse.

The steep slopes (inclination) are generally said to be more than 10%, and the main substrate is normally composed of large boulders and cobbles directly originating from the parent rock (Pikacha & Boseto, 2016) with areas of waterfalls and plunge pools (Pikacha, et al.,2016). The upper watercourse is separated from the middle watercourse by the presence of a cascade further downstream (Keith, et al., 2010). Giano (2021), further describes the the upper zones as the upper reaches of the water catchments with interesting hydrology and geomorphology, comprising steeped and rugged drainage lines having a wide distribution of the aquatic species population like fish and crustaceans.

7.3.4 Freshwater fauna and flora

Freshwater ecosystems provide an important habitat for many fish, insects, plants, birds, and numerous faunal species. They act as corridors and 'steppingstones' that connect different habitats and ecosystems (Environment Canterbury, 2017). Generally, in the Solomon Islands, the aquatic macroinvertebrate is relatively poorly studied but the overall conditions of some freshwater ecosystems are still considered excellent, despite obvious threats to the aquatic biota (Polhemus, et al., 2008). Two of the most renowned threats to the freshwater biota of the Solomon Islands are, the invasion and spread of the Little Fire Ant *(Wasmannia auropunctata)* into the riparian zones, and the impacts from logging (Polhemeus, et al., 2008; Pikacha & Boseto, 2016; Peterson, et al., 2012). The freshwater fish fauna are also poorly documented and understudied in many areas across the Solomon Islands (Polhemeus, et al., 2008; Boseto, et al., 2007). Since the first survey and collection expedition of freshwater fishes in 1974 on Guadalcanal Island, and again in 2004 (Boseto, 2005; Mennesson, et al., 2016; Keith, 2018) more and more research and surveys have been carried out specifically for different localities across various islands in the Solomon Islands and the most notable freshwater surveys on Santa Isabel Island were in the years 2005, 2012, and 2014 (Mennesson, et al., 2016; Carter & Boothroyd, 2014).

A previous article by Boseto (2005), has recorded 60 total freshwater fish fauna for the Solomon Islands yet another study by Boseto, et al., (2007) recorded 89 species from 35 families and a latest study has recorded a total of nearly 80 species of freshwater fish fauna with 14 species (from the total 80 species) mainly local or regional endemic (Keith, et al., 2021). Most freshwater ecology surveys for Santa Isabel Island covered both macroinvertebrates and fish fauna (FRC Environmental, 2012; Boseto, et al., 2013; Carter & Boothroyd, 2014). The results and datasets that were yielded over the years and observations made in the different localities around the island were representative of the island's various freshwater habitats, and having similar species diversity and composition when compared. For Santa Isabel Island, a qualitative observation that involved species surveyed at the Garana river in the Buala area in 2005 comprised, and has complemented the freshwater fish data at the Kolosori side of the island specifically, at the Jejevo area due north west of the Kolosori tenement area.

Figure 7-1 summarises total endemics and total freshwater fish fauna of Melanesian countries including Solomon Islands.

Table 7-1 Endemics and total freshwater fish fauna of Melanesian countries

Country	Endemics	Total Fauna	% of Total	Sources
PNG	60	329	18.2	Allen, 2019; Allen, 2003; Fishbase, 2004
Solomon Islands	0	60	0	Gray, 1974; Gerry Allen pers comm; Fishbase, 2004
New Caladonia	10	64	15.6	Marquet et al , 2003; Fishbase, 2004
Vanuatu	5	60	8/4	Ryan, 1986; Nimobo, 2000; Fishbase, 2004
Fiji	10	161	6.2	Boseto, 2005

(Source: Boseto, 2005).

The total freshwater fish fauna as recorded for the Solomon Islands in the Table 7-1 was 60 species. However, recently more discoveries have increased the number freshwater species by at least 80 to 89 species (Boseto, et al., 2007; Keith, et al., 2021; Jenkins & Boseto, 2007) for the Solomon Islands and an obvious significant difference in data for different locations in the Solomons. For example, on Choiseul Island, Boseto, et al., (2007) recorded 74 species (28 families) and for Tetepare Island, Jenkins & Boseto (2007) recorded at least 60 species for 29 families. The significance of including these data (Figure 7-1) in the report is to see and appreciate the importance of ongoing research and freshwater surveys that could produce new data to improve the understanding of the relationships and links of these freshwater fish species and their importance in the freshwater rivers and ecosystems and the overall biodiversity.

Table 7-2 below was produced from an assessment at the Jejevo area on Santa Isabel and has shown some of the freshwater fish species that could be found in the watercourses within the Kolosori tenement site. The survey tabulated a total of 43 species from 18 families collected from 16 sites in six river catchments within the Jejevo study area. A similar initial survey can be carried out for the Kolosori tenement site.

Table 7-2 Different fish families recorded for a study site on Santa Isabel.

Family	Species	Percent (%)	Listed in previous studies	
			Polhemeus et al., (2008)	FRC Environmental, (2012)
Gobiidae	15	34.9	Yes	Yes
Eleotridae	8	18.6	Yes	Yes
Ambassidae	2	4.7	Yes	Yes
Kuhliidae	2	4.7	Yes	Yes
Syngnathidae	2	2.3		Yes
Anguillidae	1	2.3	Yes	
Carangidae	1	2.3	Yes	
Hemiramphidae	1	2.3		
Lutjanidae	1	2.3	Yes	
Moringuidae	1	2.3		
Mugilidae	1	2.3		
Muraenidae	1	2.3		Yes
Ophichthidae	1	2.3		
Rhyacichthidae	1	2.3		
Serranidae	1	2.3		
Terapontidae	1	2.3	Yes	Yes
Tetrarogidae	1	2.3		
Toxotidae	1	2.3		Yes
Total	**43**		**100**	

(Source: Golder Associates, 2014).

Figure 7-11 *Stenogobious sp.* (left), and *Sicyopus zosterophorum* (right)

Figure 7-11 shows two of the freshwater fish species recorded at Santa Isebel. These species can be found in middle reaches and upper reaches especially in waterfalls.

Source: Polhemeus, et al., 2008

Figure 7-12 Stiphodon atratus (left), and Stiphodon rutilaureus (right).

The *Stenogobius* and *Sicyopus* species have evolved disc-like pelvic fin (joining in one to form a sucker) that assisted them with the ability to cling onto rocks and climb up wetted rock faces (Keith, 2018; Boseto, et al., 2013). The *Stiphodon* (Figure 7-12) and *Awaous* species are adpated to middle reaches of streams and rivers and can also be cosmopolitan throughout the altitudinal gradient including the lower reaches of the rivers (Keith, et al., 2010; FRC Environmental, 2012; Keith, 2018).

Table 7-3 is a summary of the fish species recorded in the 2014 study at the Jejevo locality on Santa Isabel Island. This data could also represent the fish species that are found in the Kolosori water catchments.

It is important to note that most of the freshwater surveys carried out in the Western Solomon Islands in collaboration with international partners, have been proven successful in that freshwater habitats have been surveyed and assessed, and also new species have been discovered. Some freshwater fish species that were recently discovered are *Lentipes kolobangara*, *Eleotris bosetoi*, (Keith, 2018; Keith, et al., 2016), *Schismatogobius essi, Schismatogobius mondo,* and *Schismatogobius tiola* (Keith, et al., 2017). The Schismatogobius species were mostly found in streams with moderate to fast flow in shallow areas of rocks and gravel just above tidal influence (Keith, et al., 2017) signifying that the specie(s) inhabit lower reach areas of rivers.

Table 7-3 Summary of the fish species recorded in the 2014 study at the SMM Jejevo Project Site

Family	Species	Common name [a]	Status	IUCN status
Ambassidae	*Ambassis interrupta*	Long-spined glassfish	Indigenous	Least Concern
	Ambassis miops	Flag-tailed glassfish	Indigenous	Least Concern
Anguillidae	*Anguilla marmorata*	Marbled eel	Indigenous	Least Concern
Carangidae	*Caranx sexfasciatus*	Bigeye trevally	Indigenous	Least Concern
Eleotridae	*Belobranchus belobranchus*	Throatspine gudgeon	Indigenous	Least Concern
	Bunaka gyrinoides	Green-backed gudgeon	Indigenous	Least Concern
	Butis butis	Crimson-tipped gudgeon	Indigenous	Least Concern
	Eleotris acanthopoma	Spine-cheek gudgeon	Indigenous	Least Concern
	Eleotris fusca	Brown spinecheek gudgeon	Indigenous	Least Concern
	Eleotris melanosoma	Broadhead sleeper	Indigenous	Least Concern
	Giuris margaritacea	Snakehead gudgeon	Indigenous	Least Concern
	Hypseleotris cyprinoides	Tropical Carp-gudgeon	Indigenous	Data Deficient
Gobiidae	*Awaous ocellaris*	·	Indigenous	Least Concern
	Glossogobius illimis	·	Indigenous	Least Concern

Family	Species	Common name [(a)]	Status	IUCN status
	Redigobius cf bikolanus	Speckled goby	Indigenous	Not Evaluated
	Schismatogobius sp.	-	Indigenous	-
	Sicyopterus lagocephalus	Red-tailed goby	Indigenous	Least Concern
	Sicyopterus sp. 1	-	Indigenous	-
	Sicyopterus sp. 2	-	Indigenous	-
	Sicyopus discordipinnis	-	Indigenous	Data Deficient
	Sicyopus zosterophorum	-	Indigenous	Least Concern
	Smilosicyopus chloe	Chloe's Sicyopus	Indigenous	Least Concern
	Stenogobius hoesei	-	Indigenous	Least Concern
	Stiphodon atratus	-	Indigenous	Least Concern
	Stiphodon birdsong	Black stiphodon	Indigenous	Least Concern
	Stiphodon rutilaureus	Golden-red stiphodon	Indigenous	Least Concern
	Stiphodon semoni	-	Indigenous	Data Deficient
Hemiramphidae	*Zenarchopterus dispar*	Feathered river-garfish	Indigenous	Data Deficient
Kuhliidae	*Kuhlia marginata*	Dark-margined flagtail	Indigenous	Least Concern
	Kuhlia rupestris	Rock flagtail	Indigenous	Least Concern
Lutjanidae	*Lutjanus argentimaculatus*	Mangrove red snapper	Indigenous	Least Concern
Moringuidae	*Moringua microchir*	Lesser thrush eel	Indigenous	Not Evaluated
Mugilidae	*Crenimugil crenilabis*	Fringelip mullet	Indigenous	Least Concern
	Mugil cephalus	Flathead grey mullet	Indigenous	Least Concern
Muraenidae	*Gymnothorax polyuranodon*	Freshwater moray	Indigenous	Data Deficient
Ophichthidae	*Lamnostoma cf kampeni*	Freshwater snake-eel	Indigenous	Not Evaluated
Rhyacichthyidae	*Rhyacichthys aspro*	Loach goby	Indigenous	Data Deficient
Serranidae	*Epinephalus polystigma*	White-dotted grouper	Indigenous	Data Deficient
Syngnathidae	*Microphis brachyurus*	Short-tailed pipefish	Indigenous	Not Evaluated
	Microphis retzii	Ragged-tail pipefish	Indigenous	Least Concern
Terapontidae	*Mesopristes argenteus*	Silver grunter	Indigenous	Least Concern
Tetrarogidae	*Tetraroge niger*	Tetraroge niger	Indigenous	Least Concern
Toxotidae	*Toxotes jaculatrix*	Banded archerfish	Indigenous	Least Concern

Note: [(a)] Taken from http://www.fishbase.org.

Source: Golder Associates, 2014

Along with freshwater fish, macroinvertebrates are also important part of the freshwater fauna that inhabit watercourses in the Solomon Islands (FRC Environmental, 2012). A recent survey has produced 113 distinct aquatic macroinvertebrate taxa on Santa Isabel Island (Golder Associates, Jejevo/Isabel B Project: Freshwater Ecology Baseline Report, 2014). The most diverse group according to the survey were aquatic insects (Mayflies, Caddisflies, Stoneflies, Odonata etc) (50 taxa; 42 families), followed by Malacostraca (crabs, freshwater amphipods, and freshwater prawns and shrimps like the *Macrobrachium lar* and *Caridina gracilirostris*) with 36 taxa in 4 families, and Gastropoda (freshwater snails, slugs etc) with 23 taxa in 3 families (Golder Associates, Jejevo/Isabel B Project: Freshwater Ecology Baseline Report, 2014). Polhemeus, et al., (2008), stated that taxa or species richness usually decreases downstream and in larger catchments on islands like Santa Isabel. Macroinvertebrate communities can be comparable with the larger catchments and rivers, supporting diverse species (Keith, et al., 2010). A reason for reduced species richness and sparsely distributed communities in mid-lower reaches or lower parts of catchments could be because of sedimentation and siltation from actvities in the villages, and from logging operations (Keith, 2018; Polhemeus, et al., 2008; Pippard, 2015; Pikacha & Boseto, 2016). This is fairly common in freshwater habitats in the Solomon Islands (Boseto, et al., 2007).

To understand the macroinvertebrates of Santa Isabel, like the aquatic insect biota, the relevant source to consult for community data is the one collected by FRC Environmental (Golder Associates, Jejevo/Isabel B Project: Freshwater Ecology Baseline Report, 2014) however, the taxa identified during the survey were only on a family level that did not actually provide an accurate baseline data for community and species diversity for the locality. According to Polhemeus, et al., (2008), aquatic insects are the most diverse group of macroinvertebrates in the Solomons with many species being identified as island endemics. The study by FRC Environmental (2012), concluded that macroinvertebrates on the southern and south-western end of the island are dominated by non-biting midges from the family Chironomidae, freshwater shrimp and prawns (Atyidae family), Mayflies (Baetidae and Leptophlebiidae families), snails (Neritidae family), and caddisflies (Polycentropodidae family).

Figure 7-13 are some of the key taxonomic groups of freshwater macroinvertebrates found on Santa Isabel Island, based on past freshwater surveys provided by Polhemeus, et al., (2008), and FRC Environmental, (2012).

Source: Golder Associates, 2014

Figure 7-13 An unidentified mayfly (left) in the family Lephtophlebiidae from the Ephemeropteran group, and Deleatidium sp. (Lephtophlebiidae) (right).

Deleatidium sp. is one of the only Ephemeropterans identified at the genus level (FRC Environmental, 2012). These two species above are very important bio indicators of freshwater health (Boseto, et al., 2007; Pikacha & Boseto, 2016).

Source: Keith, 2018

Figure 7-14 *Atyopsis spinipes* (left), and *Caridina gracilirostris* (right).

C. gracilirostris is a shrimp that inhabits lower reaches of rivers under marine influence and very often in brackish water and estuarine habitats (Polhemeus, et al., 2008; Keith, 2018; Mazancourt, et al., 2020). The species is widespread from Japan and eastward into the Pacific (Keith, 2018; Carter & Boothroyd, 2014), and is one of the most common *Caridina* species encountered in freshwater habitats of Santa Isabel Island.

Source: Golder Associates, 2014

Figure 7-15 *Macrobrachium glacilirostre*, a freshwater prawn (left) and *Batissa violacea* (right), a freshwater bivalve.

B. violacea is a species restricted to the lower freshwater reaches and in the upper limits of estuarine habitats (Polhemeus, et al., 2008).

Most of the *Macrobrachium* and *Caridina* species in the Solomon Islands are the least studied hence, it is unknown whether most of them are new to science and what their distribution is like on Santa Isabel, or other islands within the Solomon Islands and across other Pacific Island countries (Golder Associates, 2014). In addition, an important crab species, *Pyxidognathus sp*, was recorded for the first time in the Solomon Islands (Jejevo locality: Santa Isabel Island) and is adapted to living in both freshwater and marine environments (FRC Environmental, 2012). The newly described 11 species of freshwater shrimps in the Western Solomon Islands of which *Caridina piokerai* and *Caridina barakoma* (Mazancourt, et al., 2020) are included, shows that further study is required in the Kolosori area to redescribe and confirm the status of some unidentified freshwater macroinvertebrates including shrimps on the island which could have future implications for conservation. Most macroinvertebrate species recently discovered on Santa Isabel that are yet to be officially described were labelled as species of concern, for example, a Tateidae snail and eight undetermined shrimps (Polhemeus, et al., 2008; FRC Environmental, 2012).

Furthermore, the survey by Polhemeus, et al., 2008 has recorded 31 new species of true bugs that are related to freshwater environment from the suborder Heteroptera, and one dragonfly of the order Odonata (SIRC, 2021). The difficulty of determining whether those undescribed species are rare or threatened calls for more freshwater assessments and studies and a possible management plan in place to protect critical freshwater habitats (Carter & Boothroyd, 2014).

The aquatic flora in most tropical watercourses and rivers are composed of phytoplankton, periphyton, and aquatic macrophyte communities (Boseto, et al., 2013). These plant communities depend on habitat characteristics like moderate flow velocities, good shade, low turbidity etc to function properly and provide the necessary ecosystem services (Whitmore, 1998; Pikacha & Boseto, 2016). In low nutrient turbid rivers and streams, the benthic flora especially in the larger catchments where river flow condition is still to moderate would consist of an aquatic plant community dominated by thin algal films for example, the Botryococcus and Ankistrodesmus (Giano, 2021; Carter & Boothroyd, 2014). These algal groups can be seen dominating most rivers in larger catchments on Santa Isabel Island (Polhemeus, et al., 2008) where numerous aquatic fauna are being supported through the supply of food source and the availability of microhabitats (FRC Environmental 2012). The survey by FRC Environmental (2012), identified 19 macrophyte species from six rivers on Santa Isabel in which one of those macrophyte species has been linked to ten rivers on choiseul island showing wider distribution. In areas within the Kolosori tenement where there is minor siltation and sedimentation there is an expected low diversity of benthic periphyton communities and the distribution could be sparse from the upper reaches of main rivers down to the mid lower reaches (Lina Dorovolomo, pers. com, 2021).

Source: SIRC, 2021

Figure 7-16 Periphyton cover in a stream bed (left) and a clean stream bed in the mid lower reaches of Havihua river within the Kolosori tenement (right).

In areas within the Takata tenement and part of the Kolosori tenement site, highest filamentous green algal growth was observed and noted in the mid-lower reaches of the rivers resulting from nutrient enrichments from road constructions to drilling sites and activities from village gardens (SIRC, 2021). Few sites along the lower reaches of the streams within the Kolosori tenement have the presence of brown and green algae (freshwater *Chlorodesmis spp*) which may be attributed to exploration activities on land (SIRC, 2021).

7.4 Baseline Surface Water quality

Currently, the project area is undeveloped and because there is no previous logging within the site, the watercourses are still clear (Lina Dorovolomo, pers.com, 2021). Baseline water quality sampling for freshwater streams were undertaken. Data are summarised in Table 7-4 to Table 7-11Table 7-11, and Figure 7-17 that shows the sample locations.

7.4.1 Water sampling baseline field report

This report is a culmination of a week of baseline water quality sampling on Kolosori, Isabel Province.

Site Name: SW1	**Location**: Kokoilovadhe
Coordinates: 580158.96, 9064843.113	**Sampling Time**: 9:08 am
Sampling date: 7th June 2021	**Sampled by**: Sammy Taude

Site description:

Water level/flow	The water body appeared to be flowing well at a visual observed depth of about 60 cm
Sample appearance at time of collection	Good clarity, colourless with no odour
Sampling depth	The sample was obtained at a depth of 15 cm
Description of surrounding	Tall trees with good canopy cover, no disturbance observed
Sample treatment	Mostly unfiltered, except for where sampling is made for DOC
Other remarks	A slight change had to be made to the sampled site as per predetermined coordinates. This action had to be undertaken because it was observed that water sunk underground rather than flowed at the given coordinates. The new site as per coordinates is still in the catchment area about 70-80 meters away from the given/original coordinates.

Site photograph: Figure 7-18 **and** Figure 7-19

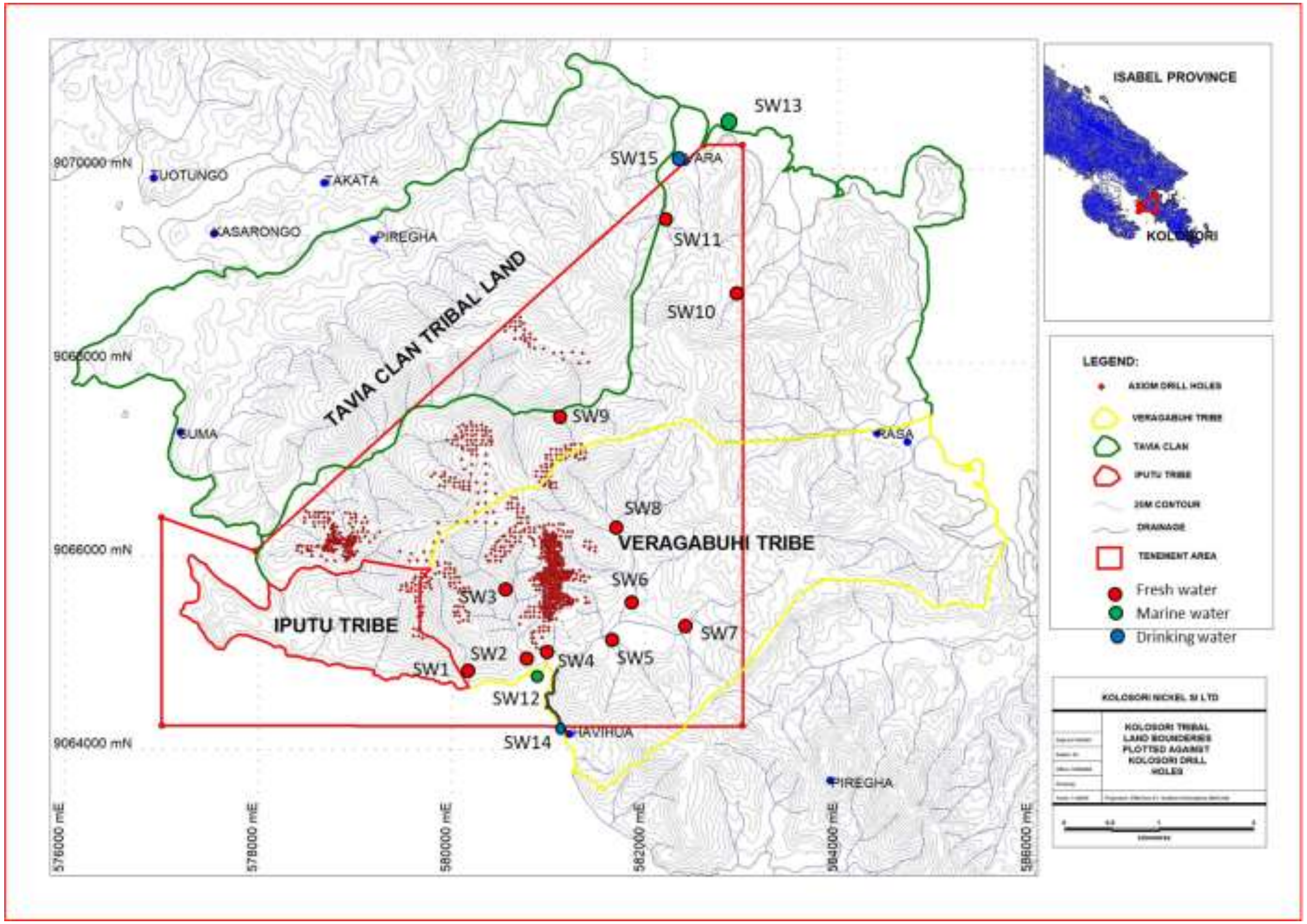


Figure 7-17 Baseline water sample locations

Figure 7-18 SW1 water sample collection site

Figure 7-19 L-R Tree canopy and surrounding landscape of SW1

Site Name: SW2
Coordinates: 580780.278, 9064931.769
Sampling date: 7th June 2021

Location: Vuavula
Sampling Time: 11:34 am
Sampled by: Wilton Da'ata

Site description:

Water level/flow	The stream is flowing well and depth at the sampling point appeared to be about 70 cm
Sample appearance at time of collection	Good clarity, colourless with no odour however a few suspended particles were observed
Sampling depth	The sample was obtained at a depth of 15 cm
Description of surrounding	The area is disturbed, surroundings are deforested (human activities)
Sample treatment	Mostly unfiltered, except for where sampling is made for DOC
Other remarks	The site is close to mangroves/shoreline and is the mouth of the stream where SW3 flows from.

Site photographs:

Figure 7-20 SW2 point of sampling.

Figure 7-21 Surrounding environment of SW2

Site Name: SW3
Coordinates: 580680.651, 9065607.876
Sampling date: 7th June 2021

Location: Vuavula
Sampling Time: 2:23 pm
Sampled by: Wilton Da'ata

Site description:

Water level/flow	The stream appeared to be flowing well at a measured observed depth of 1 meter
Sample appearance at time of collection	Good clarity, colourless with no odour
Sampling depth	The sample was obtained at a depth of 15 cm
Description of surrounding	There are hills beyond both banks of the stream with many trees. There is no observed human disturbance
Sample treatment	Mostly unfiltered, except for where sampling is made for DOC
Other remarks	The site selected for sampling is a smooth flowing area below an area of riffle

Site photograph:

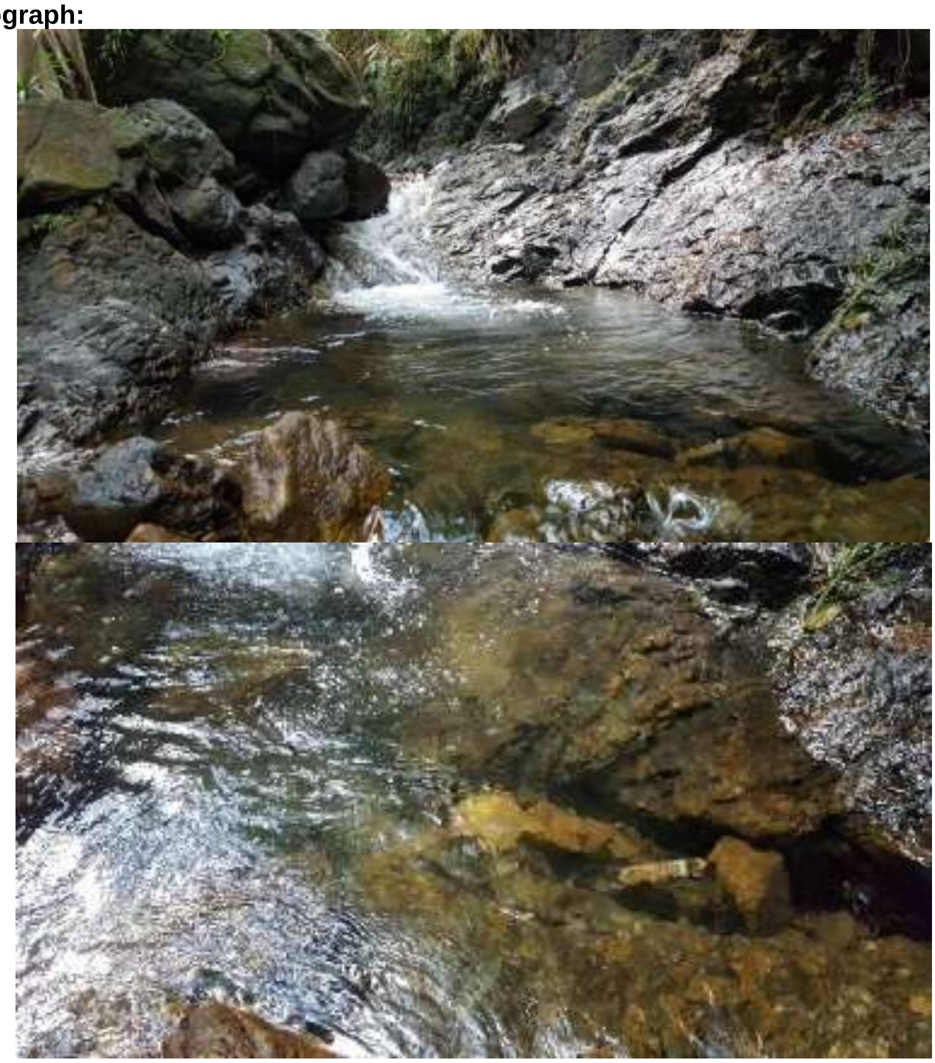


Figure 7-22 Photograph showing site at which SW3 was collected

Figure 7-23: Surrounding of SW3 collection site

Site Name: SW4
Coordinates: 581123 , 9065022
Sampling date: 11th June 2021

Location: Havihua
Sampling Time: 5:00 pm
Sampled by: Sammy Taude

Site description:

Water level/flow	The water body appeared to be flowing but at a slow rate depth of which is 2 meters
Sample appearance at time of collection	No clarity, cloudy/murky with no odour
Sampling depth	The sample was obtained at a depth of 15 cm
Description of surrounding	no disturbance observed
Sample treatment	Mostly unfiltered, except for where sampling is made for DOC
Other remarks	The site is usually accessed by women for fishing and collection of mangrove pods for food. Streams containing sampling points SW5,6,7 and 8 drain out into this area.

Site photograph:

Figure 7-24 Collection point for SW4

Site Name: SW5
Coordinates: 581989.519 , 9064869.122
Sampling date: 8th June 2021

Location: Havihua
Sampling Time: 1:34 pm
Sampled by: Wilton Da'ata

Site description:

Water level/flow	Good stream flow, shallow at sampled point, depth of 40 cm
Sample appearance at time of collection	Sample collected was clear but having some slight murky discoloration, no odours
Sampling depth	The sample was obtained at a depth of 15 cm
Description of surrounding	Surrounding area appears to be disturbed (human) where sites have been cleared for gardening
Sample treatment	Mostly unfiltered, except for where sampling is made for DOC
Other remarks	Sample collected after rain event

Site photograph:

Figure 7-25 Sampling point for SW5 including immediate surrounding

Site Name: SW6
Coordinates: 581826.682, 9065212.533
Sampling date: 8th June 2021

Location: Havihua-Kolohavi
Sampling Time: 5:53 am
Sampled by: Sammy Taude

Site description:

Water level/flow	Very good water flow, depth is estimated to be 3 meters
Sample appearance at time of collection	Colour of the water was brown when sampled due to heavy rain the previous day, there was no clarity however there was no odour
Sampling depth	The sample was obtained at a depth of 15 cm
Description of surrounding	no disturbance observed
Sample treatment	Mostly unfiltered, except for where sampling is made for DOC
Other remarks	A new site was sampled due to the pre-determined site being used as access by villagers to the river. The new site is still within the catchment or in the vicinity of the site as on the map. This area is near the village of the Sisters of the Church of Melanesia.

Site photograph:

Figure 7-26 Sampling point for SW6

Site Name: SW7
Coordinates:582425.857 , 9065158.746
Sampling date: 8th June 2021

Location: Havihua
Sampling Time: 12:55 pm
Sampled by: Sammy Taude

Site description:

Water level/flow	The river is flowing and measured depth is 40 cm
Sample appearance at time of collection	No colour, odour and clarity is good but a little cloudy due to rainfall the precious day
Sampling depth	The sample was obtained at a depth of 15 cm
Description of surrounding	There are observed signs of human disturbance – gardening. The site is also close to a road
Sample treatment	Mostly unfiltered, except for where sampling is made for DOC
Other remarks	

Site photograph:

Figure 7-27 Site of sampling point SW7

Site Name: SW8
Coordinates:581891 , 9066180
Sampling date: 11th June 2021

Location: Havihua - Komika
Sampling Time: 12:04 pm
Sampled by: Sammy Taude

Site description:

Water level/flow	The river is flowing and measured depth is 20 cm
Sample appearance at time of collection	No colour, odour and clear
Sampling depth	The sample was obtained at a depth of 10 cm
Description of surrounding	The surrounding is undisturbed
Sample treatment	Mostly unfiltered, except for where sampling is made for DOC
Other remarks	The spot where sample was collected is above a confluence. This site is close to the coast, however the trek to locate it was difficult particularly when the local tour guide got confused with the route and we lost access. The villagers were also not familiar with the locations of the streams and thus we had to follow the GPS which led us over very steep hills, deep valleys and rocky areas.

Site photograph:

Figure 7-28 This is the site where water sample SW8 was collected.

Site Name: SW9
Coordinates:581033 , 9067470
Sampling date: 12th June 2021

Location: Beahutu
Sampling Time: 11:49 am
Sampled by: Wilton Da'ata

Site description:

Water level/flow	Water level is at 1.5 meters depth and it is flowing
Sample appearance at time of collection	No colour, odour and clear
Sampling depth	The sample was obtained at a depth of 15 cm
Description of surrounding	The surrounding is undisturbed, area is deeply forested with great canopy cover
Sample treatment	Mostly unfiltered, except for where sampling is made for DOC
Other remarks	The spot where sample was collected is not far from a confluence. This is the hardest site to reach of all the sites. SW9 is located in the middle of virgin forest inland Kolosori. Most of the village people had never accessed or even reached this site in their lifetime. We attempted to reach this site with two different groups of tour guides, one from Vara and one from Havihua. The attempt with the group from Vara failed as trekking through bush to get to the site was just too difficult. A second attempt was made with villagers from Havihua which was finally successful.

Site photograph:

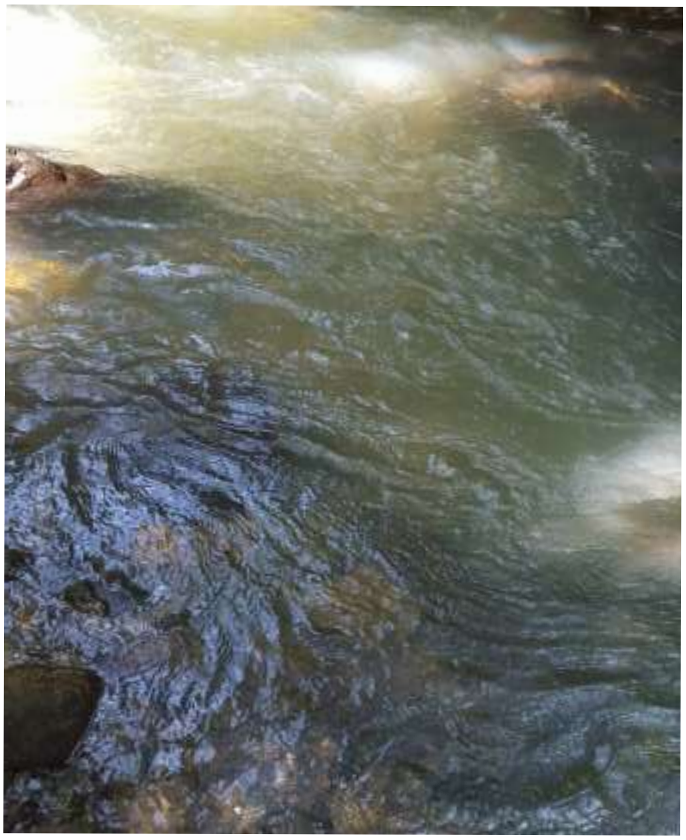


Figure 7-29 Collection site for SW9

Figure 7-30 Immediate surroundings of sampling site for SW9

Site Name: SW10
Coordinates: 587971.810,9068618.222
Sampling date: 9th June 2021

Location: Koisepi/Toiri
Sampling Time: 2:04 pm
Sampled by: Wilton Da'ata

Site description:

Water level/flow	Measured water level is at 40 cm depth and it is flowing
Sample appearance at time of collection	The water appeared cloudy when sampled, however there is no observed odour
Sampling depth	The sample was obtained at a depth of 15 cm
Description of surrounding	No current disturbance is observed, there is a lot of trees providing a very good canopy. Soil in this area appears red. There is a presence of decaying logs and there are hills on both sides of the stream
Sample treatment	Mostly unfiltered, except for where sampling is made for DOC
Other remarks	This was a previously logged area. As with SW8, this is one of the sites rarely visited by villagers so our tour guide got confused how to get to the site thus we face great difficulty getting to the site.

Site photograph:

Figure 7-31 Photograph of sampled site SW10 and surroundings

Site Name: SW11
Coordinates: 582206,9069388

Location: Vara
Sampling Time: 4:22 pm

Sampling date: 9th June 2021 **Sampled by**: Sammy Taude

Site description:

Water level/flow	Stream depth at sampling point is 50cm and is flowing
Sample appearance at time of collection	No colour, odour and clear
Sampling depth	The sample was obtained at a depth of 15 cm
Description of surrounding	The surrounding is forested and there is no observed disturbance
Sample treatment	Mostly unfiltered, except for where sampling is made for DOC
Other remarks	There is a water dam at the top of the stream, the villagers use this water

Site photograph:
No photo was obtained for this site

Site Name: SW12 **Location**: Havihua offshore
Coordinates: 580923, 9064771 **Sampling Time**: 10:21 am
Sampling date: 7th June 2021 **Sampled by**: Wilton Da'ata

Site description:

Water level/flow	This site is one of the marine sites off the shores of Havihua. Sampling took place at a site 1 meter in depth. There was a the presence of small waves driven by the wind
Sample appearance at time of collection	No colour, odour and clear. Suspended particles are observed in the sample
Sampling depth	The sample was obtained at a depth of 15 cm
Description of surrounding	The surrounding consists of mangroves, coconut trees and other trees that are scattered on these shores. There is some disturbance from road construction
Sample treatment	Mostly unfiltered, except for where sampling is made for DOC
Other remarks	The spot where sample was collected is 100 meters from the shore

Site photograph:

Figure 7-32 Site for SW12 collection

Site Name: SW13	**Location**: Vara offshore/Sosokara
Coordinates:582973.787, 997039.26	**Sampling Time**: 4:25 pm
Sampling date: 10th June 2021	**Sampled by**: Wilton Da'ata

Site description:

Water level/flow	This is the second marine site that was sampled. The area where sample is collected is about 2 metres in depth. It is an area that experiences local currents so there is a presence of waves on this particular day
Sample appearance at time of collection	Sample is brownish in colour, there is no clarity and contains a certain odour similar to mangroves/mud present not far from the site
Sampling depth	The sample was obtained at a depth of 15 cm
Description of surrounding	The surrounding is disturbed by logging, deforestation of mangroves and other trees
Sample treatment	Mostly unfiltered, except for where sampling is made for DOC
Other remarks	The spot where sample was collected is in front of a log pond

Site photograph:

Figure 7-33 Sampling point for SW13

Figure 7-34 Log pond in foreground amongst mangroves constitutes the surrounding of SW13

Site Name: SW14
Coordinates: 581194, 9064319
Sampling date: 11th June 2021

Location: Havihua
Sampling Time: 5:53 pm
Sampled by: Wilton Da'ata

Site description:

Water level/flow	Water flowing from a tap. This is a drinking water site
Sample appearance at time of collection	No colour, odour and clear
Sampling depth	
Description of surrounding	Drinking water used by 2 households
Sample treatment	Mostly unfiltered, except for where sampling is made for DOC
Other remarks	500 ml clear plastic bottle used for sampling.

Site photograph:

Figure 7-35 The Havihua Village community standpipe water supply

The standpipe is obscured but is located behind the centre line of coconut trees. The source of this water is towards the hills at the back of the village.

Site Name: SW15
Coordinates: 582476.077, 9070007.860
Sampling date: 10th June 2021

Location: Vara
Sampling Time: 2:48 pm
Sampled by: Wilton Da'ata

Site description:

Water level/flow	Water flowing from a tap. Sampling drinking water
Sample appearance at time of collection	No colour, odour and clear
Sampling depth	
Description of surrounding	This drinking water is used by 2 households
Sample treatment	Mostly unfiltered, except for where sampling is made for DOC
Other remarks	The water is said to be dirty when heavy rains occur and it is sources from SW11 stream

Site photograph:

Figure 7-36 The Vara village community standpipe that these households utilise as drinking water supply

Standpipe is located amongst the trees.

Table 7-4 Baseline sample location

Samples	Easting (m)	Northing (m)	Site name / catchment	Water type
Sw1	580158	9064843	kokoilovadhe	stream
Sw2	580780	9064931	Vuavula (DS)	stream
Sw3	580680	9065607	Vuavula (TS)	stream
Sw4	581123	9065022	Havihua	stream
Sw5	581989	9064869	Havihua	stream
Sw6	581826	9065212	Havihua	stream
Sw7	582425	9065158	Havihua	stream
Sw8	581691	9066180	Komika	stream
Sw9	581033	9067470	Beahutu	stream
Sw10	582971	9068618	Koifesi/ Toiri	stream
Sw11	582206	9069388	Vara	stream
Sw12	580923	9064771	Havihua Kolosori Bay	marine
Sw13	582973	9070390	Sosokara Huati Bay	marine
Sw14	581194	9064319	Havihua	potable
Sw15	582476	9070007	Vara	potable

Table 7-5 Baseline analytes

Monitoring Location	Physio-chemical	Total / Dissolved Metals	Major Anions and Cations	Nutrients	Pesticides/ Herbicides	Inorganics
FRESHWATER						
SW1	X	X	X	X	X	X
SW2	X	X	X	X	X	X
SW3	X	X	X	X	X	X
SW4	X	X	X	X	X	X
SW5	X	X	X	X	X	X
SW6	X	X	X	X	X	X
SW7	X	X	X	X	X	X
SW8	X	X	X	X	X	X
SW9	X	X	X	X	X	X
SW10	X	X	X	X	X	X
SW11	X	X	X	X	X	X
ESTUARINE WATER						
SW12	X	X (ultratrace)	X	X	X	X
SW13	X	X (ultratrace)	X	X	X	X
DRINKING WATER						
HAVIHUA (SW14)	X	X	X	X	X	X
VARA (SW15)	X	X	X	X	X	X

Table 7-6 Baseline Water Quality Results – Physical and major Anions and Cations

Analyte grouping/Analyte	Unit	LOR	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10	SW11	SW12	SW13	SW14	SW15
pH Value	pH Unit	0.01	8.14	8.08	8.13	7.95	7.93	7.82	7.85	8.19	7.96	8.01	8.04	7.82	7.91	8.26	8.23
Electrical Conductivity @ 25°C	µS/cm	1	168	146	148	2540	151	86	104	185	106	157	156	26400	44300	213	199
Total Dissolved Solids @180°C	mg/L	10	98	83	86	1460	109	72	82	106	68	112	111	18100	33500	123	127
Suspended Solids (SS)	mg/L	5	<5	<5	<5	<5	6	7	6	<5	<5	18	<5	6	<5	<5	<5
Turbidity	NTU	0.1	0.1	0.2	0.2	2.2	9.8	16.1	15.8	0.2	5.6	7.7	1.4	0.6	1.4	0.2	0.5
Hydroxide Alkalinity as CaCO3	mg/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	mg/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	mg/L	1	91	79	82	93	84	46	57	103	59	83	84	106	108	121	106
Total Alkalinity as CaCO3	mg/L	1	91	79	82	93	84	46	57	103	59	83	84	106	108	121	106
Sulfate as SO4 - Turbidimetric	mg/L	1	1	<1	<1	95	1	1	1	1	1	2	2	1200	2240	2	2
Chloride	mg/L	1	4	4	3	787	3	3	2	3	2	3	3	9330	15400	4	3
Calcium	mg/L	1	3	1	1	24	11	9	11	1	7	17	17	420	391	6	24
Magnesium	mg/L	1	22	19	20	58	13	4	5	24	8	7	6	1250	1170	26	9
Sodium	mg/L	1	2	2	1	409	4	4	5	1	3	6	6	10700	9990	5	11
Potassium	mg/L	1	<1	<1	<1	15	<1	<1	<1	<1	<1	<1	<1	395	369	<1	<1

Table 7-7 Baseline Water Quality Results - Dissoved Metals

Dissolved Metals by ICP-MS																	
Analyte grouping/Analyte	Unit	LOR	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10	SW11	SW12	SW13	SW14	SW15
Aluminium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	----	----	<0.01	<0.01
Antimony	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	----	----	<0.001	<0.001
Arsenic	mg/L	0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	----	----	<0.001	<0.001
Beryllium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	----	----	<0.001	<0.001
Barium	mg/L	0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	----	----	<0.001	0.005
Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	----	----	<0.0001	<0.0001
Chromium	mg/L	0.001	0.007	0.007	0.008	0.001	0.004	0.001	<0.001	0.012	0.003	<0.001	<0.001	----	----	0.003	<0.001
Hexavalent Chromium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	----	----	<0.001	<0.001
Copper	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	----	----	<0.001	<0.001

Dissolved Metals by ICP-MS																	
Analyte grouping/Analyte	**Unit**	**LOR**	**SW1**	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**	**SW7**	**SW8**	**SW9**	**SW10**	**SW11**	**SW12**	**SW13**	**SW14**	**SW15**
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	----	----	<0.001	<0.001
Manganese	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	----	----	<0.001	<0.001
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	----	----	<0.0001	<0.0001
Molybdenum	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	----	----	<0.001	<0.001
Nickel	mg/L	0.001	**0.003**	**0.012**	**0.013**	**0.002**	**0.001**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	----	----	**0.006**	<0.001
Selenium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	----	----	<0.01	<0.01
Tin	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	----	----	<0.001	<0.001
Uranium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	----	----	<0.001	<0.001
Vanadium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	----	----	<0.01	<0.01
Zinc	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	----	----	**0.006**	<0.005
Boron	mg/L	0.05	<0.05	<0.05	<0.05	**0.19**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	----	----	<0.05	<0.05
Iron	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	----	----	<0.05	<0.05

Table 7-8 Baseline Water Sample Results - Total Metals

Total Metals by ICP-MS																	
Analyte grouping/Analyte	Unit	LOR	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10	SW11	SW12	SW13	SW14	SW15
Aluminium	mg/L	0.01	<0.01	<0.01	<0.01	**0.11**	**0.74**	**0.92**	**1.03**	<0.01	**0.42**	**0.56**	**0.08**	----	----	<0.01	**0.05**
Antimony	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	----	----	<0.001	<0.001
Arsenic	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	----	----	<0.001	<0.001
Beryllium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	----	----	<0.001	<0.001
Barium	mg/L	0.001	<0.001	<0.001	<0.001	**0.004**	**0.003**	**0.002**	**0.001**	**0.001**	<0.001	**0.002**	**0.003**	----	----	<0.001	**0.007**
Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	----	----	<0.0001	<0.0001
Chromium	mg/L	0.001	**0.008**	**0.009**	**0.010**	**0.002**	**0.005**	**0.004**	**0.003**	**0.012**	**0.005**	**0.002**	<0.001	----	----	**0.003**	<0.001
Hexavalent Chromium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	----	----	<0.001	<0.001
Copper	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	**0.002**	**0.002**	**0.003**	<0.001	<0.001	**0.002**	<0.001	----	----	<0.001	<0.001
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	----	----	<0.001	<0.001
Manganese	mg/L	0.001	<0.001	<0.001	<0.001	**0.060**	**0.014**	**0.020**	**0.027**	<0.001	**0.007**	**0.030**	**0.004**	----	----	**0.001**	**0.003**
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	----	----	<0.0001	<0.0001
Molybdenum	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	----	----	<0.001	<0.001
Nickel	mg/L	0.001	**0.005**	**0.015**	**0.017**	**0.005**	**0.005**	**0.002**	**0.001**	**0.003**	**0.006**	**0.002**	<0.001	----	----	**0.007**	<0.001

Total Metals by ICP-MS																	
Analyte grouping/Analyte	Unit	LOR	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10	SW11	SW12	SW13	SW14	SW15
Selenium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	----	----	<0.01	<0.01
Reactive Silica	mg/L	0.05	**33.2**	**28.4**	**27.9**	**37.2**	**40.5**	**31.4**	**33.6**	**32.9**	**34.2**	**43.6**	**44.7**	**19.4**	**3.18**	**43.5**	**49.7**
Reactive Silica as Silicon	mg/L	0.05	**15.5**	**13.3**	**13.0**	**17.4**	**18.9**	**14.7**	**15.7**	**15.4**	**16.0**	**20.4**	**20.9**	**9.07**	**1.49**	**20.3**	**23.2**
Tin	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	----	----	<0.001	<0.001
Uranium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	----	----	<0.001	<0.001
Vanadium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.01**	<0.01	<0.01	<0.01	**0.02**	**0.02**	----	----	<0.01	**0.02**
Zinc	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	----	----	**0.011**	<0.005
Boron	mg/L	0.05	<0.05	<0.05	<0.05	**0.19**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	----	----	<0.05	<0.05
Iron	mg/L	0.05	<0.05	<0.05	<0.05	**0.52**	**0.74**	**1.00**	**1.18**	<0.05	**0.54**	**0.65**	**0.12**	----	----	<0.05	**0.06**

Table 7-9 Baseline Water Sample Results - Silica and Dissoved Metals in Saline Water

Silica by Discrete Analyser																	
Analyte grouping/Analyte	**Unit**	**LOR**	**SW1**	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**	**SW7**	**SW8**	**SW9**	**SW10**	**SW11**	**SW12**	**SW13**	**SW14**	**SW15**
Reactive Silica	mg/L	0.05	**33.2**	**28.4**	**27.9**	**37.2**	**40.5**	**31.4**	**33.6**	**32.9**	**34.2**	**43.6**	**44.7**	**19.4**	**3.18**	**43.5**	**49.7**
Reactive Silica as Silicon	mg/L	0.05	**15.5**	**13.3**	**13.0**	**17.4**	**18.9**	**14.7**	**15.7**	**15.4**	**16.0**	**20.4**	**20.9**	**9.07**	**1.49**	**20.3**	**23.2**

Table 7-10 Baseline Water Sample Results - Dissoved Metals in Saline Water

Dissolved Metals in Saline Water																	
Analyte grouping/Analyte	**Unit**	**LOR**	**SW1**	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**	**SW7**	**SW8**	**SW9**	**SW10**	**SW11**	**SW12**	**SW13**	**SW14**	**SW15**
Aluminium	µg/L	5	----	----	----	----	----	----	----	----	----	----	----	<5	<5	----	----
Antimony	µg/L	0.5	----	----	----	----	----	----	----	----	----	----	----	<0.5	<0.5	----	----
Arsenic	µg/L	0.5	----	----	----	----	----	----	----	----	----	----	----	<0.5	**1.2**	----	----
Barium	µg/L	1	----	----	----	----	----	----	----	----	----	----	----	**6**	**4**	----	----
Beryllium	µg/L	0.1	----	----	----	----	----	----	----	----	----	----	----	<0.1	<0.1	----	----
Boron	µg/L	100	----	----	----	----	----	----	----	----	----	----	----	**2210**	**3490**	----	----
Cadmium	µg/L	0.2	----	----	----	----	----	----	----	----	----	----	----	<0.2	<0.2	----	----
Chromium	µg/L	0.5	----	----	----	----	----	----	----	----	----	----	----	<0.5	<0.5	----	----
Cobalt	µg/L	0.2	----	----	----	----	----	----	----	----	----	----	----	<0.2	<0.2	----	----
Copper	µg/L	1	----	----	----	----	----	----	----	----	----	----	----	<1	<1	----	----
Iron	µg/L	5	----	----	----	----	----	----	----	----	----	----	----	<5	<5	----	----
Lead	µg/L	0.2	----	----	----	----	----	----	----	----	----	----	----	<0.2	<0.2	----	----

Dissolved Metals in Saline Water																	
Analyte grouping/Analyte	**Unit**	**LOR**	**SW1**	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**	**SW7**	**SW8**	**SW9**	**SW10**	**SW11**	**SW12**	**SW13**	**SW14**	**SW15**
Manganese	µg/L	0.5	----	----	----	----	----	----	----	----	----	----	----	<0.5	<0.5	----	----
Molybdenum	µg/L	0.1	----	----	----	----	----	----	----	----	----	----	----	**4.0**	**8.4**	----	----
Nickel	µg/L	0.5	----	----	----	----	----	----	----	----	----	----	----	**4.3**	**0.8**	----	----
Selenium	µg/L	2	----	----	----	----	----	----	----	----	----	----	----	<2	<2	----	----
Tin	µg/L	5	----	----	----	----	----	----	----	----	----	----	----	<5	<5	----	----
Uranium	µg/L	0.1	----	----	----	----	----	----	----	----	----	----	----	**0.8**	**1.2**	----	----
Vanadium	µg/L	0.5	----	----	----	----	----	----	----	----	----	----	----	<0.5	<0.5	----	----
Zinc	µg/L	5	----	----	----	----	----	----	----	----	----	----	----	<5	<5	----	----

Table 7-11 Baseline Water Quality Results – Nutrients

Analyte grouping/Analyte	**Unit**	**LOR**	**SW1**	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**	**SW7**	**SW8**	**SW9**	**SW10**	**SW11**	**SW12**	**SW13**	**SW14**	**SW15**
Ammonia as N	mg/L	0.01	**0.01**	**0.09**	<0.01	**0.12**	**0.14**	**0.23**	**0.19**	**0.03**	**0.16**	**0.16**	**0.04**	**0.03**	**0.12**	**0.19**	<0.01
Nitrite as N	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate as N	mg/L	0.01	**0.34**	**0.25**	**0.29**	**0.12**	**0.18**	**0.12**	**0.05**	**0.30**	**0.11**	**0.25**	**0.26**	**0.07**	<0.01	**0.10**	**0.37**
Nitrite plus Nitrate as N (NOx)																	
Nitrite + Nitrate as N	mg/L	0.01	**0.34**	**0.25**	**0.29**	**0.12**	**0.18**	**0.12**	**0.05**	**0.30**	**0.11**	**0.25**	**0.26**	**0.07**	<0.01	**0.10**	**0.37**
Total Kjeldahl Nitrogen as N	mg/L	0.1	<0.1	**0.1**	<0.1	**0.1**	**0.3**	**0.4**	**0.4**	<0.1	**0.2**	**0.3**	**0.1**	<0.5	<0.5	**0.1**	<0.1
Total Nitrogen as N (TKN + NOx)																	
Total Nitrogen as N	mg/L	0.1	**0.3**	**0.4**	**0.3**	**0.2**	**0.5**	**0.5**	**0.4**	**0.3**	**0.3**	**0.6**	**0.4**	<0.5	<0.5	**0.2**	**0.4**
Total Phosphorus as P	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	**0.03**	**0.04**	**0.03**	<0.01	<0.01	**0.06**	**0.03**	<0.05	<0.05	<0.01	**0.04**
Reactive Phosphorus as P	mg/L	0.01	**0.07**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.04**	**0.02**	<0.01	<0.01	<0.01	**0.02**
Dissolved Organic Carbon (DOC)																	
Dissolved Organic Carbon	mg/L	1	<1	<1	<1	<1	<1	**1**	<1	<1	<1	<1	<1	<1	<1	<1	<1
EP005: Total Organic Carbon (TOC)																	
Total Organic Carbon	mg/L	1	<1	<1	<1	**1**	**2**	**1**	**1**	<1	<1	**2**	**1**	**1**	**1**	<1	<1
EP006D: Dissolved Inorganic Carbon (DIC)																	
Dissolved Inorganic Carbon	mg/L	1	**21**	**18**	**18**	**22**	**19**	**10**	**13**	**24**	**13**	**19**	**19**	**25**	**23**	**29**	**25**
EP026SP: Chemical Oxygen Demand (Spectrophotometric)																	
Chemical Oxygen Demand	mg/L	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	**13**	<10	<50	**154**	<10	<10
EP030: Biochemical Oxygen Demand (BOD)																	

Analyte grouping/Analyte	Unit	LOR	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10	SW11	SW12	SW13	SW14	SW15
Biochemical Oxygen Demand	mg/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
EN055: Ionic Balance																	
Total Anions	meq/L	0.01	**1.95**	**1.69**	**1.72**	**26.0**	**1.78**	**1.02**	**1.22**	**2.16**	**1.26**	**1.78**	**1.80**	**290**	**483**	**2.57**	**2.24**
Total Cations	meq/L	0.01	**2.05**	**1.70**	**1.74**	**24.1**	**1.79**	**0.95**	**1.18**	**2.07**	**1.14**	**1.68**	**1.60**	**599**	**560**	**2.66**	**2.42**
Ionic Balance	%	0.01	**----**	**----**	**----**	**3.77**	**----**	**----**	**----**	**----**	**----**	**----**	**----**	**34.7**	**7.34**	**----**	**----**

7.5 Effects of project on water quality

One of the major environmental concerns that the project will have on the water quality is the seepage of effluents and sewerage from potential sources into the freshwater systems. Increasing the amount of untreated sewerage reaching the river and coastal waters increases faecal coliform, which is a health hazard. An increase in nutrient loading will also lead to a decline in water quality.

7.5.1 Monitoring

Surface Water

A surface water monitoring plan has been developed for the Kolosori tenement area to monitor major streams (11 sites), 2 marine water sampling sites and 2 drinking water sites for Vara and Havihua villages as established on the baseline sampling.

A surface water program will be undertaken for the water quality at the sites identified in the baseline sampling program. Samples will be tested for total and filtered metals, major cations and anions, tubidity, and for selected analytes such as nutrients based on the activity in the catchment. Data will be assessed against WHO for drinking water and ANZECC Guidelines for metals and nutrients.

Sampling frequency will be quarterly for routine sampling.

Groundwater

A review of the groundwater conditions of the project site will be reviewed against agreed environmental values, and potential risk of impact from mining activity on environmental values.

8 KOLOSORI MARINE ENVIRONMENTAL IMPACT STUDIES

8.1 Summary

The Thousand Ships Bay and Kolosori consists of a micro-tidal environment with a tidal plane of less than 1.5m with two high and two low tides per day on average making it a semi-diurnal. Tidal currents play a major role in driving surface current within the bay. With the influence of the Easterly winds, large waves bifurcate and contributes in moving surface currents through the southern opening and to the northern opening, which may result in the formations of large waves and swells that erodes the coastal areas in the bay. Average annual rainfall may be similar to the adjacent Takata tenement area which ranges from 3,500mm in low areas, to over 6,000mm on the mountain peaks, with most areas receiving around 4,000mm.

Water quality were influenced by tidal currents and the three fresh water streams that discharges into the Kolosori bay, forming an estuarine system with limited water movements. Turbidity increases moving deeper into the bay where silt, mud and sand are much dominant within the benthic zones.

The dominant marine habitats that were considered in the marine ecology baseline assessment were fringing reefs, patch reefs, mangrove forest, mud flats and the estuarine habitats in the semi-enclosed bay where the proposed seaport area will be located. Intertidal bare substrates, shallow seagrass meadow (poorly dense and sparsely distributed to a shallow confined area in front of Havihua village), sandy beaches and high turbidity (low visibility, >0.5m) inner bay-estuarine water with mud flats were considered to be minor habitat type in the assessment.

Flora and fauna that were targeted as part of the baseline assessment and desktop review included: flora associated with lowland forest in the coastal areas and mangrove forests; coral and benthic biota; marine invertebrates; coral reef fish and pelagic fish; marine mammals and reptiles.

A total of 47 species of coastal and mangrove flora may exist in Kolosori; the palm family Arecaceae and Rhizophoraceae, of the mangrove family, were the most diverse. The mangrove forests are dominated with the genera Rhizophora spp at the coastline and foreshore area that formed strands of short mangrove canopy, and the taller back mangrove forest were dominated by Bruguiera gymnorrhiza.

Dead corals with algae and silt dominates the coral reefs which are mostly shallow (2m-8m) and consists of low to moderate reef complexity with a shallow silt and sand dominated intertidal zones. The coral reef slopes down to 6m to 12m (in most sites) and transitioned to a lower reef complexity and barren sand- dominated sea floor which further progressed into the deeper areas of the Thousand Ships Bay. Mean live coral cover ranged below 6% and consists of sub-massive and massive coral colonies that were distributed in the shallow reef crest area in depths of 1m to 2m.

Coral diversity comprised of 21 genera of hard stony corals from 12 families and Faviidae and Poritidae records the highest species diversity; the common corals in the reefs are the genera Porites, Acropora, Leptoseris and Pachyseris. The genera Caulastrea, Lobophyllia, Alveopora, Leptastrea, Turbinaria, and the soft coral Sinularia and Sacorphyton were also common but present in much smaller patches, less-aggregated colonies or solitary.

Marine invertebrate distribution was mostly confined to reef areas where hard substrates are present and comprises 8 families with 12 species. Common marine invertebrates are Linkia laevigata (Blue Starfish) which accounts to 50% of the total count and Tridacna crocea (24%). Other species were less common and accounts to 2% to 4% in total count.

A total of 77 genera representing 21 families of coral fish fauna were recorded in the survey. Caesionidae (Caesio caerulaurea and Caesio teres) and Pomacentridae – the most diverse in species richness – were the dominant fish families in relative abundance. Fish diversity and abundance was higher in the coral reef areas and lower in the bay area. The larger occurring key food fish species recorded were comprised families Labridae, Lutjanidae, Carangidae, Scaridae, Acanthuridae and Mullidae and were present in most of the reefs reviewed.

The majority of the marine flora, invertebrate and coral fish fauna recorded in the assessment were listed ‘least concerned’ and ‘not evaluated’ by International Union for Conservation of Nature (IUCN), except for the mangrove species Bruguiera hainsii which is listed ‘critically endangered’, and the flowering tree species of Intsia bijuga that was considered to be ‘vulnerable’; fish species includes Plectropomus areolatus which were considered ‘vulnerable’ and 3 marine invertebrate species of the family Tridachnidae, T. Squamosa, T. maxima and H. hippopus, which were classified ‘conservation dependent.’

The marine mammals and reptiles reviewed in the study were mostly ‘least concerned’ and ‘data deficient’ except for the marine turtles Eretmochelys imbricata and Chelonia mydas which were respectively listed ‘critically endangered’ and ‘endangered.’ ‘Vulnerable’ enlisted species includes Dugong dugon, Lepidochelys olivacea and Dermochelys coriacea.

8.2 Introduction

The Pacific Nickel Mines Ltd. will be developing the Kolosori Nickel Mining Project (KNMP) on south Isabel in Solomon Islands. Pre-development activities of drilling programs and engineering studies had commenced in early 2021, on the site of previous drilling activity by Sumitoma. A local marine survey consultancy group had accomplished bathymetric survey and identified a potentially suitable site for a port location in Kolosori, near Havihua village. In full-filling Solomon Islands national legislative requirements for acquiring a mining license for the project, a marine environmental baseline study was conducted in June 16th to August 8th in 2021.

This report encompasses the marine and coastal environmental baseline component of the areas within the proposed Kolosori Tenement Area (KTA).

8.3 Assessment Objectives

The primary objective of the EIS was to establish baseline information and to develop an understanding of the existing ecological conditions of the marine and coastal areas in the KTA, which will support in identifying the potential impacts to the marine environment due to the establishment of the nickel mining Project.

A series of desktop reviews and field studies had been conducted to gather baseline data and information to describe the marine habitats and fauna in the vicinity of the Project. In particular, the objectives of the study will address the following:

- Compliance with the Solomon Islands legal requirements for the formulation of an Environment Impact Statement under the Environment Act 1998;
- Establish the environmental baseline conditions of the marine ecology and biodiversity in the area;
- A review of previous studies within the Thousand Ships Bay and adjacent areas to the KTA;
- Development of a marine habitat map with key marine areas which may require environmental concerns;
- Identification of key seafood species and the fishery status of the communities within and adjacent to the KTA;
- Identification of key potential impacts associated with the mining project implementation and;
- Establish a marine environmental management plans and mitigation measures.

8.4 Solomon Islands National Legislative Framework and International Treaties

8.4.1 Legislative Framework

The Solomon Islands Environment Act 1998, stipulates that all proposed prescribed developments must undergo an Environmental Impact Assessment (EIA). The Act requires EIAs to:

- Describe the environment likely to be affected by the prescribed development;
- Describe and assess any safeguards intended to be adopted for the protection of the environment; and
- State any intended monitoring and reporting of the impact of the prescribed development.

8.4.2 Other Solomon Islands Legislation

- National Environmental Management Strategy (NEMS 1993);
- National Minerals Policy 2017;
- Environmental Regulations (2008);
- Wildlife Protection and Management Act 1998;
- Wildlife Protection and Management Regulations 2008;
- Protected Areas Act (draft) 2012;
- Protection of Wrecks and War Relics Act 1973;
- Wildlife Protection and Management Act 1998;

- Provincial Government Act 1997;
- River Waters Act 1964;
- Fisheries Management Act 2015;
- Fisheries Management (Prohibited Activities) Regulations 2018
- Environment Health Act 1980;
- National Biodiversity Strategy and Action Plan 2009;
- Isabel Province Conservation Area Ordinance 1993;
- Isabel Province Draft Resource Management and Environmental Protection Ordinance 2005;
- Isabel Province Marine and Freshwater Areas Ordinance 1993;
- Shipping Act 1998;
- Quarantine Act 1978;
- Marine Safety Administration Act 2009;
- Ports Act 1998;
- Provincial Government Act 1997; and
- Emergency powers (covid-19) (no.2) regulations 2020.

8.4.3 International Environmental and Conservation of Biodiversity Treaties

Solomon Islands is a party to some of the international treaties and conventions. See Table 8-1 Multilateral agreements.

Table 8-1 Multilateral agreements

Multi-lateral Agreements that the Solomon Islands is a party to Convention or Treaty	Status	Purpose/Aim	Agency Responsible
Regional MEAs			
i. Pollution Protocol for Dumping	Ratified 10/9/98	Prevention of pollution of the South Pacific region by dumping	Marine Div/ECD
ii. Pollution Protocol for Emergencies	Ratified 10/9/98	Cooperation in combating pollution emergencies in the South Pacific region.	Marine Div/ECD Project: National Pollution Prevention Plan
iii. Natural Resources & Environment of South Pacific Region (SPREP Convention)	Ratified 10/9/98	Protection, management and development of the marine and coastal environment of the South Pacific Region	Marine Div/ECD Project: National Pollution Prevention Plan

Multi-lateral Agreements that the Solomon Islands is a party to Convention or Treaty	**Status**	**Purpose/Aim**	**Agency Responsible**
iv. Waigani Convention on Hazardous & Radioactive Wastes 1995	Ratified 7/10/1998	Bans the importation of hazardous and radioactive wastes into Forum Island countries and to control the transboundary movement and management of hazardous wastes within the South Pacific region.	ECD
Chemicals, Wastes and Pollution			
i. Liability for Oil Pollution Damage	Ratified	Strict liability of ship owner for pollution damage to a coastal state within a certain amount.	Marine Div
ii. Marine Pollution Convention (London)	Ratified	Prevention of marine pollution by dumping of 43 wastes and other matter.	ECD/Foreign Affairs
iii. Desertification (UNCCD)	Acceded 16/4/1999	Agreement to combat desertification and mitigate the effects of drought in countries experiencing drought or desertification.	Agriculture Div/ECD Project: National Action Plan on Land Degradation and Drought; National Capacity Self-Assessment (NCSA)
iv. POPs Convention (Stockholm)	Acceded 28.7/2004	Protection of human health and environment from persistent organic pollutants.	ECD/Environmental Health Div. Project: National Implementation Plan
Biodiversity			
i. CITES	Instrument of ratification being prepared	Regulations and restriction of trade in wild animals and plants through a certification system of imports and exports.	ECD
ii. World Heritage Convention	Acceded 10/6/1992	Protection of sites of Outstanding Universal Values. Solomon Islands currently has East Rennell Island as a World Heritage site.	Museum/ECD
iii. Convention on Biological Diversity (UNCBD)	Ratified 3/10/1995	Conserve biological diversity through the sustainable use of its components and the fair and equitable sharing of the benefits	ECD Project: NCSA; National Biodiversity Strategy and Action Plan; International Waters Program; 3rd National Report

Multi-lateral Agreements that the Solomon Islands is a party to Convention or Treaty	Status	Purpose/Aim	Agency Responsible
		arising out of utilizing genetic resources.	

8.5 Study Areas

8.5.1 Mining Area of Influence

In the Kolosori Tenement Area (KTA), the Mining Area of Influence (MAI) is defined as the geographical area likely to be affected by the mining's construction, operation and decommissioning activities, Figure 8-1 The Kolosori Tenement Area (KTA) – the mining area of influence. This can also be called the Mining Tenement area. This area excludes the wider area which may be affected by cumulative impacts. The MAI includes the direct impact area, upstream areas and downstream areas of rivers, terrestrial and marine habitats, stockpile areas, ore locations, quarry and the camp area.

8.5.2 Marine Baseline Study Area

The Marine Baseline Study Area (MBSA) covers the Kolosori tenement boundaries from the north and to the south along the fringing coastlines. The MBSA includes a semi-enclosed bay between Koloilovadhe and Havihua where the Pacific Nickel Mine Ltd proposed seaport site is located, as indicated in Figure 8-2. Kolosori bay is a mini-secondary bay system within the Thousand Ships Bay – the larger primary bay. Baseline data sampling stations were distributed along the fringing reefs in the north, the seaport area of the bay, and extends to the Havihua reefs where the tenement boundary ends in the south (Figure 8-3: The MBSA and the sampling stations (SS)). The MBSA consists of six sampling stations and covered a total sampling area of 4,800 m^2.

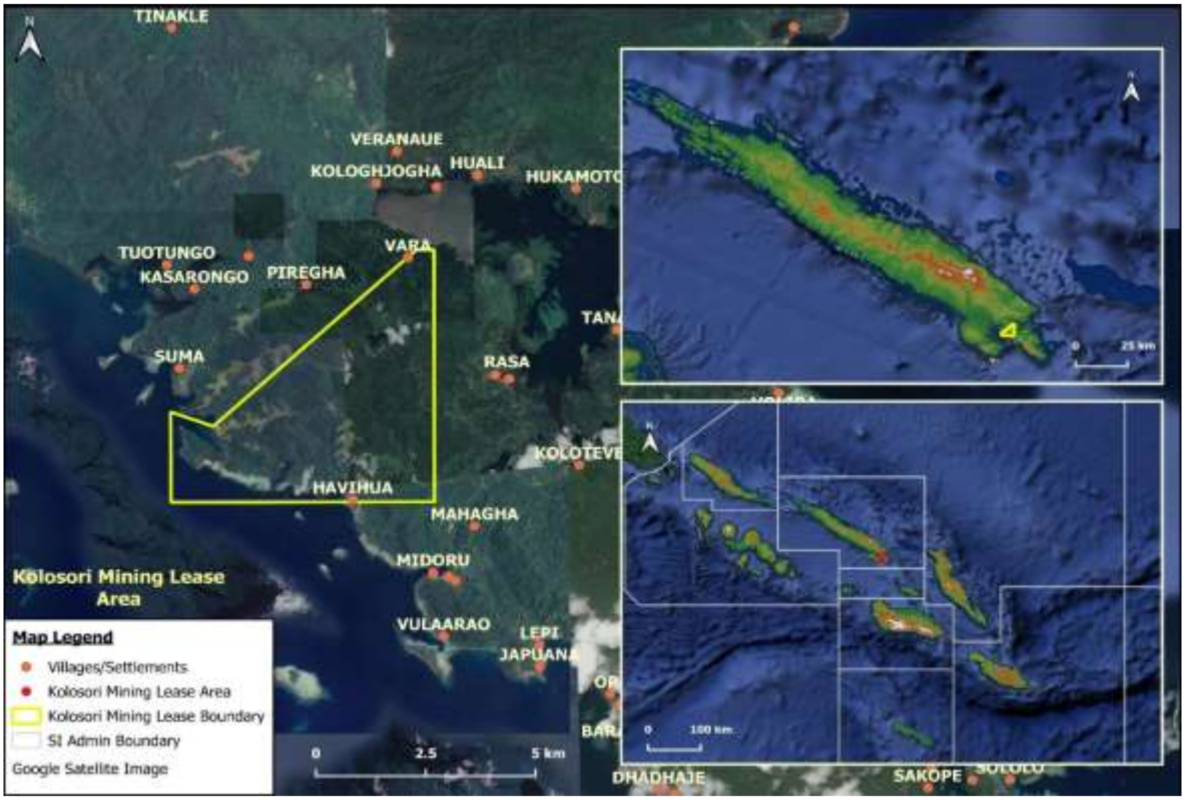


Figure 8-1 The Kolosori Tenement Area (KTA) – the mining area of influence

Figure 8-2 Proposed seaport site for Kolosori Project

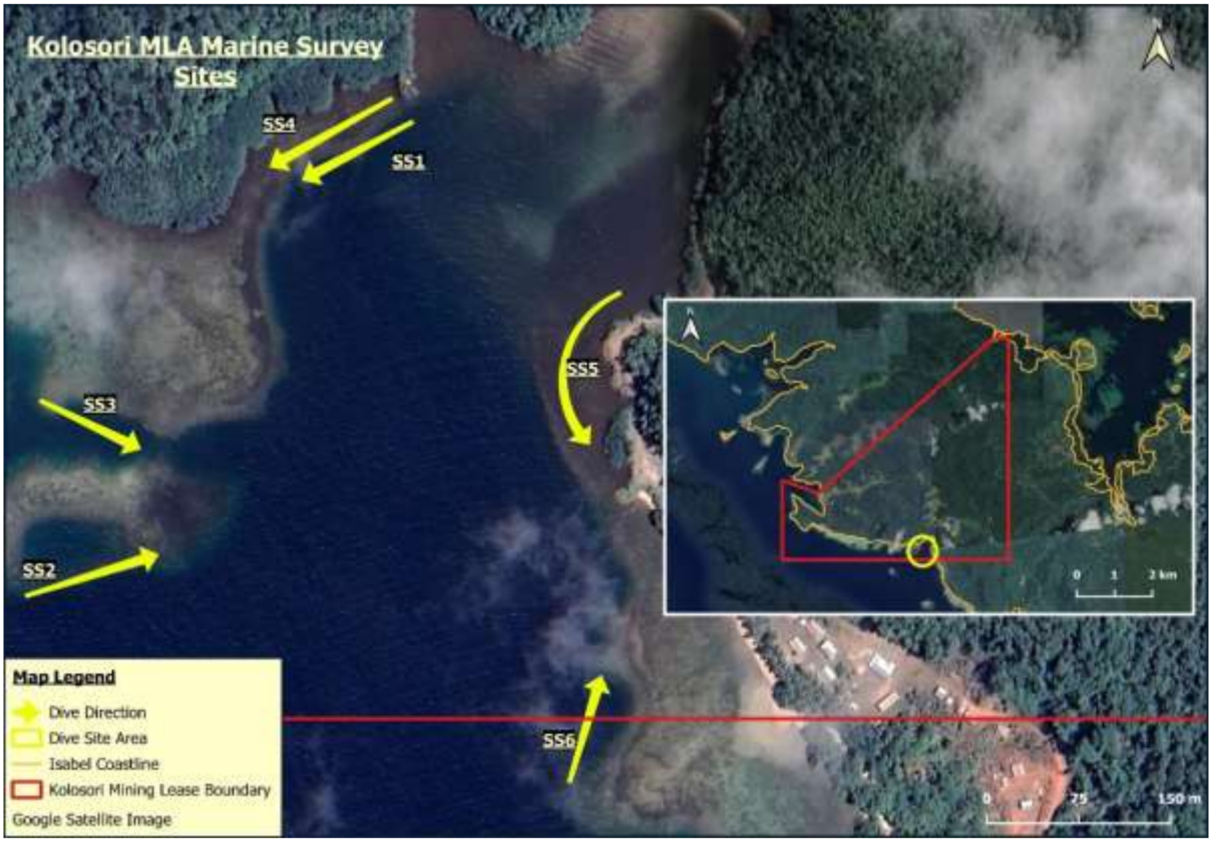


Figure 8-3: The MBSA and the sampling stations (SS)

8.6 Methodology

8.6.1 Literature review

Given the rich source of information's and data available from the past baseline assessments and EIA conducted in the Takata Tenement Area (TTA) and the San Jorge Tenement Area (STA), a thorough desktop review of all available literature, secondary information's and data to supplement this study, where necessary, and to compliment primary baseline information's gathered through field assessment and data sampling. The rationale was that these are areas located very close to the KTA, and within the Thousand Ships Bay. As such, these areas would most likely share similar features in terms of physical geographical aspects, climate conditions, ecology, habitats and biodiversity. The marine and coastal areas in the KTA are however much smaller in size in comparison to the Takata and San Jorge tenement areas.

8.6.2 Baseline Survey Design

Based on the observations made during the scoping study and the information obtained as part of the literature reviews, the following habitats were targeted during the baseline survey:

- Fringing coral reefs
- Mangrove forest
- Estuarine mudflats
- Sandy foreshore and beaches
- Shallow water habitats
- Seagrass meadows
- Soft sediment benthos
- Open bay waters

Information on a number of key marine fauna was also identified as important to develop an understanding of the existing environment within the MBSA. These marine faunas were targeted as part of the baseline surveys and included:

- Corals and other benthic biota (benthic cover)
- Coral fish and pelagic fish fauna
- Marine invertebrates
- Marine mammals
- Marine reptiles

Six sampling stations were distributed among these sites, covering a total sampling area of 4,800m². Each sampling stations (SS) consists of two transect replicates conducted at 2m-12m depth; fish assessment (UVS) was conducted at 4m width along each 50m transect replicates. The invertebrates, benthic and coral assessment was conducted at 2m width along each replicate. Photographic sampling (UPT) and films were also collected at every sampling station for thorough desktop review of data and species verifications – the identification of fish and coral species. The statistical analysis of benthic and coral cover was supported by the Coral Point Count with Excel extension (CPCe) software, supplemented by the Coral Finder BYO Guide in the classifications of coral families and genera. Opportunistic spear fishing and SCUBA dives also supported in the classification of reef assemblage profiling and in developing a species list of corals, marine invertebrates and fish fauna that is inclusive of sites that are not captured within the sampling station coverage. Refer to the Kolosori Marine Ecology Baseline Assessment Report (16-19 June, 2021) for details of the assessment methods.

8.7 Physical Marine Environment

8.7.1 The Metocean and Hydrodynamic Descriptions

The Thousand Ships Bay, in Figure 8-4: Areal view of the Thousand Ships Bay, Kolosori Bay, Huali Bay and the marine areas of the TTA in Isabel is a dual semi-enclosed bay with two openings; the opening in the north is smaller than the south opening, and connects to Kaevanga. It consists of a submerged valley which comprised of mangroves and fringed shorelines, fringing coral reefs and small islands. It is up to 50m in depth at the entrance to the Ortega Channel and the ocean floor drops rapidly to depths greater than 1,000m south of San Jorge Island.

The Kolosori and Huali bay are located north of San Jorge, on the Isabel main land and both share similar aspects in their physical environment. However, unlike Huali bay, the Kolosori bay is located within the Thousand Ships Bay and is affected by the hydrodynamics of the Thousand's Ships Bay. The semi-enclosed bay in Kolosori is sheltered from the open ocean swells and is protected from northerly Pacific Ocean swells to the south. The Thousand Ships Bay and Kolosori consists of a micro-tidal environment with a tidal plane of less than 1.5m with two high and two low tides per day on average making it a semi-diurnal. Tidal currents play a major role in driving surface current within the bay. With the influence of the Easterly winds, large waves bifurcate and contributes in moving surface currents through the southern opening and to the northern opening, which may result in the formations of large waves and swells that erodes the coastal areas in the bay. The Kaevanga passage leading to the northern opening receives the subsiding energy of the waves and swells as it moves along the narrow constricted channel. The current velocity tends to be higher during ebb and flood tide and may easily swept away canoe paddlers.

Figure 8-4: Areal view of the Thousand Ships Bay, Kolosori Bay, Huali Bay and the marine areas of the TTA in Isabel

The Huali bay hydrodynamics behaves differently. This is due to the location, orientation of the bay, coastal structures, water depth, and the presence of reefs and island barriers. Other factors may include the influence of the easterly trade wind, wind stress, tidal behaviors and climatic conditions which may affect the behavior of the waters within each bay.

8.7.2 Flushing Time

Past surveys had demonstrated that the north and south openings within the Thousand Ships Bay improved the movement of surface and sub-surface currents through the bay which had resulted in a much active and frequent flushing period within the bay than in Huali bay. However, the surface current velocity was also influenced by the high and low tides which occurs twice a day (24 hours), thus the tides a semi-diurnal. The current velocity during peak ebb tides and flood tides may range from 1 to 3 days of flushing time. However, occasionally flood tides were known to enter the northern opening through Kaevanga and exits through the southern opening, an opposite flow in current and water movement. These to-and-fro of water movement had resulted to a more frequent process of dilution and dispersion of sediments thus preventing high concentration of silt and sediments in the water column of the Thousand Ships Bay.

8.8 Marine Water Quality

Three fresh water streams discharges into the Kolosori bay, forming an estuarine system with limited water movements. Turbidity increases moving deeper into the bay where silt, mud and sand are much dominant within the benthic zones. The high presence of sediments and silt amongst the estuarine fringing reefs and benthic zones in the Kolosori bay suggest that higher sedimentations and turbidity may occur during rainy wet periods. These are the streams of Tanameko, Vuavula and Kokoilovadhe, sources of sediment run-offs into the bay and the Kolosori marine areas.

Water quality improves at the entrance of the bay and along the south and north coastlines of Kolosori where the marine areas were more exposed to the waters of the Thousand Ships Bay. Field observation had noted high turbidity at the adjacent south section of the bay where a road was constructed from the Havihua village and to the Pacific Nickel campsite in the northern plains. The exposed surface soil of the road and Cliffside's may have contributed to erosion and sedimentations within the bay.

Marine water quality sampling was undertaken as part of the Baseline water quality study. Two locations, SW12 and SW13, were sampled and results are listed in Table 7-6 to Table 7-11, and location shown in Figure 7-17.

8.9 Marine Ecology

8.9.1 Marine Habitats

In Figure 8-5 the MBSA and the dominant marine habitats identified within the KTA and the proposed seaport area:

1. Fringing coral reefs and patch reefs

2. Silt and sandy bottom

3. Mangrove forest

4. Shallow intertidal bare substrates and foreshore sandy beaches

5. Seagrass meadows

6. Estuarine water with mudflats

7. Freshwater drainage

The coastal ecology assessment is focused on the marine habitat which may be impacted due to the development plans and activities of the Pacific Nickel Project, which includes the development of the seaport within the Kolosori bay.

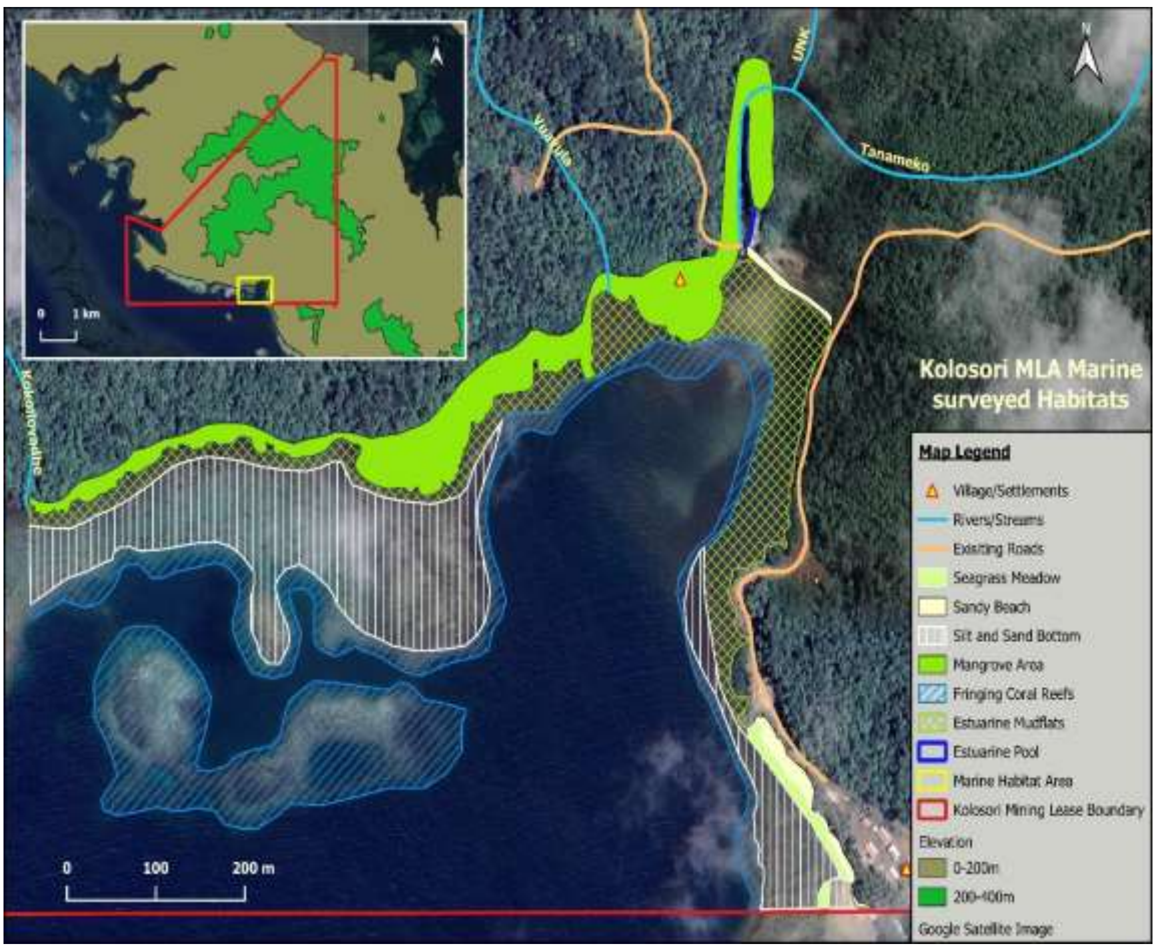


Figure 8-5: Habitat map of the MBSA in Kolosori

8.9.2 Fringing Reefs and Patch Reefs

Dead corals with algae and silt dominates the coral reefs which are mostly shallow (2m-8m) and consists of low to moderate reef complexity with a shallow silt and sand dominated intertidal zones. The coral reef slopes down to 6m to 12m (in most sites) and transitioned to a lower reef complexity and barren sand-dominated sea floor which further progressed into the deeper areas of the Thousand Ships Bay which is approximately 50m. Mean live coral cover ranged below 6% and consists of sub-massive and massive corals, whereby live colonies are distributed in the shallow reef crest area in depths of 1m to 2m, and can easily be observed from the surface in areas where clear water columns prevails. The high presence of sediments and silt (mostly >40%) in the reefs, especially in the bay may suggest the high influence of the fresh water outlets on the benthic communities and water column; turbidity and silt increases moving further into the bay.

8.9.3 Silt and Sandy Bottom

The shallow (>1m) intertidal zones of Kolosori were demarcated by the areas from the highest tide mark to the lowest tide mark where the reef crest are located, as indicated in Figure 8-5, these habitats are also dominant within the MBSA and are located in the south coastal area in front of Havihua village, and in the northern coastal area. Silt and sand were the dominant substrates, and these areas were mostly barren with few patches of lower reef complexities consisting of rubbles and dead corals.

8.9.4 Mangrove Forest

Mangrove forests are present within the bay surrounding areas and along the coastlines especially in the northern boundaries. Twenty species of mangroves have been identified in the Solomon Islands and past assessment within the Thousand Ships Bay have recorded 12 occurring species. A mangrove assessment conducted in the adjacent TTA indicated that Rhizophora spp. and Bruguiera gymnorrhiza were the dominant mangrove species within the area. It is very much likely that similar occurrence of dominant species may exist in the MBSA of Kolosori considering the close proximity and boundaries they share.

8.9.5 Seagrass Meadows

A shallow seagrass meadow is located in front of Havihua village which was sparsely distributed along the shallow turbid area along the coast. This was considered a minor habitat as the meadows are poorly dense and much confined to the shallow sea front of Havihua village. Silts and sediments had smothered portion of the seagrass meadow that are distributed close to the south section of the bay opening. Assessment within these areas had yielded very poor results of fish and invertebrate fauna thus the sampling station was excluded in the baseline data analysis component.

Past survey of the Thousand Ships Bay had documented the occurrence of 10 species of seagrass, which represents 80% of the total seagrass species diversity in the Indo-Pacific region. The study had also indicated that Thalassia hemprichii and Enhalus acoroides are the dominant species in the study, and other occurring species includes Cymodocea rotundata and Cymodocea serrulata. These are study sites close to the KTA thus the species composition would most likely be similar.

8.9.6 Estuarine Water with Mudflats

The estuarine habitats within the bay were highly turbid with lower visibility; silt and mud dominates the shallow areas thus providing a soft-sediment benthos habitat that are much common within the shallow surroundings in the bay area, and within the mangroves area. The three fresh water streams had much influence in discharging sediments into these habitats and into the bay, providing suitable conditions for macro algae's and sponges.

Studies conducted within these habitats and in other sites of the Thousand Ships Bay described healthy benthic infaunal communities dominated by Polychaete worms, bivalves, gastropods and crustaceans. Burrowing crab species such as mud crabs (Xanthilidae) and fiddler crabs (Ocypodidae) are commonly found in mangroves whilst shore crabs (Grapsidae) frequently inhabit the unvegetated soft-sediment benthos.

8.10 Marine and Coastal Flora

A thorough review of the flora species that have been recorded within the coastal lowland forest and the mangrove forest areas of the TTA – an assessment by the SIRC Ltd in 2019 – is provided in Table 8-2 Species list of marine flora observed within the TTA (KTA) Given the close proximity of the TTA, the occurring species of flora within the coastal lowland forest and mangrove forest would most likely be similar to the KTA.

Table 8-2 Species list of marine flora observed within the TTA (KTA)

Scientific Name (Genus,Species)	Habitat Description	Status (Endemic, Native, Introduced)	Conservation Status(IUCN)
Lecythidaceae (powder-puff tree)			
Barringtonia asiatica	Lowland/coastal forest	Native	Least Concerned
Barringtonia racemose	Mangrove forest	Native	Least Concerned
Rhizophoraceae (mangrove)			
Bruguiera gymnorrhiza	Mangrove forest	Native	Least Concerned
Bruguiera hainsii	Mangrove forest	Native	Critically Endangered
Rhizophora apiculate	Mangrove forest	Native	Least Concerned
Rhizophora stylosa	Mangrove forest	Native	Least Concerned
Lythraceae (ever green mangrove)			
Sonerratia spp.	Mangrove forest	Native	
Calophyllaceae (low-branching tree)			
Calophyllum inophyllum	Lowland/coastal forest	Native	Least Concerned
Calophyllum vitiense	Lowland/coastal forest	Native	Least Concerned

Scientific Name (Genus,Species)	Habitat Description	Status (Endemic, Native, Introduced)	Conservation Status(IUCN)
Burseraceae (tree)			
Cannarium spp.	Lowland/coastal forest	Native	
Casuarinacceae (tree)			
Casuarina equisetfolia	Lowland/coastal forest	Native	Least Concerned
Gymnostoma papuana	Lowland/coastal forest	Native	Least Concerned
Arecaceae (palm tree)			
Cocos nucifera	Lowland/coastal forest	Native	Not Evaluated
Heterospathe salomonensis	Lowland/coastal forest	Native	Not Evaluated
Nypa Fruiticans	Mangrove forest	Native	Least Concerned
Metroxylon spp.	Lowland/coastal forest	Native	Not Evaluated
Rutaceae (shrubs)			
Eudia spp.	Lowland/coastal forest	Native	
Moraceae (woody trees)			
Fiscus spp.	Lowland/coastal forest	Native	
Malvaceae (flowering tree)			
Heritiera littoralis	Mangrove forest	Native	Least Concerned
Hibiscus tiliaceus	Lowland/coastal forest	Native	Least Concerned
Fabacea (flowering trees)			
Intsia bijuga	Lowland/coastal forest	Native	Vulnerable
Melastomataceae (shrub-flowering plant)			
Melastoma affine	Coastal fernland/shrubland	Native	Not Evaluated
Mytaceae (shrubs-flowering)			
Myrtella beccarii	Coastal fernland/shrubland	Native	Not Evaluated
Syzgium spp.	Lowland/coastal forest	Native	
Pandanaceae (pandanus)			
Pandanus compressus	Lowland/coastal forest	Native	Not Evaluated
Pandanus tectorius	Lowland/coastal forest	Native	Least Concerned
Lamiaceae (shrub)			
Premna corymbosa	Lowland/coastal forest	Native	Not Evaluated
Vitex coffasus	Lowland/coastal forest	Native	Least Concerned
Combretaceae (known as the white mangrove family)			
Terminalia calamansanai	Lowland/coastal forest	Native	Least Concerned
Terminalia catappa	Lowland/coastal forest	Native	Least Concerned
Acanthaceae (Shrubs: undergrowth of mangroves)			
Acanthus ebracteatus	Mangrove forest	Native	Least Concerned
Pteridaceae (Undergrowth: mangrove fern)			
Acrostichum corniculatum	Mangrove forest	Native	Least Concerned
Acrostichum speciosum	Mangrove forest	Native	Least Concerned
Zingiberaceae (Undergrowth: ginger flowering plants)			
Alpinia oceanica	Lowland/coastal forest	Native	Not Evaluated
Arecaceae (palm)			

Scientific Name (Genus,Species)	Habitat Description	Status (Endemic, Native, Introduced)	Conservation Status(IUCN)
Calamus hollrungii	Lowland/coastal forest	Native	Least Concerned
Calamus stipitata	Lowland/coastal forest	Native	Not Evaluated
Cyperaceae (Undergrowth: grass-like)			
Scleria polycarpa	Coastal fernland/shrubland	Native	Not Evaluated
Asphodelaceae (flowering plant)			
Dianella ensifolia	Coastal fernland/shrubland	Native	Least Concerned
Gleicheniaceae (common fern sp.)			
Dicranopterus linearis	Lowland/coastal forest	Native	Least Concerned
Athyriaceae (vegetable fern-edible)			
Diplazium esculentum	Lowland/coastal forest	Native	Least Concerned
Convolvulaceae (creeping vines)			
Ipomea pes-caprae	Lowland/coastal forest	Native	Not Evaluated
Merremia peltata	Lowland/coastal forest	Invasive	Least Concerned
Lycopodiaceae (clubmosses)			
Lycopodium cernum	Coastal fernland/shrubland	Native	Least Concerned
Goodeniaceae (common beach shrub)			
Scaevola taccada	Lowland/coastal forest	Native	Least Concerned
Sellaginellaceae (spikemosses)			
Selaginella rechingeri	Lowland/coastal forest	Native	Least Concerned
Orchidaceae (ground orchid)			
Spathoglottis plicata	Coastal fernland/shrubland	Native	Least Concerned
Asteraceae (beach daisy)			
Wollastoria biflora	Lowland/coastal forest	Native	Least Concerned

Forty-seven species of flora, representing 29 families was recorded in the marine and coastal areas within the TTA. The most diverse in species composition was the palm family Arecaceae with a total of 6 identified species, followed by the mangrove family Rhizophoraceae which comprised of 4 species. Other occurring fauna families comprised of only 1 to 2 species. Field assessment by SIRCL (2019) had indicated the higher dominance of the genera Rhizophora spp. in the mangrove forest, forming smaller strands of short mangrove forest along the coastline and foreshore; a transition of taller mangrove forest dominated by the species of Bruguiera gymnorrhiza forms at the back of the mangrove strands, where they progressed further inland where palms, ferns, pandanus and other variety of fauna families are present.

8.11 Marine Fauna

8.11.1 Coral Diversity and Abundance

Twelve families and 21 genera of hard corals of the Order Scleractinia were observed during the study (Table 8-3). Four genera were identified for the coral family Faviidae, followed by Poritidae with 3 genera. Two genera each were recorded for the coral family Acropora, Agariciidae, Fungiidae and Mussidae; a single genus had been observed for the families Poscilloporidae, Euphyliidae, Pectiniidae, Mussidae and Trachyphyllia. Other hard corals observed within the bay include the family Millepora1, Table 8-3, commonly known as fire corals. Soft corals were also present which consist of Sinularia, Sacorphyton, Lobophyton and Anemone (Table 8-4).

A total of 21 genera were recorded during the study, however, 52% of these were not common and were sparsely distributed over a limited area in the reef. Overall, the common coral genera consist of Porites, Acropora, Leptoseris and Pachyseris which are much higher in relative abundance and were present in much larger aggregated colonies. Other common genera comprise Caulastrea, Lobophyllia, Alveopora, Leptastrea, Turbinaria, and the soft coral Sinularia and Sacorphyton, which were lower in relative abundance and occurred in smaller, less-aggregated colonies.

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Table 8-3: The list of coral families and genera recorded in the MBSA

Zooxanthelate Scleractinia			
Family	**Genus**	**Family**	**Genus**
1) Poscilloporidae	a) Stylophora	9) Mussidae	a) Cynarina
			b) Lobophyllia
2) Acroporidae	a) Acropora		
	b) Montipora	10) Faviidae	a) Caulastrea
			b) Diploastrea
3) Euphyliidae	a) Plerogrya		c) Goniastrea
			d) Leptastrea
4) Siderasteridae	a) Psammocora		
		11) Trachyphidae	a) Trachyphyllia
5) Agariciidae	a) Leptoseris		
	b) Pachyseris	12) Poritidae	a) Alveopora
			b) Goniopora
6) Fungiidae	a) Herpolitha		c) Porites
	b) Fungia		
7) Pectinidae	a) Oxypora		
8) Dendrophylliidae	a) Turbinaria		

Table 8-4 The list of Hydrozoans and Soft Coral families and genera recorded in the MBSA

Class: Hydrozoa (Non-Scleractinia)
Order : Milleporina
1) Millepora
Class: Anthozoa
Subclasses: Octocorrallia, Hexacorallia, etc. (Soft Corals)
1) Sinularia spp.
2) Sacorphyton spp.
3) Lobophyton spp.
4) Anemone

8.11.2 Marine Invertebrates Diversity and Abundance

Twelve marine invertebrate species, belonging to 8 families, were recorded during the survey (Table 8-5). Four species of the family Tridachnidae was recorded during the baseline survey which is the highest in terms of species richness. Other families consist of a single species each. All the species recorded in the survey were observed in the fringing reefs of the bay which includes the seaport area, sea front reef of the bay (north section of the entrance) and the Havihua reef. No invertebrates were encountered in the adjacent south section of the bay where the water was too shallow (<1m) with high turbidity thus the sampling station was excluded. The occurrence of invertebrates was restricted to the presence of hard subrates, water depth and turbidity.

A total of 50 individuals of marine invertebrates were counted, whereby Linkia laevigata accounts for 50% of the total count, which is the most common invertebrate in the surveyed areas, and had the highest mean density ranging between 75 to 125 individuals per hectare (Ind. ha^{-1}). Tridacna crocea was also common and accounts for 24% of the total count with a mean density which ranged from a 100 Ind. ha^{-1} and lower in the surveyed reef areas. Other species were less common and accounts for only 2% to 4% in total count with lower mean density. The occurrence and abundance of invertebrates were distributed amongst the reef areas and in habitats with hard substrates and less in silt-dominated turbid water.

Table 8-5 The list of marine invertebrate species observed in the study and their conservation status

Scientific Name (Family, Genus, Species)	Common Name	Status (Endemic, Native, Introduced)	Conservation Status (IUCN)
Aridae			
Anadora spp.	Ark Shell	Native	Not Evaluated
Diadematidae			
Diadema setosum	Sea Urchin	Native	Least Concerned
Goniasteridae			
Fromia monolis	Necklace/Tiled Starfish	Native	Not Evaluated
Holothuridae			
Pearsonothuria graeffei	Flowerfish	Native	Least Concerned
Mitridae			
Mitra mitra	Mitre Shell	Native	Not Evaluated

Scientific Name (Family, Genus, Species)	Common Name	Status (Endemic, Native, Introduced)	Conservation Status (IUCN)
Ophidiasteridae			
Linkia laevigata	Blue Starfish	Native	Not Evaluated
Ophiothrichidae			
Ophiothrix spp.	Brittle Starfish	Native	Not Evaluated
Pectinide			
Chlamys spp.	Scallop	Native	Not Evaluated
Tridachnidae			
Tridacna crocea	Boring Giant Clam	Native	Least Concerned
Tridacna squamosa	Fluted Giant Clam	Native	Conservation Dependent
Tridacna maxima	Elongate Giant Clam	Native	Conservation Dependent
Hippopus hippopus	Bear Paw Giant Clam	Native	Conservation Dependent

8.11.3 Coral Fish Diversity and Abundance

A total of 1,548 coral reef fishes were counted on the reef slopes, reef flat and patch reef within the Kolosori bay and fringing reefs, distributing 6 sampling stations and 12 transect replicates in the fish assessment. The following presents a general description of the coral reef fish communities (all recorded species) based on the sampling stations data.

This survey had recorded 23 families and 77 species (Appendix A– fish species list). Species richness ranged from 26 to 41 species at most sites.

The fish fauna of the Solomon Islands consists mainly of fish associated with coral reefs. Gobiidae being the most abundant family in terms of number of species (Allen 2006) was excluded from this study due to its very small size and cryptic behavior; the UVS method would be inefficient as fish sample collection equipment were required.

In this study the most abundant fish families in terms of number of species was Pomacentridae with 16 species, followed by Chaetodontidae (8), Apogonidae (6), Labridae (6), Scaridae (6), Acanthuridae (5), Lutjanidae (5) and Mullidae (5); the top nine families in number of species recorded. Other families ranged from 3 species or less (Figure 8-6).

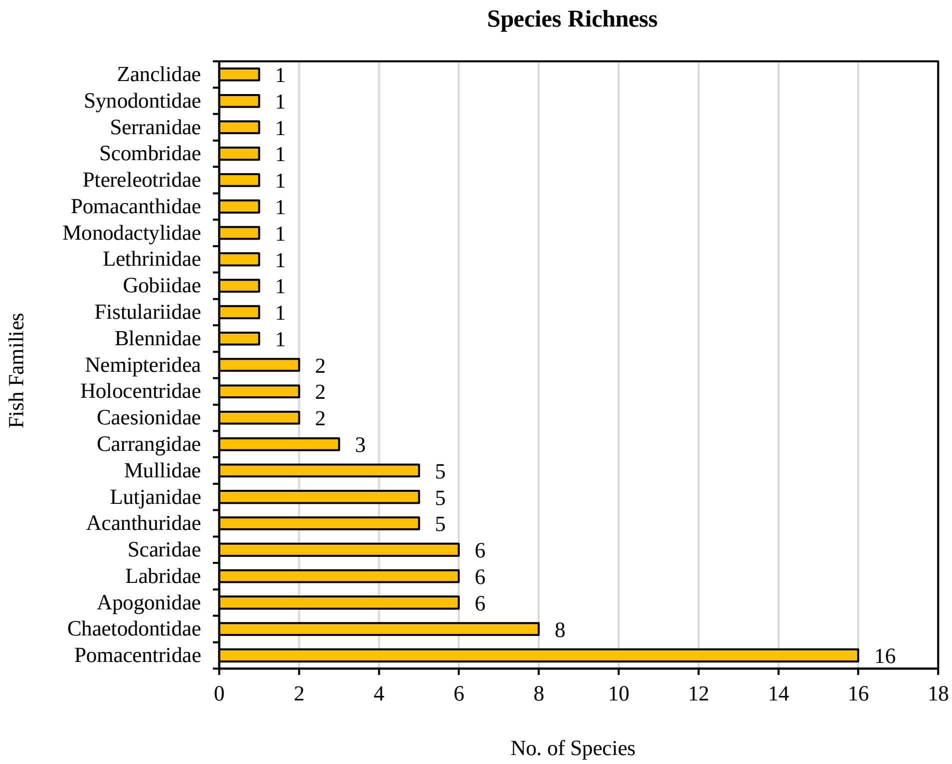


Figure 8-6: Fish families and total number of species observed.

The general trend in fish communities among the surveyed sites are dominant with Caesionidae and Pomacentridae families, with the mean densities ranging from 650 to 6,650 ind. ha^{-1} and 775 to 3,350 ind. ha^{-1} respectively, also accounting to 32.8% and 21.3% of the total fish counted. Schools of juvenile fusiliers – the species Caesio caerulaurea and Caesio teres – are common within the Kolosori fringing reefs and bay, especially where the water column is clear and not too shallow (>2m). Unlike fusiliers, Pomacentridae were observed to occur in much smaller aggregations or solitary for some species, however the highest in diversity in this study. These energetic little fish are an evident part of every coral reef community. Approximately three-quarters of the 321 known species are found in the Indo-West Pacific (Allen et al 2003).

Apogonidae accounts for 28.7% of the total fish counted with a mean density of 5,550 ind. ha^{-1}, however, they are very much confined to the patch reef located off the bay entrance where many small aggregations took shelter amongst the digitate and branching corals. Six species have been recorded and the three dominant are Apogon fragilis, Apogon leptacanthus and Apogon neotes.

Other common families, recorded in most surveyed areas were Labridae, Lutjanidae, Chaetodontidae, Carangidae, Scaridae, Acanthuridae and Mullidae. These are much larger key food fish species which were present in smaller groups, pairs or solitary, especially in areas outside the bay. The overall result indicates a lower fish count and diversity inside the bay. The most sheltered sites typically have a much depleted fish fauna, particularly those that are associated with heavy siltation (Allen, 2006).

8.11.4 Marine Mammals

During field assessment there were no encounter or sightings of any marine mammals, however, 33 marine mammals were recorded in the Solomon Islands waters. These mammals include eight baleen whales, four beaked whales and three other toothed whales, seventeen dolphin species and the dugong. The desktop review included the following species (Table 8-6) which were identified as having the potential to occur in the Jejevo marine areas – a study area north west of the Thousand Ships Bay.

Table 8-6 Marine mammals with the potential for occurrence in the MBSA

Scientific Name (Family, Genus, Species)	Common Name	Potential for Occurrence in the MBSA	Conservation Status (IUCN)
Balaenopteridae			
Balaenoptera edeni (synonym: *Balaenoptera brydei*)	Bryde's whale	Low	Least Concerned
Balaenoptera omurai	Omura's Whale	Low	Least Concerned
Megaptera novaeangliae	Humpback Whale	Low	Least Concerned
Delphinidae			
Stenella attenuate	Pantropical Spotted Dolphin	Moderate	Least Concerned
Stenella longirostris	Spinner Dolphin	Moderate	Least Concerned
Tursiops truncatus	Bottlenose Dolphin	Moderate	Least Concerned
Delphinus capensis	Long-beaked Common Dolphin	Low	Data Deficient
Delphinus delphis	Pacific Dolphin		Least Concerned
Orcinus orca	Killer Whale	Low	Data Deficient
Stenella coeruleoalba	Striped Dolphin	Low	Least Concerned
Tursiops aduncus	Indo-Pacific Bottlenose Dolphin	Low	Data Deficient
Dugongidae			
Dugong dugon	Dugong	High	Vulnerable

8.11.5 Marine Reptiles

A total of 12 marine reptiles were recorded in the Solomon Islands which comprised of five turtles, six sea snakes and the salt-water crocodile. The following species (Table 8-7) were identified as having the potential to occur in the Kolosori waters.

Opportunistic spear-gun fishing and SCUBA dives confirmed the occurrence of turtles (Chelonia mydas) and marine snakes (Laticauda sp.) in the adjacent reefs near Kolosori.

The San Jorge Islands and the Thousand Ships Bay were known to host a high number of the salt-water crocodiles, though very little information on its populace is available. Locals of Havihua village have confirmed the occasional sightings of large crocodiles passing through the Kolosori marine areas, especially at night times; small juvenile crocs were also seen foraging or taking shelter amongst the shallow mangroves and the murky estuarine habitats.

Table 8-7 Marine reptiles with the potential for occurrence in the MBSA

Scientific Name (Family, Genus, Species)	Common Name	Potential for Occurrence in the MBSA	Conservation Status (IUCN)
Acrochordidae			
Acrochordus granulatus	Wart snake	High	Least Concerned
Cheloniidae			
Chelonia mydas	Green Turtle	Moderate	Endangered
Eretmochelys imbricata	Hawksbill Turtle	Moderate	Critically Endangered
Lepidochelys olivacea	Olive Ridley Turtle	Moderate	Vulnerable
Dermochelyidae			
Dermochelys coriacea	Leatherback Turtle	Low	Vulnerable
Crocodylidae			
Crocodylus porosus	Salt-water Crcocodile	High	Least Concerned
Ealpidae			
Laticauda colubrine	Yellow-lipped Sea Krait	High	Least Concerned
Laticauda laticadata	Brown-lipped Sea Krait	High	Least Concerned

8.12 Fisheries Status and Marine Resources

8.12.1 The Local Fishery

The Havihua LMMA covered most of the marine areas within the KTA, including the Kolosori bay. The LMMA extends from the Havihua fringing reef and along the coastal areas to the northern opening of the Kolosori bay, which means that most of the fishing activities were conducted on the reefs and offshore areas outside of the KTA. The fisheries are mostly subsistence and artisanal, though very few households are engaged in the commercial fisheries that targets the Honiara fish market.

The opportunistic fisheries are not committed to a single species and may include:

- Reef and pelagic fish species
- High value marine invertebrates such sea cucumber (Holothuria species), trochus (Tectus niloticus), clams, mangrove shells, crustaceans, etc.

Fishing grounds are largely distributed within and outside of the Thousand Ships Bay. Local fisherman in Havihua had indicated some of the important fishing grounds within the Thousand Ships Bay, these areas include offshore patch reefs within the Thousand Ships Bay and fringing reefs outside of the KTA; fishing grounds were shared by multiple communities within the Thousand Ships bay. During new moon seasons, the southern opening area of the Thousand Ships Bay, adjacent to San Jorge Island, is known to gather local fisherman from nearby communities as schools of Spanish mackerel (Scomberomorus commerson), Tuna and other pelagic fish species were drawn to these fishing ground to feed on large schools of aggregating bait fish throughout the new moon season.

8.13 Key Food Fish Fauna

Important key food fish fauna in Havihua is similar to any other coastal communities' in Isabel or throughout the Solomon Islands. A socioeconomic survey of important key food fish families in Huali and Vara village had indicated the following fish families which are important to the local fishery:

- Lutjanidae (Common name: Snapper)
- Lethrinidae (Common name: Emperor)
- Chanidae (Common name: Milkfish)
- Belonidae (Common name: Needlefish)
- Carangidae (Common name: Trevally/Jacks)
- Sphyraenidae (Common name: Barracuda)
- Scombridae (Common name: Tuna & Mackerel)
- Caesionidae (common name: Fusiliers)
- Serranidae (Common name: Grouper)
- Haemulidae (Common name: Sweetlips)
- Holocentridae (Common name: Squirrelfish)
- Priacanthidae (Common name: Bigeye)
- Mullidae (Common name: Goatfish)
- Blastidae (Common name: Triggerfish)
- Carcharhinidae (common name: Sharks)

Most (80%) of the key fisheries species identified above have also been recorded within the MBSA in Kolosori, especially the coral reef dwelling fish species, thus there is high potential that the fringing reefs and marine habitat within the Thousand Ships Bay, Kolosori and Huali bay to share similar compositions in fish species diversity.

8.14 Marine Flora and Fauna of Conservation Significance

Majority of the marine and coastal flora recorded within the TTA are categorized 'least concerned' and 'not evaluated' by IUCN, except for the mangrove species Bruguiera hainsii which is listed 'critically endangered', and the flowering tree species of Intsia bijuga that was considered 'vulnerable.' These are native flora in Solomon Islands and would most likely be distributed within the KTA. An invasive species recorded in the study is the Merremia peltata, which are creeping vines that are originated in countries of the south east Asia, French Polynesia and Queensland in Australia.

The mangrove forests within the MBSA incurred some disturbance locally for over a period of time as portion of the inner section was already been cleared off. Small settlements, now, resides within the mangrove forest in the bay, north of Havihua village. Mangroves play an important role in the marine and terrestrial ecology. These forest habitats are natural deposit areas for sediments and run-offs. Moreover, mangroves act as barriers that receives high wave energy, especially from wave surges and during cyclonic seasons, it may provide some layer of protection along coastlines and foreshore areas, thus reducing impacts of erosion. A development that prioritizes the preservation of mangrove habitats may have already added an important element for mitigation measures against sedimentation and siltation's, as well as sustaining an important habitat for marine flora and fauna.

The IUCN Red List of Threatened Species was also utilized in classifying species observed in this study in terms of their global status for marine invertebrates and coral fish species. Except for corals, assessment protocols had provided classifications up to families and genera, which the IUCN Red list is not applicable. The CITES listing was utilized for coral conservation and resource management status. Appendix B to the ESIA contains CITES Appendices I, II and III listings for marine and aquatic fauna subjected to CITES listing for Solomon Islands, 26th November 2019.

Most of the marine invertebrates and coral fish recorded in the study were native to Solomon Islands and had high distribution within the Indo-Pacific regions, most of which were common and 'least concerned' or 'not evaluated' by IUCN, except the fish species Plectropomus areolatus which is listed 'vulnerable' and 3 species of giant clams (Tridachnidae) which are of 'conservation dependent', these are H. hippopus, T. maxima and T. squamosa.

The Convention on International Trade in Endangered Species of Flora and Fauna (CITES) is a guiding instrument, absorbed and enforced by the Solomon Islands Environment Act 1998, the Wildlife Protection and Management Act 2017, the Fisheries Management Act 2015 and the Fisheries Management (Prohibited Activities) Regulations 2018.

All stony corals of the family Scleractinia spp., including the coral family Milleporidae of the Order Milleporina (Class: Hydrozoa) are subjected to CITES under the second appendices (Appendices II). As such, the removal of coral reefs and the commercial exploitations of these coral species are being regulated and managed under the national authority MFMR and MECDM, which plays the respective role of the national scientific and management authority for CITES.

All Giant Clams under the family Tridachnidae were included in the Appendices II of CITES, which include the 3 species observed in the study sites. The protection of these species falls under the Fisheries Management Regulations 2018 and the Wildlife Protection and Management Act 2017.

The species and fauna covered within the Appendices II of CITES are not critically under threat of extinction. However, concerns for national management measures require immediate attention; in such cases, the assessment of local stocks and population of species to fulfil the CITES requirement for the Non-Detrimental Findings (NDF's) are required, to prevent over exploitation and local extinction of internationally traded species (exported species). In contrast, species under Appendices I (Appendix B of this EIS), are in total ban from all form of exploitation. These are critically endangered species.

8.15 Mitigation

The proposed mining project will subject to the following Environmental Management Plans which will be developed prior to the commencement of operation. These plans include:

- Sediment and erosion management plan
- Hydrocarbons spill management plan
- Acid sulfate soil management plan
- Vegetation clearing management plan
- Watrer management Plan
- Rehabiltation management plan
- Waste management Plan
- Water quality monitoring program

9 MARINE ECOLOGY BASELINE ASSESSMENT

9.1 Summary

The proposed Kolosori Tenement Area is located within the Thousand Ships Bay in Isabel Province where the Pacific Nickel Mines Ltd will establish its Nickel Mining Projects and development in the near future. This report entails the Marine and Coastal Ecology Baseline Assessment within the proposed tenement area, which also includes the proposed seaport area, north of the Havihua village.

The dominant marine habitats that were considered in the marine ecology baseline assessment were fringing reefs, patch reefs, mud flats and the estuarine habitats in the semi-enclosed bay where the proposed seaport area will be located. Intertidal bare substrates, shallow seagrass meadow (poorly dense and sparsely distributed to a shallow confined area in front of Havihua village), sandy beaches and high turbidity (low visibility, >0.5m) inner bay-estuarine water with mud flats were also present but were considered to be minor habitat type in the assessment. Six sampling stations were distributed among these sites, covering a total sampling area of 4,800m². Each sampling station (SS) consists of two transect replicates conducted at 2m-12m depth; fish assessment (UVS) was conducted at 4m width along each 50m transect replicates. The invertebrates, benthic and coral assessment was conducted at 2m width along each replicates. Photographic sampling (UPT) and films were also collected at every sampling station for thorough desktop review of data and species verifications – the identification of fish and coral species. The statistical analysis of benthic and coral cover was supported by the Coral Point Count with Excel extension (CPCe) software, supplemented by the Coral Finder BYO Guide in the classifications of coral families and genera. Opportunistic spear fishing and SCUBA dives also supported in the classification of reef assemblage profiling and in developing a species list of corals, marine invertebrates and fish fauna that is inclusive of sites that are not captured within the sampling station coverage.

Dead corals with algae and silt dominates the coral reefs which are mostly shallow (2m-8m) and consists of low to moderate reef complexity with a shallow silt and sand dominated intertidal zones. The coral reef slopes down to 6m to 12m (in most sites) and transitioned to a lower reef complexity and barren sand- dominated sea floor which further progressed into the deeper areas of the Thousand Ships Bay which is approximately 50m. Mean live coral cover ranged below 6% and consists of sub-massive and massive corals, whereby colonies are distributed in the shallow reef crest area in depths of 1m to 2m and can easily be observed from the surface in areas where a clear water column prevails. The high presence of sediments and silt (mostly >40%) in the reefs, especially in the bay may suggest the high influence of the fresh water outlets on the benthic communities and water column; turbidity and silt increases moving further into the bay.

Twenty-one genera representing 12 families of hard stony corals (Scleractinia) were recorded during the assessment and the family Faviidae and Poritidae recorded the highest in species diversity. The common corals in the reefs are the genera Porites, Acropora, Leptoseris and Pachyseris. The genera Caulastrea, Lobophyllia, Alveopora, Leptastrea, Turbinaria, and the soft coral Sinularia and Sacorphyton were also common but present in much smaller patches, less-aggregated colonies or solitary. Other benthic biota comprises four families of macro algae's whereby the families Padina and Caulerpa are much common.

Marine invertebrate distribution was mostly confined to reef areas where hard substrates are present and comprises 8 families with 12 species. Common marine invertebrates are Linkia laevigata (Blue Starfish) which accounts for 50% of the total count and Tridacna crocea (24%). Other species were less common and accounts for 2% to 4% in total count.

A total of 77 genera representing 21 families of coral fish fauna were recorded in the survey. Caesionidae (Caesio caerulaurea and Caesio teres) and Pomacentridae – the most diverse in species richness – were the dominant fish families in relative abundance. Fish diversity and abundance was higher in the coral reef areas and lower in the bay area. The larger occurring key food fish species recorded were comprised of the families of Labridae, Lutjanidae, Carangidae, Scaridae, Acanthuridae and Mullidae and were present in most of the reefs reviewed.

The majority of the marine invertebrate and coral fish fauna recorded in the assessment were listed 'least concerned' and 'not evaluated' by International Union for Conservation of Nature (IUCN), except for the fish species Plectropomus areolatus which were considered 'vulnerable' and 3 marine invertebrate species of the family Tridachnidae, T. Squamosa, T. maxima and H. hippopus, which were classified conservation dependent.' No endangered or critically endangered species were recorded.

9.2 Objectives

The objectives of this study were to conduct baseline assessment on the;

i. Benthic communities,

ii. Coral diversity and abundance,

iii. Invertebrate and vertebrate (fish) diversity and abundance.

The results will establish vital baseline information and data on the marine ecology and biodiversity of the Kolosori Tenement Area (KTA) and the proposed seaport site of the Pacific Nickel.

9.2.1 Study Areas and Sampling Sites

The Pacific Nickel proposed seaport site is located within the Thousand Ships Bay (Areal view of the Figure 9-1) east of San Jorge Islands, between Havihua village and Koloilovadhe area in the Isabel Province. The seaport site is located within the Kolosori bay, as shown in Figure 9-2. Kolosori bay is a mini-secondary bay system within the Thousand Ships Bay – the larger primary bay.

Data sampling included six sites within the bay, see Figure 9-3 six sampling stations (SS) were established covering a total sampling area of 4,800 m^2. Where SS1 and SS4 are located is the identified seaport site.

Areal view of the

Figure 9-1 Kolosori and Thousand Ships Bay, Isabel Province.

Figure 9-2 Areal view of Pacific Nickel proposed seaport site in Kolosori, Isabel Province (2021).

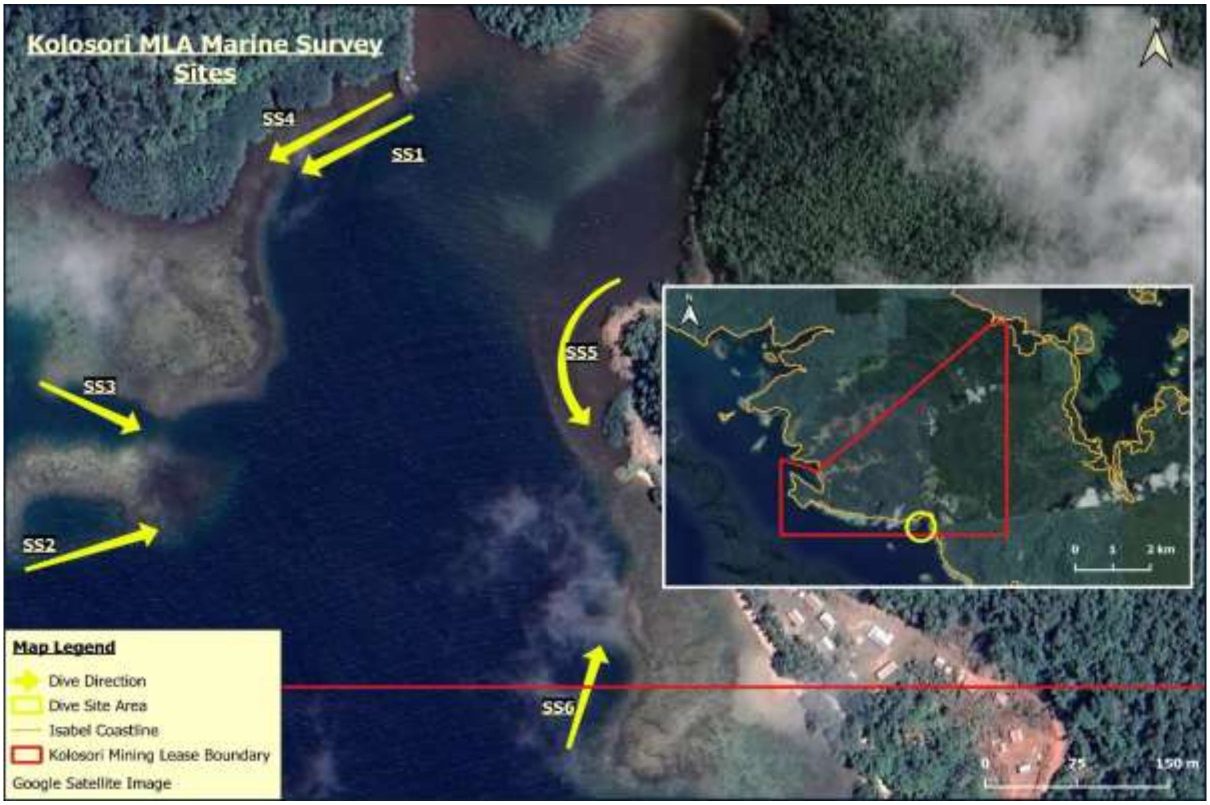


Figure 9-3 The Marine Baseline Study Area (MBSA) and the Sampling Stations (SS) site.

9.3 Methodology

9.3.1 Benthic Community Assessment

The benthic assessment sampling design involved the integration of a number of standardized methods to capture representative data samples at the target sites, while enabling coral resources by specific taxa to be assessed in sufficient detail. Corals were identified at the genus level based on the Indo-Pacific Coral Finder1 BYO guides.

The methods employed (Figure 9-4 a and Figure 9-4 b) were:

Method 1: UPT: The Under Water Photographic Sampling method with Transects (Figure 9-4 a). A 50m x 2m transect line was laid on the seafloor within the depths of 2m-12m; photographic samples of the benthic cover (Table 9-4 b) was taken along the transect per meter intervals, thus total of 502 photos per transect. Two replicates were established per sampling station (SS) at each site. (The Indo-Pacific Coral Finder is a Visual Decision Tool that brings reliable genus level identification. Using a visual navigation system the Coral Finder requires nothing more than a keen eye to get results (https://www.byoguides.com/coralfinder/).

Method 2: The photos were analyzed using the Coral Point Count with Excel extension (CPCe) computer software. The Coral Point Count with Excel extension is a windows-based software that provides tools for the determination and quantification of benthic and coral cover using underwater images. Thirty random points were spatially distributed on each photographic sample (Figure 9-5), and each point was broadly classified into major benthic/substrate cover, up to the genus level where corals are present. (Not limited to 50 photos. Additional sampling photos were being collected for coral species where thorough identifications of the corallite structure were required. These are photo-imagery captured in close-up view – macroscopic mode of the underwater camera (T5 Olympus canon).

Method 3: Indo-Pacific Coral Finder Tool: the coral finder visual tool was utilized in the classifications of coral taxa's by genus, supplemented by available sources of references by Veron and online databases (Supplementary sources for coral species classifications include the online databases: Corals of the World (http://www.coralsoftheworld.org/) and Coralpedia (https://coralpedia.bio.warwick.ac.uk/))

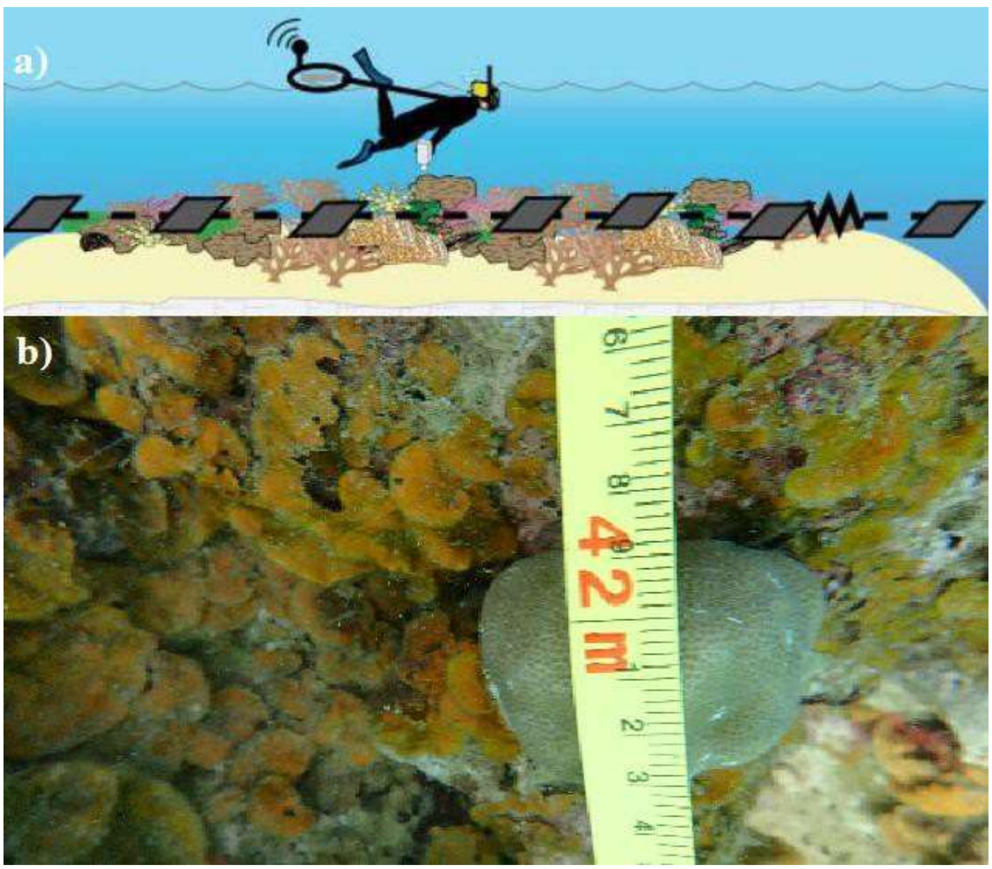


Figure 9-4 (a) Underwater Photographic Sampling with Transect (UPT) illustration; (b) Transect being laid on sea floor

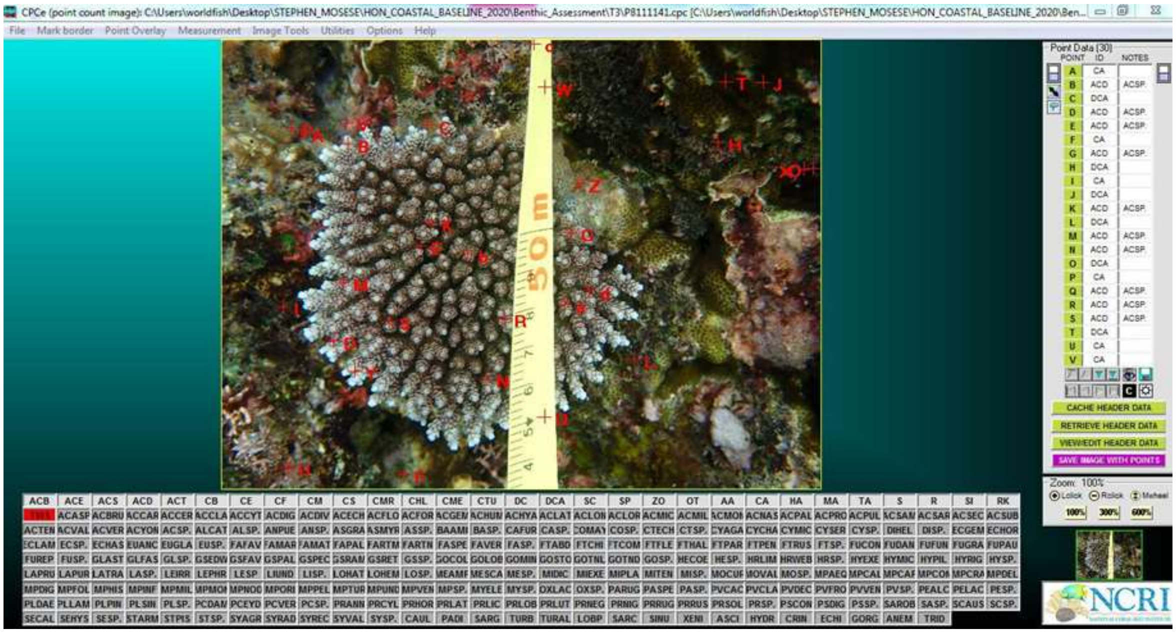


Figure 9-5 CPCe software being utilized in the analysis of photographic samples of benthic cover and corals

9.3.2 Invertebrate Assessment

The invertebrate survey was conducted along the same transect and replicates as in benthic and fish assessment. Data sampling are made within the 2m width and along the 50m transects. Species occurrences and individual counts were focused on large echinoderms, gastropods, bivalves and other species that are visible and non-microscopic. Details of the assessment methods are found in Pakoa et al 2014, SPC manual on tropical marine invertebrate resource assessment.

9.3.3 Fish Assessment

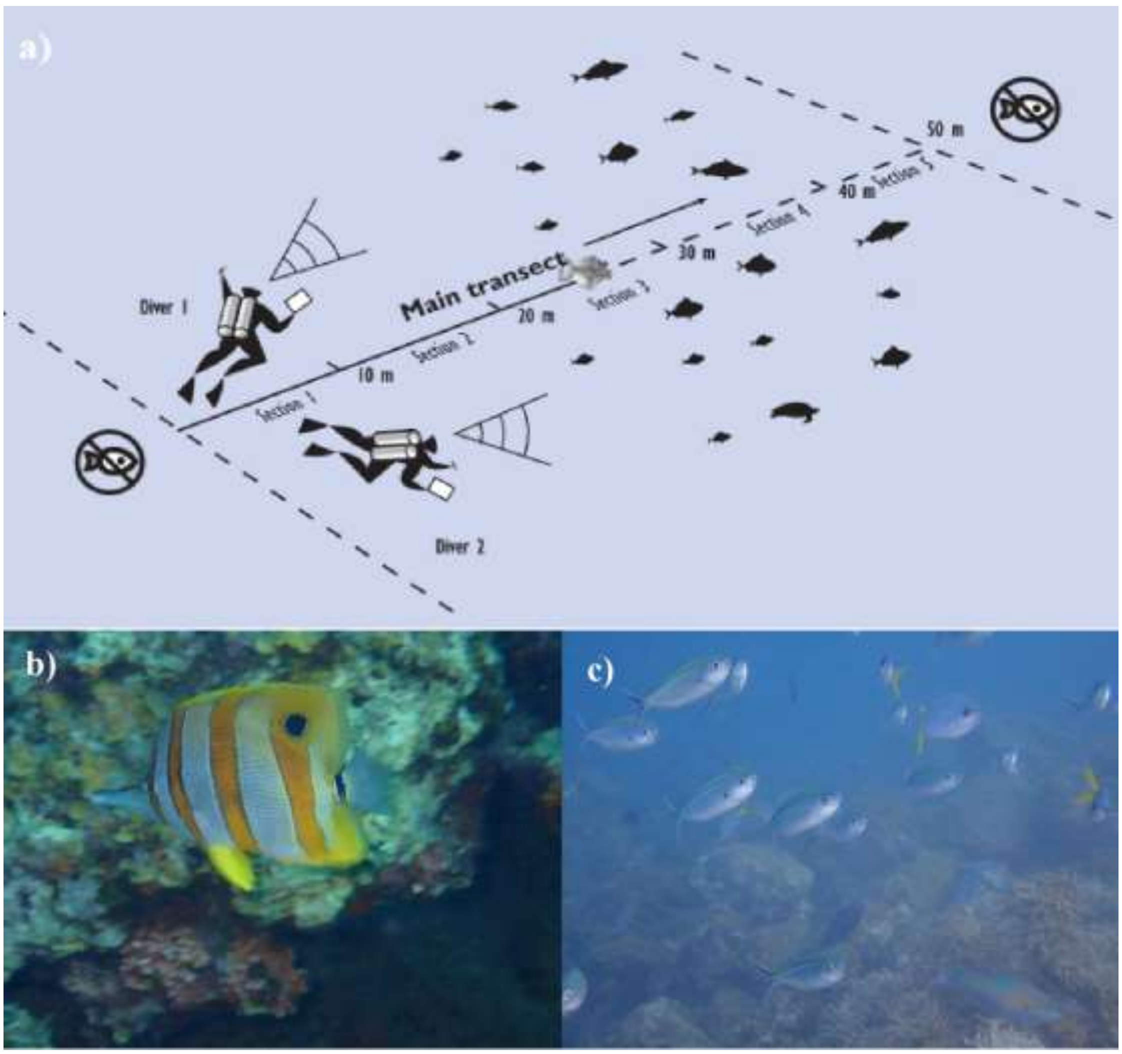
The Underwater Visual Fish Census Survey (UVS) was based on SPC standard method, see Labrosse *et al*2002 (Figure 9-7 a). In this study, each transect is 50m in length and 4m in width. With SCUBA gears, surveyswere conducted within the 4m width and along the 50m transect line, giving an area of 200m² per transect.Three transect replicates were being deployed per sampling station (SS), and a maximum of two to four

[3] Supplementary sources for coral species classifications include the online databases: Corals of the World (http://www.coralsoftheworld.org/) and Coralpedia (https://coralpedia.bio.warwick.ac.uk/).

sampling stations were established for each site. Underwater videos and photographic samples of reef fin-fish species were also gathered with underwater cameras for thorough desktop analysis (Figure 9-6b and Figure 9-6c).

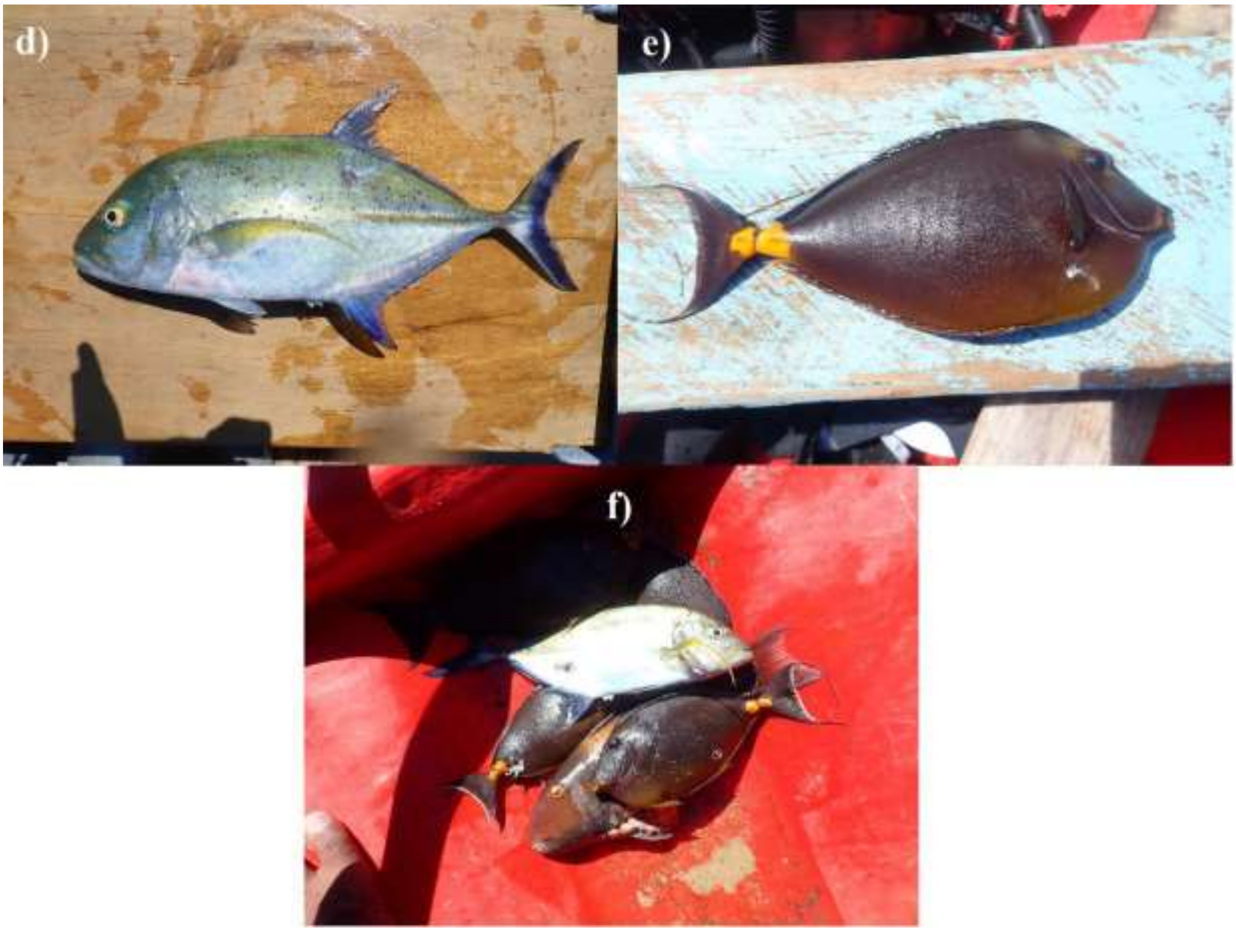
Fish data sampling were being conducted within 2m-12m depth zone where highest numbers of fish are consistently being harbored. Very small fish species were excluded from sampling and data collections. For instance, the fish family Gobiidae were not being adequately included in sampling and data collection due to their size and cryptic habits of many species.

Opportunistic spear gun fishing had also supplemented the visual survey with few occasional collections of larger non-cryptic fish species (Figure 9-7d, Figure 9-7e and Figure 9-7f). This provides the opportunity for better identifications of species and data sampling.



Photos (b) and (c): Stephen A. Mosese

Figure 9-6 (a) Underwater Visual Fish Census Survey (UVS) illustration with fish photographic samples of (b) Chelmon rostratus and (c) a school of fusiliers with two mixed species, Caesio caerulaurea and Caesio teres, including a Chlorurus capistratoid



Photos (d), (e) and (f): Stephen A. Mosese

Figure 9-7 Collections of fish samples (d: Caranx melampygus, e: Naso literatus and f: mixed collection of species) obtained through opportunistic spear-gun fishing to support species identifications and data collections of large non- cryptic fish groups

9.3.4 Survey Coverage

The detailed descriptions of Sampling Station (SS) locations, site description, coordinates and total sampling area per biotic and abiotic components, the ecological parameters selected for the study are provided in Table 9-1.

Table 9-1 Survety Coverage

Sampling Station ID (SS)	Site Description	Number of replicates	Start point (r1)		End point (r2)		Fish: Total Sampling Area (m^2)	Invertebrates: Total Sampling Area (m^2)	Benthic / Coral:Total Sampling Area (m^2)
			Latitude	Longitude	Latitude	Longitude			
a) SS1	Proposed seaport site; shallow reef slope, visibility (4m); average depth 4m.	2	08.46021°	159.73407°	08.46067°	159.73325°	400	200	200
b) SS2	Proposed seaport site, mid-section bay entrance; shallow reef slope, visibility (4m); average depth 4m.	2	08.46380°	159.73120°	08.46348°	159.73219°	400	200	200
c) SS3	Proposed seaport site, seafront section; shallow fringing reefs, visibility (3m); average depth 6m.	2	08.46233°	159.73131°	08.46269°	159.73206°	400	200	200
d) SS4	Proposed seaport site, mangrove front; shallow reef flat, low visibility (<1m); very shallow, average depth <1m.	2	08.46004°	159.73392°	08.46056°	159.73300°	400	200	200
e) SS5	Adjacent seaport site; shallow mud flats with sand, low dense seagrass meadow, low visibility (<1m); very shallow, average depth <1m.	2	08.46155°	159.73563°	08.46265°	159.73538°	400	200	200
f) SS6	Havihua protected reefs; shallow reef slope, clear visibility (7m); average depth 8m.	2	08.46520°	159.73524°	08.46439°	159.73547°	400	200	200
	Total:	12					2,400	1,200	1,200

9.3.5 Literature review

Given the rich source of information's and data available from the past baseline assessments and EIA conducted in the Takata Tenement Area (TTA) and the San Jorge Tenement Area (STA), a thorough desktop review of all available literature, secondary information's and data to supplement this study, where necessary, and to compliment primary baseline information's gathered through field assessment and data sampling. The rationale was that these are areas located very close to the KTA, and within the Thousand Ships Bay. As such, these areas would most likely share similar features in terms of physical geographical aspects, climate conditions, ecology, habitats and biodiversity. The marine and coastal areas in the KTA are however much smaller in size in comparison to the Takata and San Jorge tenement areas.

9.3.6 Baseline Survey Design

Based on the observations made during the scoping study and the information obtained as part of the literature reviews, the following habitats were targeted during the baseline survey:

- Fringing coral reefs
- Mangrove forest
- Estuarine mudflats
- Sandy foreshore and beaches
- Shallow water habitats
- Seagrass meadows
- Soft sediment benthos
- Open bay waters

Information on a number of key marine fauna was also identified as important to develop an understanding of the existing environment within the MBSA. These marine faunas were targeted as part of the baseline surveys and included:

- Corals and other benthic biota (benthic cover)
- Coral fish and pelagic fish fauna
- Marine invertebrates
- Marine mammals
- Marine reptiles

Six sampling stations were distributed among these sites, covering a total sampling area of $4,800m^2$. Each sampling stations (SS) consists of two transect replicates conducted at 2m-12m depth; fish assessment (UVS) was conducted at 4m width along each 50m transect replicates. The invertebrates, benthic and coral assessment was conducted at 2m width along each replicate. Photographic sampling (UPT) and films were also collected at every sampling station for thorough desktop review of data and species verifications – the identification of fish and coral species. The statistical analysis of benthic and coral cover was supported by the Coral Point Count with Excel extension (CPCe) software, supplemented by the Coral Finder BYO Guide in the classifications of coral families and genera. Opportunistic spear fishing and SCUBA dives also supported in the classification of reef assemblage profiling and in developing a species list of corals, marine invertebrates and fish fauna that is inclusive of sites that are not captured within the sampling station coverage. Refer to the Kolosori Marine Ecology Baseline Assessment Report (16-19 June, 2021) for details of the assessment methods.

9.4 Data Analysis and Discussions

9.4.1 The Dominant Habitats

Dominant marine habitats in the Kolosori Tenement Area (KTA). are shown in Figure 9-8. The Kolosori bay is a semi-enclosed bay system hosting seven smaller habitats, Figure 9-9. With three smaller fresh water streams/drainages the water system is mixed fresh water, an estuarine system with limited water movements. Turbidity increases moving deeper into the bay where silt, mud and sand are much dominant within the benthic zones. Flushing period of silt and sediments are highly dependent on the tidal current and the easterly wind-driven surface water currents within the Thousand Ships Bay, which runs from the south and through the north opening channels of the Kaevanga passage (Areal view of the Figure 9-1).

The important marine habitats identified within the KTA are:

1. Fringing coral reefs and patch reefs
2. Silt and sandy bottom
3. Mangrove forest
4. Shallow habitat
5. Seagrass meadows
6. Estuarine water with mudflats
7. Freshwater drainage

9.4.2 Fringing Reefs and Patch Reefs

Dead corals with algae and silt dominates the coral reefs which are mostly shallow (2m-8m) and consists of low to moderate reef complexity with a shallow silt and sand dominated intertidal zones. The coral reef slopes down to 6m to 12m (in most sites) and transitioned to a lower reef complexity and barren sand-dominated sea floor which further progressed into the deeper areas of the Thousand Ships Bay which is approximately 50m. Mean live coral cover ranged below 6% and consists of sub-massive and massive corals, whereby live colonies are distributed in the shallow reef crest area in depths of 1m to 2m, and can easily be observed from the surface in areas where clear water columns prevails. The high presence of sediments and silt (mostly >40%) in the reefs, especially in the bay may suggest the high influence of the fresh water outlets on the benthic communities and water column; turbidity and silt increases moving further into the bay.

9.4.3 Silt and Sandy Bottom

The shallow (>1m) intertidal zones of Kolosori were demarcated by the areas from the highest tide mark to the lowest tide mark where the reef crest are located, these habitats are also dominant within the MBSA and are located in the south coastal area in front of Havihua village, and in the northern coastal area. Silt and sand were the dominant substrates, and these areas were mostly barren with few patches of lower reef complexities consisting of rubbles and dead corals.

9.4.4 Mangrove Forest

Mangrove forests are present within the bay surrounding areas and along the coastlines especially in the northern boundaries. Twenty species of mangroves have been identified in the Solomon Islands and past assessment within the Thousand Ships Bay have recorded 12 occurring species. A mangrove assessment conducted in the adjacent TTA indicated that Rhizophora spp. and Bruguiera gymnorrhiza were the dominant mangrove species within the area. It is very much likely that similar occurrence of dominant species may exist in the MBSA of Kolosori considering the close proximity and boundaries they share.

9.4.5 Seagrass Meadows

A shallow seagrass meadow is located in front of Havihua village which was sparsely distributed along the shallow turbid area along the coast. This was considered a minor habitat as the meadows are poorly dense and much confined to the shallow sea front of Havihua village. Silts and sediments had smothered portion of the seagrass meadow that are distributed close to the south section of the bay opening. Assessment within these areas had yielded very poor results of fish and invertebrate fauna thus the sampling station was excluded in the baseline data analysis component.

Past survey of the Thousand Ships Bay had documented the occurrence of 10 species of seagrass, which represents 80% of the total seagrass species diversity in the Indo-Pacific region. The study had also indicated that Thalassia hemprichii and Enhalus acoroides are the dominant species in the study, and other occurring species includes Cymodocea rotundata and Cymodocea serrulata. These are study sites close to the KTA thus the species composition would most likely be similar.

9.4.6 Estuarine Water with Mudflats

The estuarine habitats within the bay were highly turbid with lower visibility; silt and mud dominates the shallow areas thus providing a soft-sediment benthos habitat that are much common within the shallow surroundings in the bay area, and within the mangroves area. The three fresh water streams had much influence in discharging sediments into these habitats and into the bay, providing suitable conditions for macro algae's and sponges.

Studies conducted within these habitats and in other sites of the Thousand Ships Bay described healthy benthic infaunal communities dominated by Polychaete worms, bivalves, gastropods and crustaceans. Burrowing crab species such as mud crabs (Xanthilidae) and fiddler crabs (Ocypodidae) are commonly found in mangroves whilst shore crabs (Grapsidae) frequently inhabit the unvegetated soft-sediment benthos.

The marine ecology baseline assessment is focused on the marine habitat which may be impacted due to the development plans and activities of the Pacific Nickel, which includes the development of the seaport within the Kolosori bay, Figure 9-10 a and Figure 9-10c

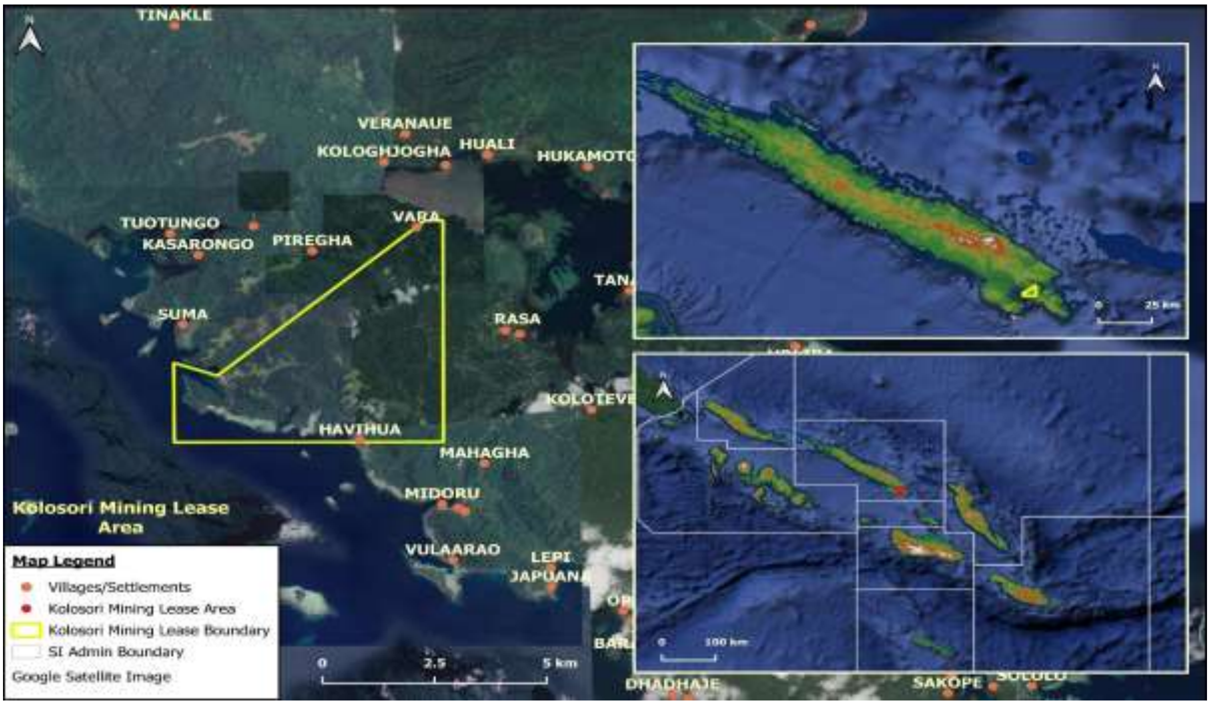


Figure 9-8 The Kolosori Tenement Area (KTA) – the mining area of influence.

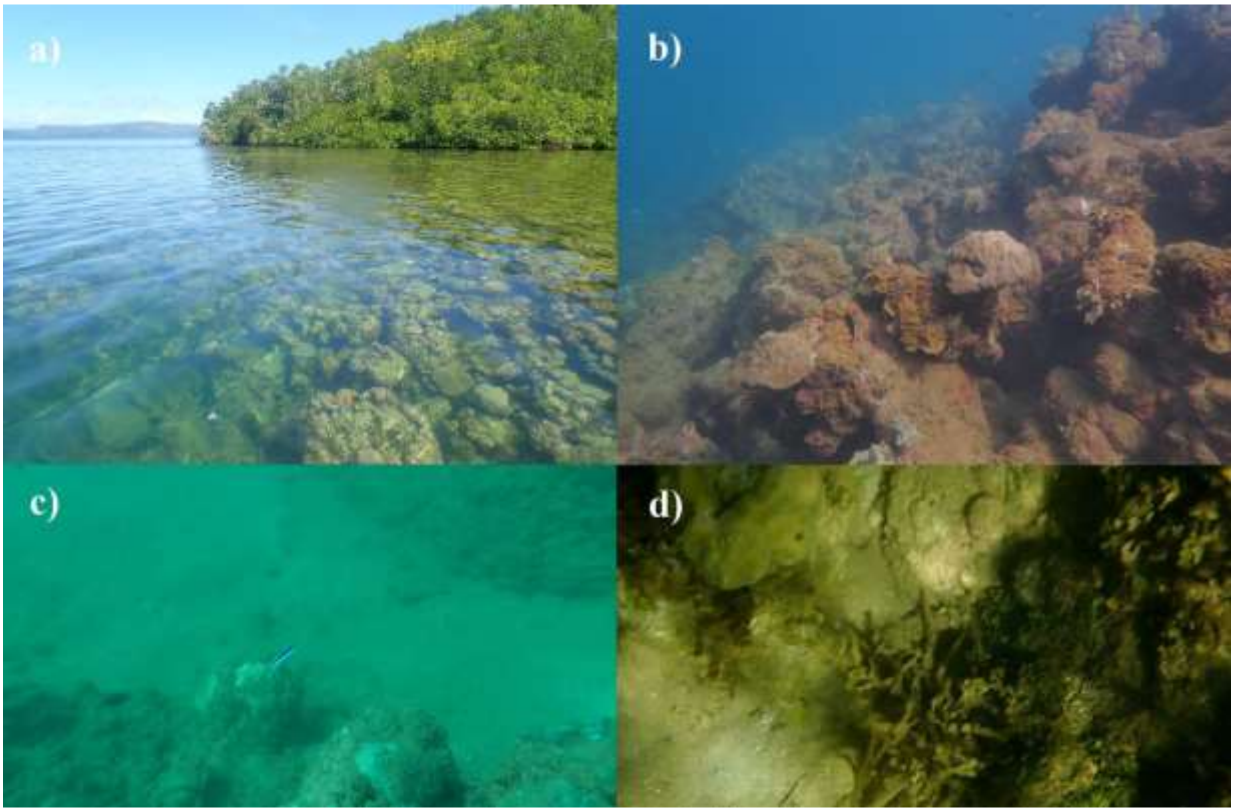
Figure 9-9 The Kolosori marine habitat map (2021).

Source: Isaac Qoloni.

Figure 9-10 Areal view of the (a) Kolosori bay and the proposed seaport area (b) and (c).

9.5 Coral Reef Assemblages and Benthic Communities

The identified area for the proposed seaport is located on a shallow estuarine fringing reef, in front of a mangrove forest in the western section of the bay as indicated in Figure 9-9 and Figure 9-10, where SS1 and SS4 were established. The seaport area consists of a moderate to lower reef complexity, Figure 9-11 . The shallower reef flat surfaces (Figure 9-11a) and the reef slope (Figure 9-11 b) hosts are moderate reef complexity which are dominant with massive and submassive corals along the shallow reef crest zone; silt, sand and other algal assemblage were common substrates within these reefs, covering the shallow intertidal zones and progressed towards the mangrove shoreline where a transition of silt to mud were observed at the mangrove areas. The reef slopes down to approximately 4m to 6m water depth where it transitioned to a much lower reef complexity (Figure 9-11c) which are dominated with silt, dead corals and macro algae (Figure 9-11d). Smaller patches and colonies of live massive and submassive corals can be observed sparsely distributed amongst the shallow reef crest zone. These are mostly corals of the genera Porites spp.



Photos: Stephen A. Mosese

Figure 9-11 (a) The shallow estuarine reef community where the proposed seaport site is located; (b) Moderate reef complexity at the shallow and deeper reef slope; (c) the reef slopes are demarcated by a transition to lower reef complexity with dominant substrate of (d) silt, dead corals with algae and other macro algae appendages at 4m to 6m water depth.

Results in Figure 9-12 indicated that silt, rubble, dead coral with algae and macro algae are the dominant substrates within these reef. In SS1 and SS4 (Figure 9-12A and Figure 9-12B) silt accounts for 57.10% ± 8.64% and 44.49% ± 13.59% in mean coverage respectively, followed by rubble (SS4:

30.51% ± 21.28%) and dead coral with algae (SS1: 26.74% ± 6.34%). Live coral cover accounts for less than 3% in mean cover within the sampling stations and having the dominant coral growth forms of massive and submassive corals. Other coral growth forms observed were encrusting and Acropora branching corals with the mean cover of less than 1%. The high presence of silt within this site is due to the limited water movements, erosion and the influence of the three fresh water drainage which may have been the primary source for sediment discharge into these system, especially during rainfalls. Turbidity is higher moving into the bay as the water is more brackish with higher silt and muddy substrates.

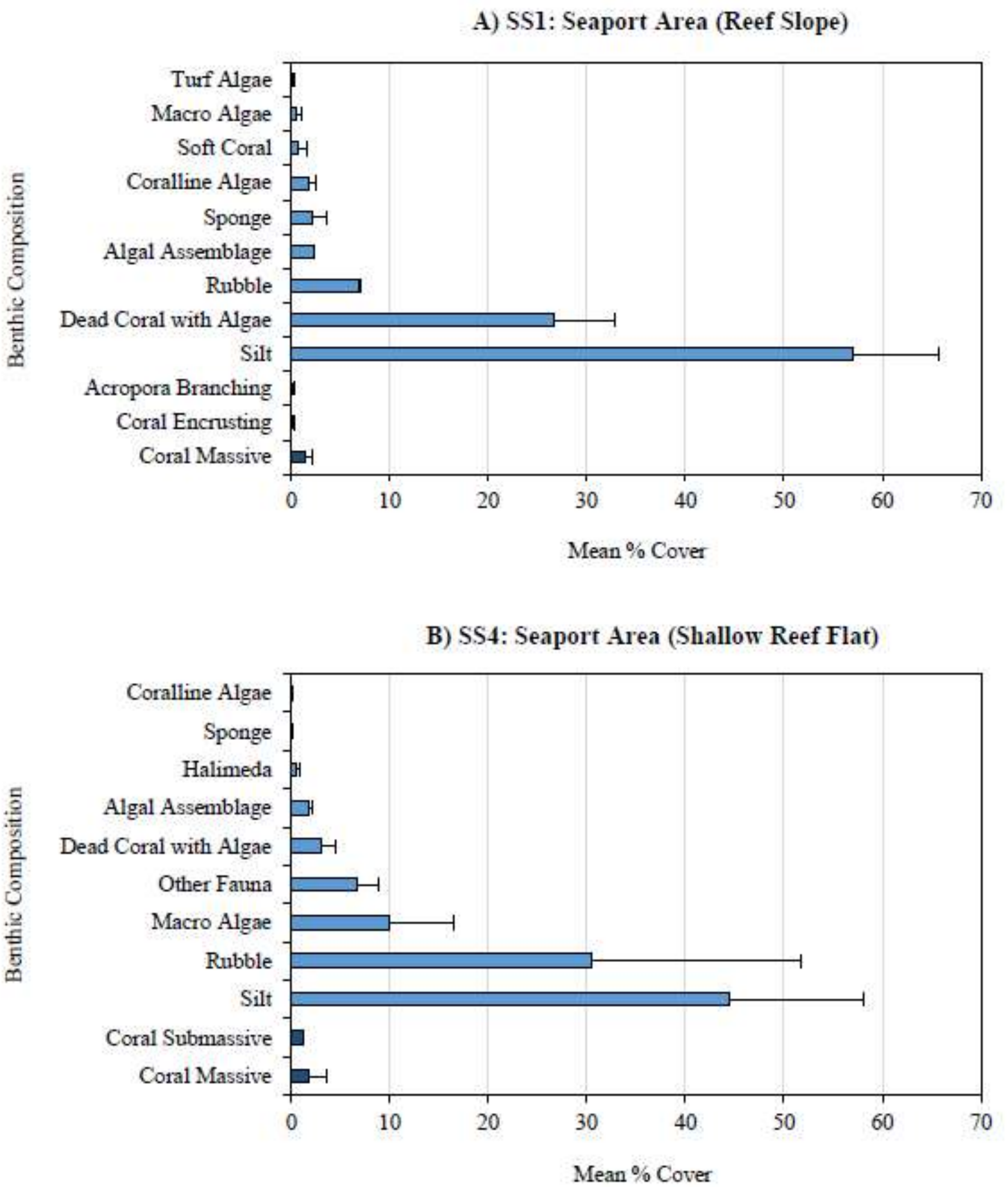
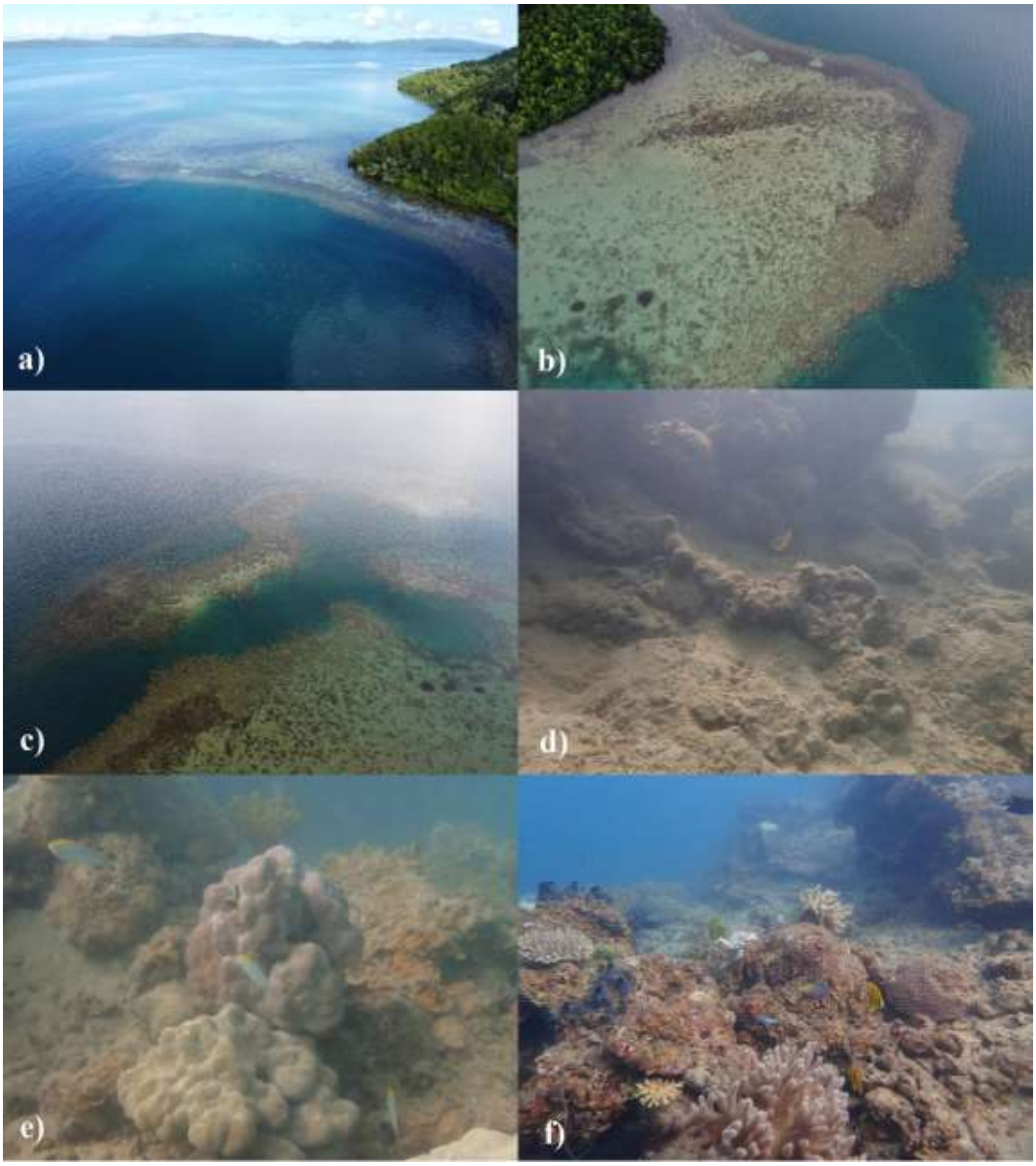


Figure 9-12 Mean benthic cover (± SE) of the proposed seaport site (A and B) within the bay.

In Figure 9-13a, the fringing reef extended approximately 200m from the proposed seaport area towards the open bay entrance (Figure 9-13b) at the western section where SS3 was established at the shallow reef slope. Situated in front of the seaport area, where SS2 was established, a shallow patch reef (Figure 9-13c) of approximately 100m width and 400m length extends along the western section, adjacent to the fringing reefs along the coastlines and bay entrance.

Low to moderate reef complexity (Figure 9-13d, Figure 9-13e and Figure 9-13f) was observed within the fringing reef slopes and the patch reef in the seaport sea front. Reef slope had dropped to 8m and 12m water depth; Silt, dead corals with algae and other macro algae appendages are the dominant substrate. Some live coral patches of submassive and massive corals can be observed in the shallow reef crest area where they are sparsely distributed.



Photos: Isaac Qoloni: (a), (b) and (c); Stephen A. Mosese: (d), (e) and (f)

Figure 9-13 (a) The shallow estuarine reef extended approximately 200m from the proposed seaport site and into the Thousand Ship Bay; (b) aerial view of the extended fringing reef at the seaport sea front; (c) patch reef located at the bay entrance, adjacent to the main land fringing reefs; (d) lower reef complexity with dominant silt and dead coral substrate within the seaport sea front fringing reef slope; (e) and (f) shows moderate reef complexity with silt and dead corals with algae dominant substrates within the fringing reef slope and the patch reef at 8m to 12m water depth.

Figure 9-15C shows that the fringing reef and patch reef within the seaport sea front consists of Silt (40.71% ± 4.17%) and dead coral with algae (32.50% ± 5.39%) as the dominant substrates, followed by algal assemblage (8.14% ± 2.37%) and rubble (7.69% ± 1.79%). Live coral cover accounts for 4.62% ± 2.44%, having five common coral growth forms that includes submassive, branching, foliose, Acropora branching and massive corals. Other substrates were below 3% in mean coverage.

Live coral accounts for 1.47% ± 0.09% within the patch reef at the bay entrance, and a higher composition of dead corals with algae (40.71% ± 4.17%), rubble (40.71% ± 4.17%) and algal assemblage (40.71% ± 4.17%) had been indicated as in Figure 9-14D.

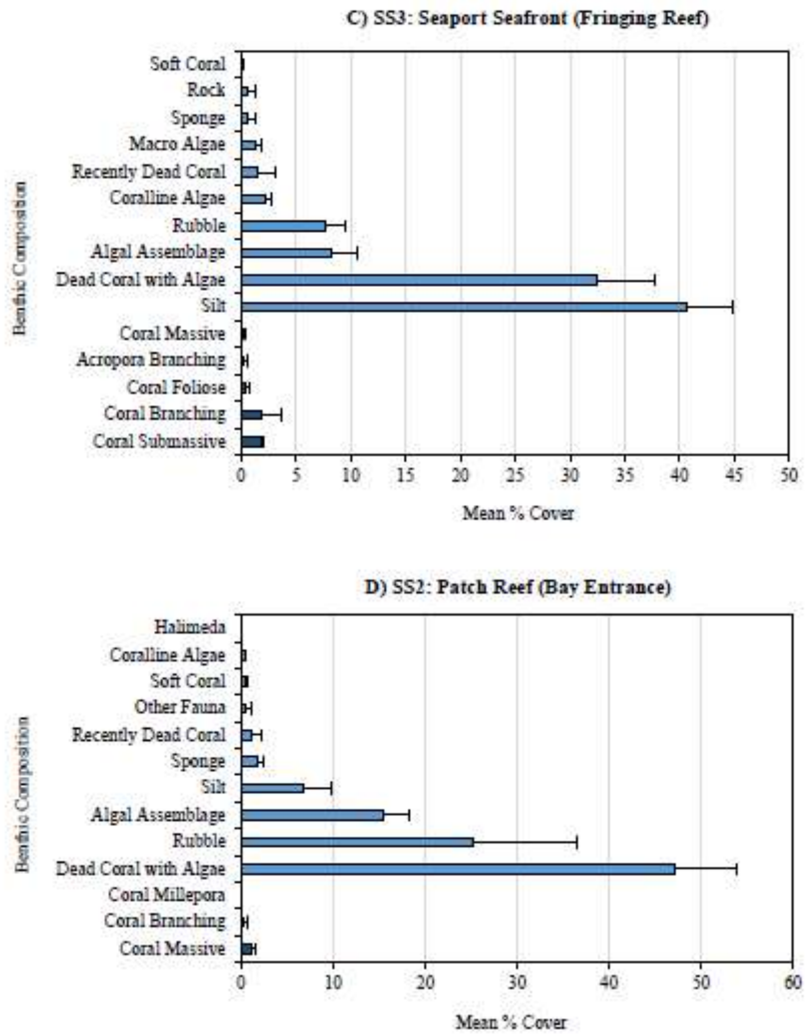
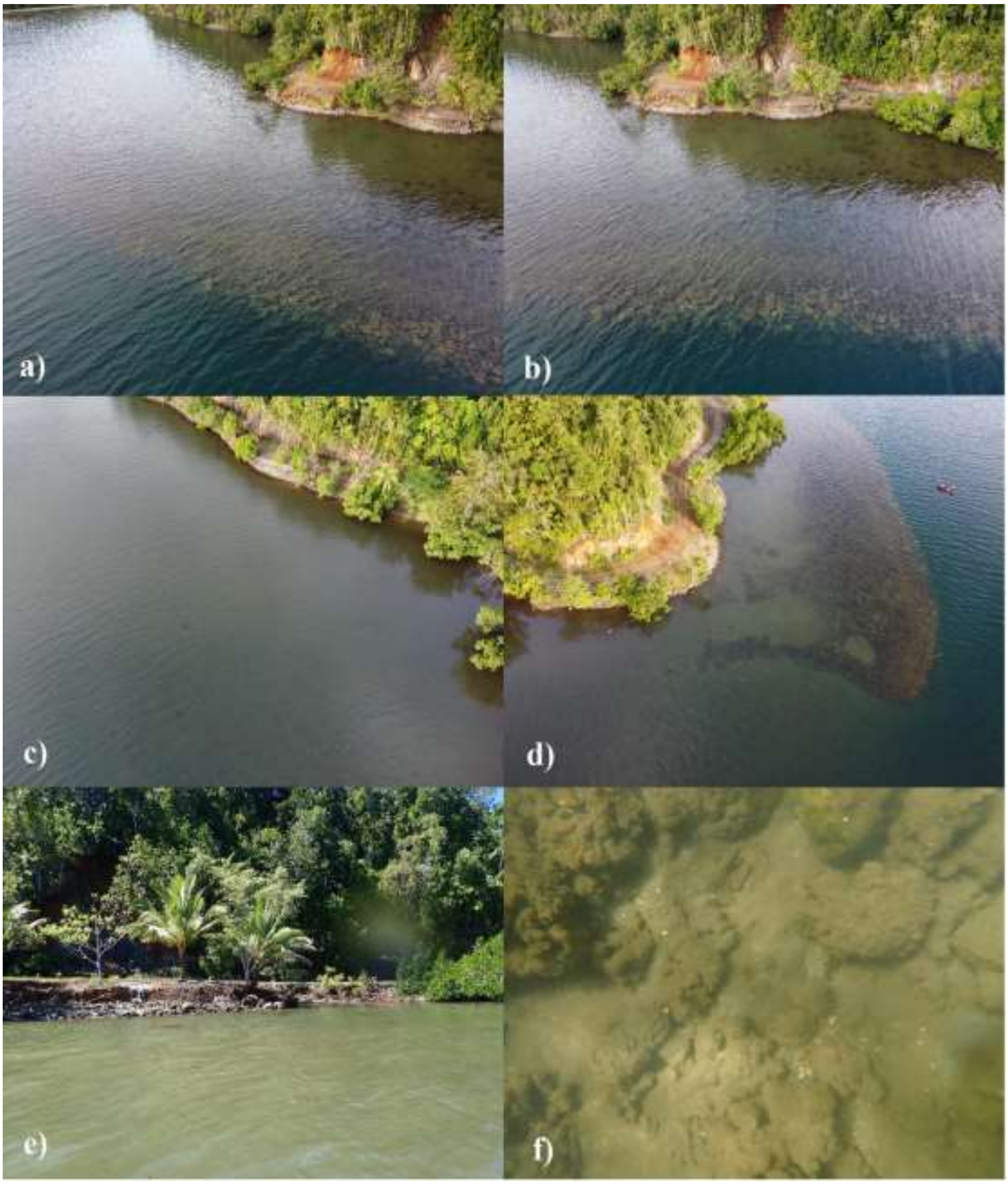


Figure 9-14 Mean benthic cover (± SE) of the fringing and patch reef at the seaport sea front and bay entrance (C and D)

The south section of the bay, adjacent to the proposed seaport area are shown in Figure 9-15a -Figure 9-15 d; the low complexity fringing reef extends 40m to 50m to a shallow reef crest area that slopes down into the bay. High composition of silt and sediments was observed within the shallow intertidal area. A road was constructed along the bay foreshore from the Havihua village in the south and to the north plains where the Sunshine Mining Co. camp is located. The exposed surface soil of the road and the cliff's may have contributed to the sedimentation in the reefs due to erosion. Moreover, smaller streams and water outlets were observed along the road and cliff side, discharging turbid water into the bay.



Photos: Isaac Qoloni: (a), (b), (c), and (d); Stephen A. Mosese: (e) and (f).

Figure 9-15 (a), (b) and (c) shows the south section of the bay, adjacent to the seaport area; (d) road developments from the Havihua village to the Pacific Nickel camp; (e) high water turbidity; (f) corals and benthic substrates that are smothered by silt.

The visibility in the water column is generally low (>0.1m), as shown in Figure 9-15 e, suggesting that the benthic communities (Figure 9-15f) were influenced by silt and sediments from the streams or mobilised seabed sediment in the bay.

Macro algae, Halimeda, coralline algae and other algal assemblage were all common substrates in the barren, low complexity fringing reef in this area of the bay.

Silt is the dominant substrate, and accounts for 42.22% ± 0.33% (Figure 9-14) in mean cover; rubble (24.64% ± 3.49%) was also common, forming consolidated patches or scattered in loose bits and pieces within the intertidal and reef crest zone. Macro algae, dead coral with algae and recently dead corals accounts to less than 12% of the mean cover. Mean live coral cover was measured at less than 5% and mainly consist of submassive (4.68% ± 1.22%) and massive (>1%) corals. Hard coral occurrence was very much confined to the shallow reef crest zone, as the corals that have/had been present within the intertidal zone were totally/or partly being smothered by silt. Algal assemblage and other substrates (coralline algae, rocks and Halimeda) were less than 2% in mean coverage.

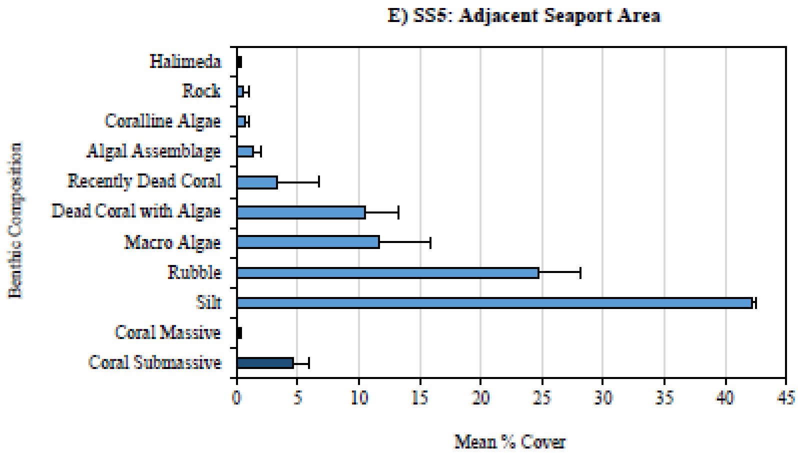
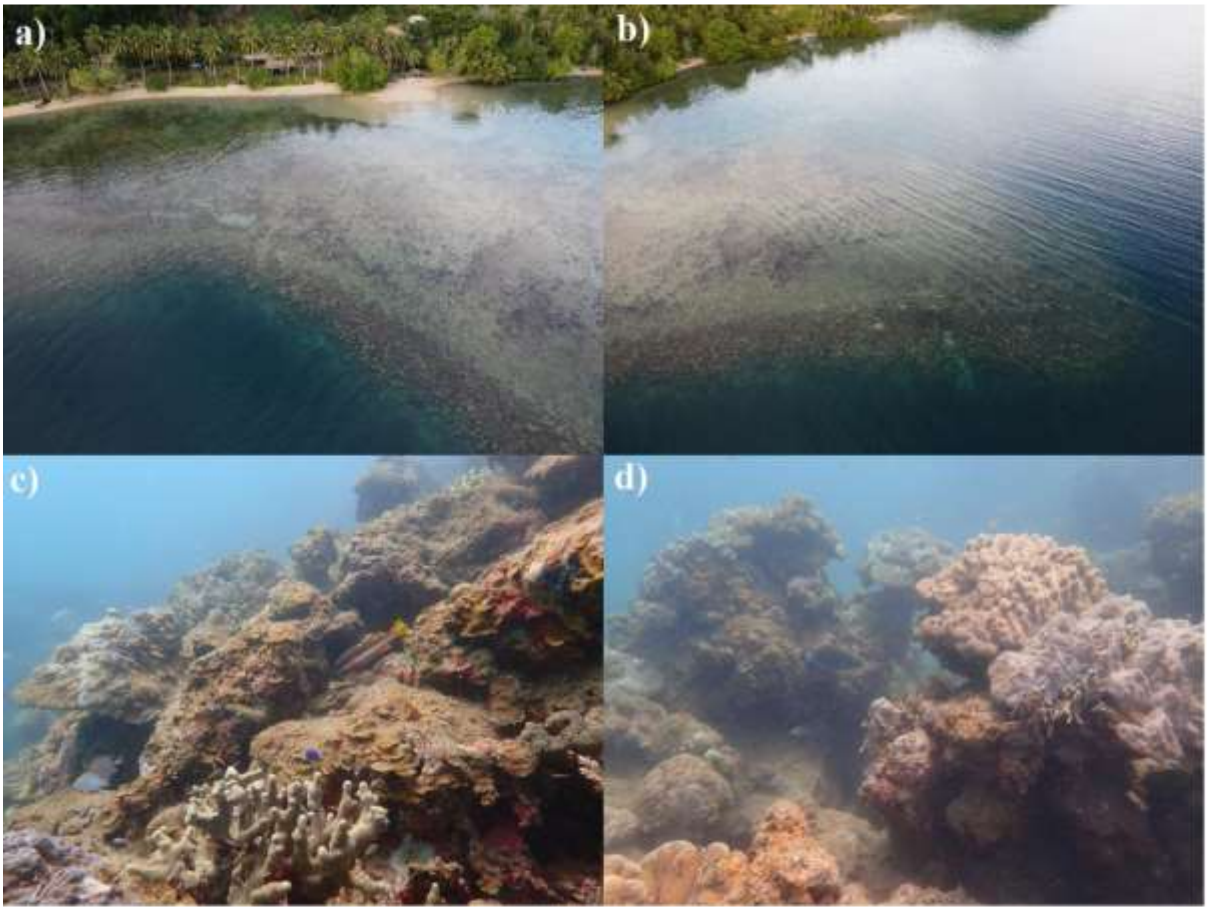


Figure 9-16 Mean benthic cover (± SE) of the adjacent seaport site (E).

The fringing reef in front of Havihua village is locally protected and restricted from all fishing activities, a Locally Marine Managed Area (Havihua LMMA: Figure 9-17a and Figure 9-17b). A Sampling station (SS6) was conducted at the reef crest and reef slope area. The reef is generally moderate in reef complexity in most parts, especially in the reef slope zone, as indicated in Figure 9-17c and Figure 9-17d, and extends beyond the Pacific Nickel tenement boundary, stretching at approximately 200m to 300m into the Thousand Ships Bay and along the coastline to the south. The intertidal area is basically a stretch of shallow water (<1m) with sandy bottom and few hard corals (mostly massive and submassive) sparsely distributed towards the reef crest area where more colonies of corals were aggregated.

Also, a low dense sea grass meadow is located along the shallow sea front area and sparsely distributed about 20 metres onto the shallow reef and along the coastline to the south. The reef slopes down to approximately 15m to 20m depth where lower complexity reef and sandy bottom habitats dominated, and progress further out into the deeper (50m) and larger area of the Thousand Ships Bay.



Photos: Isaac Qoloni: (a) and (b); Stephen A. Mosese: (c) and (d)

Figure 9-17 (a) and (b) the Havihua fringing reef and the village; (c) and (d) shows examples of the moderate reef complexity in reef slope area.

In Figure 9-18 the mean cover of benthic substrates comprises dead corals with algae accounting for 53.91% ± 5.83%, followed by silt (14.17% ± 5.06) and rubbles (14.87% ± 6.41%); Algal assemblage, macro algae, coralline algae and sponges range between 8% to 1% of the cover. The six coral growth forms identified includes submassive (2.31% ± 0.90%) and massive (1.81% ± 1.28%), which are the common forms of corals. Branching corals, foliose, Acropora branching and encrusting corals were also present, however, in smaller patch and colonies.

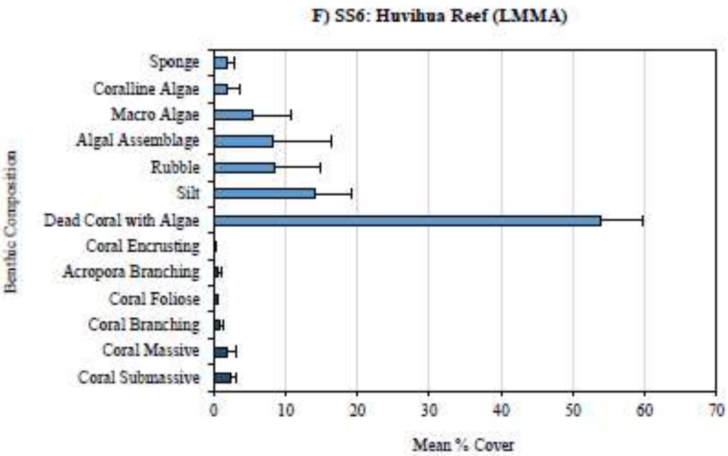


Figure 9-18 Mean benthic cover (± SE) of the Havihua reef (F).

9.6 Coral Diversity and Abundance

9.6.1 Coral Species List

Twelve families and 21 genera of hard corals of the Order Scleractinia were observed during the study (Table 9-2). Four genera were identified for the coral family Faviidae, followed by Poritidae with 3 genera. Two genera each were recorded for the coral family Acropora, Agariciidae, Fungiidae and Mussidae; a single genus were observed for the families Poscilloporidae, Euphyliidae, Pectiniidae, Mussidae and Trachyphyllia. Other hard corals observed within the bay includes the family Millepora4, Table 9-2 commonly known as fire corals. Soft corals were also present which consist of Sinularia, Sacorphyton, Lobophyton and Anemone (Table 9-3). Moreover, in Table 9-4, the three families and genera of algae recorded which consist of Caulerpaceae, Corallinaceae and Halimedaceae.

Veron et al (2006) described a total of 485 species belonging to 76 genera in the Solomon Islands, second highest only to the region of the Raja Ampat Islands of eastern Indonesia. The high diversity is due to the wide range of habitats, length of survey time and the extensive coverage of study sites (60 sites across 9 provinces in Solomon Islands).

In contrast, these are some of the similar taxa's described by Veron et al (2006) in the TNC survey, however, given the smaller size of the Kolosori coastal and marine area, the limited habitat and fringing reef area within the allocated Tenement Boundaries for the proposed seaport and the Nickel Mining Project, the result of the lower diversity in coral was expected in this baseline assessment. Moreover, the fresh water streams and the stagnant turbid water system within the bay suggest its influence on the occurring habitats and benthic communities within these sites as the results have indicated high composition of sediments and algae in the surveyed areas.

Table 9-2 The list of coral families and genera in the surveyed areas.

Zooxanthellae Scleractinia			
Family	**Genus**	**Family**	**Genus**
1) Poscilloporidae	a) Stylophora	9) Mussidae	a) Cynarina b) Lobophyllia
2) Acroporidae	a) Acropora		
	b) Montipora	10) Faviidae	a) Caulastrea b) Diploastrea
3) Euphyliidae	a) Plerogrya		c) Goniastrea
4) Siderasteridae	a) Psammocora		d) Leptastrea
5) Agariciidae	a) Leptoseris	11) Trachyphidae	a) Trachyphyllia
	b) Pachyseris	12) Poritidae	a) Alveopora b) Goniopora
6) Fungiidae	a) Herpolitha b) Fungia		c) Porites
7) Pectinidae	a) Oxypora		
8) Dendrophylliidae	a) Turbinaria		

Table 9-3 The list of Hydrozoans and Soft Coral families and genera in the surveyed areas.

Class: Hydrozoa (Non-Scleractinia)
Order : Millepora
1) Millepora
Class: Anthozoa
Subclasses: Octocorrallia, Hexacorallia, etc. (Soft Corals)
1) Sinularia spp.
2) Sacorphyton spp.
3) Lobophyton spp.
4) Anemone

Table 9-4 Algae and Seagrass families in the surveyed area.

Algae and Seagrass	
Family and Genera:	
1) Caulerpaceae	a) Caulerpa spp.
2) Corallinaceae	a) Jania spp.
3) Halimedaceae	a) Halimeda spp.
4) Dictyotatceae	a) Padina spp.

4.3.2 Coral Species Composition and Abundance

Figure 9-19 and Figure 9-20 represent the mean composition (%) of coral genera and biota recorded within the sampling stations, which are considered the most 'common' taxa within the study area due to their frequent occurrence within the sampling sites. A total of 21 genera were recorded during the study, however, 52% of these were not common and were sparsely distributed over a limited area in the reef. Overall, the common coral genera consist of Porites, Acropora, Leptoseris and Pachyseris which are much higher in relative abundance and were present in much larger aggregated colonies. Other common genera comprise Caulastrea, Lobophyllia, Alveopora, Leptastrea, Turbinaria, and the soft coral Sinularia and Sacorphyton, which were lower in relative abundance and occurred in smaller, less-aggregated colonies.

Algae biota are a common feature amongst the surveyed reef areas. The genus Padina and Caulerpa were amongst the highest in relative abundance, and were present at most of the sampling stations.

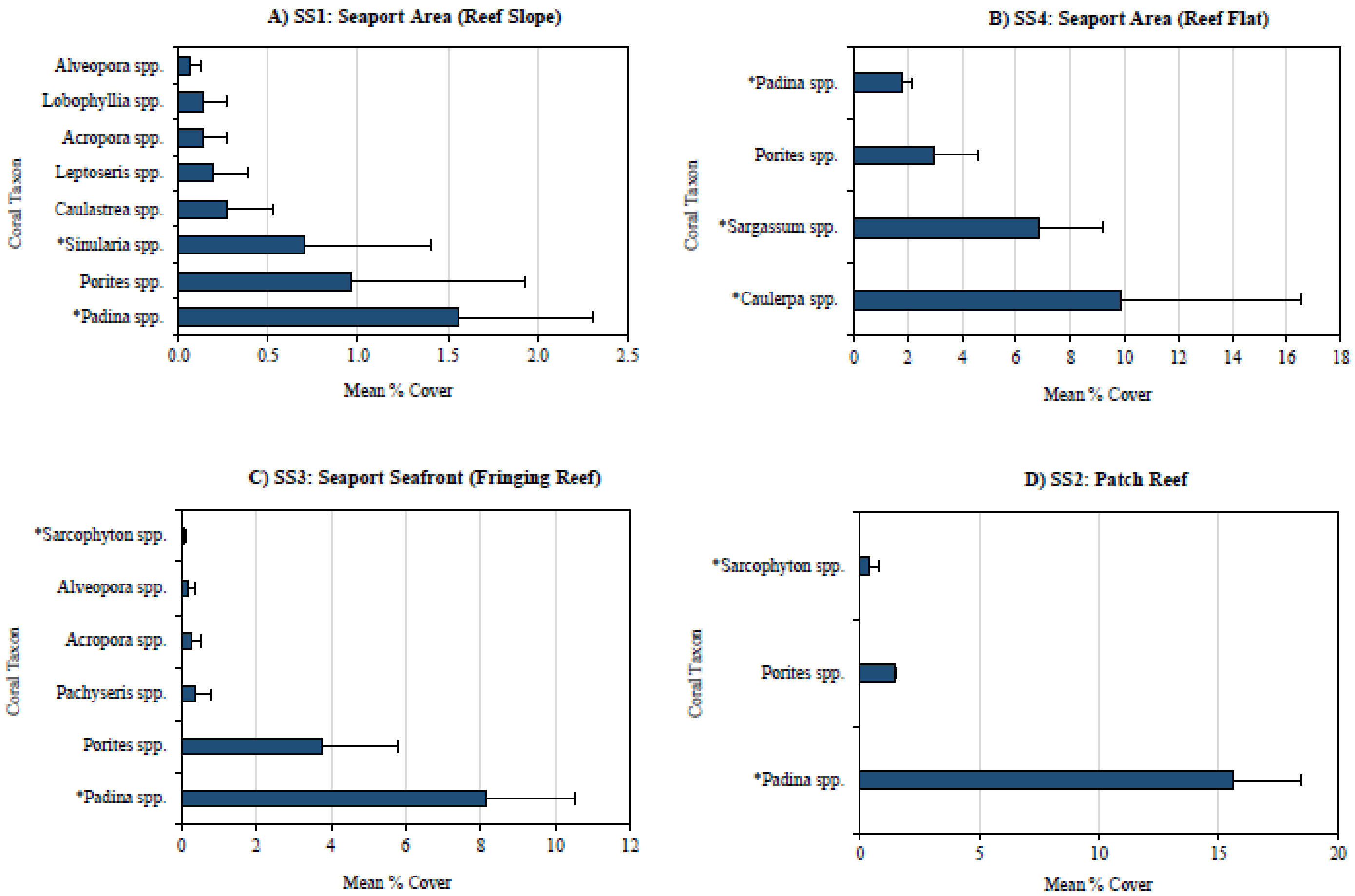


Figure 9-19 A-D: Mean cover (± SE) of coral genera and biotas in the surveyed areas.

* Is a non-stony coral of the Order Scleractinia, includes soft corals, algae's and others.

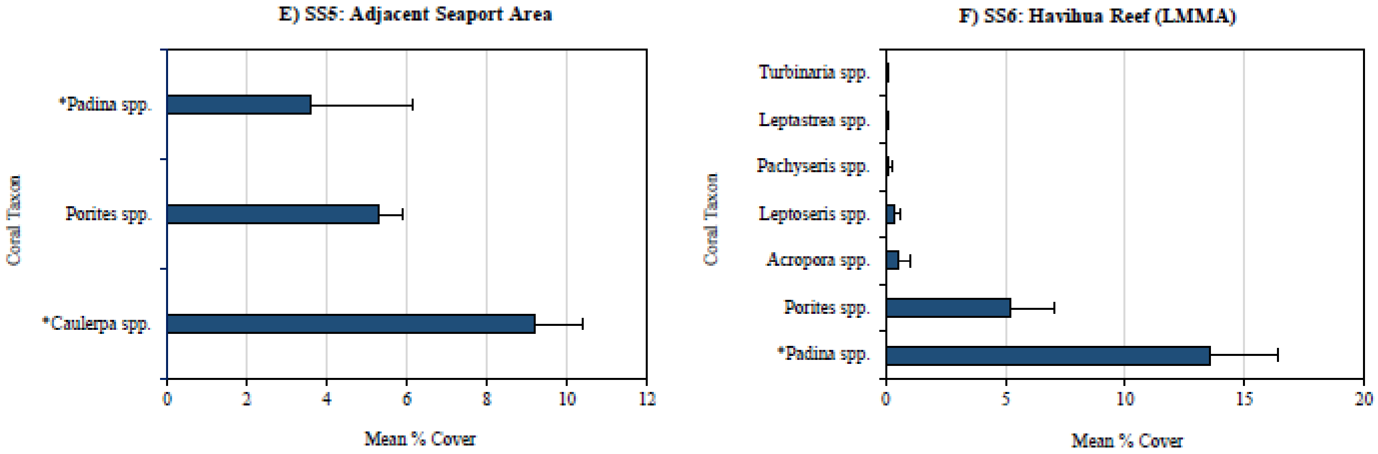


Figure 9-20 E-D: Mean cover (± SE) of coral genera and biotas in the surveyed areas

* Is a non-stony coral of the Order Scleractinia, includes soft corals, algae's and others

9.7 Invertebrate Diversity and Abundance

9.7.1 Invertebrate Species List

Twelve marine invertebrate species, belonging to 8 families, were recorded during the survey (Table 9-5). Four species of the family Tridachnidae was recorded during the baseline survey which is the highest in terms of species richness. Other families consist of a single species each. All the species recorded in the survey were observed in the fringing reefs of the bay which includes the seaport area, sea front reef of the bay (north section of the entrance) and the Havihua reef. No invertebrates were encountered in the adjacentsouth section of the bay where the water was too shallow (<1m) with high turbidity thus sampling station (SS5) was excluded. The occurrence of invertebrates was restricted to the presence of hard subrates, waterdepth and turbidity.

Table 9-5 The list of marine invertebrate species observed in the study and their conservation status.

Scientific Name (Family,Genus, Species)	Common Name	Status (Endemic, Native, Introduced)	Conservation Status(IUCN)
Aridae			
Anadora spp.	Ark Shell	Native	Not Evaluated
Diadematidae			
Diadema setosum	Sea Urchin	Native	Least Concerned
Goniasteridae			
Fromia monolis	Necklace/Tiled Starfish	Native	Not Evaluated
Holothuridae			
Pearsonothuria graeffei	Flowerfish	Native	Least Concerned
Mitridae			
Mitra mitra	Mitre Shell	Native	Not Evaluated
Ophidiasteridae			
Linkia laevigata	Blue Starfish	Native	Not Evaluated
Ophiothrichidae			
Ophiothrix spp.	Brittle Starfish	Native	Not Evaluated
Pectinide			
Chlamys spp.	Scallop	Native	Not Evaluated
Tridachnidae			
Tridacna crocea	Boring Giant Clam	Native	Least Concerned
Tridacna squamosa	Fluted Giant Clam	Native	Conservation Dependent
Tridacna maxima	Elongate Giant Clam	Native	Conservation Dependent
Hippopus hippopus	Bear Paw Giant Clam	Native	Conservation Dependent

9.7.2 Invertebrate Species Composition and Abundance

A total of 50 individuals of marine invertebrates were counted, whereby Linkia laevigata accounts for 50% of the total count, which is the most common invertebrate in the surveyed areas and had the highest mean density (Figure 9-21) ranging between 75 to 125 individuals per hectare (Ind. ha^{-1}). Tridacna crocea was also common and account for 24% of the total count with a mean density which ranged from a 100 Ind. ha^{-1} and lower in the surveyed reef areas. Other species were less common and accounts to only 2% to 4% in total count with lower mean density. The occurrence and abundance of invertebrates were distributed amongst the reef areas and in habitats with hard substrates and less in silt-dominated turbid water.

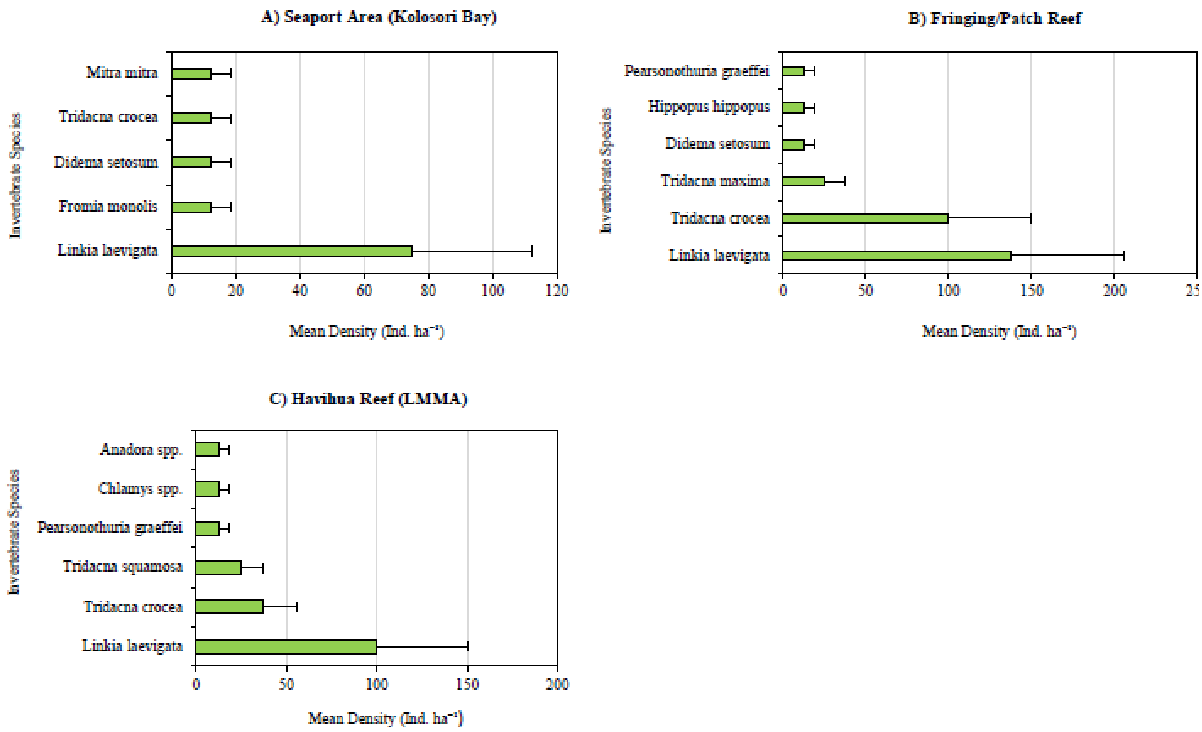


Figure 9-21 A-C: Mean density (Ind. ha^{-1} ± SE) of marine invertebrate species in the surveyed areas.

9.8 Fish Species Diversity and Abundance

9.8.1 Species Richness and Abundance

A total of 1,548 coral reef fishes were counted on the reef slopes, reef flat and patch reef within the Kolosori bay and fringing reefs, distributing 6 sampling stations and 12 transect replicates in the fish assessment. The following presents a general description of the coral reef fish communities (all recorded species) based on the sampling stations data.

Due to the natural behavior and tendency of some fish species to migrate from one ecological niche to another for food, spawning and shelter, the sampling stations (SS1 to SS6) were grouped into 3 major sites (proposed seaport area, patch reef and the Havihua reef) according to their locations. Sampling stations with no encounters of fish were excluded, these are SS4 and SS5.

This survey had recorded 23 families and 77 species (Appendix 1 – fish species list). Species richness ranged from 26 to 41 species at most sites (Table 9-6).

The fish fauna of the Solomon Islands consists mainly of fish associated with coral reefs. Gobiidae being the most abundant family in terms of number of species (Allen 2006) was excluded from this study due to its very small size and cryptic behavior; the UVS method would be inefficient as fish sample collection equipment were required.

In this study the most abundant fish families in terms of number of species was Pomacentridae with 16 species, followed by Chaetodontidae (8), Apogonidae (6), Labridae (6), Scaridae (6), Acanthuridae (5), Lutjanidae (5) and Mullidae (5); the top nine families in number of species recorded. Other families ranged from 3 species or less (Table 9-6).

Table 9-6 The number of species observed and total fish count at each surveyed area.

Site:	No. of families	No. of species	Total fish count:	SS ID:
A) Seaport Area (Kolosori Bay)	12	26	375	SS1, SS4*
B) Patch Reef (Kolosori Bay-entrance)	20	45	773	SS2, SS3
C) Havihua Reef (Protected Area)	17	41	400	SS6
D) Adjacent Seaport Site (Kolosori Bay)	0	0	0	SS5*

* Excluded Sampling Stations (SS) with no fish observed.

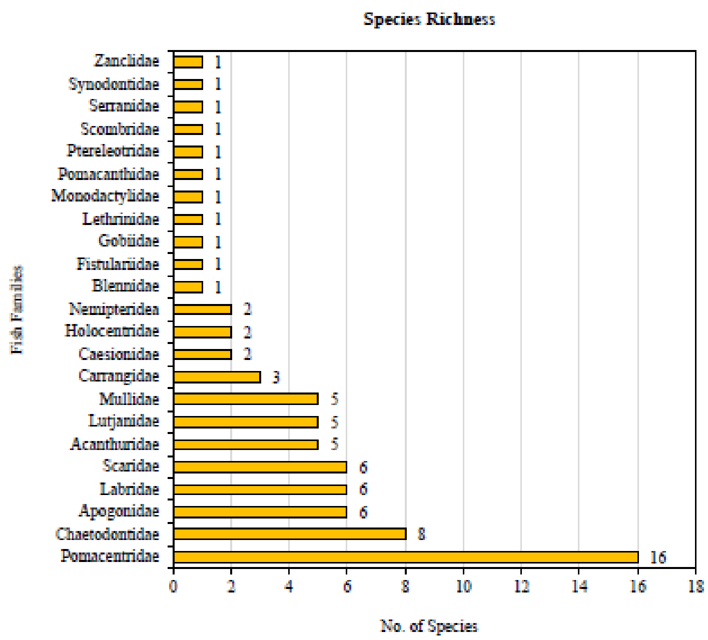


Figure 9-22 Fish families and total number of species observed.

9.9 Coral Fish Community Structure and Density

Figure 9-23A, Figure 9-23B and Figure 9-23D, the general trend in fish communities among the surveyed sites, Caesionidae and Pomacentridae are the dominant families with the mean densities ranging from 650 to 6,650 ind. ha^{-1} and 775 to 3,350 ind. ha^{-1} respectively, also accounting to 32.8% and 21.3% of the total fish counted. Schools of juvenile fusiliers – the species Caesio caerulaurea and Caesio teres – are common within the Kolosori fringing reefs and bay, especially where the water column is clear and not too shallow (>2m). Unlike fusiliers, Pomacentridae were observed in much smaller aggregations or solitary for some species, however the highest in diversity in this study. These energetic little fish are an evident part of every coral reef community. Approximately three-quarters of the 321 known species are found in the Indo-West Pacific (Allen et al 2003).

Apogonidae accounts for 28.7% of the total fish counted with a mean density of 5,550 ind. ha^{-1}, however, they are very much confined to the patch reef located off the bay entrance where many small aggregations took shelter amongst the digitate and branching corals. Six species have been recorded and the 3 dominant are Apogon fragilis, Apogon leptacanthus and Apogon neotes.

Other common families, recorded in most surveyed areas were Labridae, Lutjanidae, Chaetodontidae, Carangidae, Scaridae, Acanthuridae and Mullidae. These are much larger key food fish species (excluding Chaetodontidae), which were present in smaller groups, pairs or solitary, especially in areas outside the bay. The overall result indicates a lower fish count and diversity inside the bay. The most sheltered sites typically have a much depleted fish fauna, particularly those that are associated with heavy siltation (Allen, 2006).

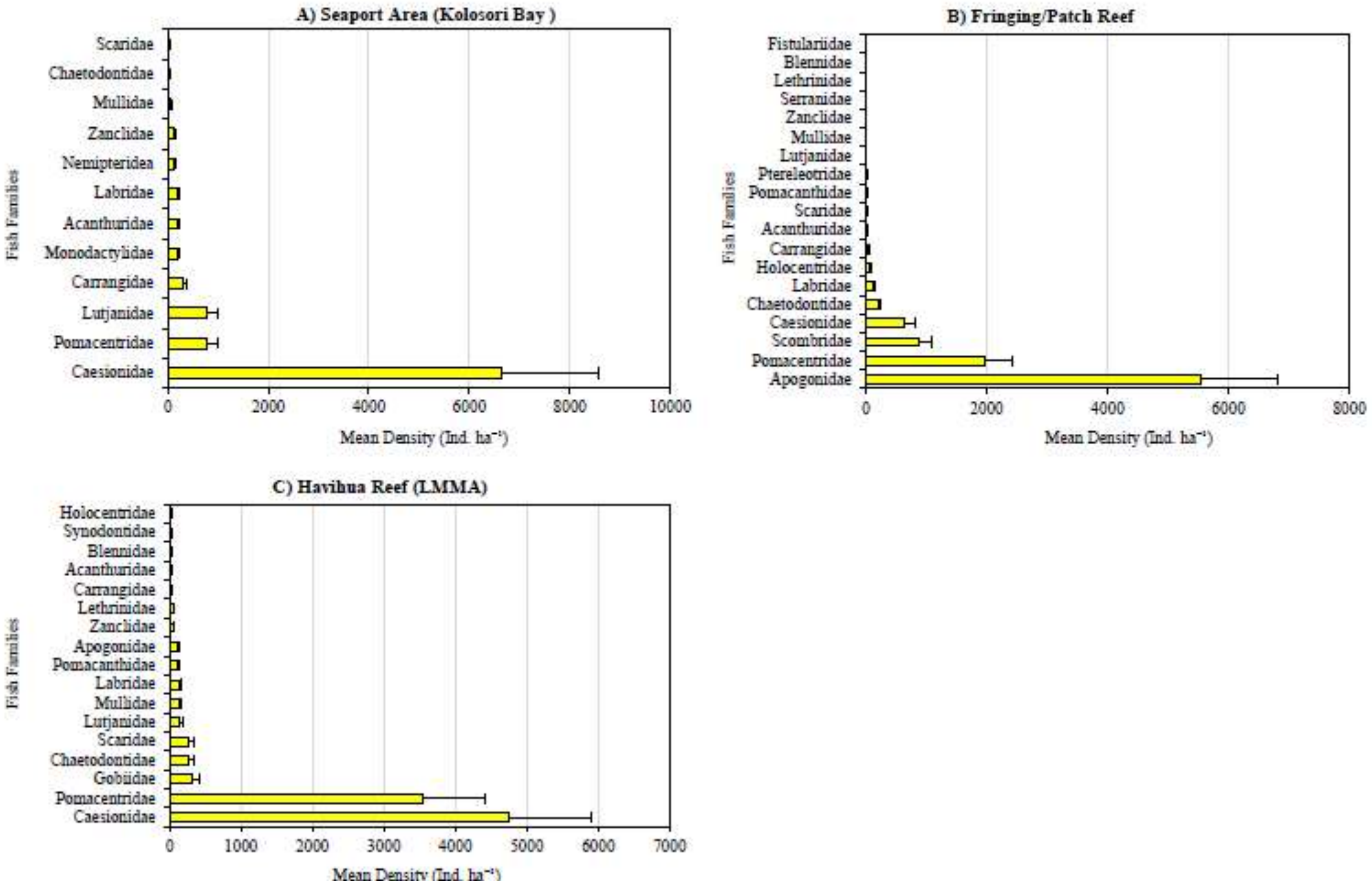


Figure 9-23 A-C: Mean density (± SE) of fish families in the surveyed areas

9.10 *The Global Conservation and National Status of Species Observed in Kolosori*

A vital task for the survey was to record any marine species that are of national or international concern, in particular species classified as endangered or were at some threatened level of becoming extinct. The species and fauna of corals, invertebrates and vertebrates that are of conservation significance are discussed below.

9.10.1 The International Union for Conservation of Nature and Natural Resources (Iucn) Red List of Threatened Species

The IUCN Red List of Threatened Species - www.iucn.org/redlist and www.iucnredlist.org was utilised in classifying species observed in this study in terms of their global status, see "Table 5 and Appendix 1" for marine invertebrates and coral fish species. Except for corals, assessment protocols had provided classifications up to families and genera, which the IUCN Red list is not applicable. The CITES listing was utilized for coral conservation and resource management status.

Most of the marine invertebrates and coral fish recorded in the study were native to Solomon Islands and had high distribution within the Indo-Pacific regions, most of which were common and 'least concerned' or 'not evaluated' by IUCN, except the fish species Plectropomus areolatus which is listed 'vulnerable' and 3 species of giant clams (Tridachnidae) which are of 'conservation dependent', these are H. hippopus, T. maxima and T. squamosa.

9.10.2 Species Under the Convention on International Trade in Endangered Species of Flora and Fauna (Cites) and the National Regulation

The Convention on International Trade in Endangered Species of Flora and Fauna (CITES) are a guiding instrument, absorbed and enforced by the Solomon Islands Environment Act 1996, the Wildlife Protection and Management Act 2017, the Fisheries Management Act 2015 and the Fisheries Management (Prohibited Activities) Regulations 2018.

All stony corals of the family Scleractinia spp., including the coral family Milleporidae of the Order Milleporina (Class: Hydrozoa) are subject to Appendices II of CITES. As such, the removal of coral reefs and the commercial exploitations of these coral species are being regulated and managed under the national authority MFMR and MECDM, which plays the role of the national scientific and management authority for CITES.

All Giant Clams under the family Tridachnidae were included in the Appendices II of CITES, which include the 3 species observed in the study sites. The protection of these species falls under the Fisheries Management Regulations 2018 and the Wildlife Protection and Management Act 2017.

The species and fauna covered within the Appendices II of CITES are not critically under threat of extinction. However, concerns for national management measures require immediate attention; in such cases, the assessment of local stocks and population of species to fulfil the CITES requirement for the Non- Detrimental Findings (NDF's) are required, to prevent over exploitation and local extinction of internationally traded species (exported species). In contrast, species under CITES Appendices I, are subject to total ban from all forms of exploitation. These are critically endangered species.

10 AMENITY

An environmental amenity refers to the pleasantness of the environment perceived by the local people and to a lesser extent the flora and fauna. The main areas of this amenity include unsightliness, noise, dust and odours. This is usually assessed from locations where the lack of amenity would be noticeable and are usually dwellings and homes, or public areas such as churches, schools or meeting halls.

The environmental amenity assessment is largely based on the background data and information from studies carried out by Sumitomo on Isabel Island for a number of nickel tenements and are considered to be representative of the Kolosori mining site.

10.1 Visual amenity

The project has a number of mining infrastructure elements which may be visible from San Jorge Island and nearby areas on Isabel Island. These include:

- Open pit mines, waste dumps and stockpiles;
- Haul roads;
- Mine equipment;
- Mine camp and buildings; and
- Wharf with barges and ships.

This section looks at the visibility impacts from mining infrastructure from the aspect of nearby sensitive locations.

10.1.1 Assessment method

The visual assessment method comprises:

- identification of viewpoints around the project area;
- description of the view type and landscape context;
- description of visual absorption capacity and view quality; and
- assessment of the significance of impacts.

For the visual amenity assessment four viewpoints were considered. These were from Havihua, Midoru and Vulaarao on Isabel Island and Talise on San Jorge Island.

Refer to Figure 10-1 that shows the various nearby villages to the project site.

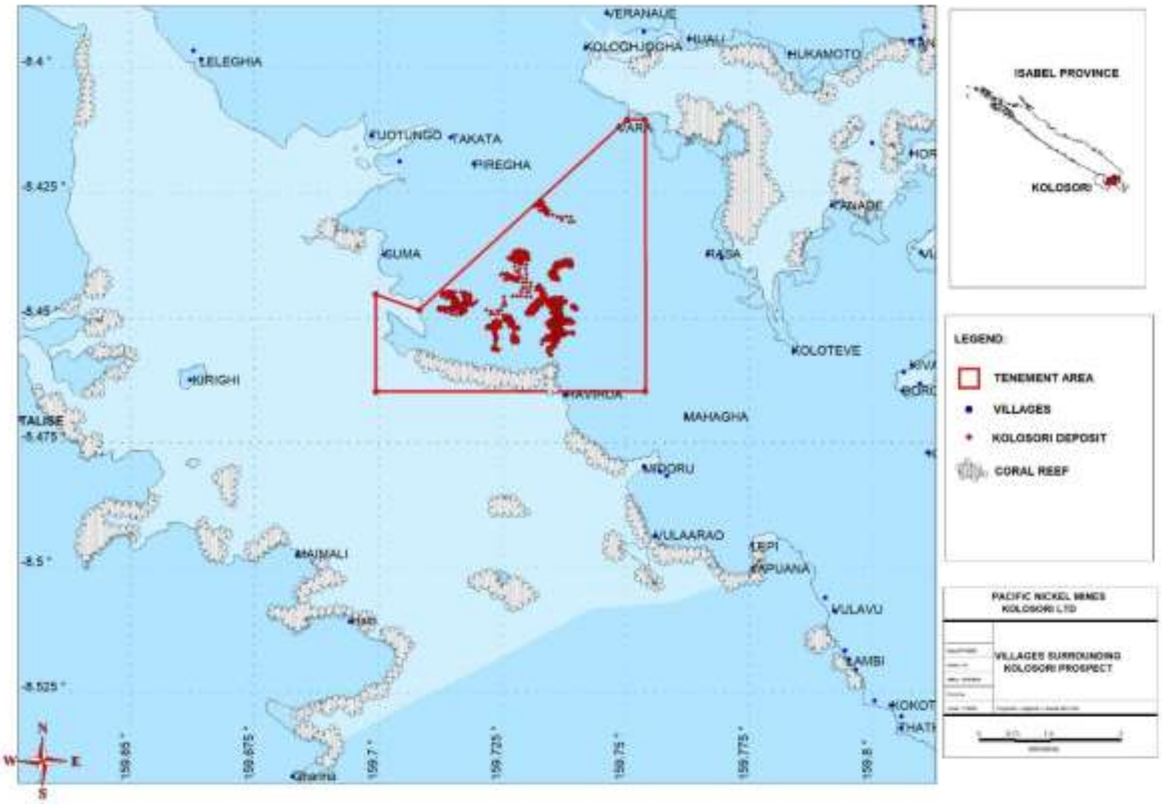


Figure 10-1 Kolosori Tenement and surrounding villages map

10.1.2 Existing environment

The landscape on the islands is characterised by inshore reefs and mangrove forest along the shoreline; heavily forested lowlands and hill slopes and some ridges devoid of vegetation at the project site where the nickel deposits occur. The majority of the forest has a tree canopy of up to 40 metres high and a dense undergrowth dominated by young trees and saplings.

The main village that will be impacted by mining is Havihua which is near the wharf site.

The other villages which may be visually impacted by the operations are Midoru and Vulaarao along the coast to the east and Talise on San Jorge across the Thousand Islands Bay.

10.1.3 Impact assessment

Havihua village will have high visual impact assessment with regard to wharf operations. The village is shielded from the mining operations by a high ridge but may see the stockpile and haul road near the wharf operations.

Talise on San Jorge is likely to see the operations but given that it is over 12km from the operations it is considered a moderate visual impact assessment.

Both Midoru and Vulaarao (approximately 3km to 4km from Havihua to the east along the coast) are unlikely to be impacted by the mining or wharf operations given the topography but will be able to observe barging and shipping operations. The visual impact on these villages is considered low as large ships in Thousand Island Bay have been a regular feature of logging operations.

10.1.4 Mitigation measures

Visual impact mitigations will be reduced by the following:

- the resource will be mined progressively to reduce exposure;
- the site will be progressively rehabilitated and revegetated;
- areas disturbed for construction, but not required for further operations, will be rehabilitated and revegetated as soon as possible;
- vegetation clearing will be reduced as far as is practicable;
- vegetation strips will be retained where practicable, particularly along drainage lines;
- low glare and directional lighting will be used to reduce light spill where practicable; and
- limiting night operations to minimal requirements subject to consultation with the chiefs of the Havihua village.

10.1.5 Residual impacts

Given the topography and distance from nearby villages to the operations, other than at Havihua, the visual impacts are considered minor.

10.2 Air

10.2.1 Assessment method

Potential air quality impacts on sensitive locations from the project have been inferred from Sumitomo studies on Isabel Island as the mining methods and localities are similar. Potential pollutants were assessed by Sumitomo using the CALPUFF model. The results showed that the villages very close to the project site are the most sensitive to impacts on air quality.

For the purposes of the air quality assessment of the project, the villages of Havihua and Vara were considered. As specific modelling was not carried out, the assessment has been done using a significance method rather than a compliance method.

10.2.2 Existing environment

There are few air pollution sources on Isabel Island, with the main source being emissions from combustion of solid fuels.

10.2.3 Impact assessment

The following air quality impacts could occur during construction and operation of the project without effective mitigation measures:

- generation of dust which could migrate from the project area to sensitive locations from:
  - ground disturbance during vegetation clearing;
  - removal of overburden and extraction of ore;
  - transportation of overburden and ore;
  - ore dumping, stockpile management and barge loading; and
  - wind blowing over dry exposed surfaces.
- generation of particulates from vehicle and generator usage which could migrate from the project area.

10.2.4 Mitigation measures

An air quality management plan will be prepared prior to project construction, which will be implemented during construction and operations and will contain the following dust and particulate management measures:

- reduce the amount of exposed surfaces to lessen dust generation;
- progressively rehabilitate and revegetate disturbed areas;
- limit vehicle speeds on access and haul roads;
- limit vehicle movements to designated trafficable areas;
- spray unsealed road areas, short-term soil stockpiles and other exposed areas susceptible to wind erosion with freshwater to reduce dust generation if required;
- reduce surface disturbance activities, excavation, dumping and stockpile management during dry or high wind conditions; and
- appropriately service and maintain vehicles and equipment to reduce generation of particulates associated with combustion of fossil fuels.

10.2.5 Residual impacts

During construction there will be some surface disturbance from making and upgrading existing roads and tracks. Also, equipment and vehicles used during construction will generate particulates.

During the operations, the air quality impacts will be greater due to increase traffic movements from trucks and mining equipment.

The residual impacts will be low provided the management mitigation measures noted above are implemented.

10.3 Noise

10.3.1 Assessment method

Previous studies on similar nickel tenements on Isabel Island has shown that only those villages close to the mining operation will be impacted by noise. In that regard, the assessment method is based on the understanding that only the Havihua village will be impacted by noise from the wharf operations.

10.3.2 Existing environment

Based on past experience from Sumitomo data the average daytime ambient noise levels was 34 dBA and the average night time ambient noise levels were around 40 dBA. Background noise mostly comprised natural sounds such as birds, insects, domestic animals and weather effects. There were short periods of noise from mechanical sources such as boats, helicopters and generators. Ambient noise was higher at night due to higher levels of insect noise.

10.3.3 Impact assessment

Given historical information from previous studies on similar nickel laterite operations on Isabel Island, the Havihua village will be impacted by noise from the operations.

10.3.4 Management measures

The key management measures to reduce noise impacts at Havihua include:

- Monitoring noise levels at the village;
- Having a management plan around operational activities to minimise noise at and around the wharf area.
- limiting night operations to minimal requirements;
- consulting with the chiefs of the Havihua village if noise levels became too great;
- implementing noise reduction measures as required (ie noise barriers); and

- changing typical mobile equipment reversing alarms to quieter versions.

10.3.5 Residual impacts

The residual impacts from noise at Havihua will need to be monitored and be subject to a mitigation plan.

11 SOCIO-ECONOMICS

This section describes the existing socio-economic values within Pacific Nickel's Kolosori Tenement area and surrounding Isabel province based on SMM (2012). These values include:

- the local economy
- small and medium enterprises
- employment
- household income
- agriculture
- forestry
- fisheries and aquaculture
- tourism
- economic development
- the potential positive and socio-economic impacts that may result from the Project

This section also assesses the significance of those impacts and proposes measures to enhance positive impacts and mitigate negative impacts.

Note that this section does not address the economic effects of the Project on the provincial and national economy nor the potential socio-economic effects of the Project on society and community in Project-impacted communities.

11.1 Methodology

Data was collected using:

- desktop analysis
- village awareness meeting and community consultation-meetings
- site surveys and appraisals
- secondary data gathering (reports, papers and studies from government and non-government organisations).

The Isabel Kolosori tenement is located in the Japuana and Tatamba Wards and bordered by Sigana Ward to the east of the tenement. The study included the two villages within the Kolosori Tenement: Havahua and Vara. Havihua is located on the coast in the southeast of the Kolosori tenement in the

Japuana Ward and Vara is located on the coast in the north of the Kolosori tenement in the Tatamba Ward. The combined population of these wards in 2020 was 5,961 which represents 16.9% of the population of Isabel province (SINSO, 2021).

Desktop review, fieldwork survey including community consultation work was undertaken over a 6 month period with people who reside within the tenement area. Baseline social profiling was undertaken by Pacific Nickel project Team between June-August 2021. Project awareness meetings were held with key stakeholder groups in August 2021 by Pacific Nickel project Team.

Stakeholder engagement workshops were conducted in centrally located ‘hub’ in Havihua and Vara villages, with representatives attending – landholders, and chiefs.

11.2 Existing Values

11.2.1 Solomon Islands

The economy of the Solomon Islands was negatively impacted by the civil unrest that occurred between 2000 and 2005. Employment, education, health, tourism, and economic development in the logging, mining, and fishing industries were all disrupted.

The American financial crisis, which began in late 2007 and spread to the rest of the world, did not spare the remote, small islands in the Pacific. With the decline in economic activities in the advanced countries, the American financial crisis soon became a global economic crisis, triggering a world-wide recession since then. Following the onset of global recession, Pacific island counties have been experiencing the impact in varying degrees. The global crisis has posed challenges with both short-and long-term implications. While the short-term challenges are thought to be dealt with by fiscal and monetary policies, which have only a limited scope, the long-run challenges can be looked upon as opportunities for renewing efforts towards sustained growth as well as minimizing the impacts of similar future uncertainties. This paper, which deals with six major countries in the South Pacific region, namely Fiji, Papua New Guinea, Samoa, Solomon Islands, Tonga and Vanuatu, seeks to examine policy options, including regional economic integration.

The current Covid pandamic is having and will continue to have a major impact on world economies, involving restricted travel movement of people locally, nationally and internationally, widespread infection resulting in hospitalisation and in extreme cases – death. The Pacific Islands are not spared from the effects of Covid pandamic and will be for some time to come.

In 2019 Solomon Islands was the number 172 economy in the world in terms of GDP (current US$), the number 163 in total exports, the number 191 in total imports, the number 137 economy in terms of GDP per capita (current US$) and the number null most complex economy according to the Economic Complexity Index (ECI).

The top exports of Solomon Islands are Rough Wood ($419M), Processed Fish ($65.1M), Aluminium Ore ($52M), Non-fillet Frozen Fish ($30.7M), and Palm Oil ($22.8M), exporting mostly to China ($415M), Italy ($57.4M), India ($36.8M), Thailand ($21.6M), and United Kingdom ($15.6M).

The current economy is dependent on primary industries such as agriculture, forestry, Mineral Resources (aluminium) and fishing and in particular timber exports, which have contributed significantly to economic growth in recent years (ADB, . Mining and mineral exploration is emerging as a significant economic activity with a resurgence of nickel as an important strategic metal in the manufacture of batteries etc.

The logging industry, which is a major exporter and source of Government revenue, is reportedly progressing at an unsustainable rate and it is predicted that the economic contribution from this industry will begin eroding by 2012 (Gay, 2009). Exports declined in 2019 (SINSO, 2019). The Solomon Islands Government is now looking to alternative industries such as mining, tourism, agriculture and fishing for economic growth opportunities.

Copra, palm oil and mining are becoming important sources of employment and revenue while the fishing industry offers positive prospects for export and domestic economic expansion in the domestic and foreign markets.

The Solomon Islands has opportunities to attract international tourism, having pristine tropical ecosystems, beautiful scenery and diverse cultures. However, the sector is relatively underdeveloped when compared to other Oceania states and accounts for less than two percent of GDP (IMF, 2011b). Possible reasons in 2021 include the recent travelling logistics limitations due to Covid pandemic.

Formal employment in the Solomon Islands rose between 2009 and 2010 by 33.7% as a result of funding received from the Solomon Islands National Provident Fund (CBSI, 2010). The labour force engaged exclusively in wage-earning activities is 14% with approximately 71.4% of the economically active population engaged in non-monetary work in villages, principally subsistence farming (CBSI, 2010).

In 2005/06 the Solomon Islands had a basic needs poverty incidence rate of 22.7% of the population (UNDP, 2008). The incidence of poverty was more prevalent in households in Honiara (24.6%) than in provincial urban households (11.2%) (UNDP, 2008).

SME’s in the Solomon Islands are limited both in scope and activity. Small enterprises include agriculture, timber supply, fish products, copra, cocoa and related support services. Business service companies include customs and shipping agents, insurers, business associations, information technology, taxation, marketing and advertising specialists. Solomon Islands media provides a variety of television and radio channels and daily newspapers, with access and delivery based in Honiara.

The main industries are geared toward the local market, including the food processing sector, which produces such items as rice, biscuits, beer, and confectionery. Other manufacturers produce twisted tobacco, corrugated roofing sheets, nails, fibre canoes and tanks, timber, and buttons (Hatch, 2010).

Solomon Islands experienced severe economic contraction and stagnation over the period of the ethnic conflict (1998-2003). During the deployment of RAMSI (2003-2017) Solomon Islands had relatively consistent economic growth. Economic growth was approximately 1.2 per cent in 2019. However, major constraints to growth and private sector investment remain, including poor infrastructure, underdeveloped labour skills, high utility costs, land tenure issues, and limited public administration and financial management capacity, which have been exacerbated by the impact of COVID-19.

11.2.2 Isabel Province

A 2009 census reported a population of 26,158 in Isabel Province, equivalent to 5.7 percent of the nation's population of 515,870 people (SINSO, 2011). The 2020 provisional population estimate was 35,257 for Isabel Province which is ~5.1% of the nation's population of 686,878.

The road system is not well developed and provides only limited accessibility for villages. Canoes, many with outboard motors, are the primary mode of travel for fishing and sea transport. There are various wharves and jetties around the Island, but no international port (Rural Development Division, 2001).

The supply of electricity in Isabel Province is limited with power generators providing electricity to schools, churches and provincial substations around the Province. Most households rely on traditional energy sources such as firewood, coconut oil, and coconut husk (Rural Development Division, 2001). A small number of households have small solar panels that provide limited power for household lighting.

The local economy in the Project area is characterised by subsistence activities including farming (gardening and coconut plantations), small-scale animal husbandry, and fishing. However, local people are increasingly engaging in the wage economy, including mineral exploration.

A number of Small to Medium sized enterprises operate on Santa Isabel Island including: retail trade, rest houses, transport, and financial institutions. There are three companies run by the Provincial Government: the Isabel Development Company (shipping services), the Isabel Timber Company and the Isabel Development Authority (financial arm of the Province).

The processing and manufacturing sector in the Province includes coconut oil milling, peanut and coffee processing, and furniture making. There are also opportunities for the establishment of downstream industries to provide value-added products (such as fruit juice making, baton making, and food processing) (Rural Development Division, 2001).

The Solomon Islands Second Rural Development Program has an objective to improve basic infrastructure and services in rural areas and to strengthen the linkages between smallholder farming households and markets. Component one aims to retain and refine the community-driven development mechanisms developed during the first phase of the RDP with a number of modifications based on implementation lessons and evaluation findings. Component two aims to: (i) assist farming households to engage in productive partnerships with commercial enterprises; (ii) build the capacity of MAL to deliver its core functions of regulation, research and sector coordination; and (iii) restore the productive assets of households critically affected by the April 2014 flash floods. Component three contains only core, cross-component management functions would remain under this overarching component including: overall program management, finance, procurement, overall M&E/MIS (including contracting studies on topics such as land use and ownership, disaster preparedness, etc.), and environmental safeguards.

There are 3,233 people employed in Isabel Province in the labour force and an additional 7,200 engaged in subsistence activities (agriculture, fishing and marine harvesting) (SISO, 2011).

The majority of inhabitants of Isabel Province are subsistence farmers and the sale of surplus produce supplements household incomes. Extensive logging of Isabel Province and several years of mining exploration has seen a gradual transition from the subsistence economy to the cash economy. This change in the economic base likely to increase if the Project proceeds.

The average total income generated by villages consulted within or near to Kolosori Tenement ranged from SBD$100 to SBD$2,500 per household per year. Most households' income comes from fishing, and subsistence farming. Households on Santa Isabel Island tend to spend their annual household income on food (i.e. mainly on cereal and cereal products), which is typical of most rural communities in the Solomon Islands.

Agriculture

Large agricultural crop growing areas are located around Kolotubi, Tausese/Koregu and to the north and south of Buala. Copra is the main agricultural crop providing employment and household income for the residents of Santa Isabel Island. Coffee is grown and processed in the villages then shipped to Honiara for further processing. A commercial pineapple crop has been recently developed at Koghe.

Nearly all villages on Santa Isabel Island grow root crops, including: sweet potato, cassava, taro, giant taro and yam. These are important staple food crops and any surplus is sold at markets. Sweet potato is the most widely grown root crop. Some fruit farms have been established and are a potential source of income that could be considered further (Rural Development Division 2001).

Kava production is an introduced crop occurring within Isabel Province. Betel nut is a crop with a traditional value and purpose in the culture of the Solomon Islands. Kava is not traditionally consumed in the Solomon Islands, betel nut is used both recreationally and as an appetite suppressant. The village of Kolotubi which is south of Isabel is engaged in small scale rice farming. Cocoa is also produced as a means of income generation, but is not as prevalent as copra due to poor shipping and agriculture services (Rural Development Division, 2001b).

Animal husbandry is not practiced on the island although pigs and chickens are kept domestically.

Forestry

The logging industry is a major source of economic activity due to the abundance of forest cover (once 90%, now estimated to be around 75%) and most logs are directly exported overseas (Gay 2009; Pauku 2009). Logging exports accounted for 46% of all exports in 2011 (CBSI 2012). Log production rose from 1.4 million cubic meters in 2010 to 1.9 million cubic meters in 2011, due to high international demand for log, and increased log prices. Isabel Province is the leading log producer in the country and contributes 35% of total production.

Fisheries

The fisheries sector is important many villages and households rely on fishing for subsistence living, and the sustainable management of these resources is vital to food security. Only 30 percent of households in Isabel Province engage in commercial fishing activities. Commercial fish products are sold in three fisheries centres throughout the Isabel Province, located at Tatamba in Gao/Bugotu, Kia in Hograno/Kia/Havulei, and Buala in Maringe/Kokota. The main constraints on the Island's fishing sector are lack of suitable transport to markets and lack of qualified staff for fishing centres.

Tourism

Tourism is in its infancy on Santa Isabel Island. It has much to offer in terms of environmental and cultural diversity but is hampered by a lack of infrastructure, with minimal accommodation options (mainly village stay or small retreats), little road infrastructure, power and communication utilities available.

There is significant opportunity to develop tourism ventures in a number of areas on the Island but development of the tourism industry will require improvements in marketing, transport infrastructure, resolution of land disputes and training of tourism operators.

The Project has the potential to generate significant economic benefits for Isabel Province and the Solomon Islands in the

However, the Project will likely result in changes to subsistence activities currently practised by local people. It will be important to monitor food security, promote livelihood restoration, and create alternative economic options amongst affected villages.

Villages in Isabel Province are currently characterised by low literacy levels and limited access to higher-level education qualifications and technical skills; this may limit local employment opportunities for Isabel people.

There is significant potential to further develop the agricultural and fisheries sectors but a number of constraints currently restrict this opportunity including:

- accessibility to both local and international markets, and transport
- limited knowledge of how to value add to their product
- limited financial institutions and financing arrangements.

The Project is expected to generate high levels of economic activity. Local business development opportunities can be maximised if appropriate measures are taken by the Project and the provincial and national government.

11.2.3 Potential Impacts

The potential socio-economic impacts of the Project are described in the following section. Further details of the potential impacts are provided in the Impact Assessment Report – Socio-economics.

Employment

Local employment opportunities may be limited due to inadequate levels of education and skills on the island. A training program will need to be established very early in the Project as local people are unlikely to have prior experience in the mining-industry.

Household Incomes

Increases in household incomes are expected due to direct employment from the Project or business activities stimulated by the Project. This is a positive economic impact of the Project that may be further enhanced by measures aimed to maximise employment of local workers and/or local procurement of Project goods and services.

Change to Relative Wages

The Project will create positive economic opportunities previously not available on Santa Isabel Island. The wages to be offered by the Project are likely to be greater than the wages offered elsewhere in the Province given the low levels of economic development and the limited wage-earning opportunities. This is a positive impact for residents employed by the Project and local businesses.

An increase in wages may also result in increased competition for labour resources across all industries, which may result in valuable human resources shifting away from forms of employment which benefit the broader community (e.g., teaching, community services). The potential for this impact to occur will be highest where local unemployment is low and wage variations are high.

Structure of the Local Economy

The introduction of a cash-based economy may cause a structural change in the local economy. Wage earners may abandon subsistence forms of employment, such as tending to gardens, and become dependent on cash incomes to purchase goods and services. The impact of this transitional shift is likely to be both positive and negative across households and is expected to be applicable in the short to medium term only as the economy moves to a cash-based structure.

Education and Training Opportunities

The Project will generate an increased demand for skilled and unskilled labour to undertake the construction and operational phases of the Project. At present Isabel people possess low levels of literacy and numeracy but the introduction of the Project may bring about increased opportunities in education and training.

Inflation

The inflow of cash from Project wages and increased business revenues is expected to cause an increased demand and shortage of supply for consumables in the short to medium term, and result in increased prices within this time frame. An inflationary effect would negatively impact households that do not benefit directly from the wage economy and/or are not self-reliant in food production. In the longer term this shortage of supply would be expected to be met and inflation to level out. A negative impact would only occur if inflationary pressures come from imported commodities (i.e. crude oil or fertiliser).

Land Area Available for Gardening or Resource Harvesting

Land required for the development of the Project (for roads, Project facilities, and the mine) will become temporarily unavailable for other uses such as gardening, harvesting of forest resources, hunting and freshwater fishing. Since the well-being of local communities is closely linked to the ability to engage in subsistence food production. This may potentially cause negative impacts for some households.

In the longer term, improved access may increase the area available for gardening and agricultural activities. This issue will be considered prior to the finalisation of the MRCP.

Harvesting of Marine Resources

Port construction, increased marine traffic and potential fuel spills may reduce the ability of local residents to harvest marine resources in affected areas and may in turn affect food security, local livelihoods, and well-being. This is a negative impact that may require monitoring during the development and operation of the Project.

Transport Opportunities

Roads constructed by the Project will be dedicated to Project-related activities and safety concerns will exclude local people from using these roads. Further arrangements whereby selected Project roads could be safely used by local people may be explored. The Project may also create opportunities for marine transport services such as the community ferry to be run by a third party.

11.3 Baseline Description of the Social and Economic Profile of the Area

11.3.1 Population in the Project Area

The surveyed population comprising Vara Village and Havihua Village is 170, comprising 52.05% male and 47.95% female (Figure 11-1). This equates to 5.4 person per household in Vara and 8.1 persons per household in Havihua.

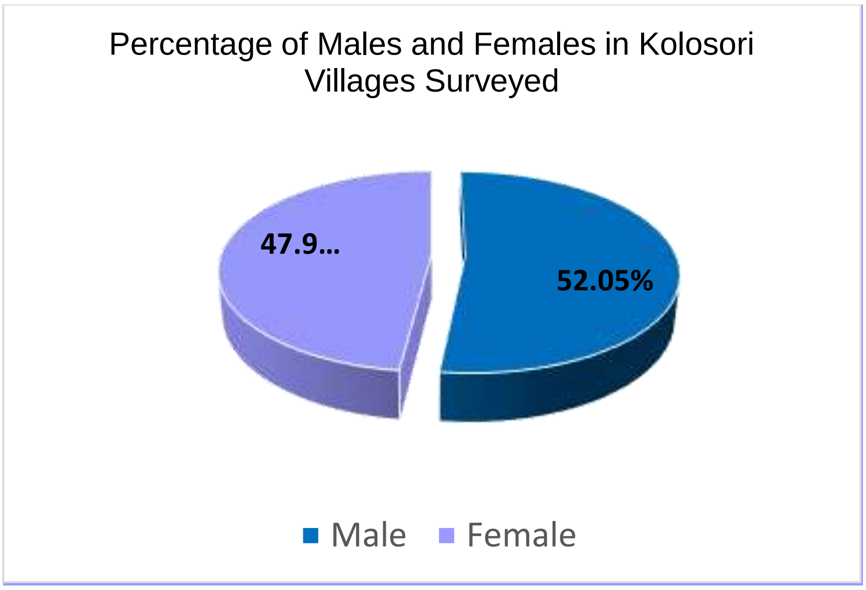


Figure 11-1 Percentage of male and female population within the Tenement area

11.3.2 Major Demographic Characteristics of the survey population

Age Structure

Table 11-1 shows the age catogory of the surveyed population and distribution by gender. The survey revealed the population of young people in the area is higher. The catogory19-64 years age group accounts for 46.3%, 5-18 years age group 30.5%, below 4 years age group 16.5% and above 65 years age group 6.7%. There are less older people in the area.

The findings indicate more male than female, Table 11-2.

Table 11-1 Age groups in Kolosori villages surveyed

Age Groups	Total	Percentage
0-4 years	14	8.2%
4-18 years	71	41.8%
18-65 years	79	46.5%
>65 years	6	3.5%
Total	170	100%

Table 11-2 Communities' age structure in the Kolosori Tenement area

Age Groups	Male		Female	
<4 years old	8	8.42%	6	8.11%
4-18 years	41	43.16%	27	36.49%
18-65 years	43	45.26%	38	51.35%
>65 years	3	3.16%	3	4.05%
Total	95	100.00%	74	100%

Marital Status of Household Head

The Figure 11-2 below shows 30.68% of the household heads are married, 3.41% are widowed, 58.52% are not married and 5.11% with unknown marital status.

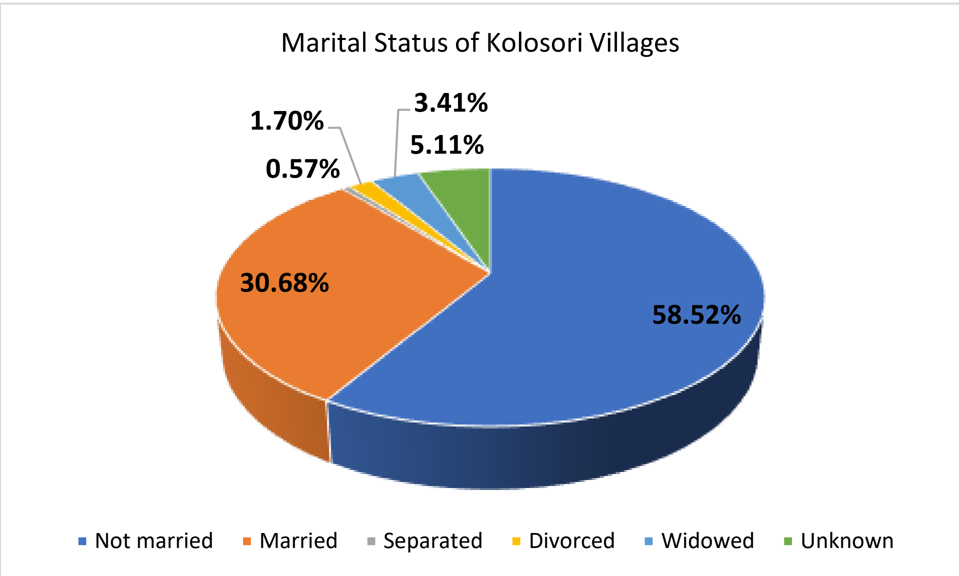


Figure 11-2 Marital Status of Kolosori Tenement area Villages

11.3.3 Household Characteristics

Family structure

As shown in the Table 11-3 below, 77.8% of the households are nuclear family and only 22.2% are made up of extended families.

Table 11-3 Household structure of Kolosori Tenement Villages

Household Structure	No. 0f Households	Percentage(%)
Nuclear Family	21	77.8
Extended Family	6	22.2
Total	27	100

Household Size

The average household size is 6.3 persons per households. Male members account for 3.6 persons per household while female members comprised 2.7 persons per household. Table 11-4 summarises household size.

Table 11-4 Average number of people per household in Tenement Villages surveyed

No. of Household	Average Household Size	Average No. of Males per Household	Average No.ofFemales per Household
27	6.3	3.6	2.7

11.4 Access to Basic Amenities

11.4.1 Potable Water

Community's access to water, sanitation and electricity is an important indicator of country's development and livelihood. According to the 2009 census, 64% of dwellings in Isabel Province were connected to a communal standpipe, another 11% used rivers or streams as their source, and 10% used tanks.

For the study area, majority of the household depend on the both the community water supply provided by an established bore and standpipe as well as nearby streams and rivers for their main water source and this accounts for 94.8% of the population surveyed in the Vara and Havilua villages. 2% of households supplement their water supply with rainwater tanks. 37% of households rely only on community water supply, and another 22% rely only on water from nearby streams and rivers. The remaining percentages are from a combination of sources summarised in Figure 11-3.

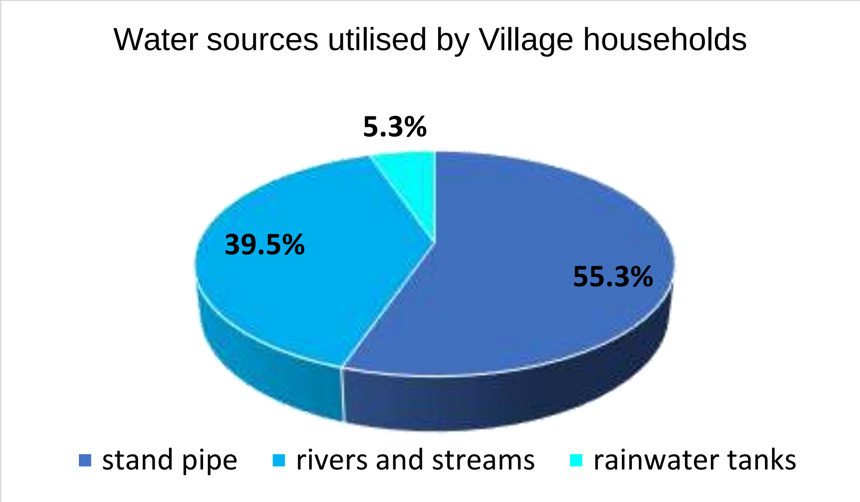


Figure 11-3 Water Sources utilised by Community

The main source for lighting is solar energy and this accounts for sxity five percent (100%) of the households. 15% of houselolds supplement their power supply using generators (22% in Havihua and 11% in Vara).

11.4.2 Sanitation

Lack of proper sanitation is a cross cutting issue in rural communities. Sixty three percent (63%) of the household interviewed did not have access to proper sanitation. People use either the bush or coast. Thirty-seven percent (37%) of the surveyed households had access to proper sanitation (Figure 11-4).

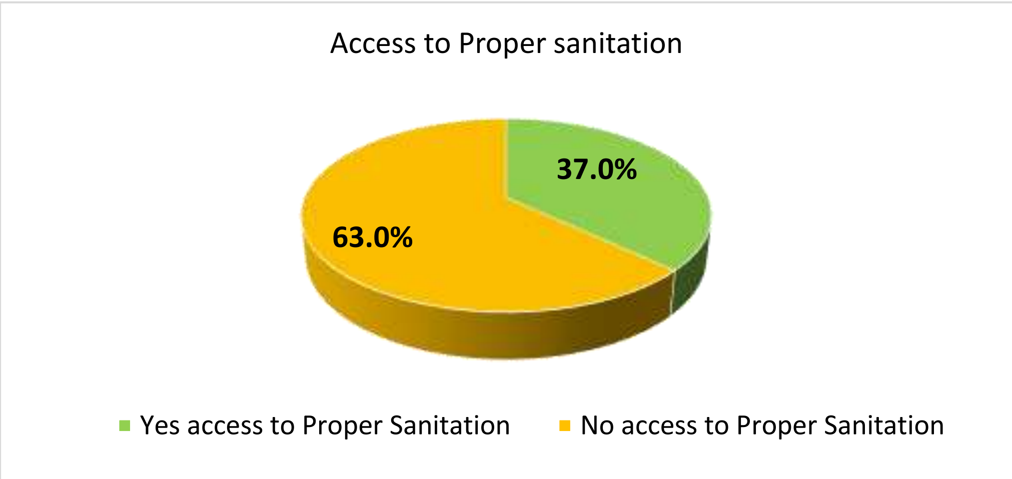


Figure 11-4 Percentage of households interviewed that have access to proper sanitation

11.5 Access to social services

11.5.1 Health services

Isabel Province is served by 1 Hospitals, 5 Area Health Centres/Clinics, and 18 Aide Posts. The hospital is located in the provicial capital, Buala. There are 2 doctors, 73 nurses, 1 dentist and 35 paramedics (including malaria microscopist, phamarcist and health promotion officers). The closest villages the people can access health services are Midoru (Havihua) and Tatamba (Vara) (Figure 11-5).

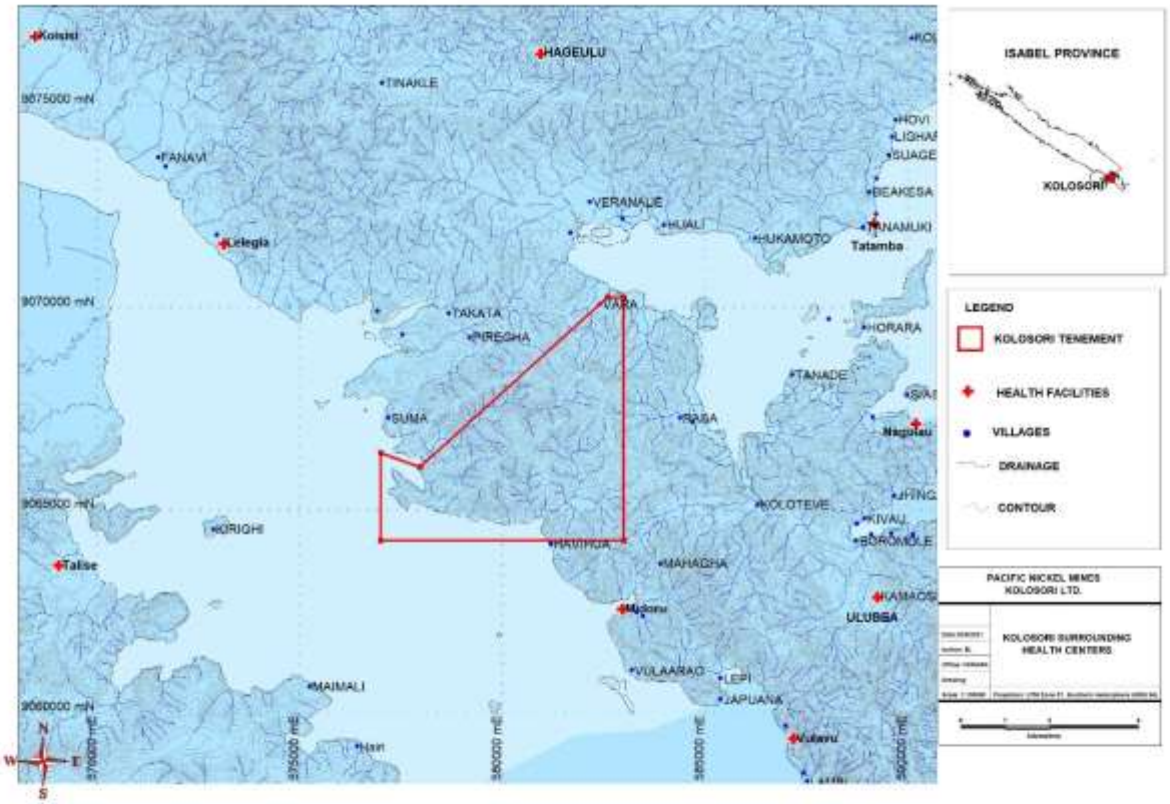


Figure 11-5 Location map for clinics accessed by communities within the Kolosori Lease area

The health centres provide treatment services, immunisation, outpatients, family planning and health awareness programmes. The major health problems faced by the people are: respiratory infection, malaria, diarrhea, high blood pressure, pneumonia and various skin diseases. Complicated cases are referred to Buala Hospital or even to Honiara (National Referral Hospital). See figure above for location of clinics communities near and wtihin the tenement area can access health services.

Pacific Nickel will establish a Health Clinic in the village for the community, subject to approval.

11.5.2 Education

The 2009 census reported approximately 87 % of the population in Isabel aged 6-15 years were enrolled in schools; of which 86 % are males and 88% are females. School enrolment rates vary significatly by age. From the household survey in the Kolosori Lease area, 51% of female and 49% of male children are attending school as dipicted in Figure 11-6.

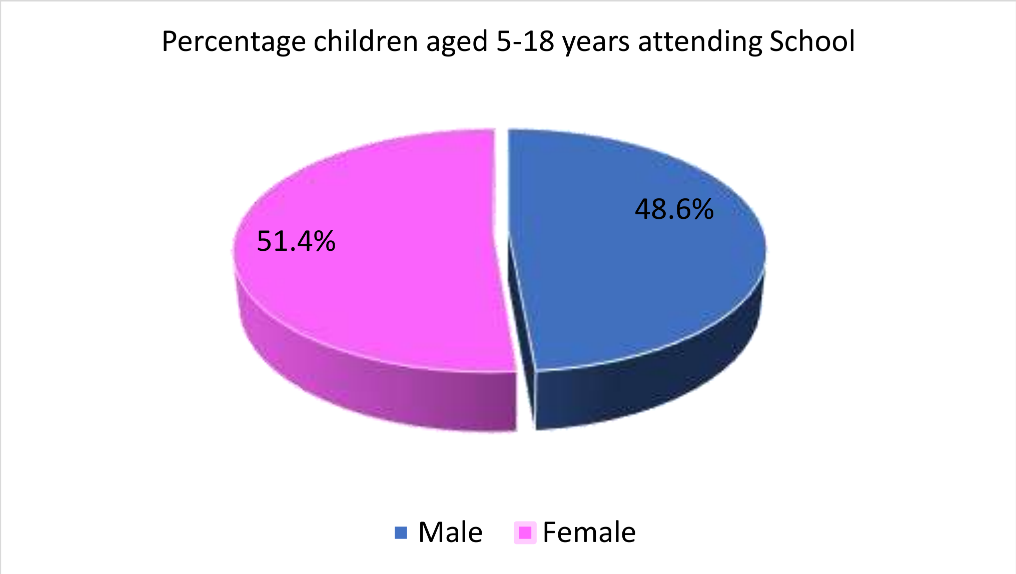


Figure 11-6 Percentage of children attending Primary and Secondary School

Children do have access to the Primary Schools in Lilura, Huali, Kamaosi, Lepi, Rasa and Sagaria (Figure 11-7). The closest community high schools are Muana and Sir Duddley Tuti College. The Primary schools are located at walkable distances, however, the community high schools can only be accessed by OBM boat.

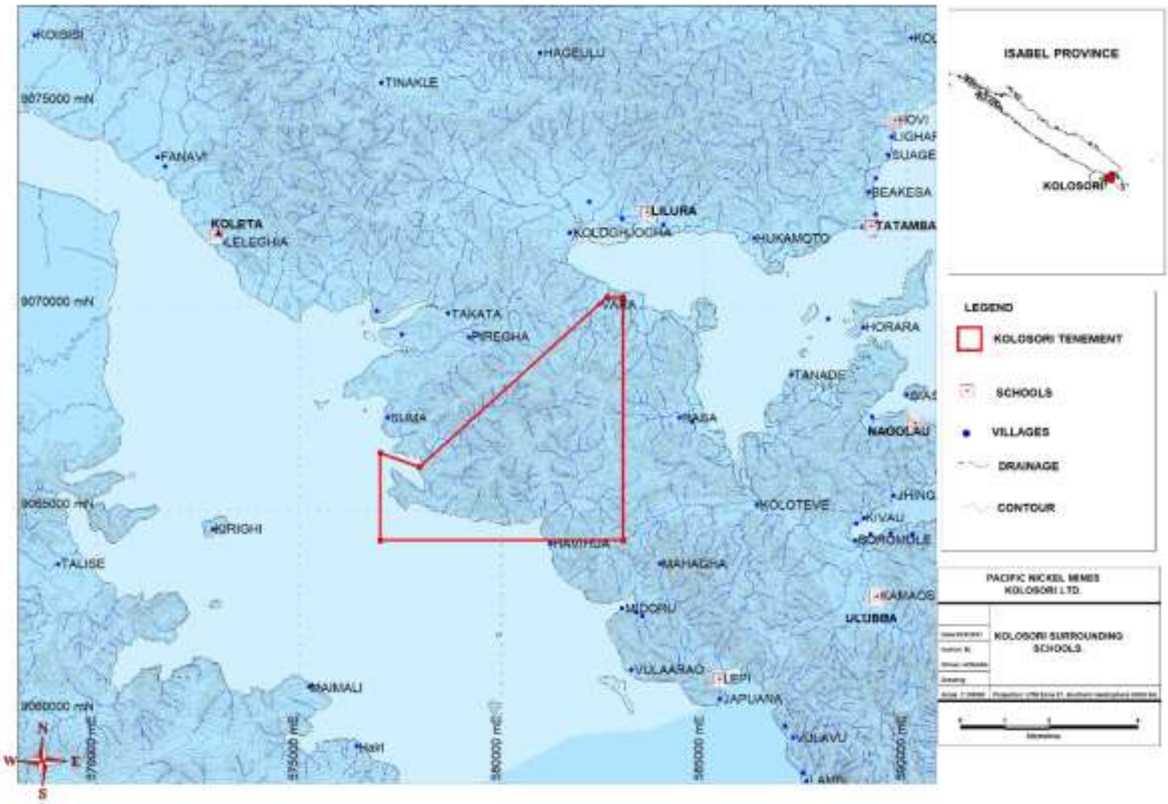


Figure 11-7 Map showing schools accessed by children in the project area

11.5.3 Communications

In the past it is common that people in the villages either lit fires, blow a conch or beat a drum to signal other communities for relaying of messages in the past. But as time goes on messages are simply passed through the use of radios and now almost all people within the Solomon Islands use mobile phones. The tenement area and adjacent communities have access to 2G and 3G telecom services.

11.5.4 Transportation

Majority of the road network in Isabel are located in the provincial Capital Buala. Feeder roads including Buala Garanga, Buala Gozoruru and Buala Tiritona Roads do link the hinterland communities to the main capital. Other roads include the Kaevaga Kolomola and Susubona to Kolaero Training Centre. These roads are isolated and connect communities inland to the coast where the main socio-economic services are located. Other forms of transportation in the province include air and shipping services to and from the province. The main airport at Suavanao and Fera receives Solomon Airlines weekly flights.

Isabel do have access to shipping services provided by IDC and UTA shipping. In the tenement area and nearby villages, IDC and UTA vessel make weekly schedules to and from Honiara. The main sea ports are Kaevanga and Tatamba. People find it easy to load and unload cargoes at these ports because they are sheltered and have wharfing facilities. Ships normally anchored offshore to collect/drop passengers and cargoes in other locations.

The surrounding communities also use OBMs and canoes as transportation mode to visit relatives from the neighboring villages or to travel across to San Jorge. Depending on weather, OBM can be used to travel to Honiara.

11.6 Socio-Economic Analysis

11.6.1 Income Sources

Household income sources are catogorised into earned and unearned income sources. Earned income is money derived from paid work and unearned income from private means other than work. According to the survey, the average total household monthly income from earned income sources particularly from wages and salary is $2,060.00 and from markeing of agricultural products averages $159 per household. A household income source can be from both unearned and earned sources.

11.6.2 Sources of Earned Income

The livelihoods of most of the households and communities in the study area are based on small-scale agricultural production and fishing, with the priority being food production for home consumption (63%). Agriculture is based on shifting horticulture, the staples being root crops, vegetables, fruits, and kava. Most households attempt to produce a surplus for sale. Formal employment mainly health, education and mineral exploration sectors accounts for 22.2% of the surveyed population. 7.4% people are self employed and work on casual basis. There are small scale businesses for example canteens, fishing, transportation services and cocoa/coconut production.

11.6.3 Sources of unearned Income

The household survey indicated that 14.8% of the households do not receive unearned income. have unearned income sources. 70.4% of the unearned income sources are by remittances from relatives and friends, 51.9% from constituency assistance and 11% receive provincial assistance.

11.7 Economic Development

Source SIRC, 2021

Economic activity is dominated by copra production, commercial logging, kava production and mineral exploration.

In Maringe District, a locally owned company called Cathliro Commodities Development (CCDL) is producing and exporting cocoa to Malaysia. The company owns 99 hectares of land at Garanga of which 20% is being used for cocoa farming. Apart from its farm, cocoa beans are also bought from other farmers in the country. CCDL in its plan aims to grow more cocoa and also to diversify into other agricultural and horticultural products such as cassava, pigs, poultry, bananas, pineapples and aloe vera.

The North Western part of Isabel has a potential for sustainable tourism industry particularly establishment of the small scale-eco tourism where visitors enhanced the traditional values and the environment and contribute positively to the livelihood of the people. Currently, Papautura Fa’a Island

Resort, a small- scale tourism is operating in the area and to that, the Suavanao Airstrip is also operating and accommodates Solomon Airlines weekly flights.

In the southern part of Isabel, in the Gao/Bughotu district, Tatamba is a sub-station, located on a Provincial Government Land. This substation hosts basic services such as health, education, agriculture, fisheries and has served as a major sea port for the people of Gao- Bughotu. In 2016, through the Overseas Fisheries Cooperation Foundation of Japan (OFCF) and Ministry of Fisheries and Resources, the Tatamba Fisheries Centre was assisted with solar powered deep freezers and lightings. A total of 600 litres deep freezers powered by solar power and six solar powered lights were installed.

There is a strong potential for mineral resources especially around the San Jorge area and on the adjacent mainland Isabel. Nickel was discovered in Isabel more than 40 years ago and overseas companies have been eyeing these substantial deposits which are among the largest nickel laterite deposits in the Pacific. In 2011 the Axiom Mining company signed a 50- year deal with landowners for a 45-square kilometre area estimated to contain nickel ore worth almost US$60 billion. However, due to disputes and court cases, the company did not proceed. Currently, other mining companies are also proposing to undertake mining exploration on the mainland Isabel, particularly at Kolosori/Takata area, and San Jorge.

Tatamba acquired a constituency fishing centre. The Centre was designed to provide shared marketing, cool store and ice making facilities for participating fishermen.

There are cocoa and copra production in the area. The recent decrease in copra prices has affected copra production in the entire area.

There is extensive logging of customary lands adjacent to the tenement area, with the landowners receiving a royalty (or stumpage) after every shipment. Payments from commercial loggers usually go to the customary land trustees and are distributed to the landowners who may invest in improving their housing and transport, and/or use it to pay for school fees or start a small business. In other cases, it is treated as windfall income and spent on consumables and alcohol.

Today, most dressed timber is produced at household level by pooling family labour. The trees are felled and dressed using chain saws or portable mills. Portable (walkabout) mills are often bought by the logging companies and later expenses associated deducted from landowner’s royalty payments. The main markets for dressed timber are locally, Buala and Honiara. The main problem people face in timber production is transportation.

There are few pig and poultry farmers in the study area. The small holder farmers who keep pigs typically have approximately 2-3 pigs, which can sell for SBD$3000-SBD$5000, depending on the size and weight. Most pigs are kept in secure fences away from the village. Imported chicken can be sold for SBD$120. However, the local chickens are cheaper at SBD$50.

11.8 Community and Family Structure

The structures of communities and families in Solomon Islands culture is tied mainly to the different tribal groups found in the islands. Belonging to a kinship group is very important in each rural community and family in and around Solomon Islands.

Isabel Province is one among the few provinces in Solomon Islands that its Chiefly system is still very strong and active and they usually work very closely with the church. This Chieftain system practiced in the study area is active and vocal. They also involve in dispute resolutions and grievances. There is a governing body that consists of Chiefs, Village Elders and Church Representatives that ensures peace and stability in the communities around Isabel.

In rural areas in Isabel including the study area, large villages are often situated on tribal lands. Villages comprise individual families placing their homes next to other relatives. The family usually consist of parents and children living together in a household which is usually about 5- 10 people.

In Isabel, men are seen as the head of the household. Men often make critical decisions because they have to negotiate and account for the decisions if required. Although men take on the critical decisions, women often play a role in these decisions in the background, out of the gaze of others. Women often make decisions pertaining to the household, those that involve women's affairs, and those that involve their own relatives. In this region particularly, men have the rights and responsibilities of decision making on land matters and women are passive observers on land matters.

11.9 Land ownership

Land is the only asset held by the majority of people of the Solomon Islands and about eighty seven percent (87%) of land is under customary resource tenure and all natural resources therein belong to customary land owners. Traditional land and resource management is usually community based. Without land, their labour is of little value as there are few opportunities for non-farm work and few have the capital to invest and start businesses. Thus, any actions that alienate, degrade, redistribute, or otherwise impact on land affects livelihoods, identity, and the people’s culture.

In Isabel Province, the land is owned by the tribe and inheritance is passed through the female line (matrilineal). For people to claim ownership of resources within the land; ie, forests, rivers and the land itself, they must understand, identify and know the main lineages and trace their ancestors to their lineage and how they move within the Isabel Province. It is important that one knows which tribe one comes from.

Customary land tenure has generally proved efficient to maintain access to land for the majority of rural Solomon Islanders. However, customary land tenure systems are under pressure to adapt to irreversible changes, including population pressure, increasing demand for land for public purposes, greater social mobility and migration, and new expectations from the cash economy.

Tribal Lands in the area are customarily owned except for some areas where it was registered for development. For customary lands, community or tribal men and women use traditional markers for customary land boundaries identification and this include are hills, valleys and streams/waterways and certain trees or plants planted (traditional).

11.10 Community food production

Traditional Knowledge is significant to the people of Isabel as they are strongly attached to it. It is a valuable and sophisticated knowledge system developed over generations and passed on through oral traditions.

People living in the surrounding communities have a vast knowledge of many aspects of their environment and how their livelihood revolve around their surroundings. Community people over the years have learnt how to grow food and preserve and to live with and survive in difficult environments. They know what varieties of crops to plant, when to sow and weed, which plants are poisonous and which plants have medicinal values that can be used for controlling of diseases in plants, livestock and people. As they find themselves depended so much on their environment, they know very well how to maintain and live in harmony with the environment.

Communities situated in the highlands have differing gardening methods compared to communities along the coasts and this is determined by the community's geographical setting and environment. Food has generally been adequate because villages produce most of their own food through farming and fishing. Slash and burn method of gardening is the usual practice in many of the communities in Isabel. Some communities however have had agriculture agencies intervention thus may have adapted to different gardening practices and technical skills for example organic farming/backyard gardening etc. in order to improve soil fertility and opportunities for growing diverse crops and vegetables.

In the traditional slash and burn method for gardening, heavy tasks such as cutting down of trees and shrubs for clearing space for gardens is done by men. Women and young girls concentrate on the planting of root crops and vegetables and it's continuing maintenance. Historically traditional rudimentary tools such as sticks and stones were used to make gardens. This has changed over time however to modern tools for improving efficiency in making gardens.

Prior to European contact fishing techniques used were very simple and ranged from shell gathering/harvesting using bare hands to more complex methods. Men are more involved in reef fishing and use a higher number of different traditional fishing methods, while women more often participate in harvesting other marine resources. Both men and (some) women participate in reef fishing, but women use a more limited number of specific fishing methods, usually from the shore or close to home. Some traditional fishing methods practiced including:

- poisoning fish when very few fish have been caught using other fishing methods. Two common plant species (B. asiatica and Derris spp.) are used to stagger freshwater and marine fish;
- Va'e or Kurao is a traditional fishing method specifically used for Turtle hunting in deep waters; and
- Kwarao'o which is a fishing method that is used on reefs or shallow waters using vines and leaves of a certain shrub to stupefy fish; the vines are used to encircle the school of fish and the crushed leaves are then thrown into the water to stupefy the fish.

Women and children's role in fishing is often in gathering and collecting shellfish in reef areas or in mangrove swamps, rivers and estuaries. Shell collecting (Trochus niloticus, Tridacna maxima, Tridacna derasa and Turbo spp) is common during extreme low tides from inshore and offshore reefs and during dry season. Women are also skilled in finding mangrove crab tracks and are more involved in this activity than men, although men sometimes help when required. These harvesting skills are then transferred by older females to younger women.

11.11 Religion

All the households surveyed are Anglican Church of Melanesia (ACOM) by denomination.

11.12 Community Consultation and Awareness

Community consultation and awareness meetings were conducted in Vara and Havihua villages on 23rd and 24th of August 2021 respectively.

Present were Community Chiefs, Church Leaders, landowners, women and youth representatives, and general community members living within/neighboring to the two villages attended the consultation. The purpose of the meeting was

- To identify and plot the cultural or tabu sites and graveyards (cemeteries).
- to facilitate a community awareness meeting to explain to the community members what is involved with the proposed mining activity to mine the nickel ore that is present in the Kolosori Lease area and what are the iactivities that may directly impact the community and how they will be managed.
- To introduce Government personnel from the Ministry for Mines and Ministry for Environment who identied the following items related to establishing a mining project.
- To carry out Socio and Economic survey and data collection of village households, as part of the baseline database for the Environment Impact Study

The community consultation and awareness meeting provided project-specific information, provided an open forum for community issues and concerns to be voiced, allowed for the collection of information on the potential social, economic and environmental impacts, relating to the mining project.

Mr. Patrick Vatopu from the Ministry of Mines provided the following:

- The purpose or objectives of holding awareness meetings is that it is a requirement under the Mining Act to conduct public awareness meetings.
- He discussed the process and stages of getting a mining lease and development consent. Acquiring development consent is the next stage the Company is applying for before the mining lease.
- The Ministry of Mines is happy on how the Pacific Nickel Mines did the prospecting. The result of this prospecting or exploration work had created a very good image for the company,
- The Ministry of Mines will also be responsible for monitoring and inspection on all Mining Companies (mining projects).

- In the Mining lease there are requirements and conditions of approval attached that the Mining Company must follow and abide by.

Mr. Michael from the Ministry of Environment introduced himself and then he elaborated on the following points on the EIA process:

- Environment Impact Assessment (EIA) is important requirement in any development. The Ministry of Environment have done the scoping study for Kolosori project and the TOR has already been drawn up and been issued.

- This EIA should have been done and the Company should have tasked. Report of the EIA has to be produced. The impact assessment or study by Axiom KB and Sumitomo had been done (in the past) as a requirement under the Environment Act.

- A public hearing will be conducted after the study, a notice will be served. The Ministry of Environment is responsible for this public hearing. After the public hearing, 14 days period will be given for review and thereafter a “Development Consent” is granted or denied

Issues raised during the consultations are listed below:

- Extent of the boundaries and area covered by the social impact study. If there was a problem what will be the mitigation measures put in place and who was responsible for it.
- What was the extent of the EIA and how far does it extend and who was responsible for implenmenting mitigation measures if there is a problem with the mining development
- What would happen to other Minerals that are not covered in the mining agreement, especially the cobalt and others (minerals that may be present).
- Fr. Wilson Mapuru formally declared that there is NO tambu or cultural sites where the exploration activities take place.
- what is the Government measure and management plans on Tubi trees in the Mining site. It should have allowed a special guarantee to resources owners to harvest tubi on mining and prospecting areas.
- Fr. Wilson Mapuru expressed that he is responsible for any environment and social impact that may happen in Havihua basically he takes on the blame because he is responsible for opening up his land for this mining project. How best placed is the Government to minimise these potential problems/impacts
- A question was asked of Pacific Nickel Mines why they had not given landowners any goodwill payment, token and no payment on the SAA.
- A question was raised on why there has to be prospecting all the time a new mining company comes the area. Where are the reports from Sumitomo, Axiom and Inco? The new mining company should use those reports and proceed on to the Mining stage.
- A question was asked of what will happen to other minerals besides the Nickel?

- He question was raised regarding what will the Government or Ministry of Mines do when there is a breach of agreement and non-compliance from the Pacific Nickel?
- What are the processes and requirements Pacific Nickel needs to do in order to get the Mining Lease?
- A question was raised on how much do Landowners and KNSI local directors received from this transfer of the PL to the Pacific Nickel Mines?
- A question was asked about this EIA when it is completed, who will be responsible for its implementation and ongoing monitoring of its worth (impacts)?
- How far do the boundaries for this social impact (study) go to (cover). And if there is problem what are the mitigations, measures in place and who is responsible for it?
- Chief Sobo -formally declares that there his tribe the Vihuvunai -goe fully supported this project and the exploration activities.
- What are the Government measure and management plans on Tubi trees in the Mining site. It should have allowed a special guarantee to resources owners to harvest tubi on mining and prospecting areas.
- A long and detailed discussion and answers to the questions raised were provided by PNM representative and the two government officers from the Ministry of Mines and the Ministry of Environment

Closing remarks were provided Pacific Nickel personnel who also provided an update and progress of the mineral exploration activity on the Kolosori project

Fr. Wilson Mapuru the Principal Landowner and Director (Havihua) acknowledged all the parties involved in this awareness meeting. He thanked the Lord Almighty for his divine blessings, thanked the two government officers for making the meeting very informative and worth(while). We are so proud and humbled to be the host of this very important meeting.

Chief Aumana (Vara) acknowledged all the parties involved in this awareness meeting. He thanked the Lord Almighty for his divine blessings, thanked the two government officers for making the meeting very informative and worth(while). We are so proud and humbled to be the host of this very important meeting.

He further expresses word of thanks to those who have assisted towards making this meeting a success. To the vihuvunagi-goe chief and relatives we have to paddle together in order to have this company develop our resources too many companies have come and go but the rich nickel deposit is yet to be fully harvested and we enjoy its benefits. We have been dreaming for this reality for so long and when will we reach the promise land he concluded.

The public consultation meeting were well attended by the ordinary people in the communities and landowners. They appreciated the consultation and awareness program and requested the company to continue to show transparency in its operation. Information provided and the issues raised are crucial to the design and implementation of the mining.

The minutes of the Vara village meeting and Havihua meeting, are provided in Appendix D.

11.13 Environmental and social values

11.13.1 Valued Components

Valued Components (VC) are typically defined as aspects of the socio-economic environment that are important to people's wellbeing and quality of life. Examples include economic development and opportunities, education and training, and community infrastructure and public services. Any change to a VC that can be attributed to the Project represents a Project effect.

For a socio-economic component to qualify as valued, the component must be known (or be reasonably expected) to occur in the Project's area of influence. There must be a reasonable expectation that the component could be affected by the Project and people must articulate in some way that value is in fact assigned to the component.

The VCs for the Social Resources Impact Assessment were based on:

- community concerns – identified during ESIA consultation and awareness meetings
- the findings of the Baseline survey
- the findings of other ESIA studies which could then be expected to create a socio-economic effect
- the professional expertise and experience of the ESIA team

The VCs are summarised in Table 11-5.

Table 11-5 Valued Components by Socio-Economic Category

Socio-economic Category	Valued Components
The Economy	• direct employment • workforce education and training • local business opportunities • local economic growth and diversification • increased incomes
Land Use and Natural Resource Use	• land availability • access to land and water for natural resources and livelihoods • access to land and water for social and cultural uses
Land Tenure	• traditional land tenure systems
Public Health and Safety	• physical and mental health • vector-borne diseases • safety and security

Socio-economic Category	Valued Components
Quality of Life and Community Wellbeing	• housing • vulnerable groups • family cohesion • community cohesion
Social and Physical Services and Infrastructure	• changes to public infrastructure • changes to access to services (education, health, social) • changes to transport

11.13.2 Mitigation and Improvement

Environmental design features are the application of environmental good practices, mitigations and management policies and procedures. Environmental design features (including those related to the social environment) include existing commitments made by Pacific Nickel. Mitigation measures were also developed through an iterative process between the Project engineering and the ESIA study teams to devise ways to avoid and/or mitigate changes to socio-economic features.

Actions to minimise socio-economic effects are presented below.

Employment & Immigration

- Recruit locally, where possible particularly for camp service, road construction and rehabilitation.
- Project wages to be comparative to the type of work and to other industries.
- Limits will be placed on foods and supplies sourced from local producers based on their capacity to provide, to avoid undue stress on local producers, retailers and resources and to avoid price inflation and unfair competition.
- In preparation for closure, collaborate with Government to identity other projects coming on line where people may be re-deployed.
- Project workers to be rested and isolated from fellow workers if suffering from infectious disease or illness.
- Incorporate traditional values into the workplace culture where possible and appropriate.
- Implement restriction of access to villages to Pacific Nickel Solomon employees who are not members of the landowning tribes. Non-local workers shall be transported directly to and from camp and must stay in camp during rostered off periods.
- Seek collaboration with relevant organisations in the design and proper implementation of health promotion and disease prevention programs such as health programs for management or lifestyle diseases (e.g., diabetes, cancer and cardiovascular diseases), infectious diseases (e.g., malaria and tuberculosis) control program and STD/HIV-AIDS prevention programs. Including establishing a clinic in the village to serve the community.

- Work with local government, churches, leaders and NGOs to develop strategies to minimise anti-social behaviours, adverse health and safety effects and law and order issues.
- Restrictions on alcohol consumption for Pacific Nickel Solomon workers.
- Develop a family friendly culture by having policies and procedures that allow workers to attend to family responsibilities.
- Provide equal opportunities for women to be employed by the Project.
- Provision of health services to all Pacific Nickel Solomon employees.
- Collaborate with relevant organisations and government to develop strategies to increase local social services.

Trade and Procurement

- Where possible, have preferred supplier agreements with local businesses.
- Restrictions for Pacific Nickel Solomon employees in relation to recreational fishing, shellfish gathering and hunting as recreational activities.
- The workforce will be restricted from fishing or taking marine resources in the area. Any fish purchases from local fisherman to supply food for the workforce will be undertaken in a manner that sustains local marine resources. The consumption of marine reptiles, mammals, sharks or species of conservational concern will be prohibited.
- Encourage local people to expand local tourism and service businesses and activities.

Training

- Implementation of a skills development training program for employees and where possible local people.
- Onsite English literacy training programs for employees to improve English language speaking and reading skills over time.
- Organise partnership with appropriate financial institution to provide education and guidance to local communities on finance management, planning and responsible expenditure of higher incomes.
- Training and awareness regarding:
    - risks associated with high risk sex
    - symptoms of communicable diseases
- Cross-cultural training program for Pacific Nickel Solomon employees and contractors. Encourage members of the tribes and clans within the Project area to participate in the cross-cultural activities as instructors.
- Implementation of effective and efficient Occupational Safety and Health programs (e.g., personal protective equipment, clinic).

Land Acquisition

- Land use to be addressed through negotiation of surface access rights as per Section 32 of the Mines and Minerals Act.
- Help to be provided to identify alternative sites for use for areas where current land use is interrupted by Project activities.

Land Clearance

- Clearing of Project areas will include consultation with the landowning tribes and clans.
- Where trees, including Tubi trees, will be cleared, Pacific Nickel will discuss with landowners at Surface Access Right Negotiation. Pacific Nickel is not going to obtain benefit from trees cleared.
- Work with relevant Government officials and landowners to make sure minimal effects to Tubi trees and other important flora of social importance such as medicinal herbs.

Construction and Operations

- Cooperate with the provincial government to make sure only operators licensed in their field (eg. Machine operator), work in the Project area .
- Construction of roads takes into account current village locations, gardening area, cultural heritage sites as well as the outcome of consultation with the tribes and clans in the Project Area.
- Monitoring of marine environment will occur in areas affected by jetty construction and shipping activities.
- Installation of jetty piles using bored piling instead of other piling methods to avoid the generation of high frequency underwater noise.
- Pile installation for the jetties should avoid periods of peak local marine mammal abundance, (e.g., during migratory or breeding seasons).
- Waste will be collected and placed in a purpose built refuse area in the camp compound. Bins will be provided to encourage waste segregation and recycling (i.e., separate bins for food waste, general waste and recyclables such as glass, metal and paper).
- Provision of health extension services, community based services and health infrastructure support.
- Waste management and pollution control, with regard to waste generation, exposure to hazards, water contamination, food contamination.
- Control of noise and vibration.
- Dust-suppression through water spraying will occur on unsealed roads and earthworks as needed.
- Cultural Heritage Management Plan and ‘Chance Finds Procedure’ to be developed and implemented.

- Identify infrastructure to be left intact post mine closure in consultation with local government.
- All waste storage infrastructure will be designed to be suitable for use, corrosion resistant and prevents spills from entering stormwater systems. Procedures will be incorporated into the construction and operation to make sure waste is handled and stored in accordance with applicable standards and that spill management kits, personal protective equipment and relevant operator instructions and emergency procedures are made available.

Land Rehabilitation

- Work with landowners to achieve collaboration and participation in rehabilitation trials and programs.
- Establish a nursery for tubestock for rehabilitation program
- Undertake progressive rehabilitation
- Stockpile effectively topsoil
- Design and install erosion protection for all operating areas of the mine and infrastructure

Local and Inter-regional Transportation

- Management measures that comply with International Maritime Organisation (IMO) conventions (IMO 2004) and industry good practice will be implemented to mitigate the risk of marine pest incursions, including:
  - ballast exchange in mid-ocean
  - regular hull hygiene maintenance and inspection
- Inspection (and treatment as necessary) of any cargoes or packaging that could introduce marine pests.
- Community awareness programs to explain the movements of Project equipment and to provide advice on public safety.
- Comprehensive study into screening methods and procedures for prevention of malaria and dengue fever for project implementation.
- Education process to inform local people about the transport timetable on both water and land to maintain safety.
- Joint initiatives with relevant organisations to develop strategies to address smooth transition of Project and public transport issues and shared facilities (where appropriate) into the public domain.
- Have a transport plan in place in advance of start of construction.
- Consider logistical strategies to achieve safe access for local people to their home, village, schools and thoroughfare to important river fishing and garden areas in the vicinity of the Port.
- Roads to be open to public for use. SMM Solomon to explore suitable safer options for public transport.

11.14 Cultural and historical heritage

Cultural heritage resources are defined by the International Finance Corporation (IFC) Performance Standard 8 as:

"…tangible forms of cultural heritage, such as tangible moveable or immovable objects, property, sites, structures, or groups of structures, having archaeological (prehistoric), paleontological, historical, cultural, artistic and religious values; (ii) unique natural features or tangible objects that embody cultural values, such as sacred groves, rocks, lakes and waterfalls; and (iii) certain instances of intangible forms of culture that are proposed to be used for commercial purposes, such as cultural knowledge, innovations and practices of communities embodying traditional lifestyles."

A desktop review of cultural and historical heritage for Santa Isabel was undertaken.

A field survey of Tambu sites was also undertaken for the Kolosori tenemenant area and surrounds.

11.14.1 Literature Review

The Solomon Islands are inhabited by a diversity of cultures, ethnicities and languages reflecting multiple colonisation events, unique histories and complex interactions across time and space (Aswani and Sheppard 2003; Green 1977; Pawley 2007; Ross 2001; Spriggs 1997; Sheppard 2011; Walter and Sheppard 2009). While there are some large gaps in the archaeological record for the Solomon Islands, it has been shown that people have been living here for many thousands of years and these islands occupy an important place in Pacific archaeology.

A broad overview of the main cultural phases for the Solomon Islands as outlined by Walter and Sheppard (2009) is provided in Table 11-6. It also includes a summary on the time of warfare and headhunting and recent history. The table shows the different time periods, some of the main attributes of each phase and common archaeological sites associated with each phase. The cultural phases are not all encompassing nor are they completely exclusive and there are likely some attribute overlaps over time.

The literature review shows that there is a wide diversity of possible archaeological sites on Santa Isabel. While people living in the region today are typically familiar with more recent sites (e.g. old villages, skull shrines), it is important for the field methods to account for older, less visible sites such as pottery sherds in the coastal mud flats and Pleistocene habitation sites in limestone caves.

Table 11-6 Cultural Phase, key details, characteristic site locations and common site types

Cultural Phase	Key Details	Characteristic Site Location	Common Site Types
Pleistocene Colonization and Adaptation (ca. 32,000 – 10,000 BP)	• Human occupation in the Solomon Islands dates back at least 28,000 years to Kilu Cave on Greater Bougainville (large land mass that included Santa Isabel). • People were living a hunter-gatherer lifestyle utilizing both terrestrial and marine foods. • No other Pleistocene sites have been identified in the Solomon Islands.	• Sea level changes will affect site location; therefore sites that were once beside the ocean could be submerged, in the inter-tidal zone, or on raised beaches (inland from the current shoreline). • Caves (especially in limestone formations).	• Habitation. • Food processing.
Early to Mid-Holocene (ca. 10,000 – 3,200 BP)	• Greater Bougainville broke up into different islands. • Development of coastal benches behind protective lagoons suitable for human occupation. • Kilu Cave continues to be occupied into this time period. • No sites from this time period have been identified on Santa Isabel.	• There is a possibility for very old sites submerged under water, along the beaches, in the inter-tidal zone, on raised beaches (away from the shoreline) and in caves.	• Habitation. • Food processing.

Cultural Phase	Key Details	Characteristic Site Location	Common Site Types
apita Cultural Complex (ca. 3,200 – 2,000 BP)	• First Lapita sites are found in the Reef /Santa Cruz Islands in the southeast Solomon Islands around 3,200 BP. • Aside from the Reef/Santa Cruz islands, no other early Lapita sites exist in the Solomon Islands. • Notable lack of pottery in the Central and Eastern Solomon Islands. • Recent investigations on the north-west end of Santa Isabel, specifically at the site of Kusira, have uncovered lapita style pottery. • Santa Isabel was likely settled around 2,700 BP during the late Lapita period.	• Lapita settlements are typically large, coastal villages found on lagoons or small offshore islands (Spriggs 2006). • Archaeological sites often located in the inter-tidal zone. • Close to fresh water sources.	• Pottery sites. • Habitation sites. • Flaked stone.
Post-Lapita and development of Solomon Island societies (ca. 2,000-1,600 BP)	• In the Northern Solomon Islands there is evidence of long term continuity in culture, pottery production and settlements. • In the Central and Eastern Solomon Islands there is no detailed pottery record. • Changes and new patterns are observed such as: evidence of warfare and headhunting, development and emergence of monumental architecture, shrines (e.g. skull caches) and material culture related to religious/spiritual domains.	• Intertidal zone • As warfare increases, sites start to move inland and away from the open coast (see site location for the warfare/head hunting phase below). • Carter's (et al. 2012) research on northern Santa Isabel indicate that some sites may be located on inland hilltop sites and intertidal mudflats.	• Pottery sites. • Flaked stone. • Start to see some of the sites associated with warfare/head hunting (see below).

Cultural Phase	Key Details	Characteristic Site Location	Common Site Types
Warfare/Head-Hunting Period (ca. 1,600- 500 BP)	• Had a visible effect on population rates and movements, settlement locations and political organisation. • Villages were abandoned or were completely wiped out. • On Santa Isabel there was a trend of people moving south to live in large settlements under the protection of regional big-men. • The few settlements that remained in northern Santa Isabel were highly fortified.	• Coastline. • Protected lagoons near freshwater sources. • Tops of ridges and hills. • In the mangroves.	• Shrines. • Burial structures. • Stone platforms. • Fortifications. • Look out sites. • Skulls repositories. • Old villages.
Interactions with Europeans (ca. 500 – 100 BP)	• Alvaro de Mendaña y Neyra, first arrived on Santa Isabel in 1568. • By the early 1900s, the influences of European colonists and Christian missionaries had really begun to take effect.	• Sites often located in areas where people commonly live today.	• Early missionary houses and schools. • European artefacts.
Modern Era (100 BP - current)	• World War IIhad a large effect on the Solomon Islands. • Battles were fought on the land and in the sea and air.	• Shipwrecks in the oceans. • The rest can feasibly be located anywhere on the landscape.	• Shipwrecks. • Aircraft. • Military remains (armaments, machinery). • Human remains. • Food containers. • Campsites.

11.14.2 Cultural/Historic Sites in the Kolosori tenement area

The Kolsori Tenement was assessed and 12 Tambu sites were identified , (Table 11-7 and Figure 11-8). Six (6) within the tenement boundary, mostly at the northern end of the tenement.

Table 11-7 Tambu sites in and near the Kolosori tenement

NAME	EASTING	NORTHING
TANAGIA	581353.04	9068268.39
TANASOPU	581333.87	9068313.47
RUVU	582093.16	9069839.74
SIRU	582177.16	9069556.32
SOBILI	582386.99	9069709.65
ATHANUGHA	582871.54	9069948.39
VIKOBOBO	582710.36	9069314.2
TAMALOGA	583178.31	9068921.96
KOKONIGHO	584016.99	9068374.58
TINAJOKRA	583055.76	9066787.48
VERAGABUHI	583739.74	9066147.53
GAHIKO HIGATOA	583440.1	9064483.64

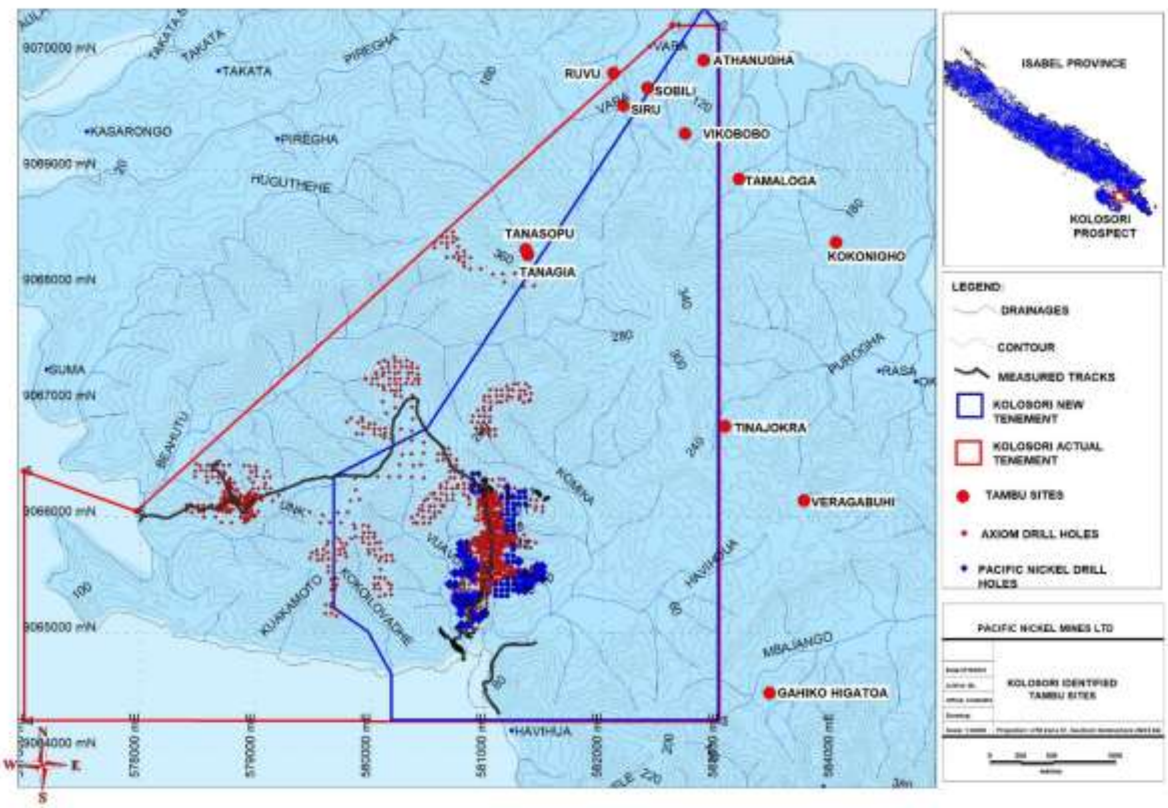


Figure 11-8 Location of Tambu sites in or near the Kolosori tenement

12 MANAGEMENT PLANS AND MITIGATION MEASURES

The Environmental Management Plan (EMP) specifies, at a strategic level, the safeguards and controls proposed in order to manage potential environmental impacts, and incorporates commitments described throughout the various chapters of the ESIA. The documented controls will be incorporated into relevant, existing Pacific Nickel operational plans, procedures and monitoring programs as part of the Project's implementation.

The EMP includes an overview of MRM's environmental management framework; and specific management plans addressing the Project aspects including:

- Air Quality and Dust Management Plan;
- Noise Management Plan;
- Biodiversity Management Plan;
- Cultural Heritage Management Plan;
- Emergency Response Management Plan;
- Fire Management Plan;
- Hazardous Substances Management Plan;
- Waste Management Plan;
- Social Impact Management Plan;
- Water Management Plan; and
- Vegetation and Weed Management Plan;
- Overburden placement;
- Erosion and sediment control;
- Monitoring Plan; and
- Health and safety.
- Rehabilitation Plan
- The ESMS is divided into five levels which are:
- Level 1 – Policies
- Level 2 – Standards
- Level 3 – Action plans
- Level 4 – Standard Operating Procedures (SOPs)
- Level 5 – Forms

The purpose of Pacific Nickel's environmental management plan is to plan and design the mining activity to minimise disturbance to the environment, identify areas that are likely to be disturbed in the course of the project's life and actively plan and implement remediation and progressive rehabilitation of disturbed land, and minimise impacts on the receiving environment.

Similarly PNM has an active and effective occupational Health and Safety approach to create a safe working environment that will ensure protection and minimise harm to staff, contractors and community during the life of the project.

Potential disturbance to the local environment and potential disturbance to the local community may occur during the four project stages summarised as follows;

Pre-Construction Stage, which includes the socialisation of activities, land acquisition and mobilization of equipment and materials.

Construction Stage, which includes recruitment, land clearing and the construction of the mining and supporting facilities.

Operational Stage, which includes stripping and removal and stockpiling topsoil, excavation and removal and stockpiling overburden, excavation of nickel ore for stockpiling and drying; progressive reclamation and revegetation in association with Pacific Nickel's Corporate Social Responsibility charter.

Post-Operational Stage, which includes the rationalization of labour, demobilization of equipment, reclamation and continued revegetation to return the area to a natural habitat completing mine closure, and monitoring and maintenance of rehabilitated disturbed land.

Pacific Nickel's Environmental Management plan will be developed for monitoring potential environmental effects of the project, determine and implement the appropriate treatment for any environmental risk that has or may eventuate.

12.1 Environmental Management Actions

The EMP provides management strategies for the potential impacts on air, land and water together with a summary of the management actions to be undertaken as listed in Table 12-1.

Table 12-1 Environmental Management Actions for Potential Impacts on Air, Land and Water

Potential Impact		Summary of Management Actions
Air		
Air quality	• Dust emissions from constructionand operation activities includingexcavation, ore movement and stockpiling.	• Operations and work practices will be modified to minimise dust generation particularly during windy or dryconditions. • Management measures will include; minimising the length of haul roads; restricting vehicle movement to defined roads; limiting vehicle speed; using water sprays; minimising vertical drop heights; sealing selected road sections; applying surfactants to roads; covering truck loads and stockpiles; and installing wind breaks where practicable. • Appropriate training will be provided for machinery

Potential Impact		Summary of Management Actions
		operators. • An Air Quality Monitoring Plan will be developed and implemented. • Any complaints received will be addressed through monitoring, corrective action and reporting.
Noise	• Noise emissions from mine and associated infrastructure and haulroads	• Detailed noise modelling may be carried out during detailed design to refine noise predictions at sensitive receiversand finalise the management measures. • Detailed design will also investigate whether implementation of a Noise Monitoring Program is needed. • Design measures could include; siting of roads and semi mobile plant equipment away from sensitive receptors; road design to minimise the need for vehicles to reverse; applying setbacks; acoustic isolation to the facades of houses affected; construction of noise barriers, berms and stockpiles; use of low noise equipment and installation of advancedengine and exhaust noise control equipment. • Operations and work practices will be modified to minimise noise as far as possible • Operations measures could include; minimising vertical drop heights; limiting vehicle speed; scheduling of equipment and machinery movements during daylight hours; regular maintenance of internal roads; shut down of vehicles and equipment when not in use (to minimise idling); purchase of low noise plant and equipment and fitting of mufflers where possible; regular maintenance of vehicles, plants and machinery; and limiting the use of vehicle warning devices to safety precautions (i.e. not for general signaling). • Acquisition and relocation of houses may also be considered. • Appropriate training will be provided for vehicle, plant and machinery operators. • Communication protocols will be established between SMM Solomon staff to advise residents when excessive noise ispredicted to occur and to address any complaint received.
Land		
Land, geology and soils Land, geology and soils	• Changes in landform. • Loss of topsoil. • Increased sedimentation anderosion. • Disturbance of acid sulfate soils. • Soil contamination. • Landslides in susceptible areas.	• Detailed design of mine areas and supporting infrastructure will determine how to reduce the long term impact oflandform changes. • Detailed design will also address engineering measures to stabilise slopes and to reduce landslide in susceptible areas. • The risk of disturbance to acid sulfate soils will be minimised through assessment of potential risk prior to construction, particularly in the port development areas. • Disturbance will be avoided wherever possible and if encountered, immediately contained, treated and appropriately managed. • An Emergency Response Plan will be prepared prior to the commencement of construction to address the response to natural disasters (e.g. volcanic eruption) and the clean-up procedures after the event. • Construction and operation will be carried out in stages to minimise the area that will be disturbed at any one time. • Erosion and sediment control measures (e.g. sediment traps) will be applied during construction and operation

Potential Impact		Summary of Management Actions
		stages. • A Waste Management Plan will be developed and implemented so that soil contamination is prevented or otherwiseminimised and contained. • Temporary mine facilities and infrastructure (e.g. haul roads) will be decommissioned and dismantled. Retention ofinfrastructure (where desirable) and rehabilitation will occur in consultation with stakeholders. • Engineering measures will be implemented to restore land and slopes disturbed during operation in areas where nofurther works will be undertaken. • Progressive rehabilitation will be implemented including conservation and reuse of topsoil and best practice regeneration/revegetation techniques. Topsoil conservation and management will be addressed as part of the overallMine Rehabilitation and Closure Plan.
Water		
Water quality and flow Water quality and flow	• Turbidity and sedimentation of freshwater and marine water. • Loss of catchment area andchanges to flow regimes. • Contamination from hydrocarbonsand other chemicals through spills, infiltration and leaching. • Nutrient enrichment • Acid mine drainage. • Altered hydrodynamics. • Reduction of water supply qualitythrough increased turbidity of streams. • Introduction of pathogens to water supply. • Competition for water sources and reduction of flow/quantity of watersupply.	• Detailed design will assess potential impact on the hydrodynamics of marine waters adjacent to the port development. • An Erosion and Sediment Control Plan will be developed prior to the commencement of construction. Erosion prevention measures may include; minimising land disturbance; binding soil in place with vegetation; surface protection devices; reduced slope lengths; enhanced drainage; and timing disturbance to capitalise on dry periods. Erosion control measures will be in place prior to the commencement of mining operations. • The risk of disturbance to acid sulfate soils will be minimised through assessment of potential risk prior to construction, particularly in the port development areas. • If dredging works are planned, a Dredge Management Plan will be developed and implemented to minimise the impact on water quality and aquatic ecosystems. • The Emergency Response Plan will establish an Emergency Response Team who will act in the event ofchannel bank failure, sediment basin breach, slope slide or other major failure of erosion and sediment control measures. • A contaminant Handling and Spill Management Plan will be developed to address spills of hydrocarbon and other potential contaminants. Implementation of its management measures will prevent impact on aquatic ecosystems including; minimisation and control of the volume of hydrocarbons and chemicals used on site; refuelling undertaken by licensed fuel suppliers in designated areas; regular maintenance of machinery and vehicles; provision of spill kits; and appropriate training of staff in relation to tasks and equipment in the event of a spill. • A Waste Management Plan and appropriate treatment and disposal of waste water will be implemented to minimiseimpacts of solid and liquid waste material on aquatic ecosystems. • Appropriate port and vessel management procedures will be put in place to minimise the risk of antifoulant leaching. • A Freshwater Monitoring Program and Groundwater

Potential Impact		Summary of Management Actions
		Monitoring Program will be implemented to measure water quality and flow. Information from these programs will be used to assess the accuracy of predicted impact, informSMM Solomon management of potential issues and facilitate responsive action. This includes potential impact on community water supply flow and quality and aquatic ecosystems.
Aquatic Ecology (Freshwater and Marine)	• Loss of aquatic organisms and habitat. • Changes in habitat and species composition. • Turbidity and sedimentation of freshwater and coral reef ecosystems. • Loss of catchment area andchanges to flow regimes • Nutrient enrichment. • . Acid mine drainage. • Contamination from hydrocarbonsand other chemicals through spills,infiltration and leaching. • Nickel ore spills in marine water. • Altered hydrodynamics. • Increased fishing pressure. • Impacts to aquatic species ofconservation significance.	• Port facilities will be located to minimise impact to sensitive marine habitats. • Where practical, curtains and jackets and pile cap cushions will be used to mitigate noise from construction activitiessuch as pile driving. • Where impact cannot be avoided or minimised, environmental offsets or compensatory activities may be considered. • Instream habitat materials such as woody debris, riparian flora and boulders will be salvaged and relocated to otherwatercourses during construction and operation of the mine. • Waterway crossings and diversions will be designed to facilitate fish passage and to promote water flow. • To manage fishing pressure Pacific Nickel will manage trade with local fishers and Project staff will be prevented fromfishing. • The extent of mosquito and midge breeding habitat will be monitored and managed • Vessel operation and maneuvering will be restricted around coral reefs to reduce suspension of fine sediment. • Vessel speed will be limited and enforced through the port areas, particularly close to critical habitats. • The Freshwater Monitoring Program will include biannual survey of aquatic habitat, flora, macroinvertebrates,macro crustaceans and fish (in accordance with baseline survey methods). • A Marine Water Monitoring Program will be implemented to confirm that ecologically sensitive marine ecosystems are not impacted. This will include seasonal (biannual) monitoring of marine biota associated with coral reefs, mangrove forests, seagrass meadows and will include benthic infauna invertebrates and fish (in accordance with baseline survey methods). • If new marine pests are observed measures to manage the outbreak will be implemented and port and vessel management procedures reviewed. • Following decommission and dismantling of facilities, mangrove habitat around the port will be regenerated or rehabilitated.

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APPENDIX A

Families and species of Osteichthyes (bony fish) recorded in the study.

Scientific Name (Family, Genus, Species)	Common Name	Status (Endemic, Native, Introduced)	Conservation Status (IUCN)
Acanthuridae			
Acanthurus auranticavus	Orange-Socket Surgeonfish	Native	Least Concerned
Acanthurus nigrofuscus	Brown Surgeonfish	Native	Least Concerned
Acanthurus pyroferus	Mimic Surgeonfish	Native	Least Concerned
Ctenochaetus striatus	Lined Bristletooth	Native	Least Concerned
Ctenochaetus tominiensis	Orangetip Bristletooth	Native	Least Concerned
Apogonidae			
Apogon fragilis	Fragile Cardinalfish	Native	Least Concerned
Apogon leptacanthus	Threadfin Cardinalfish	Native	Not Evaluated
Apogon neotes	Larval Cardinalfish	Native	Least Concerned
Archamia zosterophora	Girdled Cardinalfish	Native	Not Evaluated
Cheilodipterus isostigmus	Toothy Cardinalfish	Native	Not Evaluated
Cheilodipterus parazonatus	Mimic Cardinalfish	Native	Not Evaluated
Blennidae			
Ecsenius prooculis	Striped Blenny	Native	Least Concerned
Caesionidae			
Caesio caerulaurea	Scissortail Fusilier	Native	Least Concerned
Caesio teres	Blue and Yellow Fusilier	Native	Least Concerned
Carangidae			
Carangoides oblongus	Coachwhip Trevally	Native	Least Concerned
Caranx melampygus	Bluefin Trevally	Native	Least Concerned
Caranx sexfasciatus	Bigeye Trevally	Native	Least Concerned
Chaetodontidae			
Chaetodon lunulatus	Redfin Butterflyfish	Native	Least Concerned
Chaetodon octofasciatus	Eight-banded Butterflyfish	Native	Least Concerned
Chaetodon rafflesi	Latticed Butterflyfish	Native	Least Concerned
Chaetodon vagabundus	Vagabond Butterflyfish	Native	Least Concerned
Chaetodon trifasciatus	Redfin Butterflyfish	Native	Least Concerned
Chaetodon unimaculatus	Teardrop Butterflyfish	Native	Least Concerned
Chaetodon vagabundus	Vagabond Butterflyfish	Native	Least Concerned
Chaetodontoplus mesoleucus	Vermiculated Angelfish	Native	Least Concerned
Chelmon rostratus	Long-Beaked Coralfish	Native	Least Concerned
Heniochus acuminatus	Longfin Bannerfish	Native	Least Concerned
Heniochus varius	Humphead Bannerfish	Native	Least Concerned
Fistulariidae			
Fistularia commersonii	Cornetfish	Native	Least Concerned
Gobiidae			
Eviota bifasciata	Twostripe Pygmygoby	Native	Least Concerned
Holocentridae			
Neoniphon argenteus	Clearfin Squirrelfish	Native	Least Concerned
Sargocentron spiniferum	Sabre Squirrelfish	Native	Least Concerned
Labridae			
Bodianus mesothorax	Blackbelt Hogfish	Native	Least Concerned
Cheilinus fasciatus	Redbreasted Wrasse	Native	Not Evaluated
Coris gaimard	Yellowtail Coris	Native	Least Concerned
Halichoeres biocellatus	Twospot Wrasse	Native	Least Concerned
Labroides dimidiatus	Bluestreak cleaner Wrasse	Native	Least Concerned
Thalasoma lunare	Moon Wrasse	Native	Least Concerned
Scientific Name (Family, Genus, Species)	**Common Name**	**Status (Endemic, Native, Introduced)**	**Conservation Status (IUCN)**
Lethrinidae			
Monotaxis grandoculis	Humpnose Bigeye Bream	Native	Least Concerned

Lutjanidae			
Lutjanus biguttatus	Two-spot Snapper	Native	Least Concerned
Lutjanus carponotatus	Spanish Tag	Native	Not Evaluated
Lutjanus monostigma	Onepot snapper	Native	Least Concerned
Lutjanus russelli	Russell's Snapper	Native	Least Concerned
Lutjanus semicinctus	Black-banded Snapper	Native	Not Evaluated
Monodactylidae			
Monodactylus argenteus	Silver moony	Native	Not Evaluated
Mullidae			
Parupeneus barbarinus	Dash-dot Goatfish	Native	Least Concerned
Parupeneus bifasciatus	Doublebar Goatfish	Native	Least Concerned
Parupeneus cyclostomus	Goldsaddle Goatfish	Native	Least Concerned
Parupeneus indicus	Indian Goatfish	Native	Least Concerned
Parupeneus multifaciatus	Manybar Goatfish	Native	Least Concerned
Nemipteridae			
Scolopsis ciliatus	Whitestreak Monocle Bream	Native	Least Concerned
Scolopsis affinis	Pale Monocle Bream	Native	Not Evaluated
Pomacanthidae			
Pygoplites diacanthus	Regal Angelfish	Native	Least Concerned
Pomacentridae			
Amblyglyphidodon curacao	Staghorn Damsel	Native	Least Concerned
Chromis amboinensis	Ambon Chromis	Native	Not Evaluated
Chrysiptera cyanea	Blue Devil	Native	Not Evaluated
Chrysiptera parasema	Goldtail Demoiselle	Native	Not Evaluated
Dascyllus melanurus	Black-Tailed Dascyllus	Native	Not Evaluated
Dascyllus trimaculatus	Three-spot Dascyllus	Native	Not Evaluated
Neopomacentrus nemurus	Coral Demoiselle	Native	Not Evaluated
Pomacentrus albimaculus	Whitespot Damsel	Native	Not Evaluated
Pomacentrus aurifrons	Goldhead Damsel	Native	Not Evaluated
Pomacentrus biaculeatus	Spinecheek Anemonefish	Native	Not Evaluated
Pomacentrus brachialis	Charcoal Damsel	Native	Not Evaluated
Pomacentrus burroughi	Burrough's Damsel	Native	Not Evaluated
Pomacentrus grammorhynchus	Bluespot Damsel	Native	Not Evaluated
Pomacentrus moluccensis	Lemon Damsel	Native	Not Evaluated
Pomacentrus nigromanus	Goldenback Damsel	Native	Not Evaluated
Pomacentrus proteus	Colombo Damsel	Native	Not Evaluated
Ptereleotridae			
Ptereleotris evides	Twotone Dartfish	Native	Least Concerned
Scaridae			
Chlorurus bleekeri	Bleeker's Parrotfish	Native	Least Concerned
Chlorurus capistratoides	Indian Parrotfish	Native	Least Concerned
Hipposcarus longiceps	Pacific Longnose Parrotfish	Native	Not Evaluated
Scarus dimidiatus	Yellow-barred Parrotfish	Native	Least Concerned
Scarus flavipectoralis	Yellowfin Parrotfish	Native	Least Concerned
Scarus russellii	Eclipse Parrotfish	Native	Least Concerned
Scombridae			
Rastrelliger kanagurta	Mouth Mackerel	Native	Not Evaluated
Scientific Name (Family, Genus, Species)	**Common Name**	**Status (Endemic, Native, Introduced)**	**Conservation Status (IUCN)**
Serranidae			
Plectropomus areolatus	Squaretail coral Grouper	Native	Vulnerable
Synodontidae			
Synodus variegatus	Reef Lizardfish	Native	Not Evaluated
Zanclidae			
Zanclus cornutus	Moorish Idol	Native	Least Concerned

APPENDIX 2

CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) Appendices I, II and III. Marine and aquatic fauna subjected to CITES listing for Solomon Islands, 26th November 2019.

	APPENDICES I	APPENDICES II	APPENDICES III
FAUNA (ANIMALS) PHLYUM CHORDATA CLASS MAMMALIA (MAMMALS)			
CETACEA: Dolphins, porpoises, whales			
		CETACEA spp. (Except the species included in Appendix I)	
Balaenopteridae: Fin whales, humpback whales, rorquals			
	Balaenoptera acutorostrata ***Balaenoptera bonaerensis*** ***Balaenoptera borealis*** ***Balaenoptera edeni*** ***Balaenoptera musculus*** ***Balaenoptera omurai*** ***Balaenoptera physalus*** ***Megaptera novaeangliae***		
Delphinidae: Dolphins			
	Orcaella brevirostris ***Orcaella heinsohni*** ***Sotalia* spp.** ***Sousa* spp.**		
Physeteridae: Sperm whales			
	Physeter Macrocephalus		
Ziphiidae: Beaked whales, bottle-nosed whales			
	***Berardius* spp.** ***Hyperoodon* spp.**		
SIRENIA: Sea-cows or sirenians			
Dugongidae: Dugong			
	Dugong dugon		
CLASS REPTILIA (REPTILES)			
CROCODYLIA: Alligators, caimans, crocodiles			
		CROCODYLIA spp. (Except the species included in Appendix I)	
Crocodylidae: Crocodiles			
	Crocodylus porosus		
TESTUDINES: Turtles			
Cheloniidae: Sea turtles			
	Cheloniidae spp. (All species): ***Chelonia mydas*** ***Eretmochelys imbricata*** ***Lepidochelys olivacea*** ***Caretta carreta***		

Dermochelydae: Leatherback turtles			
	Dermochelys coriacea		
CLASS ELASMOBRANCHII (SHARKS)			
CARCHARHINIFORMES			
Carcharhinidae: Requiem sharks		***Carcharhinus falciformis*** ***Carcharhinus longimanus***	
Sphymidae: Hammerhead sharks		***Sphyrna lewini*** ***Sphyrna mokarran*** ***Sphyrna zygaena***	
LAMNIFORMES			
Alopiidae: Thresher sharks			
		***Alopias* spp. (All species)**	
Cetorhinidae: Basking sharks		***Cetorhinus maximus***	
Lamnidae: Mackerel sharks			
		Isurus oxyrinchus ***Isurus paucus*** ***Lamna nasus***	
MYLIOBATIFORMES			
Myliobatidae: Eagle and mobuild rays			
		***Manta* spp. (All species)** ***Mobula* spp. (All species)**	
ORECTOLOBIFORMES			
Rhincodontidae: Whale sharks			
		Rhincodon typus	
PRISTIFORMES			
Pristidae: Sawfishes			
	Pristidae spp.		
RHINOPRISTIFORMES			
Glaucostegidae: Guitarfishes			
		***Glaucostegus* spp. (All species)**	
Rhinidae: Wedgefishes			
		***Rhinidae* spp. (All species)**	
PERCIFORMES			
Labridae: Wrasses			
		Cheilinus undulatus	
PHYLUM ECHINODERMATA CLASS HOLOTHUROIDEA (SEA CUCUMBERS)			
HOLOTHURIIDA			

<u>Holothuridae</u>: Teatfishes, sea cucumbers			
		Holothuria fuscogilva (Entry into effect delayed by 12 months, i.e. until 28 August 2020) ***Holothuria nobilis*** (Entry into effect delayed by 12 months, i.e. until 28 August 2020) ***Holothuria whitmaei*** (Entry into effect delayed by 12 months, i.e. until 28 August 2020)	
PHYLUM MOLLUSCA CLASS BIVALVIA (CLAMS AND MUSSELS)			
VENEROIDA			
<u>Tridachnidae</u>: Giant Clams			
		Tridachnidae spp. (All species): ***Tridachnidae crocea*** ***Tridachnidae maxima*** ***Tridachnidae squamosa*** ***Tridachnidae derasa*** ***Tridachnidae gigas*** ***Hippopus hippopus***	
CLASS CEPHALOPODA (SQUIDS, OCTOPUSES, CUTTLEFISH)			
NAUTILIDA			
<u>Nautilidae</u>: Chambered nautilus			
		Nautilidae spp. (All species)	
PHYLUM CNIDARIA CLASS ANTHOZOA (CORALS AND SEA ANEMONES)			
ANTHIPATHARIA: Black corals			
		ANTIPATHARIA spp. (All species)	
HELIOPORACEA			
<u>Helioporidae</u>: Blue corals			
		Helioporidae spp. (Includes only the species *Heliopora coerulea*. Fossils are not subject to the provisions of the Convention)	
SCLERACTINIA: Stony corals			
		SCLERACTINIA spp. (Fossils are not subject	

		to the provisions of the Convention)	
STOLONIFERA			
Tubiporidae: Organ-pipe corals			
		Tubiporidae spp. (Fossils are not subject to the provisions of the Convention)	
CLASS HYDROZOA (SEA FERNS, FIRE CORALS AND STINGING MEDUSAE)			
MILLEPORINA			
Milleporidae: Fire corals			
		Milleporidae spp. (Fossils are not subject to the provisions of the Convention)	
STYLASTERINA			
Stylasteridae: Lace corals			
		Stylasteridae spp. (Fossils are not subject to the provisions of the Convention)	

APPENDIX C

Baseline surface water sample results
Certificate of Analysis

CERTIFICATE OF ANALYSIS

Work Order	: **EB2117975**	Page	: 1 of 25
Amendment	: **1**		
Client	: **PACIFIC NICKEL MINES LIMITED**	Laboratory	: Environmental Division Brisbane
Contact	: GEOFF HILLER	Contact	: Customer Services EB
Address	: SUNSHINE MINERALS LTD OUTBACK HAUS, ROVE PO BOX 2112 HONIARA	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: ----	Telephone	: +61-7-3243 7222
Project	: 932/1 Kolosori Baseline Surface Water	Date Samples Received	: 28-Jun-2021 10:05
Order number	: ----	Date Analysis Commenced	: 29-Jun-2021
C-O-C number	: ----	Issue Date	: 09-Jul-2021 12:46
Sampler	: BARCLAY LILITI		
Site	: Kolosori SI		
Quote number	: BN/478/20		
No. of samples received	: 15		
No. of samples analysed	: 15		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Franco Lentini	LCMS Coordinator	Sydney Organics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Matt Frost	Assistant Laboratory Manager	Brisbane Organics, Stafford, QLD
Morgan Lennox	2IC Organic Chemist	Brisbane Organics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG093-F (Dissolved Metals in Saline Water by ORC-ICP-MS): The high failing method blank for Copper and Selenium is deemed acceptable as all results are less than the limit of reporting.
- It is recognised that EG020-T (Total Metals by ICP-MS) is less than EG020-F (Dissolved Metals by ICP-MS) for some samples. However, the difference is within experimental variation of the methods.
- EK061G (Total Kjeldahl Nitrogen as N) / EK067G (Total Phosphorus as P): Some samples were diluted due to matrix interference. LOR adjusted accordingly.
- EP075 (SIM): Where reported, Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) per the NEPM (2013) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- EP068: Where reported, Total Chlordane (sum) is the sum of the reported concentrations of cis-Chlordane and trans-Chlordane at or above the LOR.
- EP080: Where reported, Total Xylenes is the sum of the reported concentrations of m&p-Xylene and o-Xylene at or above the LOR.
- EP075(SIM): Where reported, Total Cresol is the sum of the reported concentrations of 2-Methylphenol and 3- & 4-Methylphenol at or above the LOR.
- It has been noted that EK055G (Ammonia as N) is greater than EK061G (Total Kjeldahl Nitrogen as N) for some samples, however this difference is within the limits of experimental variation.
- EP026SP(COD) Sample #012 and #013 required dilution prior to analysis due to matrix interferences. LOR values have been adjusted accordingly.
- Amendment (09/07/2021): This report has been amended as a result of a request from Peter Scott via email 09/07/2021, to change the project reference to "932/1 Kolosori Baseline Surface Water" and the site to "Kolosori SI". All analysis results are as per the previous report.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.
- EG093: Samples containing high levels of sulfate may precipitate barium under the acidic conditions of this method and may therefore bias results low.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW1	SW2	SW3	SW4	SW5
			Sampling date / time	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00
Compound	CAS Number	LOR	Unit	EB2117975-001	EB2117975-002	EB2117975-003	EB2117975-004	EB2117975-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**8.14**	**8.08**	**8.13**	**7.95**	**7.93**
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**168**	**146**	**148**	**2540**	**151**
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**98**	**83**	**86**	**1460**	**109**
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	<5	<5	<5	<5	**6**
EA045: Turbidity								
Turbidity	----	0.1	NTU	**0.1**	**0.2**	**0.2**	**2.2**	**9.8**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**91**	**79**	**82**	**93**	**84**
Total Alkalinity as CaCO3	----	1	mg/L	**91**	**79**	**82**	**93**	**84**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**1**	<1	<1	**95**	**1**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**4**	**4**	**3**	**787**	**3**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**3**	**1**	**1**	**24**	**11**
Magnesium	7439-95-4	1	mg/L	**22**	**19**	**20**	**58**	**13**
Sodium	7440-23-5	1	mg/L	**2**	**2**	**1**	**409**	**4**
Potassium	7440-09-7	1	mg/L	<1	<1	<1	**15**	<1
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	**0.001**	<0.001	<0.001
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	**0.19**	<0.05
Barium	7440-39-3	0.001	mg/L	<0.001	<0.001	<0.001	**0.003**	<0.001
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	**0.007**	**0.007**	**0.008**	**0.001**	**0.004**
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	SW1	SW2	SW3	SW4	SW5
			Sampling date / time	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00
				EB2117975-001	**EB2117975-002**	**EB2117975-003**	**EB2117975-004**	**EB2117975-005**
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	**0.003**	**0.012**	**0.013**	**0.002**	**0.001**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	**0.11**	**0.74**
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	**0.19**	<0.05
Barium	7440-39-3	0.001	mg/L	<0.001	<0.001	<0.001	**0.004**	**0.003**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	**0.008**	**0.009**	**0.010**	**0.002**	**0.005**
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	**0.002**
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	**0.060**	**0.014**
Nickel	7440-02-0	0.001	mg/L	**0.005**	**0.015**	**0.017**	**0.005**	**0.005**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	**0.52**	**0.74**
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG035T: Total Recoverable Mercury by FIMS								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW1	SW2	SW3	SW4	SW5
			Sampling date / time	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00
Compound	CAS Number	LOR	Unit	EB2117975-001	EB2117975-002	EB2117975-003	EB2117975-004	EB2117975-005
				Result	Result	Result	Result	Result
EG035T: Total Recoverable Mercury by FIMS - Continued								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG050F: Dissolved Hexavalent Chromium								
Hexavalent Chromium	18540-29-9	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EG050T: Total Hexavalent Chromium								
Hexavalent Chromium	18540-29-9	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EG052G: Silica by Discrete Analyser								
Reactive Silica	----	0.05	mg/L	**33.2**	**28.4**	**27.9**	**37.2**	**40.5**
Reactive Silica as Silicon	----	0.05	mg/L	**15.5**	**13.3**	**13.0**	**17.4**	**18.9**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.01**	**0.09**	<0.01	**0.12**	**0.14**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.34**	**0.25**	**0.29**	**0.12**	**0.18**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.34**	**0.25**	**0.29**	**0.12**	**0.18**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	**0.1**	<0.1	**0.1**	**0.3**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**0.3**	**0.4**	**0.3**	**0.2**	**0.5**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	**0.03**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	**0.07**	<0.01	<0.01	<0.01	<0.01
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**1.95**	**1.69**	**1.72**	**26.0**	**1.78**
ø Total Cations	----	0.01	meq/L	**2.05**	**1.70**	**1.74**	**24.1**	**1.79**
ø Ionic Balance	----	0.01	%	----	----	----	**3.77**	----
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	----	1	mg/L	<1	<1	<1	<1	<1
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	<1	<1	<1	**1**	**2**
EP006D: Dissolved Inorganic Carbon (DIC)								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW1	SW2	SW3	SW4	SW5
			Sampling date / time	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00
Compound	CAS Number	LOR	Unit	EB2117975-001	EB2117975-002	EB2117975-003	EB2117975-004	EB2117975-005
				Result	Result	Result	Result	Result
EP006D: Dissolved Inorganic Carbon (DIC) - Continued								
Dissolved Inorganic Carbon	----	1	mg/L	**21**	**18**	**18**	**22**	**19**
EP026SP: Chemical Oxygen Demand (Spectrophotometric)								
Chemical Oxygen Demand	----	10	mg/L	<10	<10	<10	<10	<10
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	<2	<2	<2	<2	<2
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
beta-BHC	319-85-7	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
gamma-BHC	58-89-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
delta-BHC	319-86-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor	76-44-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Aldrin	309-00-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Dieldrin	60-57-1	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDE	72-55-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Endrin	72-20-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDD	72-54-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDT	50-29-3	2.0	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
Endrin ketone	53494-70-5	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Methoxychlor	72-43-5	2.0	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
^ Total Chlordane (sum)	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
EP068B: Organophosphorus Pesticides (OP)								
Dichlorvos	62-73-7	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW1	SW2	SW3	SW4	SW5
			Sampling date / time	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00
Compound	CAS Number	LOR	Unit	EB2117975-001	EB2117975-002	EB2117975-003	EB2117975-004	EB2117975-005
				Result	Result	Result	Result	Result
EP068B: Organophosphorus Pesticides (OP) - Continued								
Monocrotophos	6923-22-4	2.0	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
Dimethoate	60-51-5	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Diazinon	333-41-5	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Parathion-methyl	298-00-0	2.0	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
Malathion	121-75-5	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Fenthion	55-38-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Parathion	56-38-2	2.0	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Fenamiphos	22224-92-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Prothiofos	34643-46-4	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Ethion	563-12-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Carbophenothion	786-19-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: WATER
(Matrix: WATER)

Compound	CAS Number	LOR	Unit	SW1	SW2	SW3	SW4	SW5
			Sampling date / time	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00
				EB2117975-001	EB2117975-002	EB2117975-003	EB2117975-004	EB2117975-005
				Result	Result	Result	Result	Result
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued								
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L	<100	<100	<100	<100	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L	<100	<100	<100	<100	<100
EP080: BTEXN								
Benzene	71-43-2	1	µg/L	<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L	<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L	<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L	<2	<2	<2	<2	<2
^ Total Xylenes	----	2	µg/L	<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L	<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L	<5	<5	<5	<5	<5
EP202A: Phenoxyacetic Acid Herbicides by LCMS								
4-Chlorophenoxy acetic acid	122-88-3	10	µg/L	<10	<10	<10	<10	<10
2.4-DB	94-82-6	10	µg/L	<10	<10	<10	<10	<10
Dicamba	1918-00-9	10	µg/L	<10	<10	<10	<10	<10
Mecoprop	93-65-2	10	µg/L	<10	<10	<10	<10	<10
MCPA	94-74-6	10	µg/L	<10	<10	<10	<10	<10
2.4-DP	120-36-5	10	µg/L	<10	<10	<10	<10	<10
2.4-D	94-75-7	10	µg/L	<10	<10	<10	<10	<10

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW1	SW2	SW3	SW4	SW5
			Sampling date / time	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00
Compound	CAS Number	LOR	Unit	EB2117975-001	EB2117975-002	EB2117975-003	EB2117975-004	EB2117975-005
				Result	Result	Result	Result	Result
EP202A: Phenoxyacetic Acid Herbicides by LCMS - Continued								
Triclopyr	55335-06-3	10	µg/L	<10	<10	<10	<10	<10
Silvex (2.4.5-TP/Fenoprop)	93-72-1	10	µg/L	<10	<10	<10	<10	<10
2.4.5-T	93-76-5	10	µg/L	<10	<10	<10	<10	<10
MCPB	94-81-5	10	µg/L	<10	<10	<10	<10	<10
Picloram	1918-02-1	10	µg/L	<10	<10	<10	<10	<10
Clopyralid	1702-17-6	10	µg/L	<10	<10	<10	<10	<10
Fluroxypyr	69377-81-7	10	µg/L	<10	<10	<10	<10	<10
2.6-D	575-90-6	10	µg/L	<10	<10	<10	<10	<10
2.4.6-T	575-89-3	10	µg/L	<10	<10	<10	<10	<10
EP068S: Organochlorine Pesticide Surrogate								
Dibromo-DDE	21655-73-2	0.5	%	**86.8**	**95.2**	**88.8**	**87.2**	**86.2**
EP068T: Organophosphorus Pesticide Surrogate								
DEF	78-48-8	0.5	%	**73.4**	**80.6**	**74.7**	**74.5**	**75.4**
EP075(SIM)S: Phenolic Compound Surrogates								
Phenol-d6	13127-88-3	1.0	%	**32.3**	**34.4**	**31.3**	**32.0**	**35.5**
2-Chlorophenol-D4	93951-73-6	1.0	%	**75.0**	**81.5**	**72.8**	**75.5**	**76.3**
2.4.6-Tribromophenol	118-79-6	1.0	%	**59.1**	**67.8**	**55.6**	**64.7**	**72.4**
EP075(SIM)T: PAH Surrogates								
2-Fluorobiphenyl	321-60-8	1.0	%	**91.4**	**99.0**	**91.4**	**88.7**	**88.9**
Anthracene-d10	1719-06-8	1.0	%	**84.2**	**91.4**	**83.8**	**83.9**	**84.3**
4-Terphenyl-d14	1718-51-0	1.0	%	**98.2**	**106**	**101**	**98.0**	**98.4**
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	2	%	**102**	**101**	**100**	**102**	**101**
Toluene-D8	2037-26-5	2	%	**98.2**	**97.1**	**97.6**	**99.8**	**95.9**
4-Bromofluorobenzene	460-00-4	2	%	**112**	**115**	**112**	**113**	**112**
EP202S: Phenoxyacetic Acid Herbicide Surrogate								
2.4-Dichlorophenyl Acetic Acid	19719-28-9	10	%	**112**	**102**	**102**	**118**	**102**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW6	SW7	SW8	SW9	SW10
			Sampling date / time	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00
Compound	CAS Number	LOR	Unit	EB2117975-006	EB2117975-007	EB2117975-008	EB2117975-009	EB2117975-010
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.82	7.85	8.19	7.96	8.01
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	86	104	185	106	157
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	72	82	106	68	112
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	7	6	<5	<5	18
EA045: Turbidity								
Turbidity	----	0.1	NTU	16.1	15.8	0.2	5.6	7.7
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	46	57	103	59	83
Total Alkalinity as CaCO3	----	1	mg/L	46	57	103	59	83
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	1	1	1	1	2
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	3	2	3	2	3
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	9	11	1	7	17
Magnesium	7439-95-4	1	mg/L	4	5	24	8	7
Sodium	7440-23-5	1	mg/L	4	5	1	3	6
Potassium	7440-09-7	1	mg/L	<1	<1	<1	<1	<1
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Barium	7440-39-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	0.001	<0.001	0.012	0.003	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW6	SW7	SW8	SW9	SW10
			Sampling date / time	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00
Compound	CAS Number	LOR	Unit	EB2117975-006	EB2117975-007	EB2117975-008	EB2117975-009	EB2117975-010
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.92**	**1.03**	<0.01	**0.42**	**0.56**
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Barium	7440-39-3	0.001	mg/L	**0.002**	**0.001**	**0.001**	<0.001	**0.002**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	**0.004**	**0.003**	**0.012**	**0.005**	**0.002**
Copper	7440-50-8	0.001	mg/L	**0.002**	**0.003**	<0.001	<0.001	**0.002**
Manganese	7439-96-5	0.001	mg/L	**0.020**	**0.027**	<0.001	**0.007**	**0.030**
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.001**	**0.003**	**0.006**	**0.002**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L	**0.01**	<0.01	<0.01	<0.01	**0.02**
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Iron	7439-89-6	0.05	mg/L	**1.00**	**1.18**	<0.05	**0.54**	**0.65**
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG035T: Total Recoverable Mercury by FIMS								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW6	SW7	SW8	SW9	SW10
			Sampling date / time	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00
Compound	CAS Number	LOR	Unit	EB2117975-006	EB2117975-007	EB2117975-008	EB2117975-009	EB2117975-010
				Result	Result	Result	Result	Result
EG035T: Total Recoverable Mercury by FIMS - Continued								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG050F: Dissolved Hexavalent Chromium								
Hexavalent Chromium	18540-29-9	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EG050T: Total Hexavalent Chromium								
Hexavalent Chromium	18540-29-9	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EG052G: Silica by Discrete Analyser								
Reactive Silica	----	0.05	mg/L	**31.4**	**33.6**	**32.9**	**34.2**	**43.6**
Reactive Silica as Silicon	----	0.05	mg/L	**14.7**	**15.7**	**15.4**	**16.0**	**20.4**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.23**	**0.19**	**0.03**	**0.16**	**0.16**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.12**	**0.05**	**0.30**	**0.11**	**0.25**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.12**	**0.05**	**0.30**	**0.11**	**0.25**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.4**	**0.4**	<0.1	**0.2**	**0.3**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**0.5**	**0.4**	**0.3**	**0.3**	**0.6**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.04**	**0.03**	<0.01	<0.01	**0.06**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	**0.04**
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**1.02**	**1.22**	**2.16**	**1.26**	**1.78**
ø Total Cations	----	0.01	meq/L	**0.95**	**1.18**	**2.07**	**1.14**	**1.68**
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	----	1	mg/L	**1**	<1	<1	<1	<1
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**1**	**1**	<1	<1	**2**
EP006D: Dissolved Inorganic Carbon (DIC)								
Dissolved Inorganic Carbon	----	1	mg/L	**10**	**13**	**24**	**13**	**19**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			*Sample ID*	SW6	SW7	SW8	SW9	SW10
			Sampling date / time	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00
Compound	*CAS Number*	*LOR*	*Unit*	EB2117975-006	EB2117975-007	EB2117975-008	EB2117975-009	EB2117975-010
				Result	Result	Result	Result	Result
EP026SP: Chemical Oxygen Demand (Spectrophotometric)								
Chemical Oxygen Demand	----	10	mg/L	<10	<10	<10	<10	**13**
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	<2	<2	<2	<2	<2
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
beta-BHC	319-85-7	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
gamma-BHC	58-89-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
delta-BHC	319-86-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor	76-44-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Aldrin	309-00-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Dieldrin	60-57-1	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDE	72-55-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Endrin	72-20-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDD	72-54-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDT	50-29-3	2.0	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
Endrin ketone	53494-70-5	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Methoxychlor	72-43-5	2.0	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
^ **Total Chlordane (sum)**	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
^ **Sum of DDD + DDE + DDT**	72-54-8/72-55-9/50-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
^ **Sum of Aldrin + Dieldrin**	309-00-2/60-57-1	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
EP068B: Organophosphorus Pesticides (OP)								
Dichlorvos	62-73-7	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Monocrotophos	6923-22-4	2.0	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
Dimethoate	60-51-5	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW6	SW7	SW8	SW9	SW10
			Sampling date / time	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00
Compound	CAS Number	LOR	Unit	EB2117975-006	EB2117975-007	EB2117975-008	EB2117975-009	EB2117975-010
				Result	Result	Result	Result	Result
EP068B: Organophosphorus Pesticides (OP) - Continued								
Diazinon	333-41-5	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Parathion-methyl	298-00-0	2.0	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
Malathion	121-75-5	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Fenthion	55-38-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Parathion	56-38-2	2.0	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Fenamiphos	22224-92-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Prothiofos	34643-46-4	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Ethion	563-12-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Carbophenothion	786-19-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW6	SW7	SW8	SW9	SW10
			Sampling date / time	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00
Compound	CAS Number	LOR	Unit	EB2117975-006	EB2117975-007	EB2117975-008	EB2117975-009	EB2117975-010
				Result	Result	Result	Result	Result
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L	<100	<100	<100	<100	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L	<100	<100	<100	<100	<100
EP080: BTEXN								
Benzene	71-43-2	1	µg/L	<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L	<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L	<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L	<2	<2	<2	<2	<2
^ Total Xylenes	----	2	µg/L	<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L	<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L	<5	<5	<5	<5	<5
EP202A: Phenoxyacetic Acid Herbicides by LCMS								
4-Chlorophenoxy acetic acid	122-88-3	10	µg/L	<10	<10	<10	<10	<10
2.4-DB	94-82-6	10	µg/L	<10	<10	<10	<10	<10
Dicamba	1918-00-9	10	µg/L	<10	<10	<10	<10	<10
Mecoprop	93-65-2	10	µg/L	<10	<10	<10	<10	<10
MCPA	94-74-6	10	µg/L	<10	<10	<10	<10	<10
2.4-DP	120-36-5	10	µg/L	<10	<10	<10	<10	<10
2.4-D	94-75-7	10	µg/L	<10	<10	<10	<10	<10
Triclopyr	55335-06-3	10	µg/L	<10	<10	<10	<10	<10
Silvex (2.4.5-TP/Fenoprop)	93-72-1	10	µg/L	<10	<10	<10	<10	<10
2.4.5-T	93-76-5	10	µg/L	<10	<10	<10	<10	<10

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW6	SW7	SW8	SW9	SW10
			Sampling date / time	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00
Compound	CAS Number	LOR	Unit	EB2117975-006	EB2117975-007	EB2117975-008	EB2117975-009	EB2117975-010
				Result	Result	Result	Result	Result
EP202A: Phenoxyacetic Acid Herbicides by LCMS - Continued								
MCPB	94-81-5	10	µg/L	<10	<10	<10	<10	<10
Picloram	1918-02-1	10	µg/L	<10	<10	<10	<10	<10
Clopyralid	1702-17-6	10	µg/L	<10	<10	<10	<10	<10
Fluroxypyr	69377-81-7	10	µg/L	<10	<10	<10	<10	<10
2.6-D	575-90-6	10	µg/L	<10	<10	<10	<10	<10
2.4.6-T	575-89-3	10	µg/L	<10	<10	<10	<10	<10
EP068S: Organochlorine Pesticide Surrogate								
Dibromo-DDE	21655-73-2	0.5	%	**81.6**	**80.0**	**79.6**	**81.7**	**81.7**
EP068T: Organophosphorus Pesticide Surrogate								
DEF	78-48-8	0.5	%	**81.3**	**66.0**	**67.0**	**71.8**	**67.5**
EP075(SIM)S: Phenolic Compound Surrogates								
Phenol-d6	13127-88-3	1.0	%	**33.9**	**30.6**	**28.4**	**33.6**	**29.6**
2-Chlorophenol-D4	93951-73-6	1.0	%	**69.6**	**72.3**	**66.2**	**73.2**	**69.2**
2.4.6-Tribromophenol	118-79-6	1.0	%	**75.4**	**61.9**	**48.0**	**61.6**	**57.4**
EP075(SIM)T: PAH Surrogates								
2-Fluorobiphenyl	321-60-8	1.0	%	**73.5**	**82.6**	**79.3**	**80.2**	**76.4**
Anthracene-d10	1719-06-8	1.0	%	**80.1**	**76.1**	**73.6**	**78.9**	**73.5**
4-Terphenyl-d14	1718-51-0	1.0	%	**85.9**	**93.2**	**94.4**	**95.6**	**94.6**
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	2	%	**100**	**98.9**	**99.9**	**102**	**103**
Toluene-D8	2037-26-5	2	%	**95.8**	**96.7**	**97.1**	**95.2**	**97.5**
4-Bromofluorobenzene	460-00-4	2	%	**111**	**116**	**113**	**114**	**116**
EP202S: Phenoxyacetic Acid Herbicide Surrogate								
2.4-Dichlorophenyl Acetic Acid	19719-28-9	10	%	**116**	**104**	**104**	**102**	**113**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW11	SW12	SW13	SW14	SW15
			Sampling date / time	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00
Compound	CAS Number	LOR	Unit	EB2117975-011	EB2117975-012	EB2117975-013	EB2117975-014	EB2117975-015
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	8.04	7.82	7.91	8.26	8.23
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	156	26400	44300	213	199
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	111	18100	33500	123	127
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	<5	6	<5	<5	<5
EA045: Turbidity								
Turbidity	----	0.1	NTU	1.4	0.6	1.4	0.2	0.5
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	84	106	108	121	106
Total Alkalinity as CaCO3	----	1	mg/L	84	106	108	121	106
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	2	1200	2240	2	2
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	3	9330	15400	4	3
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	17	420	391	6	24
Magnesium	7439-95-4	1	mg/L	6	1250	1170	26	9
Sodium	7440-23-5	1	mg/L	6	10700	9990	5	11
Potassium	7440-09-7	1	mg/L	<1	395	369	<1	<1
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	----	----	<0.01	<0.01
Antimony	7440-36-0	0.001	mg/L	<0.001	----	----	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	----	----	<0.001	<0.001
Boron	7440-42-8	0.05	mg/L	<0.05	----	----	<0.05	<0.05
Barium	7440-39-3	0.001	mg/L	0.002	----	----	<0.001	0.005
Beryllium	7440-41-7	0.001	mg/L	<0.001	----	----	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	----	----	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	0.003	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	----	----	<0.001	<0.001

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			Sample ID	SW11	SW12	SW13	SW14	SW15
			Sampling date / time	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00
Compound	CAS Number	LOR	Unit	EB2117975-011	EB2117975-012	EB2117975-013	EB2117975-014	EB2117975-015
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Manganese	7439-96-5	0.001	mg/L	<0.001	----	----	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	----	----	**0.006**	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L	<0.01	----	----	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	----	----	**0.006**	<0.005
Molybdenum	7439-98-7	0.001	mg/L	<0.001	----	----	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L	<0.001	----	----	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L	<0.001	----	----	<0.001	<0.001
Iron	7439-89-6	0.05	mg/L	<0.05	----	----	<0.05	<0.05
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.08**	----	----	<0.01	**0.05**
Antimony	7440-36-0	0.001	mg/L	<0.001	----	----	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	----	----	<0.001	<0.001
Boron	7440-42-8	0.05	mg/L	<0.05	----	----	<0.05	<0.05
Barium	7440-39-3	0.001	mg/L	**0.003**	----	----	<0.001	**0.007**
Beryllium	7440-41-7	0.001	mg/L	<0.001	----	----	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	----	----	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	**0.003**	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	----	----	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.004**	----	----	**0.001**	**0.003**
Nickel	7440-02-0	0.001	mg/L	<0.001	----	----	**0.007**	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L	**0.02**	----	----	<0.01	**0.02**
Zinc	7440-66-6	0.005	mg/L	<0.005	----	----	**0.011**	<0.005
Molybdenum	7439-98-7	0.001	mg/L	<0.001	----	----	<0.001	<0.001
Tin	7440-31-5	0.001	mg/L	<0.001	----	----	<0.001	<0.001
Uranium	7440-61-1	0.001	mg/L	<0.001	----	----	<0.001	<0.001
Iron	7439-89-6	0.05	mg/L	**0.12**	----	----	<0.05	**0.06**
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.005	µg/L	----	<0.005	<0.005	----	----
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	<0.0001	<0.0001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW11	SW12	SW13	SW14	SW15
			Sampling date / time	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00
Compound	CAS Number	LOR	Unit	EB2117975-011	EB2117975-012	EB2117975-013	EB2117975-014	EB2117975-015
				Result	Result	Result	Result	Result
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	<0.0001	<0.0001
EG050F: Dissolved Hexavalent Chromium								
Hexavalent Chromium	18540-29-9	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EG050T: Total Hexavalent Chromium								
Hexavalent Chromium	18540-29-9	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EG052G: Silica by Discrete Analyser								
Reactive Silica	----	0.05	mg/L	**44.7**	**19.4**	**3.18**	**43.5**	**49.7**
Reactive Silica as Silicon	----	0.05	mg/L	**20.9**	**9.07**	**1.49**	**20.3**	**23.2**
EG093F: Dissolved Metals in Saline Water by ORC-ICPMS								
Aluminium	7429-90-5	5	µg/L	----	<5	<5	----	----
Antimony	7440-36-0	0.5	µg/L	----	<0.5	<0.5	----	----
Arsenic	7440-38-2	0.5	µg/L	----	<0.5	**1.2**	----	----
Barium	7440-39-3	1	µg/L	----	**6**	**4**	----	----
Beryllium	7440-41-7	0.1	µg/L	----	<0.1	<0.1	----	----
Boron	7440-42-8	100	µg/L	----	**2210**	**3490**	----	----
Cadmium	7440-43-9	0.2	µg/L	----	<0.2	<0.2	----	----
Chromium	7440-47-3	0.5	µg/L	----	<0.5	<0.5	----	----
Cobalt	7440-48-4	0.2	µg/L	----	<0.2	<0.2	----	----
Copper	7440-50-8	1	µg/L	----	<1	<1	----	----
Iron	7439-89-6	5	µg/L	----	<5	<5	----	----
Lead	7439-92-1	0.2	µg/L	----	<0.2	<0.2	----	----
Manganese	7439-96-5	0.5	µg/L	----	<0.5	<0.5	----	----
Molybdenum	7439-98-7	0.1	µg/L	----	**4.0**	**8.4**	----	----
Nickel	7440-02-0	0.5	µg/L	----	**4.3**	**0.8**	----	----
Selenium	7782-49-2	2	µg/L	----	<2	<2	----	----
Tin	7440-31-5	5	µg/L	----	<5	<5	----	----
Uranium	7440-61-1	0.1	µg/L	----	**0.8**	**1.2**	----	----
Vanadium	7440-62-2	0.5	µg/L	----	<0.5	<0.5	----	----
Zinc	7440-66-6	5	µg/L	----	<5	<5	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.04**	**0.03**	**0.12**	**0.19**	<0.01
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW11	SW12	SW13	SW14	SW15
			Sampling date / time	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00
Compound	CAS Number	LOR	Unit	EB2117975-011	EB2117975-012	EB2117975-013	EB2117975-014	EB2117975-015
				Result	Result	Result	Result	Result
EK058G: Nitrate as N by Discrete Analyser - Continued								
Nitrate as N	14797-55-8	0.01	mg/L	**0.26**	**0.07**	<0.01	**0.10**	**0.37**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.26**	**0.07**	<0.01	**0.10**	**0.37**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.1**	<0.5	<0.5	**0.1**	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**0.4**	<0.5	<0.5	**0.2**	**0.4**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.03**	<0.05	<0.05	<0.01	**0.04**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	**0.02**	<0.01	<0.01	<0.01	**0.02**
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**1.80**	**290**	**483**	**2.57**	**2.24**
ø Total Cations	----	0.01	meq/L	**1.60**	**599**	**560**	**2.66**	**2.42**
ø Ionic Balance	----	0.01	%	**----**	**34.7**	**7.34**	**----**	**----**
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	----	1	mg/L	<1	<1	<1	<1	<1
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**1**	**1**	**1**	<1	<1
EP006D: Dissolved Inorganic Carbon (DIC)								
Dissolved Inorganic Carbon	----	1	mg/L	**19**	**25**	**23**	**29**	**25**
EP026SP: Chemical Oxygen Demand (Spectrophotometric)								
Chemical Oxygen Demand	----	10	mg/L	<10	<50	**154**	<10	<10
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	<2	<2	<2	<2	<2
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
beta-BHC	319-85-7	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
gamma-BHC	58-89-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
delta-BHC	319-86-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor	76-44-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Aldrin	309-00-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW11	SW12	SW13	SW14	SW15
			Sampling date / time	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00
Compound	CAS Number	LOR	Unit	EB2117975-011	EB2117975-012	EB2117975-013	EB2117975-014	EB2117975-015
				Result	Result	Result	Result	Result
EP068A: Organochlorine Pesticides (OC) - Continued								
Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Dieldrin	60-57-1	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDE	72-55-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Endrin	72-20-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDD	72-54-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDT	50-29-3	2.0	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
Endrin ketone	53494-70-5	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Methoxychlor	72-43-5	2.0	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
^ Total Chlordane (sum)	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
EP068B: Organophosphorus Pesticides (OP)								
Dichlorvos	62-73-7	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Monocrotophos	6923-22-4	2.0	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
Dimethoate	60-51-5	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Diazinon	333-41-5	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Parathion-methyl	298-00-0	2.0	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
Malathion	121-75-5	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Fenthion	55-38-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Parathion	56-38-2	2.0	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Fenamiphos	22224-92-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Prothiofos	34643-46-4	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW11	SW12	SW13	SW14	SW15
			Sampling date / time	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00
Compound	CAS Number	LOR	Unit	EB2117975-011	EB2117975-012	EB2117975-013	EB2117975-014	EB2117975-015
				Result	Result	Result	Result	Result
EP068B: Organophosphorus Pesticides (OP) - Continued								
Ethion	563-12-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Carbophenothion	786-19-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L	<100	<100	<100	<100	<100

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW11	SW12	SW13	SW14	SW15
			Sampling date / time	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00
Compound	CAS Number	LOR	Unit	EB2117975-011	EB2117975-012	EB2117975-013	EB2117975-014	EB2117975-015
				Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued								
>C34 - C40 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L	<100	<100	<100	<100	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L	<100	<100	<100	<100	<100
EP080: BTEXN								
Benzene	71-43-2	1	µg/L	<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L	<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L	<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L	<2	<2	<2	<2	<2
^ Total Xylenes	----	2	µg/L	<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L	<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L	<5	<5	<5	<5	<5
EP202A: Phenoxyacetic Acid Herbicides by LCMS								
4-Chlorophenoxy acetic acid	122-88-3	10	µg/L	<10	<10	<10	<10	<10
2.4-DB	94-82-6	10	µg/L	<10	<10	<10	<10	<10
Dicamba	1918-00-9	10	µg/L	<10	<10	<10	<10	<10
Mecoprop	93-65-2	10	µg/L	<10	<10	<10	<10	<10
MCPA	94-74-6	10	µg/L	<10	<10	<10	<10	<10
2.4-DP	120-36-5	10	µg/L	<10	<10	<10	<10	<10
2.4-D	94-75-7	10	µg/L	<10	<10	<10	<10	<10
Triclopyr	55335-06-3	10	µg/L	<10	<10	<10	<10	<10
Silvex (2.4.5-TP/Fenoprop)	93-72-1	10	µg/L	<10	<10	<10	<10	<10
2.4.5-T	93-76-5	10	µg/L	<10	<10	<10	<10	<10
MCPB	94-81-5	10	µg/L	<10	<10	<10	<10	<10
Picloram	1918-02-1	10	µg/L	<10	<10	<10	<10	<10
Clopyralid	1702-17-6	10	µg/L	<10	<10	<10	<10	<10
Fluroxypyr	69377-81-7	10	µg/L	<10	<10	<10	<10	<10
2.6-D	575-90-6	10	µg/L	<10	<10	<10	<10	<10
2.4.6-T	575-89-3	10	µg/L	<10	<10	<10	<10	<10
EP068S: Organochlorine Pesticide Surrogate								
Dibromo-DDE	21655-73-2	0.5	%	**73.8**	**78.9**	**78.7**	**68.2**	**75.0**
EP068T: Organophosphorus Pesticide Surrogate								
DEF	78-48-8	0.5	%	**62.0**	**64.6**	**63.6**	**54.0**	**58.0**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SW11	SW12	SW13	SW14	SW15
			Sampling date / time	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00	22-Jun-2021 00:00
Compound	CAS Number	LOR	Unit	EB2117975-011	EB2117975-012	EB2117975-013	EB2117975-014	EB2117975-015
				Result	Result	Result	Result	Result
EP075(SIM)S: Phenolic Compound Surrogates								
Phenol-d6	13127-88-3	1.0	%	27.1	27.1	32.6	24.0	26.1
2-Chlorophenol-D4	93951-73-6	1.0	%	61.8	67.1	70.6	58.5	62.7
2.4.6-Tribromophenol	118-79-6	1.0	%	50.5	53.8	55.8	41.2	42.0
EP075(SIM)T: PAH Surrogates								
2-Fluorobiphenyl	321-60-8	1.0	%	66.6	72.5	72.8	62.6	70.4
Anthracene-d10	1719-06-8	1.0	%	67.8	69.9	70.4	61.0	63.9
4-Terphenyl-d14	1718-51-0	1.0	%	86.4	93.3	94.5	84.2	91.6
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	2	%	99.9	98.7	99.9	100	99.9
Toluene-D8	2037-26-5	2	%	98.1	96.3	95.6	96.7	97.8
4-Bromofluorobenzene	460-00-4	2	%	112	114	113	111	116
EP202S: Phenoxyacetic Acid Herbicide Surrogate								
2.4-Dichlorophenyl Acetic Acid	19719-28-9	10	%	106	116	114	101	102

Surrogate Control Limits

Sub-Matrix: WATER		Recovery Limits (%)	
Compound	CAS Number	Low	High
EP068S: Organochlorine Pesticide Surrogate			
Dibromo-DDE	21655-73-2	45	139
EP068T: Organophosphorus Pesticide Surrogate			
DEF	78-48-8	45	139
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	72
2-Chlorophenol-D4	93951-73-6	27	130
2.4.6-Tribromophenol	118-79-6	19	181
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	14	146
Anthracene-d10	1719-06-8	35	137
4-Terphenyl-d14	1718-51-0	36	154
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	66	138
Toluene-D8	2037-26-5	79	120
4-Bromofluorobenzene	460-00-4	74	118
EP202S: Phenoxyacetic Acid Herbicide Surrogate			
2.4-Dichlorophenyl Acetic Acid	19719-28-9	64	140

Inter-Laboratory Testing

Analysis conducted by ALS Sydney, NATA accreditation no. 825, site no. 10911 (Chemistry) 14913 (Biology).

(WATER) EP202A: Phenoxyacetic Acid Herbicides by LCMS

(WATER) EP202S: Phenoxyacetic Acid Herbicide Surrogate

Analysis conducted by ALS Sydney, NATA accreditation no. 825, site no. 10911 (Chemistry) 14913 (Biology). Only applies to samples EB2117975 (012, 013).

(WATER) EG035F: Dissolved Mercury by FIMS

APPENDIX D

Community Awareness Meetings Minutes

HAVIHUA MEETING

DATE: 23 AUGUST 2021
TIME: 3:00 PM

PARTICIPANTS: 28
OFFICIALS: 5

AGENDAS:

1. WORDS OF PRAYER – FR.WILSON MAPURU.
2. WELCOME ADDRESS – CHIEF PAUL VAHIA
3. PURPOSE OF THE MEETING
4. TALK FROM OFFICER OF MINES
5. TALK FROM OFFICER OF ENVIRONMENT
6. TALK FROM OFFICER OF THE COMPANY (PACIFIC NICKELS MINES).
7. QUESTIONS AND ANSWERS
8. CLOSING REMARKS
    I. LANDOWNERS REPS
    II. GOVERNMENT REPS
    III. COMPANY REPS
9. CLOSING OF THE MEETING
10. CLOSING PRAYER

MINUTES…

1. WORDS OF PRAYER – FR.WILSON MAPURU.
   The Principal Landowner and the Director of the Pacific Nickel Mines – Kolosori Ltd Fr. Wilson Mapuru said the opening prayer. In his short devotion, he thanked the Almighty for protection and guidance; he further uttered and acknowledges the many blessings. Without his will and blessings there is nothing he prayed.

2. WELCOME ADDRESS – CHIEF PAUL VAHIA.
   Catechist and village chief Mr. Paul Vahia warmly welcomes every participant to the meeting. In his welcome speech he articulated the followings:
    I. Welcome Government Environment Officers Mr. Michael from the Ministry of Environment and Mr. Patrick Vatopu from the Ministry of Mines, we are so privilege to have you here at Havihua. As government officers, we are honoured and humbled to host you Mr. Paul said.
    II. To all the participants he is also grateful for the participants and landowners for making it to the venue. Your personal presence in the meeting is highly acknowledged. Without your presence this meeting is nothing but your presence mean a lot and I thanked God for this.
    III. He concluded his speech by apologizing for any inconvenience the hosting community may fall short of. Particularly, the uncomfortable beds, not enough foods, or any other awkwardness the participants experienced in this short stay. It was regrettable and beyond our capacity that this meeting has been postponed on several occasions and he cautious the Company to be mindful in the future for such mishaps. However, he thanked God we have finally made it..

3. PURPOSE OF THE MEETING
Mr. David Deva from the Pacific Nickels Mines ltd formally declares the purpose of the meeting and also highlighted the following matters:
    A. The purposes of this meeting are, 1. To identify and plot the cultural or tabu sites and graveyards (cemeteries). 2. To carry out Socio and Economic data collections a household survey, 3, to make awareness meeting or mining awareness to directly impacted communities.
    B. He also introduces officers of the Government and staff of the company. Apologizes for unforeseen circumstances that resulted in several postponement of the meeting. We had not articulated that we would encounter such but on behalf of the Company I apologize and thanks for your understanding.
    C. He went on to update the meeting on several developments that take place in the company,
    D. He concluded by thanking and acknowledging every stakeholder and especially to Fr. Wilson Mapuru for opening up his land to mining development and his confidence and trust with Pacific Nickels Mines.

4. TALK FROM OFFICER OF MINES
Mr. Patrick Vatopu from the Ministry of Mines starts off his awareness talk by introducing himself. Thereafter conveys the following information:
    A. The purpose or objectives of this awareness as a requirement under the Mining Act to conduct public awareness meetings.
    B. He reiterated the process and stages of getting a mining lease and development consent. Acquiring development consent is the next stage the Company is applying for before the mining lease.
    C. The Ministry of Mines is happy on how the Pacific Nickel Mines did the prospecting. The result of this prospecting or exploration work had created a very good image for the company,
    D. The Ministry of Mines will also be responsible for mornitoring and inspection on all Mining Companies.
    E. In the Mining lease there are requirements and conditions to it and the Companies has to abide.

    After further explanation on the household survey and the social and economic impact of mining Mr. Patrick concluded his presentation.

5. TALK FROM OFFICER OF ENVIRONMENT
Mr. Michael from the Ministry of Environment introduced himself and then he elaborated on the following points:
    A. Environment Impact Assessment (EIA) is important requirement in any development. They have done the scoping for Kolosori project and then the TOR has already been drawn.
    B. This EIA should have been done and the Company should have tasked. Report of the EIA has to be produced. This impact assessment or study Axiom KB and Sumitomo had done and it is a requirement under the environment act.
    C. A public hearing will be conducted after the study, a notice will be serving. The Ministry of Environment is responsible for this public hearing.

After the public hearing, 14 days period will be given for review and thereafter a "Development Consent" is granted or denied.

D. A confirmatory report from the previous study could be used for some understanding. A mandatory requirement before the Development Consent is given or granted,

   The Environment Officer concluded his talk that this EIA report is a public document and could be accessible for public consumption.

6. QUESTIONS AND ANSWERS

The following comments and questions have been solicited in the meeting:

I. Mr. Brian Lezzy – asked how far are the boundaries for this social impact go to. And if there is problem what are the mitigations, measures in place and who is responsible for it?
II. Chief Paul Vahia – asked what would happen to other Minerals that are not covered in the mining agreement, especially the cobalt and others?
III. Fr. Wilson Mapuru –formally declares that there is NO tabu or cultural sites where the exploration activities take place.
IV. Mr. Brian Lezzy – asked what is the Government measure and management plans on Tubi trees in the Mining site. It should have allowed a special guarantee to resources owners to harvest tubi on mining and prospecting areas.
V. Fr. Wilson Mapuru – expressed that he is responsible for any environment and social impact that may happen in Havihua basically he take on the blame because he is responsible for opening up his land for this mining project. How best is the Government can do to minimise these problems?

After lengthy answers, deliberations and discussions from the Government Officers and representative from the Pacific Nickel Mines Ltd, the meeting proceed to the closing.

7. CLOSING REMARKS

A. Mr. David Deva from the Pacific Nickel Mines gave very positive and informative information about the company. He thanked the Mines and Environment Officers for their time and for the information they disseminated.
B. Acknowledges the Havihua Community and the Landowners for their patience and understanding and especially for the personal presence in the meeting.
C. The Kolosori tenement or prospecting has received an overwhelming feedback and positive report from the Mines Department, making it as one of the best in the country. This positive feedback is a combine efforts or cooperation from Company workers and landowners. I therefore acknowledged all for the support and working together.
D. He further updates the meeting that the exploration team will resume work this week and this second phase we are all anticipating for the similar result.

E. The 80 plus bags of sample from Kolosori is now in the Aussie laboratory for testing and we are expecting the results soon.
F. Sunshine Minerals Ltd now gone and the joint venture company is Pacific Nickel Mines – Kolosori Ltd is the name of the company. A transfer of the Prospecting License (PL) is currently going well and should be given an OK from the Mineral Board.
G. The CEO Mr. Jeff Hiller left the country on Friday and he conveys his greetings to you. He also very happy and grateful for the work done on the first phase of the exploration.

8. GOVERNMENT REPS

Mr. Patrick from Mines acknowledges the participants for their presence, patient and listening and questions during the meeting. He has been very optimistic all along as mining and environment awareness had become norm in bugotu area because of the potential nickel deposit in your area. Company and Officers will come and go doing awareness and other public awareness but as a requirement we have to be here.

Mr. Michael from the Environment and myself would like to convey our sincere acknowledgement on behalf of ourselves and the Ministry we represent for according us this opportunity and chance to meet and know you.

9. LANDOWNERS REPS

Fr. Wilson Mapuru the Principal Landowner and Director acknowledged all the parties involved in this awareness meeting. He thanked the Lord Almighty for his divine blessings, thanked the two government officers for making the meeting very informative and worth. We are so proud and humbled to be the host of this very important meeting.

He further registered his support and his continuous ambitious to develop the nickel deposit at Kolosori for his people, the province and the country. I have opened up my land for this development and will hold fast to this dream he concluded. This is a small community and it is made up of one family and to be able to tarnish this development amidst us is both a challenging undertaking and it is risk taking.

10. CLOSING OF THE MEETING

The have been no other matters and the meeting closed at 4:30 pm.

11. CLOSING PRAYER

Fr. Wilson Mapuru said the closing prayer and the meeting comes to an end.

VARA MEETING

DATE: 24 AUGUST 2021
TIME: 3:00 PM

PARTICIPANTS: 20
OFFICIALS: 5

AGENDAS:

11. WORDS OF PRAYER – CHIEF SOBO.
12. WELCOME ADDRESS – CHIEF AUMANA
13. PURPOSE OF THE MEETING
14. TALK FROM OFFICER OF MINES
15. TALK FROM OFFICER OF ENVIRONMENT
16. TALK FROM OFFICER OF THE COMPANY (PACIFIC NICKELS MINES).
17. QUESTIONS AND ANSWERS
18. CLOSING REMARKS
    - IV. LANDOWNERS REPS
    - V. GOVERNMENT REPS
    - VI. COMPANY REPS
19. CLOSING OF THE MEETING
20. CLOSING PRAYER

MINUTES…

12. WORDS OF PRAYER – CHIEF SOBO.
    The Principal Landowner Ltd Chief Sobo said the opening prayer. In his short devotion, he thanked the Almighty for protection and guidance; he further uttered and acknowledges the many blessings. He concluded his prayer by asking God for his continues blessing, wisdom and knowledge to inspire the facilitators,

13. WELCOME ADDRESS – CHIEF AUMANA.
    VARA Village Chief Aumana warmly welcomes every participant to the meeting. In his welcome speech he articulated the followings:
    - IV. Welcome Government Environment Officers Mr. Michael from the Ministry of Environment and Mr. Patrick Vatopu from the Ministry of Mines, we are so privilege to have you here at Havihua. As government officers, we are honoured and humbled to host you Mr. Aumana said.
    - V. To all the participants he is also grateful for the participants and landowners for making it to the venue. Your personal presence in the meeting is highly acknowledged. Particularly, Chief Sobo and relatives at Horara village. Without your presence this meeting is nothing but your presence mean a lot and I thanked God for this.
    - VI. He concluded his speech, it was regrettable and beyond our capacity that this meeting has been postponed on several occasions and he cautious the Company to be mindful in the future for such mishaps. However, he thanked God we have finally made it..

14. PURPOSE OF THE MEETING

Mr. David Deva from the Pacific Nickels Mines ltd formally declares the purpose of the meeting and also highlighted the following matters:

E. The purposes of this meeting are, 1. To identify and plot the cultural or tabu sites and graveyards (cemeteries). 2. To carry out Socio and Economic data collections a household survey, 3, to make awareness meeting or mining awareness to directly impacted communities.
F. He also introduces officers of the Government and staff of the company. Apologizes for unforeseen circumstances that resulted in several postponement of the meeting. We had not articulated that we would encounter such but on behalf of the Company I apologize and thanks for your understanding.
G. He went on to update the meeting on several developments that take place in the company,
H. He concluded by thanking and acknowledging every stakeholder and especially to Landowners for opening up your land to mining development and his confidence and trust with Pacific Nickels Mines.

The meeting proceed on to the awareness talk from the Government Officers.

15. TALK FROM OFFICER OF MINES

Mr. Patrick Vatopu from the Ministry of Mines starts off his awareness talk by introducing himself. Thereafter conveys the following information:

F. The purpose or objectives of this awareness as a requirement under the Mining Act to conduct public awareness meetings.
G. He reiterated the process and stages of getting a mining lease and development consent. Acquiring development consent is the next stage the Company is applying for before the mining lease.
H. The Ministry of Mines is happy on how the Pacific Nickel Mines did the prospecting. The result of this prospecting or exploration work had created a very good image for the company,
I. The Ministry of Mines will also be responsible for monitoring and inspection on all Mining Companies.
J. In the Mining lease there are requirements and conditions to it and the Companies has to abide.

After further explanation on the household survey and the social and economic impact of mining Mr. Patrick concluded his presentation.

16. TALK FROM OFFICER OF ENVIRONMENT

Mr. Michael from the Ministry of Environment introduced himself and then he elaborated on the following points:

E. Environment Impact Assessment (EIA) is important requirement in any development. They have done the scoping for Kolosori project and then the TOR has already been drawn.
F. This EIA should have been done and the Company should have tasked. Report of the EIA has to be produced. This impact assessment or study Axiom KB and Sumitomo had done and it is a requirement under the environment act.

G. A public hearing will be conducted after the study, a notice will be serving. The Ministry of Environment is responsible for this public hearing. After the public hearing, 14 days period will be given for review and thereafter a "Development Consent" is granted or denied.
H. A confirmatory report from the previous study could be used for some understanding. A mandatory requirement before the Development Consent is given or granted,

The Environment Officer concluded his talk that this EIA report is a public document and could be accessible for public consumption.

17. QUESTIONS AND ANSWERS

The following comments and questions have been solicited in the meeting:

VI. Mr. Tupiti – asked Pacific Nickel Mines had not given us landowners any goodwill payment, token and no payment on the SAA. Why?
VII. Chief Aumana – asked why there have to be prospecting all the time a new mining company comes in. Where are the reports from Sumitomo, Axiom and Inco? Should have used those reports and proceed on to the Miningg stage.
VIII. Chief Aumana – asked what will happened to other minerals besides the Nickel?
IX. Mr. Clement – asked what will the Government or Ministry of Mines do when there is a breach of agreement and non-compliance from the PNM?
X. Chief Aumana – asked what are the processes and requirements PNM needs to do in order to get the Mining Lease?
XI. Mr. Tupiti –asked how much do Landowners and KNSI local directors received from this transfer of the PL to the Pacific Nickel Mines?
XII. Chief Aumana – asked this EIA when it is completed, who will be responsible for its implementation and ongoing monitoring of its worth?
XIII. Mr. Aron – asked how far are the boundaries for this social impact go to. And if there is problem what are the mitigations, measures in place and who is responsible for it?
XIV. Chief Sobo –formally declares that there his tribe the Vihuvunai –goe fully supported this project and the exploration activities.
XV. Mr. Raja – asked what is the Government measure and management plans on Tubi trees in the Mining site. It should have allowed a special guarantee to resources owners to harvest tubi on mining and prospecting areas.

After lengthy answers, deliberations and discussions from the Government Officers and representative from the Pacific Nickel Mines Ltd, the meeting proceed to the closing.

18. CLOSING REMARKS

H. Mr. David Deva from the Pacific Nickel Mines gave very positive and informative information about the company. He thanked the Mines and Environment Officers for their time and for the information they disseminated.

I. Acknowledges the Vara Community and the Landowners for their patience and understanding and especially for the personal presence in the meeting.
J. The Kolosori tenement or prospecting has received an overwhelming feedback and positive report from the Mines Department, making it as one of the best in the country. This positive feedback is a combine efforts or cooperation from Company workers and landowners. I therefore acknowledged all for the support and working together.
K. He further updates the meeting that the exploration team will resume work this week and this second phase we are all anticipating for the similar result.
L. The 80 plus bags of sample from Kolosori is now in the Aussie laboratory for testing and we are expecting the results soon.
M. Sunshine Minerals Ltd now gone and the joint venture company is Pacific Nickel Mines – Kolosori Ltd is the name of the company. A transfer of the Prospecting License (PL) is currently going well and should be given an OK from the Mineral Board.
N. The CEO Mr. Jeff Hiller left the country on Friday and he conveys his greetings to you. He also very happy and grateful for the work done on the first phase of the exploration.

19. GOVERNMENT REPS

Mr. Patrick from Mines acknowledges the participants for their presence, patient and listening and questions during the meeting. He has been very optimistic all along as mining and environment awareness had become norm in bugotu area because of the potential nickel deposit in your area. Company and Officers will come and go doing awareness and other public awareness but as a requirement we have to be here.

Mr. Michael from the Environment and myself would like to convey our sincere acknowledgement on behalf of ourselves and the Ministry we represent for according us this opportunity and chance to meet and know you.

20. LANDOWNERS REPS

Chief Aumana acknowledged all the parties involved in this awareness meeting. He thanked the Lord Almighty for his divine blessings, thanked the two government officers for making the meeting very informative and worth. We are so proud and humbled to be the host of this very important meeting.

He further expresses word of thanks to those who have assisted towards making this meeting a success. To the vihuvunagi-goe chief and relatives we have to **paddle together** in order to have this company develop our resources too many companies have come and go but the rich nickel deposit is yet to be fully harvested and we enjoy its benefits. We have been dreaming for this reality for so long and when will we reach the promise land he concluded.

21. CLOSING OF THE MEETING

The have been no other matters and the meeting closed at 4:30 pm.

22. CLOSING PRAYER

Chief Aumana said the closing prayer and the meeting comes to an end.