Chapter 14 Development Plan for Airports

14.1 Present Situation on Airports

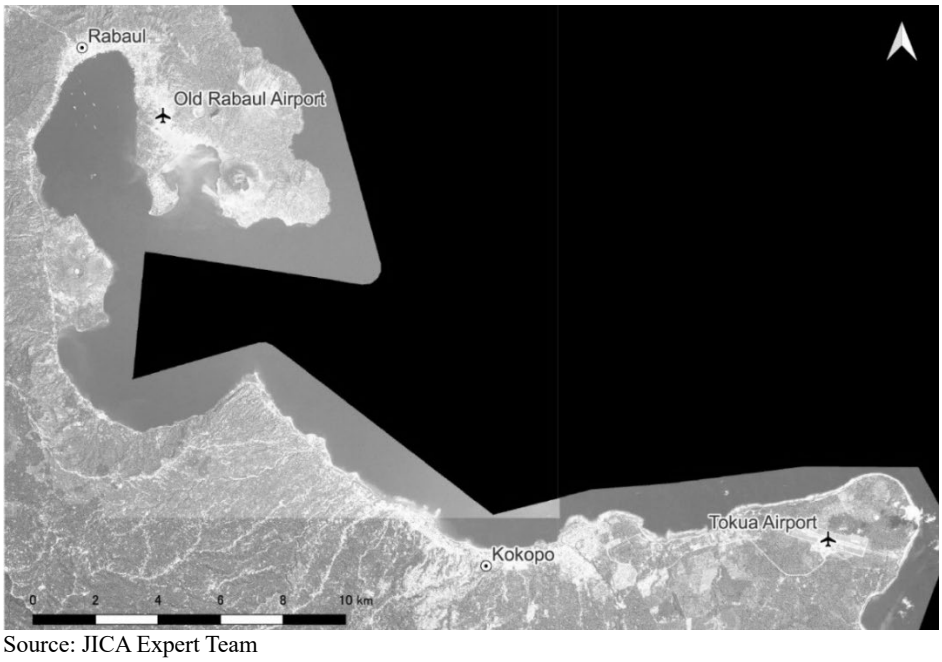
14.1.1 Present Situation of Tokua Airport

(1) Background

Tokua Airport is a hub airport for East New Britain Province and its surrounding islands. It is one of the 27 airports in PNG. It is the third airport in the country in terms of take-off distance available, following Port Moresby Jacksons International Airport and Nadzab Airport (Lae) in Morobe.

Tokua Airport was developed to take over the role of Rabaul Airport which was closed in September 1994 as a result of the eruptions of two volcanoes near Rabaul. Tokua Airport's development project was carried out as Japan's grant-aid project known as "The Project for Upgrading of New Rabaul Airport (Tokua) in Papua New Guinea", agreed in the Exchange of Notes in 1996. Tokua Airport was completed in 1998.

Tokua Airport is located 13km east of Kokopo Town. (See Figure 14.1.1.)



Source: JICA Expert Team

Figure 14.1.1 Location of Tokua Airport

(2) Organisation Structure

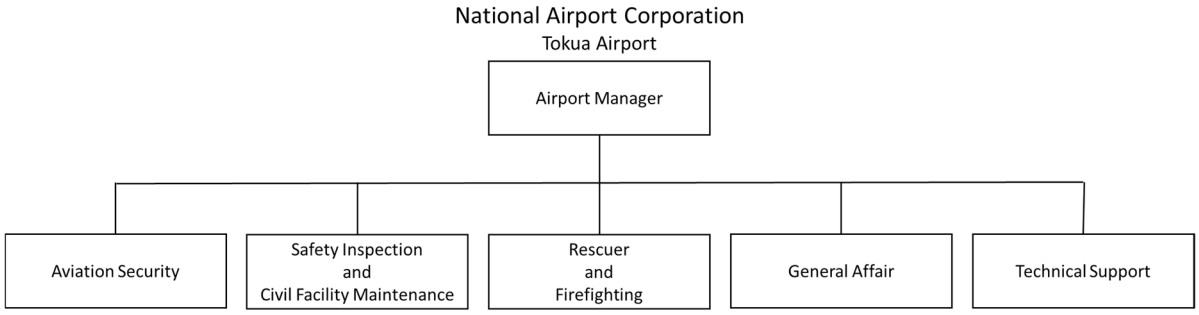
1) Department of Transport (DOT)

The Department of Transport (DOT) is the organisation at the central level to provide ministerial advisory services and policy and planning input to the air transport sector of Papua New Guinea. The Air Transport Division of DOT is responsible for issuing air service licences to carriers.

2) National Airport Corporation (NAC)

Tokua Airport is operated and managed by National Airport Corporation (NAC) that operates and maintains 22 airports in PNG. According to the National Airport Corporation 2030 Growth Strategy formulated in 2017, NAC aims to have a minimum of 15 of all airports under it to comply with the minimum ICAO Recommended Standards and Practices for airport operations under CAR Part 139 by 2030.

The organisational chart of the Airport Management Office at Tokua Airport is shown in Figure 14.1.2. Under the Airport Manager, there are Aviation Security Department, Safety Inspection and Civil Facility Maintenance Department, Rescue and Firefighting Department, General Affairs Department, and Technical Support Department.



Source: JICA Expert Team

Figure 14.1.2 Organisational Chart of Tokua Airport

3) PNG Air Service Limited (PNG ASL)

PNG Air Services Limited (PNG ASL) is a state-owned enterprise which started its operation in 2008. Its primary business is to provide air navigation services to the airline operators who use air space of PNG.

(3) Passenger Movement

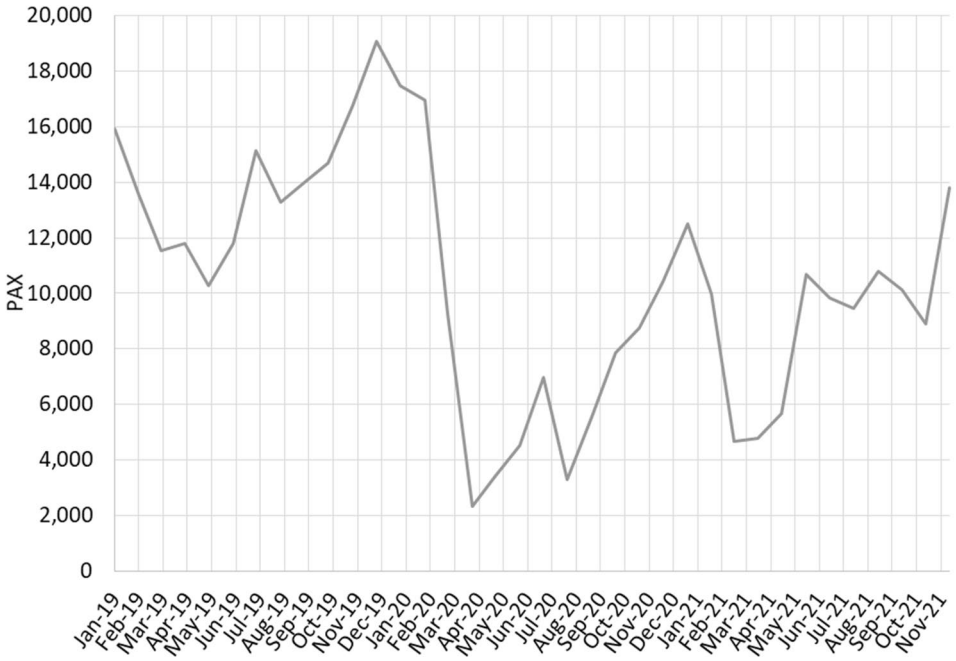
Annual number of passengers of Tokua Airport in recent years had gradual increase as shown in Table 14.1.1. The year with highest number of passengers in the past decade was in 2018 with 171,753 passengers.

Table 14.1.1 Annual Number of Passengers at Tokua Airport (2013-2021)

Year	Number of Domestic Passengers	Number of International Passengers
2013	113,505	18,987
2014	150,476	20,492
2015	151,732	20,263
2016	137,658	25,488
2017	162,427	NA
2018	171,753	NA
2019	167,916	NA
2020	96,804	NA
2021	111,157	NA

Source: NAC

Figure 14.1.3 shows monthly passenger movements from 2019 to 2021 at Tokua Airport. The number of passengers decreased drastically because of the COVID-19 pandemic in March 2020. The number of passengers decreased due to lockdown, but since end of 2021, the number of passengers has returned to pre-COVID-19 level.



Source: NAC

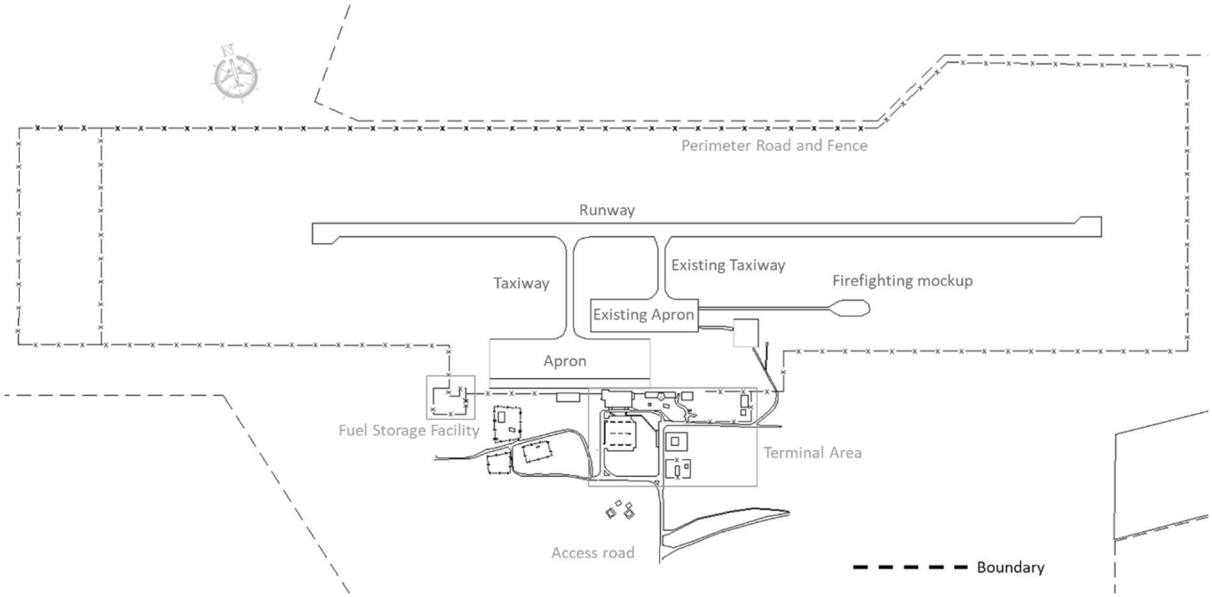
Figure 14.1.3 Number of Passengers per Month at Tokua Airport (2019-2021)

(4) Cargo Transport

There is no cold storage facility at Tokua Airport. Therefore, cargoes that need refrigerated transport are brought to Tokua Airport prior to shipment for necessary paper work, then brought back to the clients' facilities for storage until the cargo aircraft arrives at Tokua Airport. All cargoes to be transported overseas are transhipped at Jacksons International Airport at Port Moresby.

(5) Airport Facilities

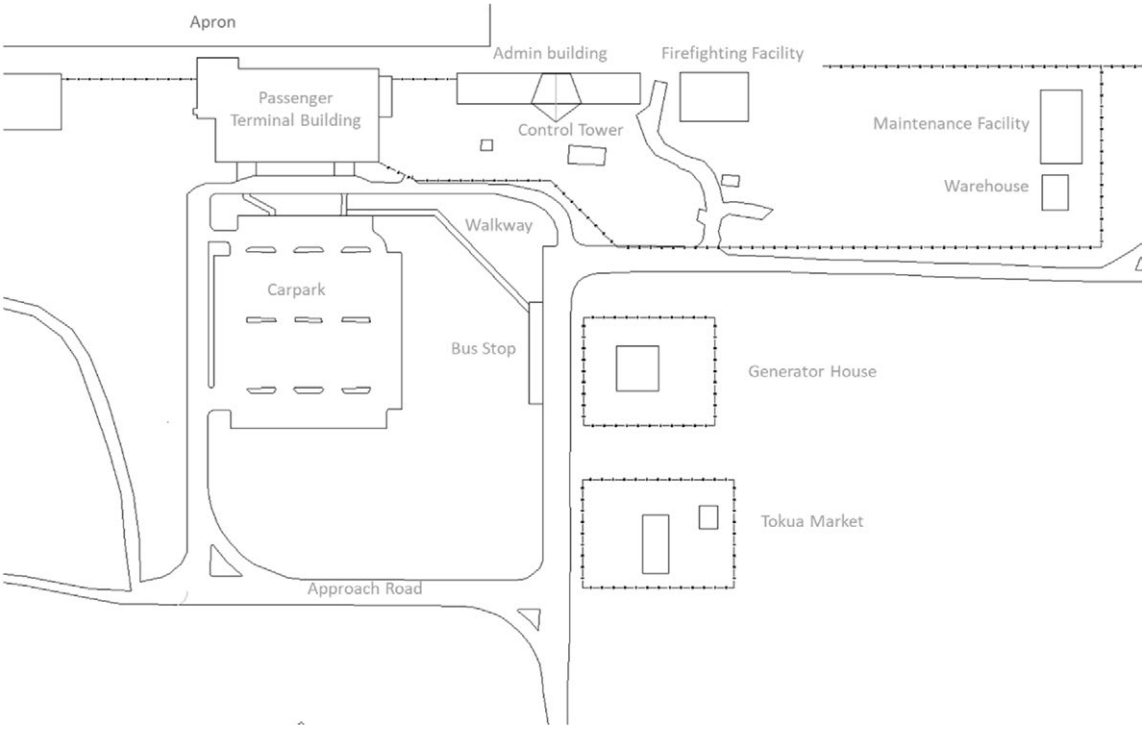
Figure 14.1.4 shows the overall facility layout of Tokua Airport. There are runway, taxiway, apron and firefighting mockup in the airside located in the restricted area.



Source: Oriental Consultants Global Co., Ltd. and Azusa Sekkei Co., Ltd., February 2021, Preparatory Survey on Tokua Airport Redevelopment Project in the Independent State of Papua New Guinea, JICA.

Figure 14.1.4 Overall Facility Layout of Tokua Airport

Figure 14.1.5 shows the layout of terminal area and administration area. There are passenger terminal building, carpark, bus stop with walkway, administration building with control tower, firefighting facility, maintenance house, maintenance office, generator house, Tokua market, approach road and access road. The fuel storage facility is located west of the terminal area. Some facilities were installed by the Civil Aviation Development Investment Programme (CADIP) funded by Asian Development Bank (ADB).



Source: Oriental Consultants Global Co., Ltd. and Azusa Sekkei Co., Ltd., February 2021, Preparatory Survey on Tokua Airport Redevelopment Project in the Independent State of Papua New Guinea, JICA.

Figure 14.1.5 Landside Facility Layout of Tokua Airport

1) Runway

Tokua Airport has a single runway that is 1,720 m in length, which is not sufficient for international flights. The runway direction is 10/28, which means aircraft takes off/lands in both directions. The runway has 30 m width for Code C. The runway longitudinal slope is 0.82%. The cross-sectional slope is 1.5%, centre crown. The strength of pavement is PCN/20F/C/Y/T

The rise of pavement surface, by 2 to 5 mm from adjacent area, is often observed. This may be due to construction crack by depression of base courses under aircraft load.

Airside pavement deterioration, especially runway pavement, is extreme, while the central area (600 m in length, 12 m in width) received repair works two times by CADIP in 2018 and 2021. The repair work consists of the replacement of the upper 20 cm thick layer with crushed river stones and 2 cm thick chip seal surface.

2) Taxiway

The width of the taxiway is 15 m, with 7.5 m-wide shoulder along each edge. This suffices taxiing of aircraft with 9 m or less outer main gear wheel span. The taxiway curve radius is 30 m. There is only single stab taxiway. It sometimes makes surface movement stagnant.

3) Aircraft Parking Stand

The existing aircraft parking apron paved with asphalt is rectangular with 350 m length and 85 m width with 5m-wide shoulder. GSE road and staging lanes run between the apron and terminal

building; its length is 360 m and 20 m width. The current strength of pavement is mentioned as PCN/20F/C/Y/T in AIP.

No commercial carrier utilises Tokua Airport as its base who operates scheduled flights, therefore the number of night stay aircraft is more or less three. However, the apron becomes congested under peak situations when non-scheduled flights and Australian military operations coincide, and four units of UH-60 helicopters cannot stay. The apron pavement is asphalt.

4) Perimeter Road

The perimeter road and the fence were developed by CADIP in 2019. There are no perimeter and service roads inside the security fence line.

5) Terminal Road and Car Park

The frontal curb is located in front of the Passenger Terminal Building. There is a car park for public use at the south of the frontal curb. The use of frontal curb is permitted only for hotel pick-up and drop-off, while the other vehicles use the car park in the south. The approach road is located south and west of the car park to connect the access road and car park. The number of lanes of approach road is two.

The frontal curb is paved with asphalt. ENBP government repaired the potholes on the car park and approach road recently.

There is a drainage facility. However, it is not maintained sufficiently, so flooding occurs during heavy rain at the frontal curb.

6) Bus Stop

Currently, PMVs are also parked at the car park, and often stay on lanes of car parks, which preventing smooth running of other cars. Bus stop was constructed by CADIP to separate PMVs and private cars at the east side of the car park in 2020.



Bus Stop **Walkway**

Source: JICA Expert Team

Figure 14.1.6 Bus Stop and Its Walkway at Tokua Airport

7) Access Road

Kokopo-Tokua Road serves as the main access to Tokua Airport from the town of Kokopo. It has two carriage lanes, one lane in each direction, and good linearity. ENBP government has repaired its potholes by cold asphalt pavement in 2021.

Kokopo-Tokua Corridor Subject Development Plan 2016 was formulated which included widening of Kokopo-Tokua Road. A design proposal was offered by a Chinese enterprise in 2014. The design proposal shows four lanes, two lanes for each direction road.

8) Passenger Terminal Building

The passenger terminal building was built over twenty years ago with the support of Japanese ODA grant aid in 1998. Since then, it has been expanded and renovated by local and self-funded works. The total floor area is 1,699 m^2 including 221 m^2 of expanded area.

The original building was designed so that the departure function could be expanded to the west, and that the arrival function could be expanded to the east. The number of passengers exceeded the demand forecasted at the opening, and the width of the existing arrival lobby (which is now approximately 7.0 m) is too small. Therefore, there is congestion during peak time. The departure lobby is located between the check-in lobby and arrival lobby.

There are no conspicuous deterioration and damage of the building structure. However, the building exterior is damaged with some windows broken by luggage cart. The edge of the roof or fascia is also heavily damaged and the soffit is left peeled off. This might have caused the rainwater leakage.



Broken Window **Roof and Eave**

Source: Oriental Consultants Global Co., Ltd. and Azusa Sekkei Co., Ltd., February 2021, Preparatory Survey on the Project for Tokua Airport Redevelopment Project in the Independent State of Papua New Guinea Final Report, JICA

Figure 14.1.7 Deterioration of Passenger Terminal Building at Tokua Airport

9) Administration Building and Air Traffic Control Tower

The Administration Building is a one-storey structure which holds the administration office, while the Air Traffic Control Tower Building has 5-storey control tower. The total floor area is 896 m^2.

Since the roof of the control tower was leaking, the Civil Aviation Development Investment Program (CADIP), supported by ADB, repaired the control tower in 2020. This project was originally to be funded by PNG ASL.

10) Fuel Facility

Located at east of the passenger terminal building is a fuel facility provided with the support of CADIP for Puma Energy. There are four fuel tanks that can each store 68,000 L, so it is possible to store a total of 272,000 L fuel at Tokua Airport. Puma Energy has two fuel supply cars that load 6,000 L and 8,000 L respectively.

The fuel is transported by tank lorry loading 36,000 L from Rabaul Port. During heavy rainfall, the tank lorry cannot come to Tokua Airport because it cannot pass through Kokopo-Rabaul Road due to landslide. In 2019, the tank lorry arrived 2 days later than scheduled due to landslide caused by heavy rain.

11) Generator House

The Generator House is located south of the Administration Building. There are two generators: one generator is working, and the other generator will need cables connected and start to work.

12) Maintenance House and Maintenance Office

The Maintenance House and Maintenance Office are located east of the Administration Building. It was constructed under CADIP. However, operation of those buildings is not yet transferred from ADB to NAC. NAC will maintain and repair the equipment.

13) Market

The market, constructed under CADIP, is located east of Tokua Airport. Its operation was transferred from ADB to ENBP's Market Authority. Tokua Market is one of the four markets in ENBP. Local people visit to sell and buy crops.

14.1.2 Review of Existing Policies, Development Plans and Projects

(1) National Transport Strategy 2011-2030

The National Transport Strategy (NTS) 2011-2030 was formulated in 2011 by the Department of Transport (DOT). In the NTS, upgrading of 10 national airports to medium range regional standard airports by 2030 is proposed. Tokua Airport is included in the Long Term Investment Plan along with the airports at Mt. Hagen, Wewak and Kavieng.

(2) Medium Term Transport Plan

The Medium Term Transport Plan 2014-2018 (MTTP 2014-18) was the first medium term plan formulated by DOT for the transport sector, followed by the Medium Term Transport Plan 2019-2022 (MTTP 2019-22).

In the MTTP 2014-18, the upgrade of Tokua Airport to accommodate F100 aircrafts was included as a project under CADIP.

In the MTTP 2019-22, the priority for the aviation sector was to focus on completing the projects already appropriated. The project to repair the control tower at Tokua Airport was included which is aligned with one of the strategies in the Medium Term Development Plan III (MTDP III): Improvement in air navigation aid systems for major airports. The budget for the repair was 20 billion kina and was allocated as part of the 2021 and 2022 budget for MTDP III.

(3) Airport Master Plan 2009-2030 for Papua New Guinea National Airports Corporation: Tokua

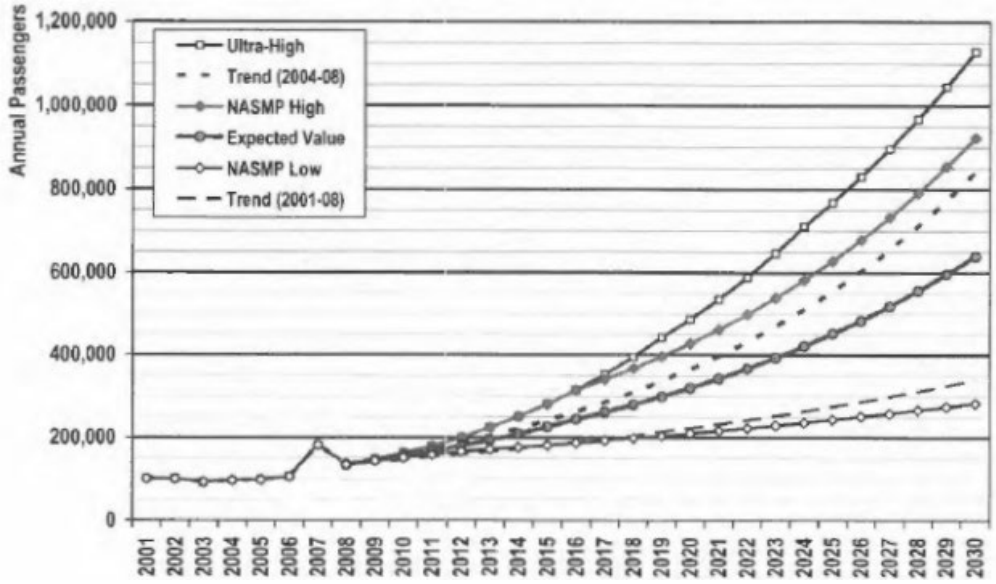
The Airport Master Plan 2009-2030 for Tokua Airport was formulated in 2010.

The objectives of the master plan are as follows:

- Safety and Security: The airport is developed in a manner that maintains the safety and security of aircraft and terminal operations.
- Operational Capacity: The master plan provides a framework for the development of facilities for potential growth in aircraft movements to 2030.
- Commercial: The master plan facilitates development of the airfield in an environmentally sustainable manner.
- Regional Development: The master plan provides guidance for adjoining land use to facilitate orderly development, minimise conflicting land uses, and support regional and national economic development opportunities
- Community: The master plan facilitates the continued delivery of reliable air transport services that are essential to the welfare of the community.

The master plan includes the forecast growth in passenger traffic at Tokua Airport. In Ultra-High Scenario which assumes growth in excess of the National Airports Strategic Master Plan's high scenario, it is assumed that the number of passengers using Tokua Airport will become

approximately 550,000 by 2021 and exceed 1.1 million in 2030. On the other hand, in the NASMP low scenario, which assumes growth at the annual growth over the period 2009-2018 assumed in the NASMP Phase 1 Low Economic Growth Scenario, then continuing at 1.5% p.a. until 2030, it is assumed that the number of passengers using Tokua Airport will become approximately 210,000 by 2021, reaching around 300,000 in 2030 (see Figure 14.1.8).



Source: Parsons Brinckerhoff, et al., 2010, Airport Master Plan 2009-2030 for Papua New Guinea National Airports Corporation Tokua, Civil Aviation Authority Papua New Guinea

Figure 14.1.8 Forecast Growth in Passenger Traffic by Scenario (2008-2030) in Airport Master Plan 2009-2030

The number of passengers was highly affected by COVID-19 pandemic, but until 2019, the actual number of passengers was following the NASMP Low Scenario.

There were five projects identified as development priorities which are shown in Table 14.1.2.

Table 14.1.2 Development Priorities in PNG's Airport Master Plan 2009-2030

Development	Trigger Event	Estimated Timing
Widening of runway 10/28 to 45 metres	Introduction of B737 or other Code 4C aircraft to airline fleet	2015-2020
Terminal expansion (Phase 1)	Introduction of B737 or other Code 4C aircraft	2015-2020
Extension of runway 10/28 to 2,350 metres	Introduction of regular B727 international services	2020-2030
Terminal expansion (Phase 2)	500,000 pax per year plus coincident international services	2025-2030
Provision of parallel taxiway	22,000 annual movements	2020-2030

Source: Parsons Brinckerhoff et. al., 2010, Airport Master Plan 2009-2030 for Papua New Guinea National Airports Corporation Tokua, Civil Aviation Authority Papua New Guinea

(4) Airport City Master Plan 2023-2050 (Updated Version in 2023) based on the Strategic Master Plan (2012): "The Gateway to the New Guinea Islands"

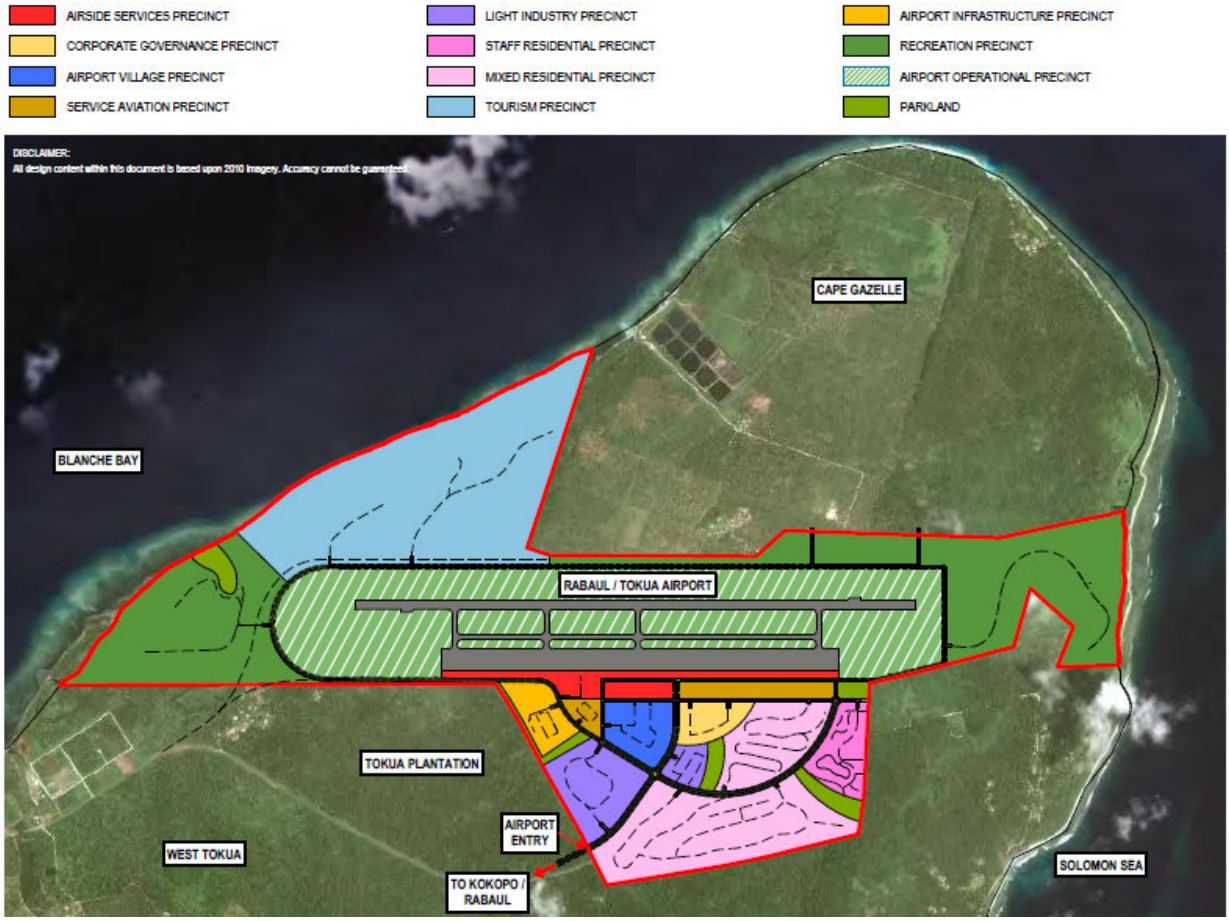
The Strategic Master Plan for Tokua Airport was formulated in 2012 for NAC. The objective of the master plan is to establish Tokua Airport as an integrated development that capitalises on:

- The large and diversified area of greenfield land suitable for potential development with a diverse range of commercial/industrial and tourism land-use activities
- Its function as a principal gateway to East New Britain
- Its function as a principal gateway to its surrounding provinces developing tourism and mineral resource sectors
- Its role as the eastern hub of the Kokopo Rabaul urban corridor

The master plan identifies preferred land uses intended for the Airport City consisting of the following different precincts as shown in Figure 14.1.9:

- Airside Services Precinct
- Corporate Government Precinct
- Airport Village Precinct for hotels, shopping areas, recreation centres, and offices
- Service Aviation Precinct
- Light Industry Precinct
- Staff Residential Precinct
- Mixed Residential Precinct
- Tourism Precinct
- Airport Infrastructure Precinct
- Recreation Precinct
- Airport Operational Precinct
- Parkland

By updating this 2012 master plan, Tokua Airport City Master Plan 2023-2050 was formulated in 2023 for the purpose of attracting investors and developers. The plan includes not only land use for transportation and aviation, but also land use for residential, commercial, light industry and is intended for the surrounding area of Tokua Airport to develop as an airport city.



Source: Tokua Airport City Master Plan 2023-2050, prepared by updating "Planpac Group PNG, 2012, Rabaul Tokua Strategic Master Plan, NAC"

Figure 14.1.9 Precincts Related to Airport City Proposed by Tokua Airport City Master Plan 2023-2050 (Updated Version 2023)

(5) Tokua Airport Redevelopment Project (JICA)

NAC is planning to develop Tokua Airport as an international airport to promote tourism development in the country, along with Jacksons International Airport which is the main airport of PNG located in the National Capital District, and Nadzab Airport which is a regional airport located 35 km northwest of Lae City functioning as a business airport.

Based on the NAC's plan to develop Tokua Airport, "The Preparatory Survey for Tokua Airport Redevelopment Project" was conducted by JICA from 2019 to 2021 in order to prepare a basic plan of the upgrading of the existing Tokua Airport and to examine the feasibility of the basic plan.

The basic plan was prepared based on the NAC's plan to develop the Tokua Airport to achieve the following aspects:

- To accommodate B737-8 aircraft as an alternative to F100 planned by Air Niugini.
- To play the role of an alternative airport for Jacksons International Airport by receiving B767-300ER to be diverted from Jacksons International Airport
- To function as an international airport by complying with ICAO Standards and Recommended Practices.
- To function as a regional base for disaster relief activities during an incident of natural disaster such as an earthquake, tsunami and volcanic eruption.
- To continue to support the lives of local residents and industries, provide transportation to other areas in the central regions without disruption, and improve the quality of service.

1) Demand Forecast

The demand forecasts for years 2026, 2031, 2036 and 2041 were prepared by "The Preparatory Survey for Tokua Airport Redevelopment Project". It is assumed that the number of domestic passengers is to increase to 367,300 in 2031 and 543,200 in 2041, whereas the number of international passengers is to become 45,300 in 2031 and 142,200 in 2041.

Table 14.1.3 Demand Forecasts for Tokua Airport 2041 by JICA Feasibility Study

			2026	2031	2036	2041
Domestic	Passengers	Annual	300,000	367,300	437,000	543,200
		Peak Day	1,040	1,270	1,510	1,880
	Flights	Annual	6,153	7,457	9,385	11,419
		Peak Day	20	24	30	37
International	Passengers	Annual	19,900	45,300	96,100	142,200
		Peak Day	700	160	320	470
	Flights	Annual	312	834	1668	2190
		Peak Day	2	4	6	6

Source: Oriental Consultants Global Co., Ltd. and Azusa Sekkei Co., Ltd., February 2021, Preparatory Survey on the Project for Tokua Airport Redevelopment Project in the Independent State of Papua New Guinea Final Report, JICA

2) Development Phases

The airport development plan is divided into two stages: short-term development plan with 2031 as the target year, and long-term development plan with 2041 as the target year.

The development plan includes the following:

- The airport terminal area is to be located approximately in the centre of the entire runway length after extending the runway to the west.
- The airport terminal area will be located in the west side of the existing airport access road as a passenger terminal area with a new passenger terminal building, approach road, car parking, and future expansion area is considered (2041).

- The area near the existing passenger terminal is secured as a cargo terminal area, and the west side is secured as a future maintenance area (2041).
- The east side of approach road is planned as an administration area where a new air traffic control tower, administration building, power house, firefighting building, workshop, and area for fuel facility to be relocated by the supplier.

(6) Civil Aviation Development Investment Program (CADIP) (ADB)

CADIP is a loan project by ADB. It was conducted in three tranches. CADIP supported to develop 21 airports in PNG, and Tokua Airport was among one of the airports which was supported. The table below shows the contents of construction work conducted by CADIP at Tokua Airport. It was part of CADIP Tranche-2 and was approved by ADB on 19th September 2018.

Table 14.1.4 Contents of CADIP for Tokua Airport

Type	Contents
Construction work	Perimeter road, Perimeter fence, PUMA fuel facility, NAC staff accommodation, Generator house, Kokopo market, Bus stop, Maintenance house, Maintenance office, Firefighting mock-up
Improvement work	Runway pavement, Control Tower, Car park

Source: NAC

Following the CADIP, Civil Aviation Development Investment Programme II (formerly Second Civil Aviation Development Investment Program, hereafter CADIP Phase II) is now under consideration by ADB. The contents of the CADIP II are still to be determined.

(7) ENBP Economic Development Plan 2003-2033

The ENBP Economic Development plan 2003-2033 proposes to consider Tavilo airstrip in Gazelle District close to Ataliklikun Bay which was during the Second World War to be ustilised as the international airport, while Tokua Airport remains as the domestic airport.

This proposal is based on the geographical location of Tavilo which is safe from the volcanic dusts emissions causing problems for aircraft landing at Tokua.

(8) ENBP Strategic Development Plan 2011-2021

The East New Britain Province Strategic Development Plan (ENBP SDP) formulated in 2011, proposed a feasibility study on a possible alternative airport at Vunakanau.

The ENB Provincial Executive Council approved Vunakanau as an alternative emergency airport, for short term and for emergency use for when Tokua is closed because of continuous ash fall in 2009. 15 million kina was estimated for the feasibility study for Vunakanau Emergency Airport Project.

14.2 Issues on Airports

(1) Upgrading of Airport Infrastructure and Facilities for Promoting International Tourism and Exporting Business of Fresh Food

The current capacity of facilities at Tokua Airport is not sufficient for accommodating the increasing number of passengers. Moreover, the current Tokua Airport does not have any facilities to keep cargoes that need to be refrigerated.

With the completion of the preparatory survey by JICA, both governments of PNG and Japan intend to move to the next stage of project implementation. However, the actual schedule for the implementation of the upgrading project of Tokua Airport is uncertain due to the current situation of PNG government's high percentage of external debt to GDP.

However, it is still expected that the Short-Term Development Plan of Tokua Airport be completed by 2031. With the implementation of the Short-Term Development Plan, Tokua Airport is planned to become an international airport so as to export fresh food and vegetables to Guam, the Philippines and Japan, and to accommodate an increasing number of international tourists and business travellers, not only for ENBP, but also for its surrounding islands, such as New Ireland and Bougainville. In order to upgrade Tokua Airport to an international airport, it is necessary to extend runway length and apron area, install new taxiways, and construct a new passenger terminal building and a control tower. If a new terminal is constructed and regular international flights are in service, it will be possible to increase concession incomes and operate duty-free shops. To that end, it is necessary to consider capacity building of managing commercial facilities.

(2) Difficulties in Association with Super-Long Term (beyond 2050) Development of Tokua Airport

The JICA-supported preparatory survey for upgrading Tokua Airport reveals that the expansion of runway up to 2,600 m will enable Tokua Airport to accommodate short-haul and middle-haul flights between those of Singapore, Manila and Brisbane and Tokua Airport. However, a further expansion of the runway longer than 2,600 m for accommodating larger aircrafts, such as B767-300ER, for the flight between Hong Kong and Tokua will not be easy, due to the surrounding conditions of the current site of Tokua Airport. Such further expansion might cause not only negative social and environmental impacts, but also larger costs.

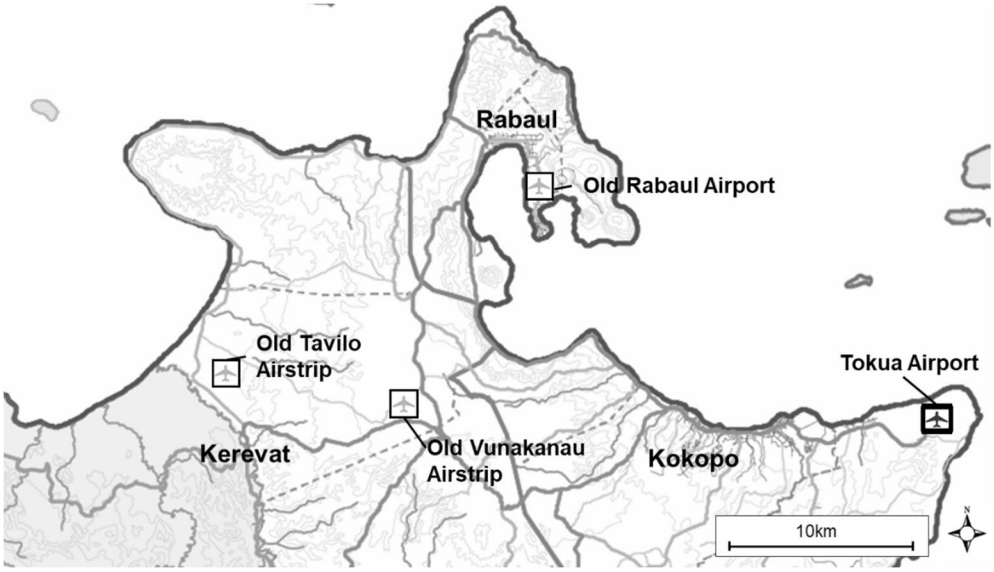
(3) Consideration of an Alternative Airport in Gazelle District

The ENBPA has an idea of utilising an old airstrip in Tavilo which was used by the Japanese military in Gazelle District as an alternative airport owned and operated by ENBP. Although this is just an idea at the moment, ENBPA proposes this alternative airport for the case in which a large increase of the number of international tourists occurs for the super-long term (beyond 2050).

Besides the old airstrip in Tavilo, Vunakanau in Gazelle District close from Tokarongon Junction was also considered as an alternative airport in 2011.

Considering the future demand of international tourism, it may not be necessary for Northeast Gazelle Peninsula to have a second airport until beyond 2050. On the other hand, taking in consideration that the existing Tokua Airport could be affected by the volcanic ashes depending on the wind direction, it may be necessary to consider an alternative airstrip to be prepared from the perspective of disaster resilience.

The location of the second airport in Northeast Gazelle Peninsula should be determined considering not only the disaster risk, but also the future regional development direction of Northeast Gazelle Peninsula and availability of land which can accommodate 3,000m runway so that the emergency airport can be transformed into an international airport in the far future.



Source: JICA Expert Team

Figure 14.2.1 Locations of Old Airstrips and Tokua Airport

(4) Promoting the Development of International Tourism and Tuna Processing Industries in ENBP

The upgrading or redevelopment of the current Tokua Airport will become feasible enough when the number of international tourists and business travellers to ENBP, as well as to its surrounding islands, will increase as much as the future demands for international flights which are forecast by the JICA preparatory study for the upgrading of the Tokua Airport. In order to make these conditions happen, it is necessary to take necessary actions to attract foreign and domestic investments in tourism sectors not only in ENBP, but also in New Ireland and Bougainville, and to create a good investment environment supported by sufficient infrastructure provision for tuna processing industries and other fresh food sectors.

(5) Promotion of Airport City Precincts by setting a Special Economic Zone

The transformation of Tokua Airport into an international airport that serves international flights based on the technical and physical upgrading of Tokua Airport is one of basic strategies to promote international tourism in ENBP and its surrounding provinces. To that end, in addition to the current tourist attractions, it is important to develop Airport City including upgraded tourist attractions (shopping facilities, etc.) and tourist infrastructure (hotels, resorts and conference centres).

In 2012, a plan was drawn up to develop precincts for Airport City on land adjacent to Tokua Airport and to attract investment in hotels, resorts and conference centres, as described in Section 14.1.2 (4). However, so far there has been no progress towards the implementation of the plan.

In East New Britain Province, setting up an SEZ in the tourism sector is under consideration. It important to maintain the land and plans for the above-mentioned Airport City Precincts and include them in the Kokopo Tourism SEZ to give tax exemption incentives to Airport City development and encourage private investment.

14.3 Objectives for Development of Airports

The objectives for development of airports are as follows:

- To strengthen the international air transport connectivity with major air transport hubs, such as those in Southeast Asia and Australia

  - For attracting international tourists and business travelers not only for ENBP, but also surrounding island provinces
  - For promoting international investments in Kokopo, Rabaul and Kerevat Growth Areas, especially in manufacturing sectors and business sectors by establishing strong international air connectivity
  - For promoting export of fresh fisheries and agricultural products
- To make a regional hub airport at Tokua Airport, the central airport not only of ENBP, but also of the Islands Region
- To enhance resilience of Tokua Airport, the central airport not only of ENBP, but also of the Islands Region
- To fulfill the function of alternative airport for Port Moresby and Lae International Airports
- To strengthen the air transportation function from the perspective of disaster resilient

14.4 Strategies for Development of Airports

In order to achieve the identified objectives for development of airports, the following strategies are to be implemented:

- To increase capacity and improve safety of Tokua Airport to meet the increasing demand for air traffic by constructing a new terminal building and extending the runway
- To promote the increase of frequency of flights for passengers and cargo by promoting international tourism and by promoting international investments in economic sectors, such as tourism and manufacturing
- To promote exporting fresh tuna and agricultural products by taking advantage of international flight connections
- To develop an airport city development, adjacent to Tokua Airport, including hotels, convention centres, and shopping centres, by promoting private investments
- To prepare for development of an alternative emergency airport in Northeast Gazelle Peninsula

14.5 Projects for Development of Airports

14.5.1 Important Projects for Development of Airports

In accordance with the preliminarily considered development directions of the airport sector in Northeast Gazelle Peninsula, the following important projects are identified:

- [AP-01] Redevelopment of Tokua Airport Phase 1 (Upgrading of the Capacity and the Status of Tokua Airport to International Airport Phase 1)
- [AP-02] Redevelopment of Tokua Airport Phase 2 (Upgrading of the Capacity and the Status of Tokua Airport to International Airport Phase 2)
- [AP-03] Promotion of Investment in Airport City Precincts Adjacent to the Prospective Upgraded Tokua Airport (in PPP Scheme)
- [AP-04] Feasibility Study for Development of Tavilo Emergency Airport

The location for the emergency airport is considered as Tavilo which is located in Kerevat Growth Area with less risk of volcanic ash fall. However, it is recommended that other possibilities should be considered in the feasibility study.

The first project above [AP-01] is selected as the priority project of the port sector.

14.5.2 Phased Development of Airports

Land expropriation issues make it difficult to secure a 3,000m or longer runway on the current Tokua Airport site. If Tokua Airport needs to accommodate larger aircrafts in the very long term future (after 2052) than the current Tokua Airport redevelopment plan, it will be necessary to find another relocation site where a runway longer than 3 000 m can be developed.

The Tavilo Emergency Airport is planned to be developed on the site used by the Japanese military as a military airfield near the Ataliklikun Bay. Due to the availability of relatively spare land, Tavilo Emergency Airport could be expanded to meet the needs of larger aircrafts in the very long term future.

Moreover, the Taviro Emergency Airport has the following two advantages:

- The location of Tavilo Emergency Airport is farther away from the volcanoes of Rabaul than Tokua Airport, which could reduce the risk of ashfall damage.
- If the functions of the new international airport are transferred to Tavilo, the construction of a new international airport could also help the area around Ataliklikun Bay become a new resort attracting international tourists.

The phased development and the changes in the function of the airports are shown in Table 14.5.1.

Table 14.5.1 Phased Development and Functions of Airports (Super-Long Term)

	Short Term Present-2027	Short Term 2028-2032	Medium Term 2033-2037	Short Term 2038-2042	Long Term 2043-2047	Long Owner Term 2048-2052	2025-Beyond 2052-Beyond
Tokua Airport	[AP-01] Redevelopment of Tokua Airport Phase 1 [AP-03] Promotion of Investment in Airport City Precincts Adjacent to the Prospective Upgraded Tokua Airport (in PPP Scheme)		[AP-02} Redevelopment of Tokua Airport Phase 2 Development of Airport City				
	Operate as Domestic Airport		Operate as an International Airport				
Tavilo Airport		[AP-04] Feasibility Study for Development of Tavilo Airport	Land Acquisition for Development of Tavilo Airport	Development of Tavilo Emergency Airport		Upgrade of Tavilo Airport	
					Operate as an Emergency Airport		

Source: JICA Expert Team

14.5.3 Priority Projects for Development of Airports

(1) Project Name

[AP-01], [AP-02] Tokua Airport Redevelopment Project Phase 1 and Phase 2 (Upgrading of the Capacity and the Status of Tokua Airport to International Airport Phase 1 and Phase 2)

(2) Project Location

Tokua, Kokopo District, East New Britain Province

(3) Expected Project Funding

Japanese Loan Project (STEP)

(4) Project Description

The objective of the project is to increase capacity and improve safety of Tokua Airport to meet the growth of air traffic demand at the airport by constructing a new terminal building, extending the runway etc., and to upgrade the current airport to the status of international airport. The preparatory survey was completed in January 2021 by JICA.

The required scale of each facility for the short-term (2031) and long-term (2041) development plans are as shown in Table 14.5.2.

Table 14.5.2 Required Scales of Facilities at Tokua Airport (Phase 1 and Phase 2)

	Facility	[AP-01] Short-Term Development (Phase 1; 2027-2031)	[AP-02] Long-Term Development (Phase 2: 2032-2041)	Future Consideration
1	Runway Length and Width	2,600 m, B=45m	2,600 m, B=45m	Ex: 3,000 m
	Category	Non-precision	Non-precision	Cat-I
2	Runway Strip Length and Width	2,720 m, B=280m	2,720 m, B=280m	Ex: 3,120 m
3	Taxiway Type and Width	2 x stab, B=25m	2 x stab, B=25m	Parallel taxiway
4	Aircraft Parking Apron (New)	B737-8 x 1 B767-300ER x 1	B737-8 x 1 B767-300ER x 1	Code E apron
	Aircraft Parking Apron (Existing)	F70 x 1 ATR72 x 1 DH-8 x 1 General Aviation	F70 x 1 ATR 72 x 1 DH-8 x 1 General Aviation	
5	Parking	116 lots	150 lots	Expansion
6	Access Road	2 lanes	2 lanes	
7	Passenger Terminal Building	6,003 m^2 (in 2036)	6,160 m^2	Expansion
8	Cargo Terminal Building	660 m^2	740 m^2	
9	ATC Tower	320 m^2	320 m^2	
10	Others	Utilities: Electricity, Water Supply and Sewage, etc. will be enhanced in accordance with each demand. Navigation Aids: GNSS, Air Traffic Control System and Aeronautical Ground Lighting System will be constructed. Rescue and Firefighting: Cat-6 level will be considered. Aviation Fuel Facility will be constructed by the supplier.		

Source: Oriental Consultants Global Co., Ltd. and Azusa Sekkei Co., Ltd., February 2021, Preparatory Survey on the Project for Tokua Airport Redevelopment Project in the Independent State of Papua New Guinea Final Report, JICA

(5) Project Content

The project content is to upgrade Tokua Airport to fulfil the requirement as shown in Table 14.5.3.

Table 14.5.3 Required Facilities at Tokua Airport Redevelopment Phase 1

	Facility	Short Term Development Plan (2031)
1	Runway length, Width	2,600 m, B=45m
	Category	Non-precision
2	Runway strip length, Width	2,720 m, B=280m
3	Taxiway type, Width	2 x stab, B=25m
4	Aircraft parking apron (New)	B737-8 x 1, B767-300ER x 1
	Aircraft parking apron (Existing)	F70 x 1, ATR72 x 1, DH-8 x 1, General Aviation
5	Parking	116 lots
6	Access road	2 lanes
7	Passenger terminal building	6,003 m^2 (in 2036)
8	Cargo terminal building	660 m^2

	Facility	Short Term Development Plan (2031)
9	ATC tower	320 m^2
10	Others	• Utilities: Electricity, Water Supply and Sewage, etc. will be enhanced in accordance with each demand. • Navigation Aids: GNSS, Air Traffic Control System and Aeronautical Ground Lighting System will be constructed. • Rescue and Firefighting: Cat-6 level will be considered. • Aviation fuel facility will be constructed by the supplier.

Source: NAC/JICA

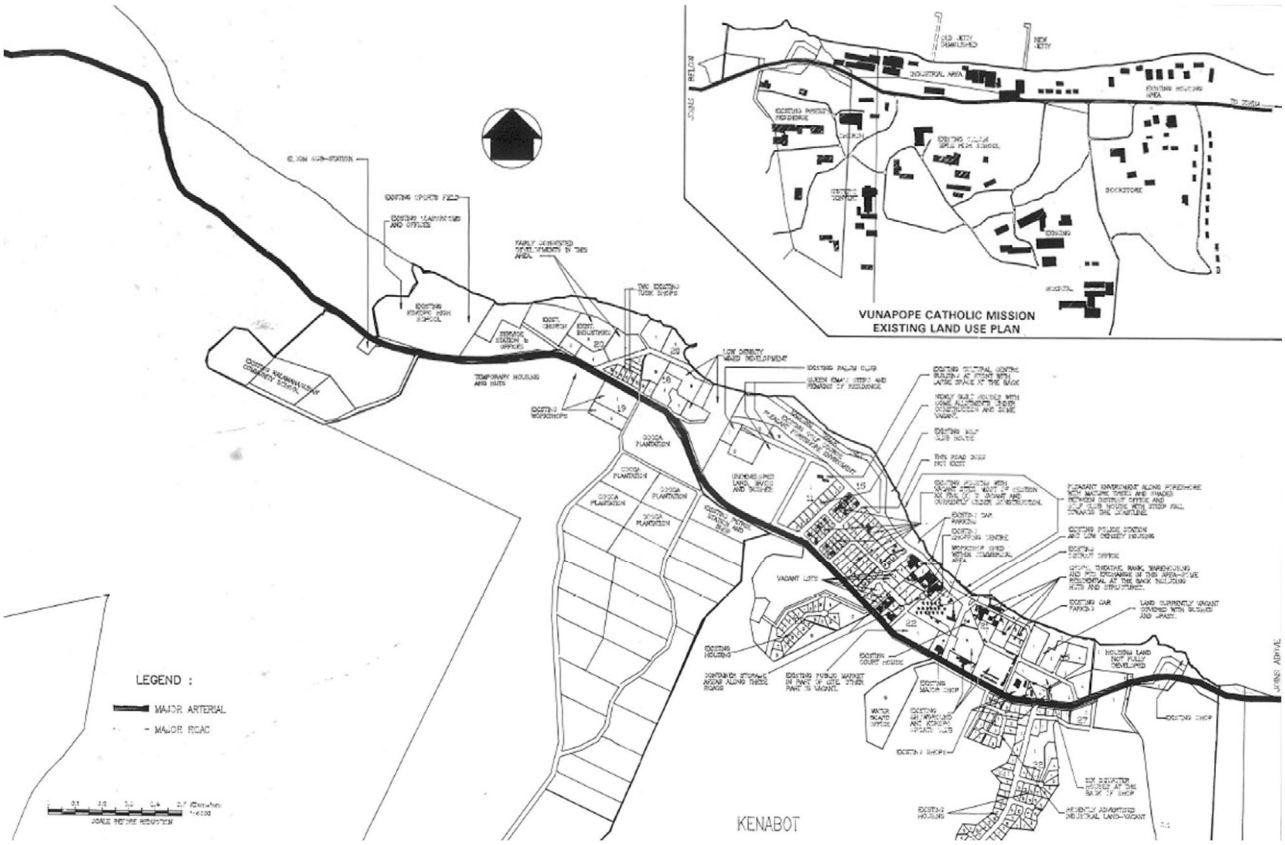
Chapter 15 Development Plan for Urban Roads

15.1 Present Situation and Issues on Urban Roads

15.1.1 Present Situation and Issues of Urban Roads

(1) Present Situation and Issues of Urban Roads in Kokopo Town

In Kokopo Town, most roads are relatively well maintained, compared to urban roads in Rabaul Town. However, considering that Kokopo Town is a primary business, commercial and service centre not only for ENBP but also for the Islands Region, it will be necessary to upgrade the urban functions of the Kokopo Town and to expand urban areas for accommodating more urban facilities (including office buildings and tourist/business hotels) and residences. The urban expansion in Kokopo has occurred along the coast to the south-east from Kokopo Town toward Tokua Area. For satisfying these needs, urban road development is necessary.



Source: East New Britain Province Administration, 1995, Kokopo Urban Development Plan,

Figure 15.1.1 Existing Urban Roads in Kokopo Urban Area

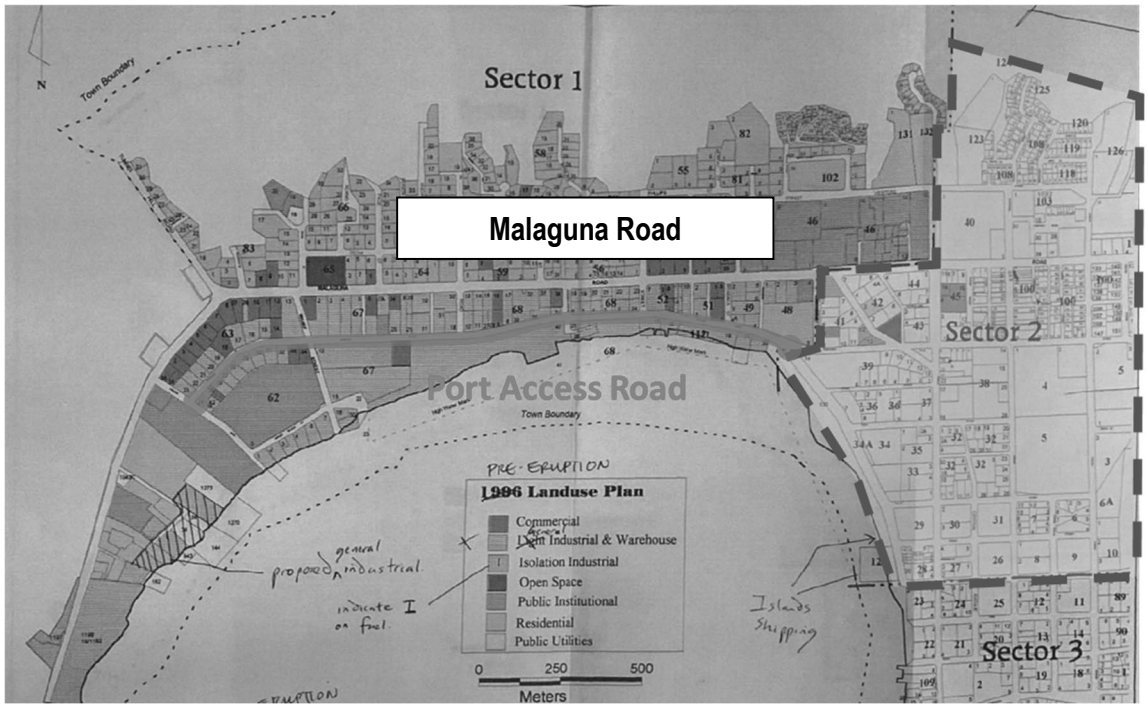
(2) Present Situation and Issues of Urban Roads in Rabaul Town

Rabaul Town is divided into three sectors, namely Sector 1, Sector 2, and Sector 3. Sector 1 is the priority area for restoration from the volcanic ashfall disaster in 1994.

Due to 1994 volcanic eruption, Sector 3 was buried and devastated by volcanic ashfall. Because of the proximity to volcanos, Sector 3 was decided not to be restored. The Rabaul Airport was relocated to Takua Area.

On the other hand, external support had not come for restoring Sector 2 after 1994. Sector 2 has been not restored yet. As most roads in Sector 2 have not functioned after the volcanic eruption in1994, the roads should be restored and rehabilitated according to the expansion of urbanized area.

In Sector 1 of Rabaul Town, "Kokopo - Rabaul Road (Malaguna Road)" and "Port Access Road" are major urban roads in the currently urbanized area. "Kokopo - Rabaul Road (Malaguna Road)" keeps good to fair condition, but some parts require rehabilitation. On the other hand, the condition of "Port Access Road" is very poor due to drainage problems. This road should be rehabilitated by managing sediments from the northern hill of the town away from the Rabaul Port area and Port Access Road.



Source: Rabul Landuse Plan, 1996

Figure 15.1.2 Major Urban Roads in Sector 1 of Rabaul Town

15.2 Objectives for Development of Urban Roads

Roads are fundamental infrastructures in urban areas. Roads compose the spatial structure of urban areas. Urban roads should serve existing urban areas and future urban areas. Urban roads should be properly developed to provide necessary mobility and connectivity for peoples and goods.

Urban road development has the following objectives:

- To provide accessibility and mobility with primary centres / primary functions in urban areas not only by extending and upgrading urban roads, but also by connecting urban roads with trunk roads
- To provide accessibility and mobility with secondary centres / functions in urban areas not only by extending and upgrading urban roads, but also connecting urban roads with trunk roads
- To support the expansion of urban areas in primary centres and secondary centres by extending and upgrading urban roads
- To improve the resilience of urban roads against disasters by providing disaster risk reduction measures

15.3 Strategies for Development of Urban Roads

15.3.1 Strategies for Development of Urban Roads in Kokopo

There are 3 strategies for road development in Kokopo-Tokua Urban Areas, namely, CBD Ring Road Strategy, Town Bypass Strategy, and Corridor Strategy. These strategies will be basically applied in combination to the Kokopo-Tokua Urban Areas.

In Corridor Strategy, it was proposed that key connecting roads between urban centres in the region should be upgraded. These roads are categorised as trunk roads connecting urban centres but not as urban roads. Thus, this strategy is not considered for urban roads.

In order to make Kokopo-Tokua Urban Areas (Urban Corridor) a primary centre for government, business and manufacturing not only for Northeast Gazelle Peninsula, ENBP, but also for surrounding island provinces, urban roads should be strengthened by connecting with the regional trunk road network.

15.3.2 Strategies for Development of Urban Roads in Rabaul Towns

In order to provide necessary access not only for the existing urban area, but also for restored and expanded urban areas, all roads in Sector 1 and Sector 2 should be restored and rehabilitated. By doing so, the function of Rabaul Port could be well functioning and tourist attractions in Rabaul Town could be accessed easily by tourists.

15.3.3 Strategies for Development of Urban Roads in Kerevat Town and Ataliklikun Bay

In the Kerevat Growth Area consisting of Kerevat Town and Ataliklikun Bay Area, the development of urban facilities, pot facilities and SEZ facilities are proposed. For supporting these development, road rehabilitation and upgrading is required. Such roads are categorized as trunk roads in the region.

15.4 Projects for Development of Urban Roads

15.4.1 Important Projects for Development of Urban Roads

(1) Important Projects of Urban Roads in Rabaul Town

In accordance with the strategy, it is proposed that all roads in Sector 1 and Sector 2 of Rabaul shall be rehabilitated. Especially the following three roads should be rehabilitated as important projects.

1) Project for Rehabilitation of Port Access Road in Rabaul Town (1.8 km) including the Improvement of Drainage Network in Rabaul Town [UR-01]

The port access road (Blanche Street) is essential not only in enhancing the port's function, but also in reduction of vehicle operation costs for transporting cargo to and from the port.



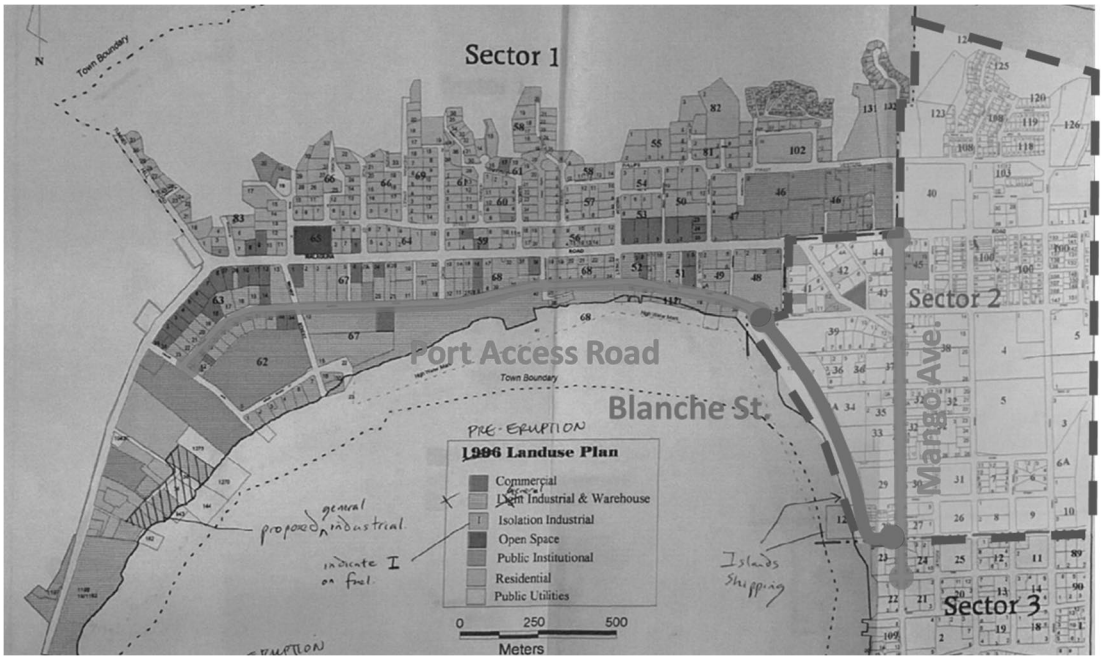
Source: JICA Expert Team

Figure 15.4.1 Severely Damaged Rabaul Port Access Road

The port access road has a poorly functioning drainage system along the road and the drainage channel network in Rabaul Town, which causes rainwater to remain on the road surface after each rainfall, resulting in road breakages. Fundamental improvements for drainage network are required for managing rainwater and sediment run-off from the hills behind Rabaul Town away from Rabaul Port and Port Access Road.

2) Project for Rehabilitation of Mango Avenue and Blanche Street in Rabaul Town[UR-02]

Mango Avenue and Blanche Street are major roads in Sector 2 of Rabaul Town, connecting the seaside area, and Matupit Island. The rehabilitation of these roads could create the urban environment conducing to revitalisation of Rabaul Town.



Source: JICA Expert Team

Figure 15.4.2 Important Urban Road Project in Rabaul Town

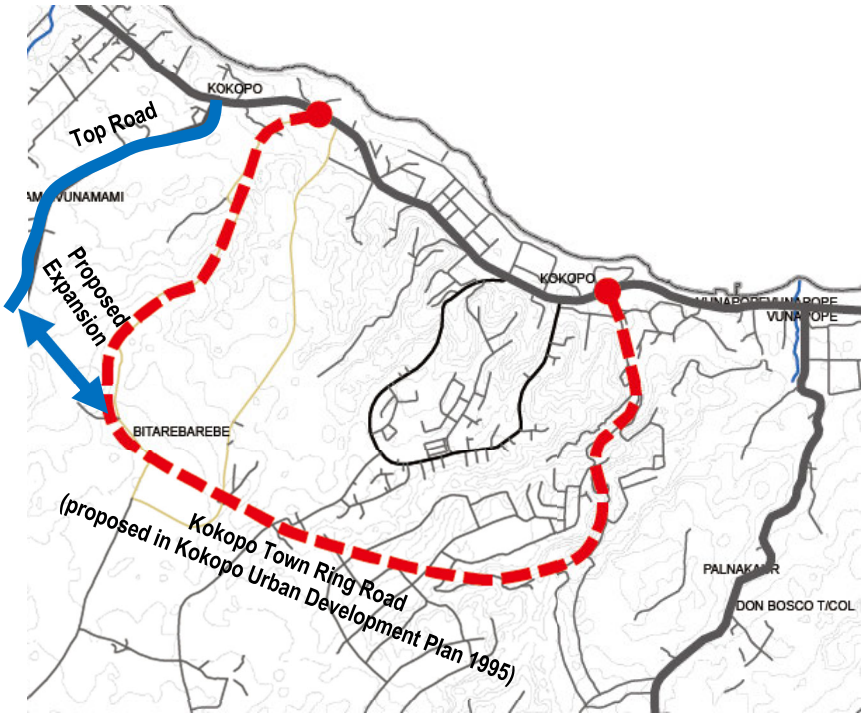
The eastern part of Blanche Street is currently completely under the volcanic ashes and not passable. On the other hand, Mango Avenue is one of the few roads in Sector 2 which is passable, but rehabilitation is necessary.

(2) Important Projects for Development of Urban Roads in Kokopo

1) Project for Development Southern Section of the Kokopo Town Ring Road [UR-03]

In accordance with CBD Ring Road Strategy, it is proposed that ring road around Kokopo CBD should be constructed.

For the ring road to function as part of the bypass road for Kokopo Town, it is recommended that part of Top Road is utilised as part of the ring road as shown in Figure 15.4.3.The development of the southern section of the Kokopo Town Ring Road is intended not only to provide road access to southern part of the Kokopo Town, but also to compose the part of the Kokopo Town Bypass Road connecting Kabakaul and Top Road, as shown in Figure 15.4.5.



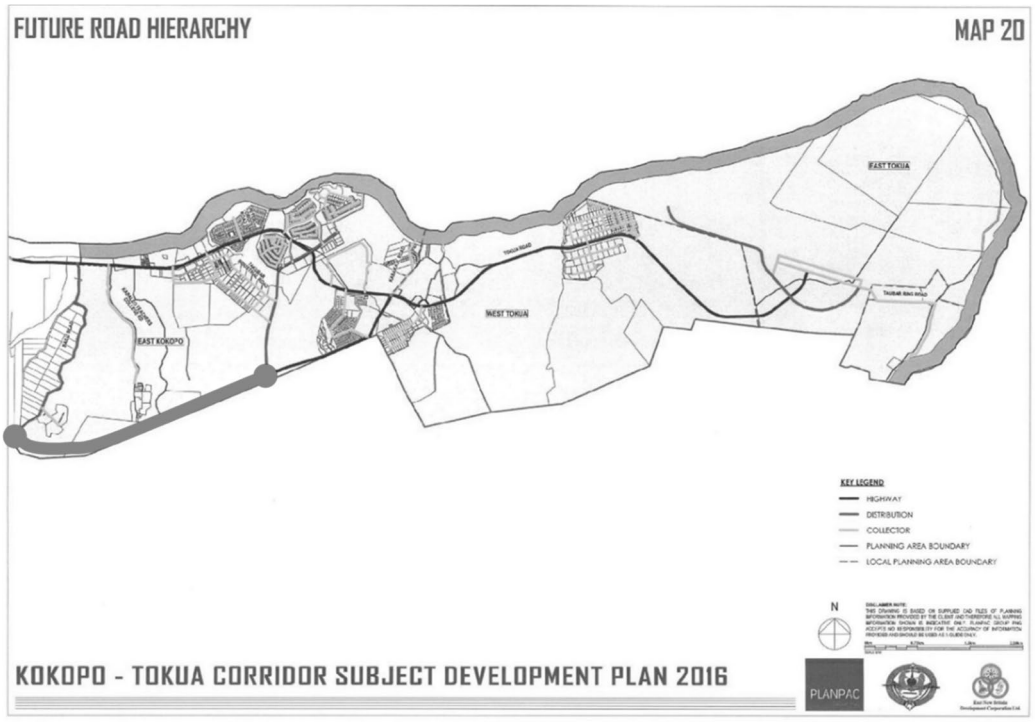
Source: JICA Expert Team, based on Kokopo Urban Development Plan 1995

Figure 15.4.3 Kokopo Ring Road Proposed by Kokopo Development Plan 1996 and Proposed Expansion to Top Road

2) Project for Development of Kokopo Town Bypass Road (6.5 km) [UR-04]

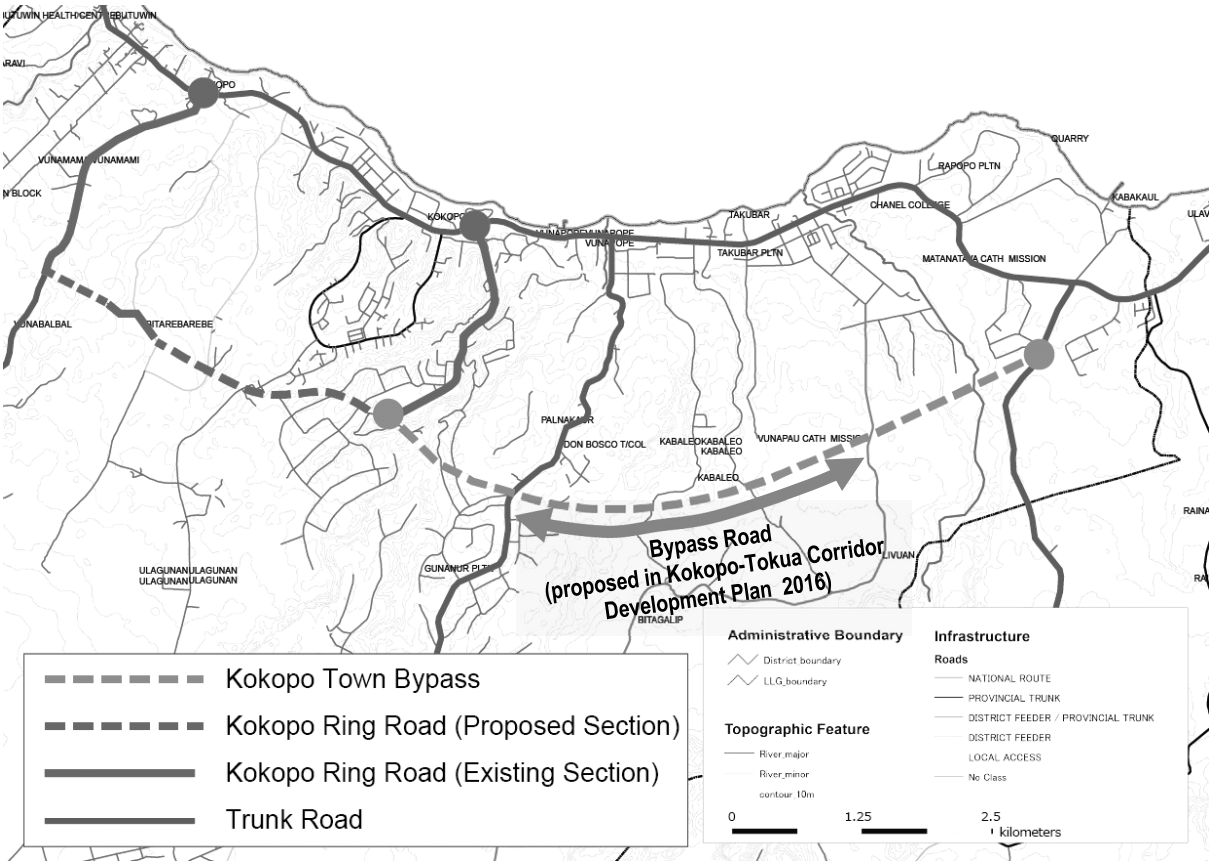
In accordance with Town Bypass Strategy, it is proposed that town bypass, connecting east of the Vunapope-Gelagela Road and Ualaveo will be constructed. Part of this road (approximately 3km) is proposed in the Kokopo-Tokua Corridor Sector Development Plan 2016 as shown in Figure 15.4.4.

By connecting this bypass road with the southern section of the Kokopo Town Ring Road, this will create a bypass road connecting Ulaveo to Top Road without going through the present Kokopo developed area. (See Figure 15.4.5.)



Source: Kokopo - Tokua Corridor Subject Development Plan 2016

Figure 15.4.4 Proposed Kokopo Town Bypass in Kokopo-Tokua Corridor Subject Development Plan 2016



Source: JICA Expert Team, based on Kokopo - Tokua Corridor Subject Development Plan 2016

Figure 15.4.5 Integrated Kokopo Ring Road and Kokopo Town Bypass in Kokopo-Tokua Urban Corridor: Proposed Urban Road Plan by NEGID-Plan

15.4.2 Priority Projects for Development of Urban Roads

All the important projects discussed in the previous section are considered priority roads for urban roads. A phased implementation plan for the identified priority projects is as follows:

Between 2024-2032

[UR-01] Project for Rehabilitation of Port Access Road in Rabaul Town including Improvement of Drainage Network in Rabaul Town (1.8 km)

[UR-02] Project for Rehabilitation of Mango Avenue (1.1 km) and Blanche Street (0.9 km) in Rabaul Town

[UR-03] Project for Development of Southern Section (3.7 km) of Kokopo Town Ring Road

Between 2033-2042

[UR-04] Project for Development of Kokopo Town Bypass Road (6.5 km)

Chapter 16 Development Plan for Water Supply

16.1 Present Situation of Water Supply

16.1.1 Present Situation of Water Supply Systems in Northeast Gazelle Peninsula[1]

The current water supply systems of Rabaul Area and Kokopo Area had undergone restoration/ improvement with the assistance of ADB. The damaged water supply system in Rabaul area caused by the volcanic eruption in 1995 was restored. On the other hand, the water supply system of Kokopo area was expanded, as a result of the relocation of the provincial capital from Rabaul to Kokopo.

In Northeast Gazelle Peninsula, average annual rainfall amount is over 2000 mm while the average monthly rainfall is over 100 mm, which means that there is abundant and stable rainwater. There are abundant groundwater resources, and the water can be withdrawn by borehole easily.

(1) Rabaul and Kokopo Improvement of Water Supply Capacity, Reliability, and Extension of Distribution System in Rabaul

This component includes the following works:

- Development of raw water sources from two springs and five deep wells, with a total capacity of 8,800 m^3/day; and
- Construction of trunk mains, secondary mains and reticulation networks including a balance tank, a clear water reservoir, and service connections.

(2) Minor Repairs and Restoration of Water Supply and Sewerage Facilities in Rabaul, and Minor Expansion of Rabaul Water Supply System

Repairs and restoration include the following:

- Materials, equipment, supplies, and manpower to restore water supply and sewerage services in Rabaul, and
- Nonga Restoration, one storage tank (500 m^3), trunk main (4000 m, 200 mm in diameter) of water supply services.

(3) Development of New Water Supply System in Kokopo

Kokopo has been designated as the capital of ENBP, as well as the Islands Region. A number of government offices and commercial activities have relocated from Rabaul to Kokopo.

In response to this change of provincial capital relocation from Rabaul to Kokopo, a new water supply system with the following features was developed for Kokopo Town:

- 2,800 m^3/day capacity system to serve 6,500 population (Note: A surface water system with an intake and water treatment plant of up to 6,600 m^3/day capacity was considered but was replaced by the lower cost groundwater system). Pipeline completed.
- Groundwater was tapped instead of surface water. New infrastructure provided, including:

[1] The information in the project description was based on the "Project Completion Report on the Third Urban Water Supply (ADB Loan 1211-PNG) (ICDF/CTB Loan 8144-PNG) prepared in December 2003."

seven wells, five of them placed into service; chlorination facilities; a rising main; two 2,800 m^3 storage reservoirs; distribution mains and reticulation to Kokopo (5,540 m of rising mains; 5,245 m trunk main; 8,180 m reticulation); booster pumps and water storage tower to Kenabot (2,970 m of rising main; 11,980 m of reticulation); reticulation to Vunapope (5,548 m); extension and distribution to Takubar (7,320 m); Water board office constructed; telemetry and control systems provided.

- The newly developed water supply system had 1,050 residential connections and 130 commercial connections. (Based on the Water Board MIS Report, there were 1,522 domestic connections in Kokopo Town as of June 2003.)
- Additional 10,654 people were provided with piped water supply. Reduced water costs, timesaving, reduction of morbidity from waterborne diseases were expected.

The water quality of seven wells is shown in Table 16.1.1. All wells were good sources of drinking water. However, the concentrations of nitrate and arsenic were high. Three wells had arsenic concentration found close to the allowable maximum value of the WHO water guideline. It is costly to remove this material, if necessary.

As for nitrate, the concentration of this material in groundwater is affected by people living nearby. The value of nitrate is often high when groundwater sources are close to houses which do not have proper sewage disposal.

Table 16.1.1 Water Quality of Borehole Samples from Kokopo Water Supply System

Analysis	BH1	BH2	BH3	BH4	BH5	BH6	BH7	Guideline Value*
pH	7.6	7.6	7.9	7.0	7.0	7.4	7.2	6.5-8.5
Conductivity (uS/cm)	217	210	250	190	200	180	200	-
TDS (mg/L)	280	270	300	250	270	220	210	1000
Total Alkalinity (mg/L)	100	100	140	95	100	83	100	-
Bicarbonate (mg/L)	100	101	140	95	100	83	100	-
Carbonate (mg/L)	-	<1	<1	<1	<1	<1	<1	-
Chloride (mg/L)	4.5	3.0	2.5	2.8	3.3	2.2	3.0	250
Sulphate (mg/L)	7.0	2.9	3.4	2.9	2.8	1.7	3.4	400
Sodium (mg/L)	36.0	29	24	29	28	26	26	200
Potassium (mg/L)	-	5.8	5.4	5.6	6.2	5.3	5.9	
Calcium (mg/L)	4.9	11	22	6	8	6.5	6.7	-
Magnesium (mg/L)	1.9	3	4	3	4	3.0	4.2	-
Silicon (mg/L)	-	51	49	49	52	105	44	-
Nitrate (mg/L)	-	2.2	2.0	1.4	3.4	2.2	5.4	10.0
Manganese (mg/L)	-	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	0.1
Iron (mg/L)	0.8	<0.05	0.07	0.06	<0.05	0.02	<0.02	0.3
Fluoride (mg/L)	-	0.43	0.37	0.40	0.38	0.50	0.46	1.5
Cadmium (mg/L)	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.005
Arsenic (mg/L)	-	0.0004	0.004	0.003	0.004	0.002	<0.001	0.005
Lead (mg/L)	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.05
Cyanide (mg/L)	-	0.011	<0.005	<0.011	<0.005	<0.01	<0.01	0.1

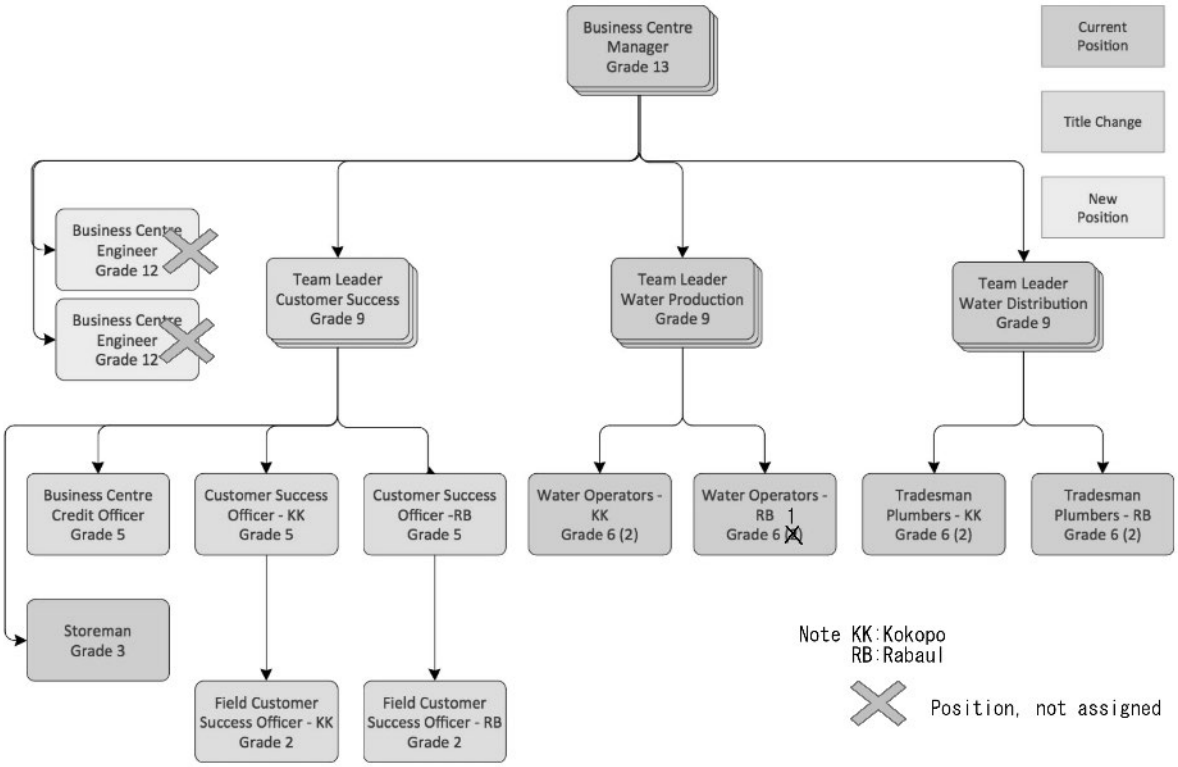
Source: Guidelines for Drinking Water Quality, World Health Organization 1984
Source: Project Completion Report on the Third Urban Water Supply (ADB Loan 1211-PNG) (ICDF/CTB Loan 8144-PNG) TA 1803-PNG: Institutional Strengthening of the Waterboard in Papua New Guinea in December 2003

16.1.2 Water Organisation and Water Tariff

(1) Water Supply Organisation

The total number of staff is 13, and among them, eight are working for Kokopo while the rest are working for Rabaul. The organisational chart of Water PNG for Kokopo and Rabaul area is shown

in Figure 16.1.1. Although the water supply system is simple, no equipment is installed for monitoring the operating situation of the water supply system. Therefore, the number of staff engaged in the operation seems too few to enable the conduct of proper operation.



Source: Water PNG 2022

Figure 16.1.1 Organisational Chart and Number of Staff of Water PNG for Kokopo and Rabaul Areas

(2) Water PNG's Tariff System

The water tariff is 1.5Kina/kl in the case of less than 15kl/month of consumption, while it is 8 Kina/kl in the case of above 15kl/month, as shown in Table 16.1.2.

This difference in the water price (tariff) is quite large.

Table 16.1.2 Water PNG's Tariff System

	SERVICES	TARIFF (Kina)
1.0	**Water Supply**	
1.1	0.1 to 15 Kilolitres	1.50 per kilolitre
1.2	Above 15 Kilolitres	8.00 per kilolitre
1.3	Water Tankers (Filling Station)	At cost
2.0	**Sewerage**	
2.1	0.1 to 15 Kilolitres	0.50 per kilolitre
2.2	Above 15 Kilolitres	3.00 per kilolitre
2.3	***Sludge Tankers (Dumping Station)***	At cost
2.4	***Trade Waste***	At cost
3.0	**Connection Fees**	
3.1	Standard Connections - Water	Free
3.2	Non Standard Connection - Water	At cost
3.3	Reconnection – Water	At cost
4.0	**Standby Fees**	
4.1	Standby Fee – Water	4.40 per Kilolitre
4.2	Standby Fee – Sewerage	1.00 per Kilolitre
4.3	***Compliance & Licensing***	***At cost***

Source: Water PNG 2022

16.1.3 Ongoing Projects for Water Supply

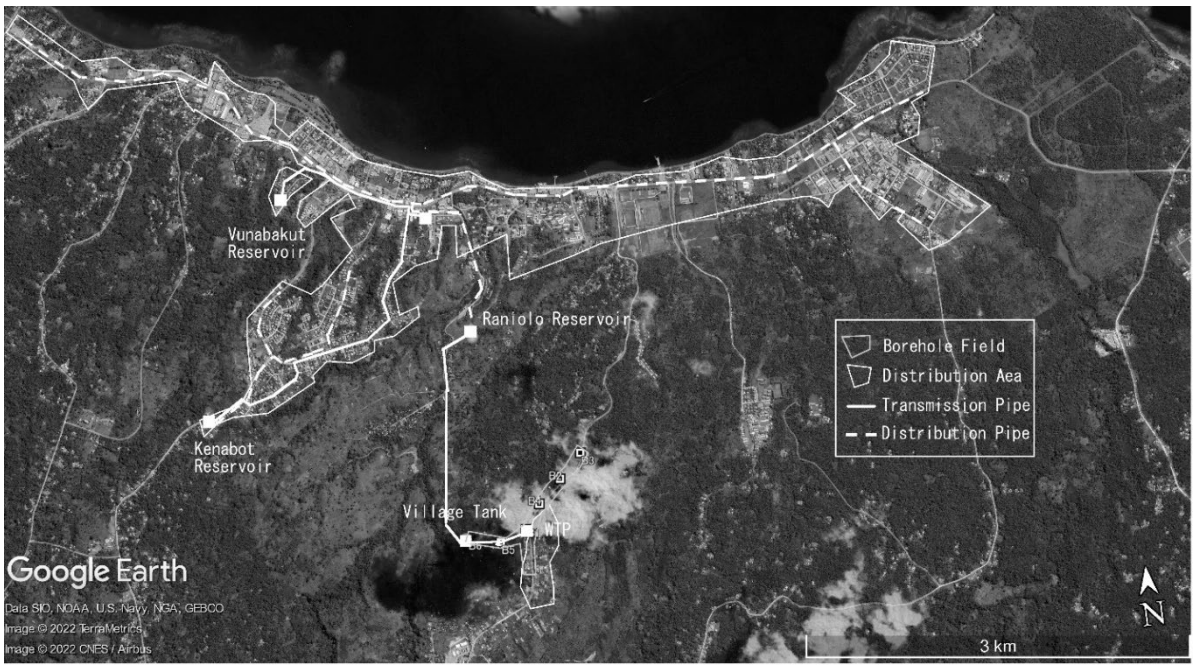
Currently the following two projects are ongoing:

- Project for Water Supply to Kerevat Town supported by WB
- Project for Water Supply Area Expansion to Nonga Northern Area by Water PNG

16.1.4 Present Situation of Kokopo Water Supply System

(1) Water Supply System of Kokopo Town

The coverage area of the Kokopo Water Supply System is depicted on a satellite photo in Figure 16.1.2. In the figure, the layout of water distribution areas, borehole fields, transmission pipes, reservoirs, and distribution pipes of the Kokopo Water Supply System is shown.



Source: JICA Expert Team, based on the information obtained from Water PNG

Figure 16.1.2 Kokopo Water Supply System and Its Distribution Areas

The location and system such as borehole fields, transmission pipes, reservoirs, and distribution pipes of the Kokopo Water Supply System is shown on a topographic map in Figure 16.1.3. The flow chart (in terms of elevation) of the Kokopo Water Supply System is illustrated in Figure 16.1.4 Almost all water infrastructure and facilities were constructed in response to the relocation of provincial capital from Rabaul Town to Kokopo Town after the volcanic eruption in 1994.

The current volume of daily water supply to Kokopo Area is 3,550 m^3/d, and the number of total connections is around 2,300. The water demand is on the rise to reach the water intake capacity at Vunabosco bore field, although two boreholes were added in 2014.

The water source is groundwater taken from seven deep wells of depth of 86-13m in the Vunabosco bore field. Adjacent to the deep wells, a Water Treatment Plant (WTP) and an elevated tank are located. The number of deep wells increased from five at the first construction stage to seven in 2014, and the total yield capacity by yield tests at installation is around 5,800m^3/d.

The intake water from the borehole field is transmitted to the Raniola Reservoir with volume of 2600m^3 by the well pump pressure and lifted to the village tanks by the lift pump in the WTP. The water is distributed from Raniola Reservoir to the city centre, and part of it is transmitted by Kenabot pump to Kenabot Reservoir and Vunabakut Reservoir. Water is further distributed from both reservoirs to surrounding high elevation areas.

An elevated Kenabot Reservoir with volume of 540 m^3 is distributing water to surrounding housing complexes at high elevation areas. There are two circle reservoirs in Vunabakut area. One was abandoned due to deterioration, and one was constructed recently. These reservoirs are for distributing water to surrounding high elevation areas.

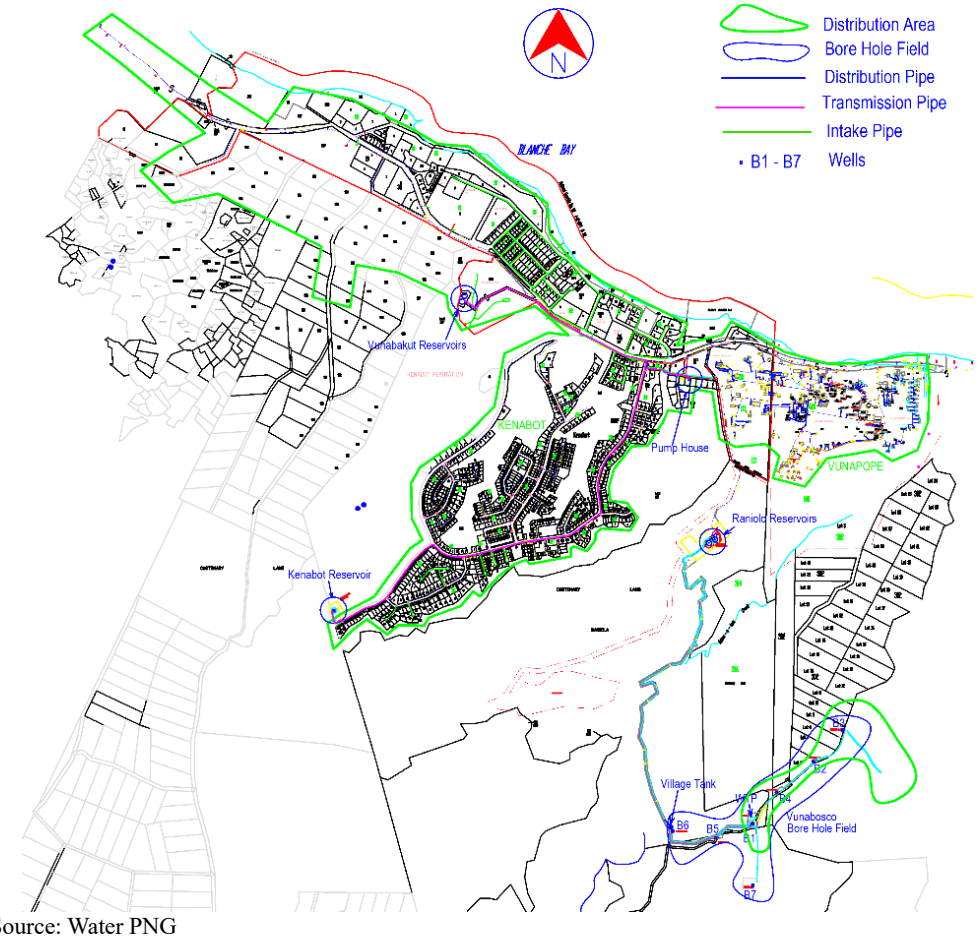
The water supply system has three pumps: 1) well pumps at Vunabosco borehole field, 2) lift pump at WTP, and 3) transmission pump at Kenabot pump house located in Water PNG Office. For such pump systems, an automatic operation system is usually used, of which pumps are automatically operated to be on and off by the water level of intake and receiving tank.

These pump systems have problems including the lack of a basic automatic operation system, any electric monitoring system for water flow and water level are not used in the water supply system. It may cause the increase in the number of staff and wasting of water resource, power and chemicals due to inefficient operation.

The water supply is supposed to be for 24 hours. However, a low-pressure distribution occurs in the western high elevation area.

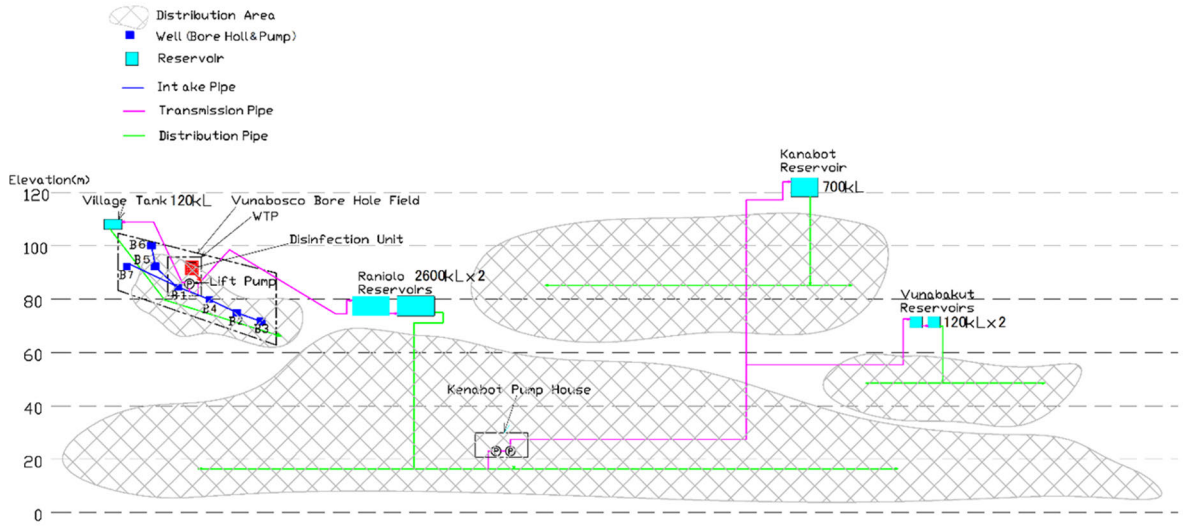
For chlorine injection, a powder hypochloride is dissolved. The dissolved liquid is injected to the transmission pipe in which all pumped well water is concentrated. The water injected chlorine is transmitted to the Raniolo Reservoir site by the well pumps directly and it is transmitted to a village tank by lift pump unit located in the WTP.

The water is distributed from the WTP to village tanks in surrounding villages. The village tanks have distance of 20 m up to 600 m from the WTP.



Source: Water PNG

Figure 16.1.3 Layout and Pipeline Network of Kokopo Water Supply System



Source: JICA Expert Team, based on the information from Water PNG

Figure 16.1.4 Flow Chart in Terms of Elevation of Kokopo Water Supply System

(2) Water Distribution in Kokopo Town

The current volume of daily water supply to Kokopo area is 3,550 m^3/day, and the number of total connections is approximately 2,300. The water demand is on the rise to reach ethe water intake capacity at Vunabosco bore field, although two boreholes were added in 2014.

In 2021, the average monthly amount of water intake was 107,700 m^3/month while the average monthly amount was 98,700 m^3/month, and that of water sales was 70,800 m^3/month, as shown in Table 16.1.3.

The amounts of water from four reservoirs in January and February 2022 are shown in Table 16.1.4. As shown in the table, every reservoir had inlet and outlet flow meter for direct reading. The annual average ratio of non-revenue water (NRW) was 28% for the Kokopo Water Supply System as mentioned previous section.

Water supply amounts from four reservoirs in 2022 are also shown in Table 16.1.4, and the amounts from Vunabakut and Village are very little.

Table 16.1.3 Monthly and Daily Amounts of Water Intake, Supply and Sales for Kokopo Town in 2021

Month	Monthly Water Volume(m^3/month)			Daily water Volume(m^3/day)			NRW(%)	Month
	Intake	Supply	Sales	Intake	Supply	Sales		
1	113,472	102,652	74,762	3,660	3,311	2,412	27.2	1
2	99,155	91,653	71,102	3,541	3,273	2,539	22.4	2
3	104,540	96,667	69,500	3,372	3,118	2,242	28.1	3
4	98,512	91,534	69,086	3,284	3,051	2,303	24.5	4
5	104,121	98,159	58,904	3,359	3,166	1,900	40.0	5
6	98,449	91,310	66,164	3,282	3,044	2,205	27.5	6
7	104,139	97,221	69,601	3,359	3,136	2,245	28.4	7
8	114,848	113,337	74,214	3,705	3,656	2,394	34.5	8
9	111,271	101,030	71,154	3,709	3,368	2,372	29.6	9
10	117,918	102,683	80,277	3,804	3,312	2,590	21.8	10
11	112,996	99,028	71,795	3,767	3,301	2,393	27.5	11
12	112,555	99,133	73,437	3,631	3,198	2,369	25.9	12
Average	107,665	98,701	70,833	3,539	3,245	2,330	28.1	Average
Total	1,291,976	1,184,407	849,996					Total

Source: Water PNG 2021

Table 16.1.4 Amounts of Distribution Water from Four Reservoirs in Kokopo Water Supply System

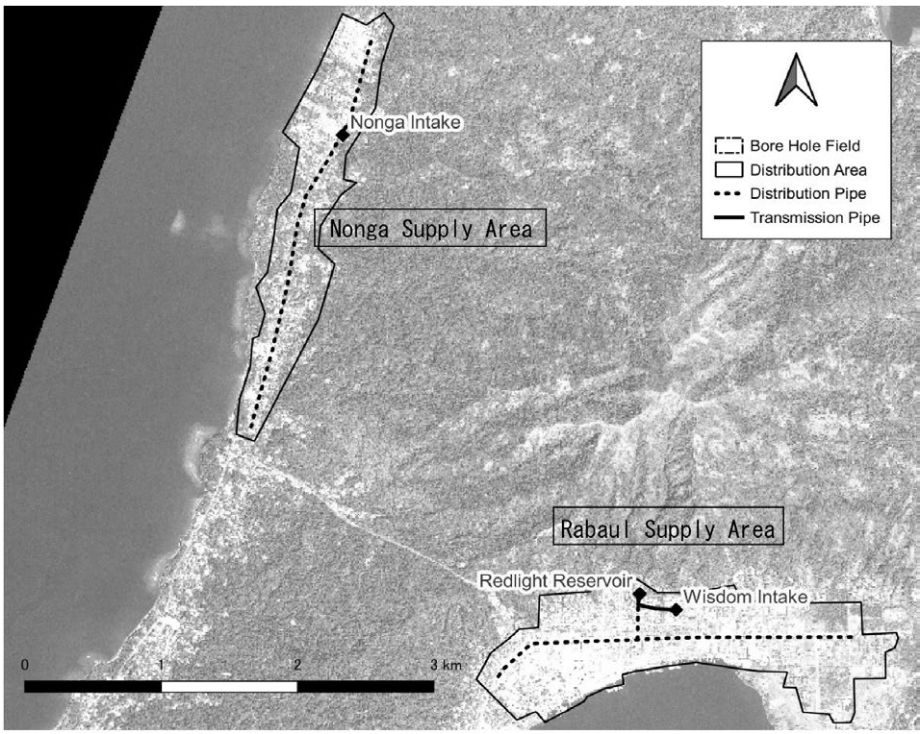
Month /Position		Distribution from Four Reservoirs							
		Raniola		Kenabot		Vunabakut		Village	
		In	Out	In	Out	In	Out	In	Out
22/01	Monthly (m^3)	97,267	98,782	18,266	16,863	1,423	1,414	1,085	774
	Daily (m^3)	3,138	3,187	589	544	46	46	35	25
22/02	Monthly (m^3)	86,617	87,705	16,734	15,463	1,397	1,291	1,312	1,030
	Daily (m^3)	3,093	3,132	598	552	50	46	47	37

Source: Water PNG 2022

16.1.5 Present Situation of Rabaul Water Supply System and Nonga Water Supply System

(1) Water Supply Systems in Rabaul District

In Rabaul District, there are two separate water supply systems. The one is for Rabaul Town including areas facing Rabaul Port. The other is for Nonga Area including Nonga General Hospital. Nonga Area is located at the backside of the peninsular (to the west of Rabaul Port). The water distribution areas of water supply systems in Rabaul District are shown in Figure 16.1.5.



Source: JICA Expert Team, based on the information obtained from PNG Water.

Figure 16.1.5 Rabaul Water Supply System and Nonga Water Supply System and the Distribution Areas

(2) Infrastructure of Rabaul Water Supply System

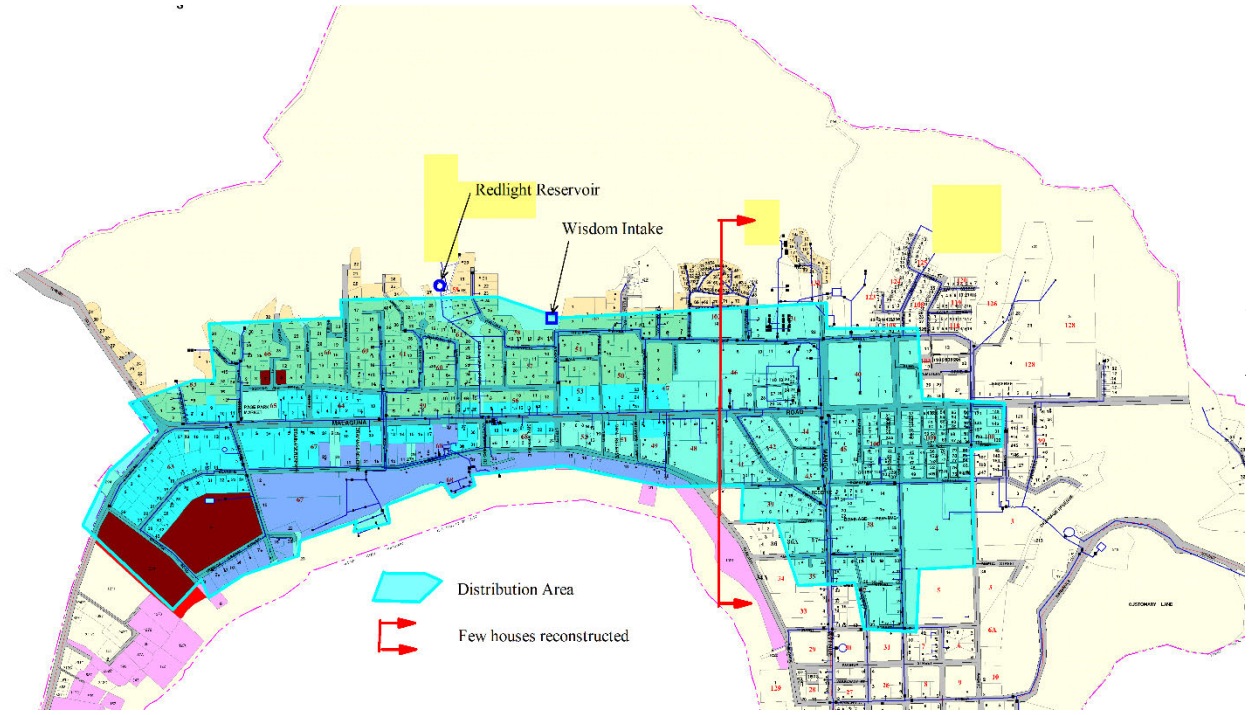
Rabaul is used to be the capital of ENBP and the Islands Region. However, it was heavily destroyed by the volcanic eruption in 1994. After the eruption, the infrastructures of Rabaul Town were reconstructed, and people also recovered their homes. However, the previous town situation, such as availability of water supply, was not restored at once so that many people did not return to Rabaul.

The water distribution area for Rabaul Water Supply System is shown in Figure 16.1.6 and the flow chart is shown is Figure 16.1.7.

The water supply system of Rabaul Town was also heavily damaged by the eruption, and the recovery work was done using the old system. Therefore, the old facilities, especially the distribution pipes, are covered by thick volcano ash of 3-4m and it causes of current troubles, such as difficulty of repair of pipe leaking and shortage of supply capacity for some areas.

The Rabaul Water Supply System facing Rabaul Port is composed of Wisdom Intake at an elevation of 19 m, Redlight Reservoir at an elevation of 38 m, and a water distribution pipe network. In the intake site, a well, a chlorine injection unit, and a power generator are installed.

The flow rate of the well pump is around 15 l/sec (which equals to 1,300 m^3/day). After chlorination, the well pump transmits water to the reservoir directly. In the reservoir site, a steel reservoir with volume of 500 m^3 is installed and regulated water is distributed to Rabaul Town from the reservoir.



Source; JICA Expert Team Source: JICA Expert Team, based on information from Water PNG 2022

Figure 16.1.6 Water Distribution Area of Rabaul Water Supply System for City Centre Area in Rabaul Town

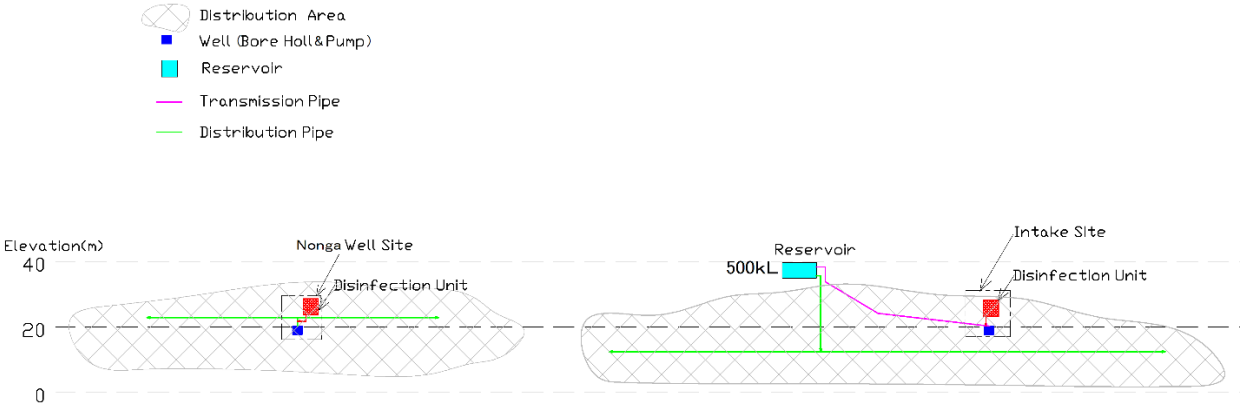


Figure 16.1.7 Flowchart of Rabaul Water Supply System

In accordance with the water system operator, the daily water distribution amount for this system is 600 m^3 to 580 m^3, which is a much smaller amount than the water volume taken from the wells (1,300 m^3/day).

The well pumps are operating for 24 hours a day due to lack of auto-operation system of the pump. It means that the transmission amount of well pump is much larger than the distribution amount. The difference in water volumes between transmission and distribution may be discharged by the overflow pipe from the reservoir.

(3) Infrastructure of Nonga Water Supply System

The water supply system for Nonga area was also damaged by the volcanic eruption in 1994, and it was restored with assistance of ADB and other development partners.

The Nonga Water Supply System is simply composed of a well, a disinfection unit, and a generator.

In the Nonga well site, the following are installed: well and a house where the power generator is located, chlorine injection unit, and electronic panel.

The well water, discharge flow of which as measured by flow meter is 0.5 m^3/min (720m^3/d), is directly distributed to 330 users by the well pump. In the users, Nonga General Hospital is included and the hospital has two large storage tanks of total 260m^3, but there is no reservoir for other users.

In Nonga Intake, a direct distribution to users except for the hospital from well pump is being conducted. For operating of stable water distribution, the water pressure should be controlled. In addition, much water should not be distributed at midnight when people do not use water. A high rate of NRW is caused by this condition.

The depth of the well is 21m, the power is 7.5 kW, and the yield capacity is 8.3 (1,000 l/120sec) l/sec. A wasting of power, water resource and hypochloride are occurring because of the same reason.

This water supply system was not properly designed and made so as to manage pressure control for water users. For solving this problem, a pressure regulation system, such as an elevated reservoir or pressure regulation tank, should be installed. In the case of using a reservoir, it should be established on a hill nearby the distribution area at a high-enough elevation of 10 m, higher than the highest elevation of water users.

16.2 Issues on Water Supply

(1) Necessity of a Large-Scale Expansion

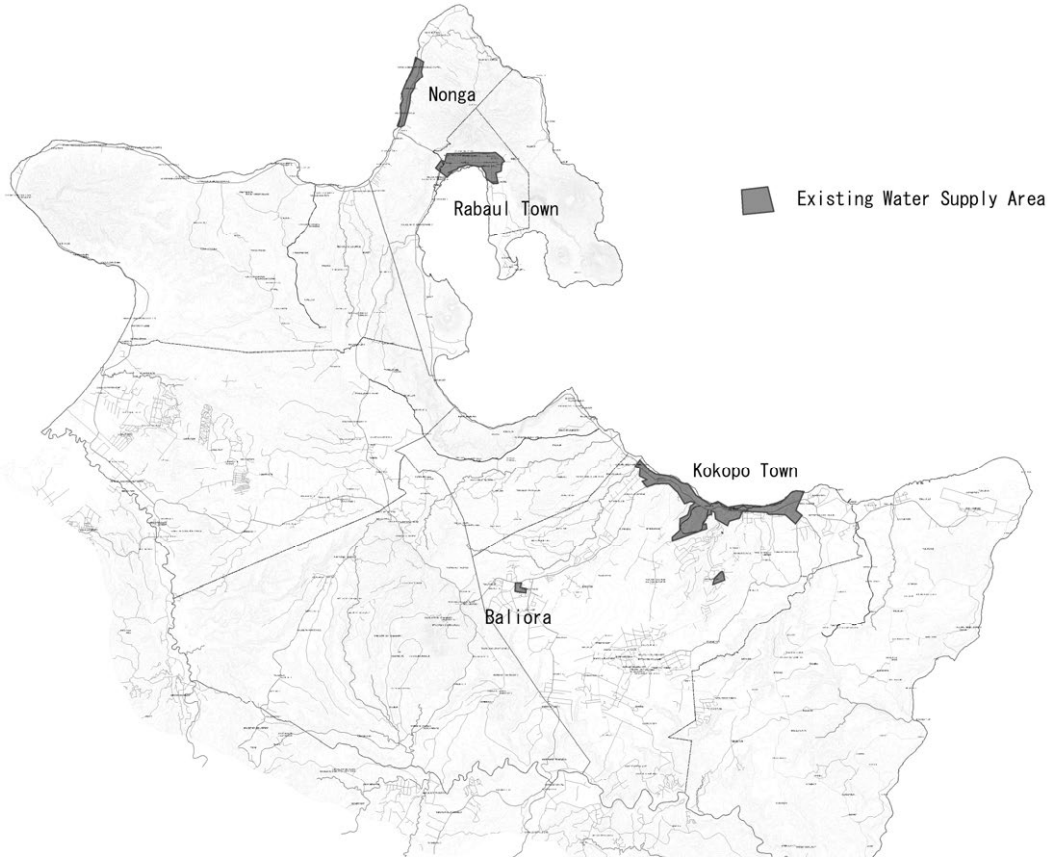
In the target area, Water PNG manages three water supply systems, which serve Kokopo, Rabaul Town and Nonga Areas. The current condition of facilities and managing situations are explained in previous sections. The service areas, as shown in Figure 16.2.1, are very limited in the whole target area and those living outside supply areas usually use stored rainwater that falls from the roof of their housing.

In Figure 16.2.1, Baliora Water Supply System was constructed after the volcanic eruption, and now it is serving a public housing complex for policemen and a school managed by the police authority.

The NEGID-Plan identified future urbanised areas by 2032 as shown in Figure 16.2.2. The planned urbanised areas should be covered as much as possible by the water supply system as important infrastructure for urban areas.

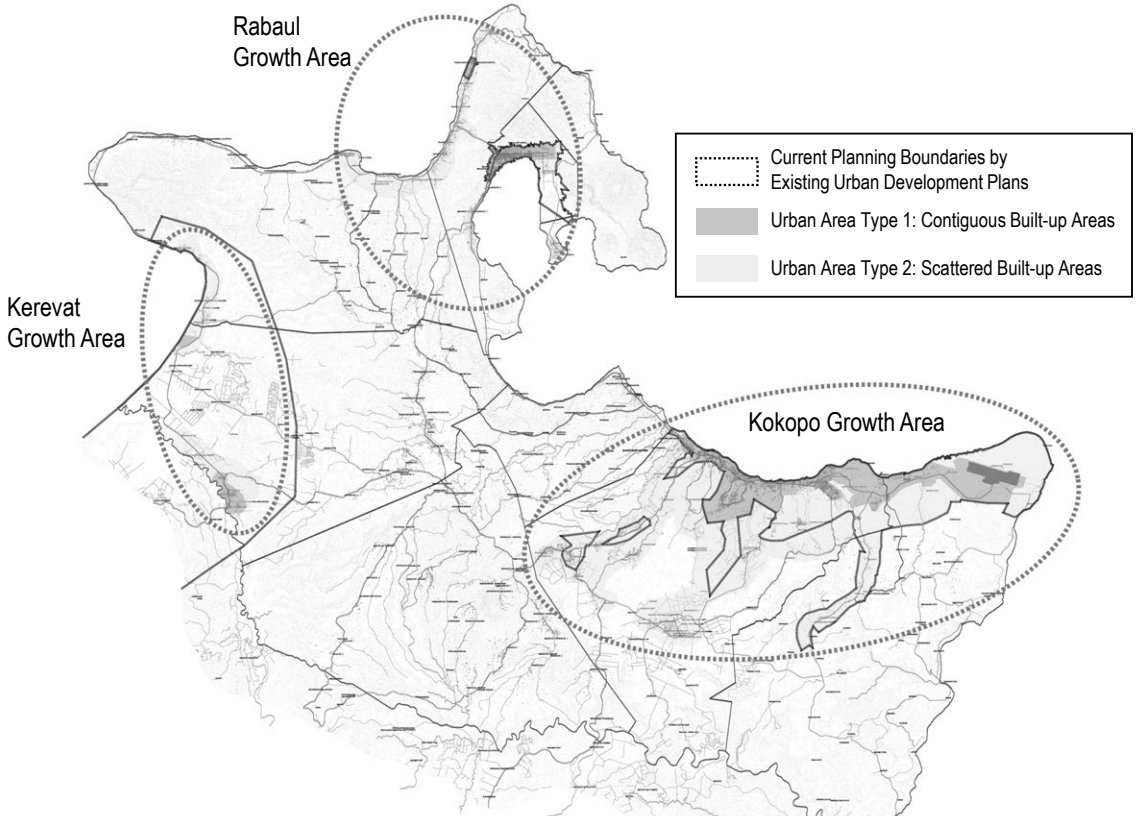
The target areas requiring expansion of the water supply system are extensive in Northeast Gazelle Peninsula. Accordingly, the existing water supply system shall be utilised as much as possible and water supply plans by various entities shall be utilised effectively. For example, Kokopo-Tokua Corridor in Kokopo Eastern Area is planned as an important new developing area by ENBP and this area is included as an urbanised area.

On the other hand, in Baliora area, a small-scale water supply system constructed after the eruption is serving a police housing complex and a school, but the scale of facilities seems too large for the served population.



Source: JICA Expert Team

Figure 16.2.1 Current Water Supply Areas by Water PNG



Source: JICA Expert Team

Figure 16.2.2 Urban Areas in Northeast Gazelle Peninsula

(2) Necessity of Rehabilitation and Improvement for Existing Facilities

For realisation of the above purposes, the rehabilitation and improvement of these systems are required as the precondition of expansion because the existing systems are quite inefficient and deteriorated. Accordingly, improvements of the current system should be considered for the effective utilisation of existing facilities.

In addition, because the water supply to existing supply areas is not adequate, especially for Rabaul Town and Nonga Area, the above improvements and rehabilitations can contribute not only to the expansion, but also to improving current user satisfaction.

(3) Current Issues for the Existing Water Supply Systems

Current issues for water supply systems of Kokopo, Rabaul and Nonga have already been reported in previous sections. After additional research, the following problems to be solved by Water PNG have been found:

i) The lifespan of well pumps is too short.

As mentioned in the previous sections, the well pumps only function for half of the normal lifespan of over 7 years, which may be caused by 24-hour operation of the pump due to lack of auto-operation. This results in wasting the budget and lengthy water supply stoppages while waiting for pump replacement.

This problem will be solved by the introduction of automatic pump operation systems.

ii) Too expensive borehole installation

For Water PNG, the cost of 90 m of borehole construction is around 500,000 Kina (USD 150,000) by some quotations, but it is normally 15,000- 20,000 USD in the majority of countries. Since the high cost causes a delay in borehole installation, the abundant groundwater resource cannot be utilised effectively.

The cost should be reduced by efforts of Water PNG between clients and contractors.

iii) Inadequate lifespan of steel reservoirs and/or tanks

The lifespan of steel tanks seems to be around 20 years, which is inadequate as infrastructure. Concrete tanks are recommended because they cost about the same as steel tanks and can reach a lifespan of around 50 years. In this study, concrete tanks are applied for tanks.

iv) No stand-by well pumps

As mentioned in section i), well pumps frequently break down, and ordering and delivery of parts takes a long time. Water supply for users is stopped while waiting for replacements. Although a stand-by pump cannot be installed in a borehole, it needs to be stored at the intake site to prevent lengthy stoppage of the water supply.

v) High Cost and Low-Level Service

Since there are fundamental problems for these water supply systems, the service level to users is low, and incur a high cost. In addition, expansion to surrounding areas is impossible without refurbishing and improvement of the systems.

16.3 Objectives for Development of Water Supply

The objectives for development of the water supply are as follows:

1) To cover urbanised areas by water supply systems

2) To improve and rehabilitate existing water supply systems

3) To manage the systems properly with satisfaction of users

4) To save the costs

(1) To Cover Urbanised Areas by Water Supply Systems

As mentioned in the previous section, planned urbanised areas should be covered by water supply systems as much as possible. Current water supply systems and their management cannot cope with user needs, and therefore the systems shall be improved to satisfy the users.

(2) To Rehabilitate and Improve Existing Water Supply Systems

Existing facilities must be improved because those of the current water supply system are apparently inefficient and deteriorated. Through rehabilitations and improvement, current users will be satisfied by the water supply condition and expansions surrounding existing water supply areas can be realised effectively.

(3) To Manage the Systems Properly to Get Satisfaction of Users

Improvements of current systems include automatic operations and monitoring systems, which will result in the staff of Water PNG being able to manage the systems and services for users easily. Most of the facilities can be operated automatically, and monitoring systems will be introduced.

(4) To Save the Costs

The average water price for Kokopo and Rabaul is around 6 Kina/m^3. This is over 2 USD and is much more expensive than 0.2-0.4 USD of Manila (Philippines), 0.2 USD of Phnom Penh (Cambodia) and 0.07 USD of Yangon (Myanmar). The price shall be reduced by saving costs for welfare of the people.

However, although it is difficult and a long time is required to attain this target, Water PNG shall make efforts to realise this as much as possible.

16.4 Strategies for Development of Water Supply

For Water PNG, some changes of design and procurement are recommended:

- Introduction of automatic operation for pumps and other machines in order to save operation costs and to expand the lifespan of the machines.
- To avoid installation of galvanised steel tanks due to the short lifespan.
- To reduce the installation costs of boreholes because it is 10 times more expensive compared to international levels.

(1) Strategies for Development of Water Supply

Strategies of water supply should focus on how to attain the target objectives shown in Chapter 16.3 effectively, considering the conditions described in section (1).

1) To Cover Urbanised Areas by Water Supply System

Target urban areas shown in Figure 16.2.2 are in the surrounding area of current water supply areas of Kokopo Town, Rabaul Town and Nonga Area except for Kerevat District, and therefore expansions from the existing water supply system have a great advantage to cover these areas. In addition, it is better for Water PNG to manage the expanded areas.

For Kerevat Town, since a water supply project to Kerevat Town is underway by WB, the project will contribute to this purpose. The project of expansion of water supply area for Nonga Northern Area will also contribute to this purpose.

On the other hand, Kokopo-Tokua Corridor shall be included as a coverage area by the water supply system, but a new intake and supply system may be required due to the wide area. For the inland urbanised areas to Kokopo Town shown in Figure 16.2.2, the Baliora water supply system may be expanded for this purpose.

2) To Rehabilitate and Improve Existing Water Supply Systems

As mentioned in Section 16.2, there are many problems that require rehabilitation and improvement, which are the preconditions of the expansion of supply areas.

Accordingly, rehabilitations and improvement must be included in the project as the first priority.

3) To Manage the Systems Properly to Get User Satisfaction

The staff of Water PNG will be able to control/manage facilities properly and obtain operation records easily because the above-mentioned improvements will include the introduction of automatic operation, monitoring systems and stand-by machines.

Because of the above, the staff can manage the facilities efficiently and properly, and cope with requests from users.

4) To Save the Costs

Saving costs is a fundamental requirement for almost all organizations, but it is not easy to attain the request, especially for a well-managed organization.

For Water PNG, some cost reduction can be achieved only by implementation of the improvements shown in this report. In addition, some changes are recommended, such as selection of durable equipment/facilities, negotiation of some installation cost and staff arrangement.

16.5 Rehabilitation and Improvement for Kokopo Town Water Supply System

(1) Summarised Problems for Kokopo Water Supply System

Major problems for the Kokopo Water Supply System are shown below:

i) Lack of monitoring facilities and auto-operation system of pumps for all facilities

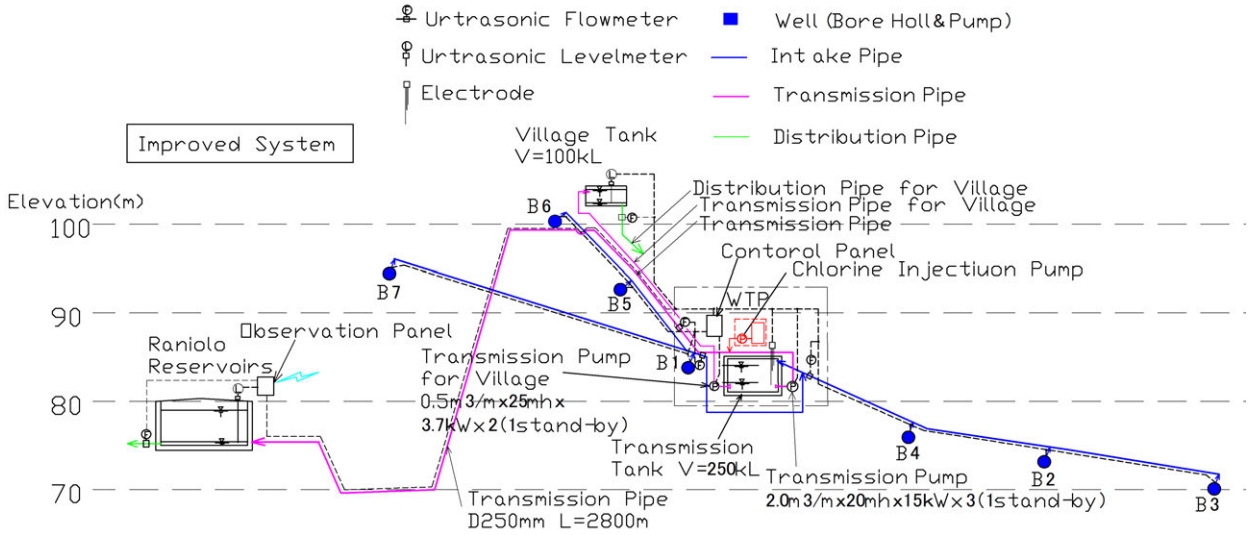
ii) Inadequate composition of facilities such as well pumps and pressure pipes for Vunabosco Borehole Field.

The most important facility in the whole system is the intake system at Vunabosco Borehole Field because it is producing all intake water and consumes 83% of power of the whole Kokopo water supply system consumption. Due to item ii), reduction of yield capacity of wells and power wasting is generated.

Accordingly, the intake system must be improved in order to solve the above problems including the introduction of monitoring and auto-operation.

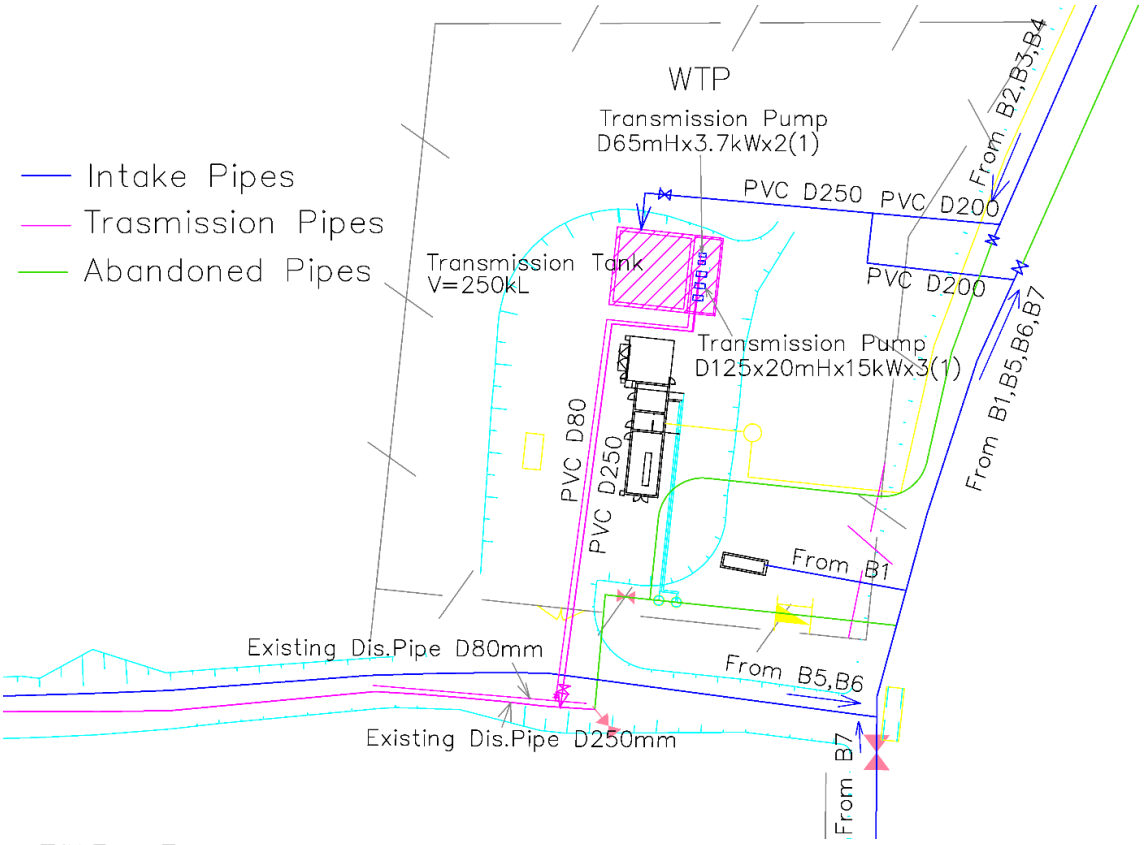
(2) Improvement Items for Borehole Field

To solve the above problems, the following improvements shall be done as shown in the flowchart in Figure 16.5.1, and in Figure 16.5.2, which shows a layout plan surrounding the WTP.



Source: JICA Expert Team

Figure 16.5.1 Improved Flow for Borehole Field



Source: JICA Expert Team

Figure 16.5.2 Improved Layout Plan for Borehole Field

1) Installation of a Tank and Pumps for the Transmission from Borehole Field to Raniolo Reservoirs

To solve flow disturbance by each well pump, the pressure by well pumps should be released once through installation of a tank while other pumps for transmission are installed at WTP sites.

a) Transmission tank with the retention time of 1 hour will be constructed. The volume is 256 m^3 (8.0 m x 8.0 m x WH4 m=256 m^3)

b) The transmission pump for transmitting to Raniola Reservoir is designed with two on duty

pumps with one standby to save capacity of the generator. The capacity can transmit the total yield capacity of wells (67 litre/sec = 4 m^3/min).

Pump specifications: 2.0 m^3/min x 20 mH x 15 kW x 3 (1 standby)

c) The transmission pump for Village Tank is designed to be one on duty with one standby.

The capacity can transmit the full capacity of Village Tank of 100 m^3 within 4 hours.

Pump specifications: 0.5 m^3/min x 25 mH x 3.7 kW x 2 (1 standby)

2) Introduction of Automatic Pump operation Coping with the Water Level of Receiving Tanks

a) Well pumps shall be operated automatically depending on the water level of the new transmission tank. For this control, signal lines from every well pump to a control panel at WTP shall be connected.

b) New transmission pumps shall be operated automatically depending on the water level of Raniolo Reservoir. For this control, signal lines from the new pumps to a control panel at WTP shall be connected.

c) The transmission pump to Village Tank shall be operated automatically depending on the water level of the tank. For this control, signal lines from the new pumps to the control panel at WTP shall be connected.

d) The chlorine injection unit will be replaced, and the injection pump shall be linked with the well pump operation.

3) Introduction Observatory Instrumentations and Monitoring System

As preconditions of this system, the following items are selected:

- An electromagnetic flowmeter is selected by the cheaper price to applied diameter.
- Signal lines installed for above the pump control are also used for monitoring.
- Pressure-type level meters installed in tanks/reservoirs are used for water level indication and pump control.

This system is designed as follows:

a) To install two intake flowmeters from the one by B2, B3, and B4 and another by B1, B7, B5, and B6 as shown in Figure 16.2.2.

b) To install a flowmeter for transmission to Raniolo Reservoir, while the meter for transmission pipe to Village Tank will be a reading-type because of the small capacity.

c) To install flowmeters for distribution pipe from Raniolo Reservoir and Village Tank to distribution areas.

d) To install pressure-type level meter for Raniolo Reservoir and Village Tank, while only an electrode for pump control is installed at the new transmission tank.

e) All indication of instrumentations and operation conditions in Borehole Field and Raniola Reservoir will be transmitted to Kokopo Water-PNG Office, where an observance panel and a computer will be installed.

This observation system will monitor not only Kokopo Water Supply Facilities, but also Rabaul/Nogna Facilities. Based on the monitoring, the manager of Kokopo office can always grasp the operation conditions for the above-mentioned facilities.

(3) Direct Effects by Rehabilitation and Improvements

The effects by carrying out rehabilitations and improvements as mentioned in the previous section are as follows:

i) The total yield capacity will be recovered to the original capability,

ii) Because operators and managers of Water-PNG Kokopo office can grasp the operation status of the borehole field, they can manage the operation of the system properly,

iii) The total power consumption at the borehole field will be reduced drastically,

iv) Current abbreviated lifetspan of well pumps will be lengthened due to avoiding long-time continuous operation,

v) The groundwater resource at the borehole field will be saved matching the water demand of Kokopo Town.

(4) Effects of Rehabilitation and Improvement for the Expansion of Water Supply Areas

The expansions to surrounding areas will be realised by these rehabilitations and improvements.

The current maximum monthly flow amount is summarised in Table 16.5.1. When daily fluctuation to the monthly average is sat at 1.2, the estimated maximum flow is calculated as shown in Table 16.5.1.

If the figures are current daily maximum flow, the allowance of yield capacity is around 1,223 m^3/d while the maximum well pump capacity is 1300 m^3/d as shown in the table. The pump with maximum capacity broke down in January and February 2022 and two months was required to replace the pump.

As previously mentioned, breakdown of submerged well pumps in this area occurs 3-5 years after installation, and there is almost no allowance in the yield capacity considering the risk of the pump breaking down.

In order to solve such problems, keeping stand-by pumps is recommended, but because the ground level and water table of every well in the borehole field is quite different, each well pump's specifications are different. Thus, since stand-by pumps for each one need to be prepared, the costs for preparation of well pumps are high. However, keeping stand-by pumps shall be executed for a stable water supply in the near future.

Table 16.5.1 Estimation of Water Supply Amount and Allowance of Well Yield Capacity

Month with Maximum Flow	Item	1) Measured Data	2) Estimated Max.	3) Allowance
---	Yield Test Flow	5,788		
2021/Oct.	Water Intake (m^3/d)	3,804	4,565	1,223
2021/Aug.	Water Supply (m^3/d)	3,656	4,387	1,401
2021/Oct.	Water Sales (m^3/d)	2,590	3,108	---
Maximum well pump capacity=1300 m^3/d				

Source: Modified Water PNG data by JICA Expert Team
Note: 2) Measure data multiplies 1.2 of daily fluctuation

The urban area nearby Kokopo is planned to expand to the eastern coastal area and southern hill area from the existing Kokopo Town, and these areas shall be covered by water supply networks.

For this purpose, the distribution pipe surrounding the existing network should be expanded within the flow allowance as shown in Table 16.5.1.

If the water demand of the expansion area will exceed the allowance, dispersed water supply systems for each village should be constructed, which are composed of a well system and distribution network with reservoirs. In addition, the operation status shall be monitored by Water PNG Kokopo office through an internet system utilising some mobile networks.

16.6 Rehabilitation and Improvement for Rabaul Town Water Supply System

(1) Problems on Water Supply Facilities to be Solved for Rabaul Town

For the system, problems pointed out by the users are below:

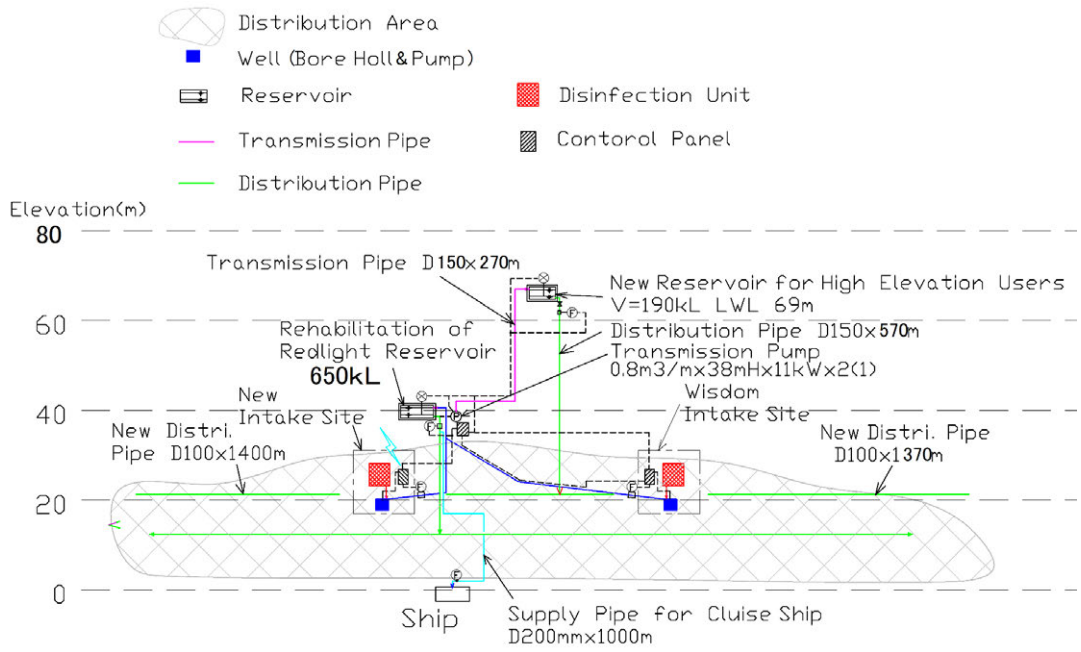
- Many low-pressure users exist.
- When water is supplied to cruise ships from Redlight Reservoir, for which the volume is a maximum 250 m^3/time, all users' water supply conditions in the town worsen greatly.

In addition, the problems below have been found based on the operation records and observation of operation.

- Because of manual operation of the intake site and no monitoring system at Redlight Reservoir, much water has been discharged and power wasting has occurred.
- Sometimes the water supply to Rabaul Town is stopped because of the breakdown of the sole pump and generator at Wisdom Intake.
- The steel reservoir at Redlight Site is already corroded and has started to leak.

(2) Improvement Items for Rabaul Town

From the problems mentioned in section (1), the improvements below shall be done for Rabaul Town Area as shown with the composition of facilities in Figure 16.6.1 and the layout plan in Figure 16.6.2.



Source: JICA Expert Team

Figure 16.6.1 Composition of Facilities for Rabaul Town Water Supply System



Source: JICA Expert Team

Figure 16.6.2 Layout Plan of Improved Rabaul Town Water Supply System

Improvements and rehabilitations mentioned previously will be realised as follows:

1) To Solve Problems on Low Pressure Areas

To solve low pressure areas, a new reservoir at a high-elevation site shall be constructed and new distribution pipes for these areas should be installed. Facilities to be installed are shown below:

a) To construct a new reservoir with the capacity of 190 m^3 (8.0 m x 8.0 m x WH 3.0 m=192 m^3).

b) To install transmission pumps from Redlight Reservoir to a new reservoir at high elevation. The pumps can transmit water equalling the full volume of the reservoir within 6 hours.

Pump specifications: 0.8 m^3/min x 38 mh x 11 kW x 2 unit (1)

c) To install new distribution pipes for high elevation areas with diameter 150 mm – 100 mm.

2) To Solve Water Shortage for Local Population caused by Supplying Water to Cruise Ships

A simple solution is to install an exclusive pipe from Redlight Reservoir to the port. It is recommended to install a 200 mm diameter PVC pipe which can supply 250 m^3 of water to the ship within one hour. This can also be used for the planned tuna processing factory at the port.

3) To Solve the High Risk of Whole Water Stoppage to the Rabaul Town by Breakdown of Intake Facilities

To construct a new intake facility in order to solve the risk.

Nearby, the existing Wisdom Intake and Redlight Reservoir seem to be a good location for deep well digging. Therefore, a new intake facility is planned below the Redlight Reservoir Site which is separated from the existing borehole by over 300 m, which is the necessary distance between each borehole.

The facility includes a borehole well, a generator and a disinfection facility including an auto-control and monitoring system. The yield capacity can be expected to be over 15 litre /sec = 0.9 m^3/min referring to the existing borehole capacity.

4) To Introduce an Automatic Pump Operation by Receiving Tank Water Level

a) A well pump at Wisdom Intake Site and a new intake site shall be operated automatically depending on the water level of Redlight Reservoir. For this control, a signal line from each intake site to the Reservoir site shall be connected.

b) The transmission pump at Redlight Reservoir Site shall be operated automatically depending on the water level of the new reservoir. For this control, a signal line from Redlight Reservoir Site to new reservoir site shall be connected.

5) To Replace Existing Steel Reservoir

The existing reservoir tank was heavily corroded and began to leak and thus should be replaced.

For this replacement, a concrete tank is considered due to the better cost and duration. In addition, a rectangular tank can be easily applied to the site.

The size of the reservoir is 15.0 m x 15.0 m x WH 3.0 = 650 m^3

6) Introduction of Observatory Instrumentations and Monitoring System

This system is designed as follows:

a) To install intake flowmeters for Wisdom borehole and for the new borehole.

b) To install flowmeters for transmission pipes from the Redlight Reservoir to the new reservoir.

c) To install flowmeters for distribution pipes from Redlight Reservoir and the new reservoir to distribution areas.

d) To install pressure-type level meters for Redlight Reservoir and the new reservoir, while these are used for monitoring of reservoir storage volume and pump control.

e) All indication of instrumentations and operation at the two intake sites and two reservoir sites will be concentrated at the new intake site, and then the information will be transmitted to Rabaul and Kokopo Water-PNG office, where an observance panel and a computer will be installed.

(3) Direct Effects by Rehabilitation and Improvement

The effects by carrying out and rehabilitations and improvements mentioned in the previous section are as follows:

- The total yield capacity will be doubled due to the construction a new intake facility,
- The water supply to the town will not stop due to machine troubles because of the dual intake system,
- Because operators and managers of Water PNG Kokopo office and Rabaul office can grasp the operation status of their water supply system, they can manage the operation of the system properly,
- The Redlight Reservoir can be used without concerns for breakdown due to the rehabilitation,
- The power consumption of well pumps will be reduced due to the reduction in operation time,
- The short lifespan of well pumps will be solved due to avoidance of long-time continuous operation,
- User complaints about low pressure will be solved due to the construction of a high elevation reservoir and installation of distribution pipes for high elevation areas; in addition, the distribution can be expanded to high elevation areas and far away areas,
- Water distribution trouble in the town by supplying water to cruise ships will be solved due to installation of an exclusive pipe,

- The groundwater resource for the town will be saved matching the water demand of Rabaul Town.

(4) Effects of Rehabilitation and Improvement for the Expansion of Water Supply Areas

Based on the production and distribution amount of Rabaul and Nonga in 2022 February, an analysis of the Rabaul and Nonga water supply conditions was done as shown in Table 16.6.1.

Table 16.6.1 Analysis of Rabaul and Nonga Water Supply Condition

Month	Item		Rabaul	Nonga	Total
2022/Apr.	Measured Well Yield Flow		1,300	740	2,040
2022/Feb.	1)	Water Intake (m^3/d)	958	746	1,704
	2)	Water Supply (m^3/d)	661	746	1,407
	3)	No. of Users (no.)	586	330	916
	4)	Estimated Actual Supply (m^3/d)	661	372	1,033
2021/Jul.	5)	Water Intake (m^3/d)	---	---	1,915
	6)	Estimated Max Supply (m^3/d)	743	418	1,161
7) Setting up Max Water Supply (m^3/d)			891	502	1,280
Allowance(m^3/d)			409	238	760

Note: 2) of Rabaul is outflow from reservoir
2) of Nonga is outflow from the well
4) of Nonga : multiply to 2) of Rabaul the rate of users (330/586)
Monthly intake amount in 2021/Jul. is the maximum in 2021
6) Multiply the rate of intake flow of 2022/Feb./2021.Jul.
7) Multiplied daily fluctuation rate of 1.2
Source: Modified Water PNG data by JICA Expert Team

In the table, the water supply amount to Rabaul Town is measured by the flowmeter discharged from Redlight reservoir and then the water supply 2) of Rabaul in the Table 16.6.1 is the water supply amount to the town. But figure 2) of Nonga is discharge amount from the well and because no reservoir is installed for the Nonga water supply system, around half of the water amount may overflow. Thus, the supply amount of Nonga was estimated based on the amount of Rabaul and the rate of user numbers between Rabaul and Nonga.

Since the calculated amount is an average of the monthly maximum, setting up supply flow was considered to have a daily fluctuation rate of 1.2.

Although there seems to be enough allowance between intake and supply amount, a new intake facility will be constructed in the water supply system considering prevention of water stoppage risk, expansion of area and construction of new factories. Since the intake capacity by the improvement will be doubled compared to current levels and a new reservoir at a high elevation site will be constructed, the water distribution area can be expanded to high elevation areas and all the coastal areas of Simpson Bay.

In this town, some new factories such as a tuna processing facility, which uses a large amount of water (10-12 m^3/tonnage of tuna), are planned, and therefore the water consumption of the town will be largely increased.

In order to avoid risk of pump breakdown, a stand-by well pump shall be kept at the intake site. The well pump of the new intake may be same as the existing well pump, and thus, the stand-by pump can be used for both wells.

16.6.1 Rehabilitation and Improvement for Nonga Area Water Supply System

(1) Problems to Be Solved for Nonga Area

The water supply facilities for Nonga Area were also constructed after the eruption for the important Nonga General Hospital, but the system is composed of a deep well with a disinfection facility and distribution pipes.

Since the hospital has two large storage tanks each with a capacity of 130 m^3, water supply to the hospital basically has no problems, but sometimes the water supply is completely stopped due to the breakdown of the well pump or power generator.

Compared to the hospital, other areas are supplied directly by the well pump without any pressure regulation system such as a reservoir and a pressure tank. As a result, in the system, the well pump that is continuously operating though the water consumption by users fluctuates greatly. This means a large amount of water resource and power wasting is generated by the system.

(2) Improvement Items for Nonga Area

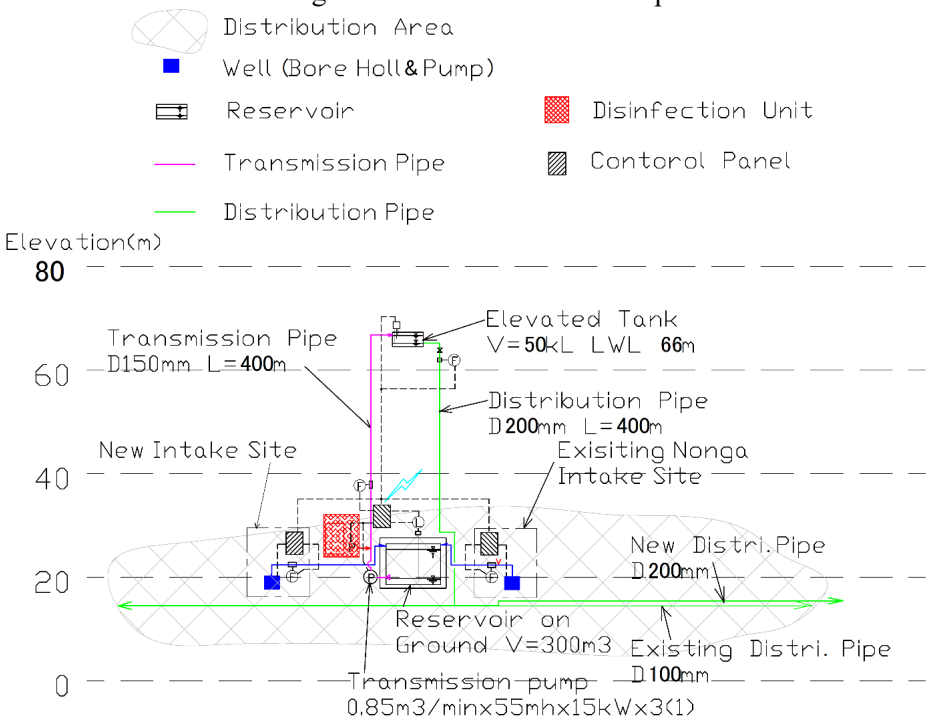
From the problems mentioned in section (1), the improvements below shall be done as shown for Nonga Area in Figure 16.6.3 as facility composition and Figure 16.6.4 as a layout plan.

For this area's system, wasting of water resource and power shall be stopped and improved to be able to expand the supply area to the North Coastal Areas.

A new borehole has been installed in the premises of Nonga Hospital, and it should be used for the improvement of the Nonga water supply system. To prevent water resource and power wasting, a reservoir with adequate volume shall be constructed.

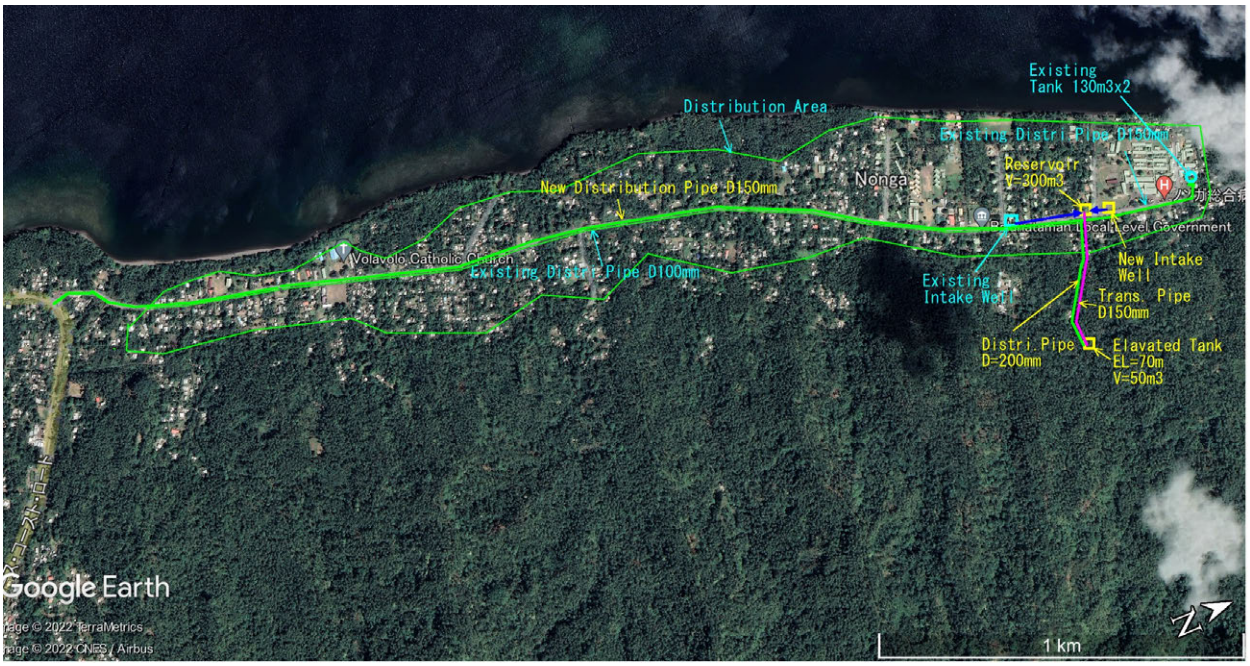
For the new borehole, an intake pump and a generator with electrical system must be installed. In addition, a reservoir installation nearby the existing intake site and the new intake site is recommended. In this case, a small, elevated tank will be constructed on a high-elevation hill. The reasons are shown below:

- If a large-volume reservoir is constructed on the high-elevation site, the current well pump at the existing intake site cannot be used due to the increased head.
- In this case, since a disinfection pump can be injected in the transmission pipe, only one disinfection facility is necessary.
- It is difficult to construct a large-volume reservoir on a steep hill.



Source: JICA Expert Team

Figure 16.6.3 Composition of Nonga Water Supply System



Source: JICA Expert Team

Figure 16.6.4 Layout Plan of Nonga Water Supply System

As mentioned above, the following facilities are planned.

a) To construct a new reservoir with the capacity of 300 m^3 (10 m x10 m x WH 3.0 m =3 00 m^3) nearby both intake sites.

b) To install transmission pumps from the new reservoir to the elevated tank. The pump can transmit the water volume of the new reservoir within 6 hours.

Pump specifications: 0.85 m^3/min x 55 mh x 15 kW x 2 unit (1)

c) Disinfection facilities will be installed at the reservoir site and chlorine is injected in the transmission pipe to the elevated tank while injection pump is linked to the transmission pump.

d) An elevated tank will be constructed on a hill to supply the expanded supply area.

e) The future daily maximum distribution flow is assumed to be 1200 m^3/d and the retention time to the flow is 1 hour. The capacity of the tank has been decided to be 50 m^3 and made by FRP.

f) The following pipes should be installed.

- 100 mm diameter intake pipe from both intake wells to the new reservoir.
- 150 mm diameter transmission pipe from the new reservoir to elevation tank.
- 200 mm diameter main distribution pipe to connect existing pipes.
- 200 mm diameter distribution pipe expansion to North Coastal Area.

As in the system of the Kokopo and Rabaul Area, an automatic pump operation and monitoring system should be introduced.

a) Well pumps at both intake sites shall be operated automatically depending on the water level of new reservoir. For the control, a signal line from each intake site to reservoir site shall be installed.

b) The transmission pump at the reservoir shall be operated automatically depending on the water level of the elevated tank. For this control, a signal line shall be installed with the powerline.

c) Chlorine injection pump shall be linked with the transmission pump.

d) To install intake flowmeters for the well pumps at both intake sites.

e) To install a flowmeter for transmission from the reservoir to the elevated tank.

f) To install flowmeters for distribution from the elevated tank.

g) To install pressure-type level meters for the new reservoir in order to monitor the reservoir storage volume and to control the well pumps.

h) To install an electrode at the elevated tank to control the transmission pump.

i) All indication of instrumentations and operation at two intake sites, the new reservoir and elevated tank will be concentrated at the new reservoir site, and then transmitted to Rabaul and Kokopo Water-PNG office, where an observance panel and a computer will be installed.

(3) Direct Effects by Rehabilitation and Improvement

The effects by carrying out rehabilitations and improvements as mentioned in the previous section are as follows.

- The total yield capacity will be doubled due to construction of a new intake site,
- The water supply to the supply areas will not stop due to machine troubles because of the dual intake system,
- Because operators and managers of Water-PNG Kokopo and Rabaul office can grasp the operation status of their water supply system, they can manage the operation of the system properly,
- The power consumption of well pump will be drastically reduced due to the regulation function of the reservoir,
- Users can be supplied water with stable pressure due to the pressure regulation function of the reservoir,
- The groundwater resource for the town will be saved matching the water demand of Nonga Area,
- The short life span of well pumps will be solved due to avoidance of long-time continuous operation.

(4) Effects of Rehabilitation and for the Expansion of Water Supply Areas

The rehabilitations and improvements were planned as the precondition of expansion of the water supply areas.

The estimated water supply amount of this area is calculated in Table 16.6.1.

A new deep well was installed at Nonga Hospital and its yield capacity, installation elevation and water table are almost same as the existing one. Because this well will be used for the Nonga Area water supply, the water yield capacity will be doubled. In this case, a yield test of a new borehole was done and the capacity was almost the same as the existing one.

For each well pump, one stand-by pump shall be kept at the new intake site to use both well's capacity effectively. In the aforementioned plan, since an elevated intake is constructed for water distribution, southern area and northern coastal areas can be included in the water supply area by gravity.

16.6.2 Target Years and Formulation of Development Plan of Water Supply System

(1) Target Years

The target year of NEGID-Plan is set at each 10-year interval from 2022 to 2052. However, it is not realised for the distant future of water supply service because relative actual plans are formulated in this study. Consequently, the year 2032 is stipulated as the final year for the middle-term expansion plan, and the year 2027 is set as the 5-year short-term development plan.

(2) Formulation of Short-Term Projects

The existing systems of the Kokopo, Rabaul Town and Nonga Area are serving limited urban areas, and therefore expansion should be carried out from the surrounding areas. Accordingly, improvements and rehabilitations for existing water supply systems is the first priority for the expansion plan since these systems have some fundamental problems as mentioned in previous chapters and these works are the preconditions for the expansion.

As a short-term project, improvements and rehabilitations of the existing systems of Kokopo, Rabaul Town and Nonga Area shall be included. In addition, underway projects, such as a water supply project for Kerevat Town and an expansion project of water supply area for Nonga Southern Area, should be included.

(3) Formulation of Middle-Term Projects

As middle-term projects, urbanised areas shown in Figure 16.2.2 have first priority as project areas. Kokopo-Tokua Corridor stipulated as a high priority development plan by ENBP is selected as the middle-term project areas for surrounding Kokopo Town.

An expanding area surrounding Rabaul Town is selected as the project, and Rabaul Port is possible to be selected as SEZ. In addition, an expansion to Nonga southern coastal areas is also selected as the project. Both expansions of the area are to be realised by the improvement and rehabilitation of existing systems, especially the increase of intake capacity and construction of high elevation reservoirs.

Additionally, the area surrounding Ataliklikun Bay is selected as a new port with new large-scale consumers (Agro-processing SEZ). As an inland high-elevation area, expansion of the existing Baliora Water Supply Area is selected.

16.7 Projects for Development of Water Supply

16.7.1 Short-Term Projects

As short-term projects, rehabilitation and improvement for Kokopo Town, Rabaul Town and Nonga Area should be conducted as a precondition of the expansion of surrounding areas. In addition, current concrete plans for water supply in target areas should be included.

Such current concrete plans are: a water supply project for Kerevat Area and an expansion project of water supply area for Nonga Southern Area.

(1) [WS-01] Project for Rehabilitation and Improvement for Kokopo Borehole Field

The contents of the rehabilitations and improvement and the effect for Kokopo Borehole Field were mentioned in Section 13.4. The detailed contents and costs are shown in Table 16.7.1.

(2) [WS-02] Project for Rehabilitation and Improvement of Water Supply System for Rabaul Town Area

The contents of the rehabilitations and improvement and the effects for Rabaul Town Area were mentioned in Section 13.5. The detailed contents and costs are shown in Table 16.7.2.

(3) [WS-03] Project for Rehabilitation and Improvement of Water Supply System for Nonga Area

The contents of the rehabilitations and improvement and the effects for Nonga Area were mentioned in previous section. The detailed contents and costs are shown in Table 16.7.3.

Table 16.7.1 Project Contents and Costs of Rehabilitation and Improvement for Borehole Field of Kokopo

Name		Specifications	Quantity	Unit	Unit Price($)	Total Cost($)
Transmission Tank		Concrete	256	m^3	300	76,800
Pump House		Concrete	32	m^2	1,200	38,400
Stand-by well Pumps		7 units 7.0-30kW	1	no		100,000
Disinfection Unit		Tank Pump and Panel	1	no		30,000
Transmission Pump	for Town	D125mmx15kW	3	no	5,000	15,000
	for Village	D65mmx3.7kW	2	no	2,500	5,000
Pipe Connection and Installations			1	no		50,000
Miscellaneous Items			1	no		14,800
Sub-Total						330,000
Control Panel at WTP			1	lot		134,160
Monitoring Panel at Raniola	With transmitter to Water PNG		1	set		125,400
Monitoring unit	at Water PNG Office		1	set		136,800
Generator for transmission pump		100kVA	1	set		136,800
Flow-meter	for well pumps	D100	2	no	11400	22,800
	for trans. Pump	D200	1	no		15,960
	for Dis. of town	D150	1	no		14,250
	for dis. of village	D50	1	no		6,840
Level Meter-Pressure type		0-5m	2	no	6840	13,680
Signal-line (newly)	wells to panel		1.6	km	15000	24,000
	Raniolo to WTP		2.9	km	15000	43,500
	Village tank to panel		0.5	km	15000	7,500
Miscellaneous Items			1	no.		8,310
Sub-total						690,000
Indirect Cost		20%	1	no		204,000
Total						1,224,000

Source: JICA Expert Team

Table 16.7.2 Project Contents and Costs of Rehabilitation and Improvement for Rabaul Town Area

Name		Specifications	No.	Unit	unit Price($)	Total Cost($)
Red-light replaced reservoir		Concrete	650	m^3	300	195,000
Red-light reservoir abandon		Steel	1	no		30,000
New reservoir		Concrete	190	m^3	400	76,000
Disinfection Unit for Wisdom		Tank,Pump and Panel	2	no	30,000	30,000
Transmission Pump	for New Reservoir	D80mmx11kW	2	no	4,000	8,000
Borehole(200mmx50m)			1	no		100,000
Borehole Pump & others		11kW	1	no		20,000
Stand-by Well Pump		11kW	2	no	6,000	12,000
Pump House			40	m^2	1,500	60,000
New Intake Site Work			200	m^2	200	40,000
Disinfection Unit for New Intake			1	no		30,000
Water supply pipe	to ship	D200m	1,000	m	80	80,000
Intake pipe	New intake to Red-light	D150	170	m	60	10,200
Transmission pipe	Redlight to new Res.	D150	270	m	60	16,200
Distribution Pipe	New Res. To town	D200m	570	m	80	45,600
Distribution Pipe	in town	D100	2,770	m	50	138,500
Miscellaneous Items			1	no.		8,500
Sub-Total						900,000
Control Panel	For Wisdom Intake site		1	no		62,960
	For New Intake site with transmitter		1	no		74,360
	For Redlight Reservoir Site		1	no		62,960
Monitoring Panel	at New Reservoir		1	no		125,400
Monitoring unit	at Water PNG Office in Kokopo		1	no		50,000
	at Water PNG Office in Rabaul		1	no		50,000
Generator for new intake & Redlight Reservoir		50kVA	2	no	70,000	140,000
Flow-meter	for well pump in Wisdom	D100	2	no	11,400	22,800
	for well pump in new intake	D100	1	no		11,400
	for Trans. to new reservoir	D150	1	no		14,250
	for distribution to town	D200	1	no		15,960
	for dis. to high elevation town	D50	1	no		6,840
Level Meter	for Redlight & new reservoir 0-5m		2	no	6,840	13,680
Signal-line (sole)	Wisdom to Redlight		370	m	15	5,550
Signal-line (with Pipe inst.)	New intake to Red-light		170	m	15	2,550
	Redlight to new Reservoir		270	m	15	4,050
Miscellaneous items						37,240
Sub-total						700,000
Indirect Cost		20%				320,000
Total						1,920,000

Source: JICA Expert Team

Table 16.7.3 Project Contents and Costs of Rehabilitation and Improvement for Nonga Area

Name		Specifications	No.	Unit	Unit Price ($)	Total Cost($)
New Reservoir on ground		Concrete	300	m^3	300	90,000
Elevated tank at hill		FRP 50m^3	1	no		40,000
Elevated tank Base		40m^2	1	no		5,000
Transmission Pump for Elevated Tank		D80mmx15kW	2	no	4,000	8,000
Borehole installation		200mmx50m	1	no		100,000
Borehole pump & others		7.5kW	1	no		20,000
Stand-by Well Pump		7.5kW	2	no	5,000	10,000
Pump House		W5mx10m	50	m^2	1,200	60,000
Disinfection Unit for New reservoir			1	no		30,000
Water Intake pipe	to new reservoir	D150	620	m	60	37,200
Transmission pipe	Redlight to new Reservoir	D150	270	m	60	16,200
Distribution Pipe	New reservoir to Existing Dis.	D200m	3,400	m	80	272,000
Miscellaneous items			1	no		11,600
Sub-Total						700,000
Control Panel	For existing Intake site		1	no		35,600
	For New Intake site		1	no		62,960
	For new reservoir Site with transmitter		1	no		62,960
Monitoring Panel	at Elevated tank		1	no		125,400
Monitoring unit	at Water PNG Office in Kokopo		1	no		50,000
	at Water PNG Office in Rabaul		1	no		50,000
Generator for new intake		50kVA	2	set	70,000	140,000
Flow-meter	for well pump	D100	2	no	11,400	22,800
	for New reservoir to elevated tank	D150	1	no		14,250
	for dis. from elevated tank to town	D150	1	no		14,250
Level Meter	for new reservoir and elevated tank 0-5m		2	no	6,840	13,680
Signal-line (sole)	existing intake to new reservoir		580	m	15	8,700
Signal-line (with Pipe inst.)	New intake to new reservoir		50	m	15	750
	new reservoir to elevated Tank		400	m	15	6,000
Miscellaneous items			1	no		12,650
Sub-total						620,000
Indirect Cost						264,000
Total						1,584,000

Source: JICA Expert Team

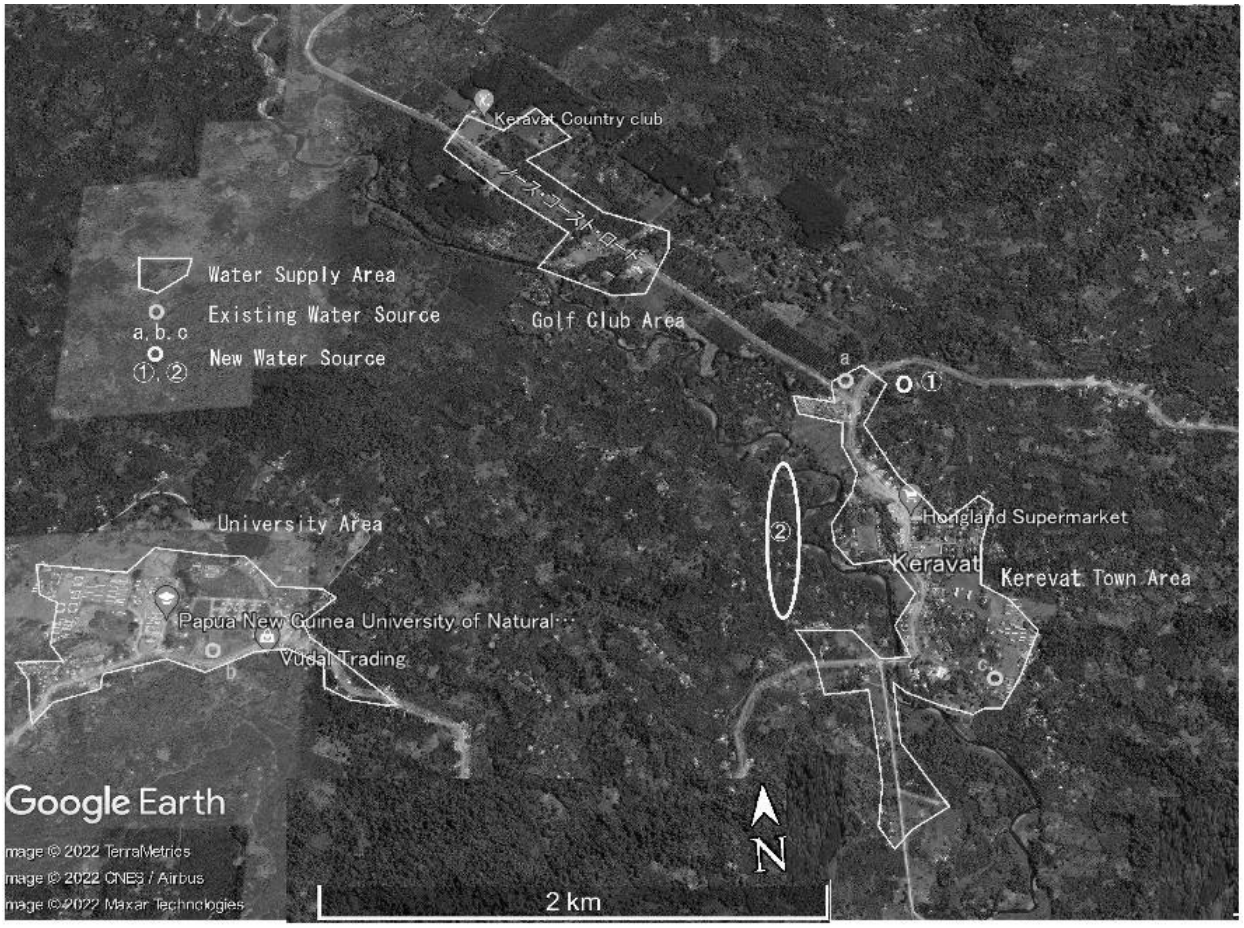
(4) [WS-04] Project for Development of Water Supply System for Kerevat Area

A Water Supply Project for Kerevat Town has been planned as a World Bank donated project. Its feasibility study was underway in November 2022. The layout of the plan is shown in Figure 16.7.1, and as shown, the supply areas are Kerevat Town, Papua New Guinea University of Natural Resources and Environment and a golf club.

Currently there are three water sources without rainwater storage tanks, which are a deep well in a hospital, a deep well in the university, and a water treatment plant for surface water for a National High School. These are marked as a, b and c, respectively in Figure 16.7.1.

The water of source a has a distinct odour and colour, and the treatment plant for source c is not functioning.

The source b by borehole is of good quality. Source a may be able to be improved by the refurbishing of a well, but the water treatment plant for source c seems to be unrepairable.



Source: JICA Expert Team

Figure 16.7.1 Layout of Kerevat Town Water Supply Plan

The spring marked (1) was selected for one water resource and one or two boreholes will be installed in the area marked (2). In addition, the borehole marked b, located in the university, will be used for water resource of the project. Table 16.7.4 shows the number (using Google Maps) of housing units and major buildings counted in each supply area.

Table 16.7.4 Number of Housings and Major Buildings in Each Water Supply Area

Area	Major Buildings	Housing units
Kerevat Town	National High School, District office, Hospital, Supermarket	150
University	University	60
Golf Club	Golf Club	60

Source: JICA Expert Team

(5) [WS-05] Project for Expansion of Water Supply System for Nonga Northern Area

Currently, Water-PNG has started a Nonga Northern Area water supply project with the budget of 3 million Kina. In the project, an intake site with a borehole, a reservoir and distribution network for the northern area will be included. The borehole was installed in 2020 for the project, but other work has not progressed.

In the aforementioned plan in this report for Nonga Area, some contents of the Water PNG project, such as intake facilities and reservoir are included. Since the plan in this report considers an expansion to wide coastal areas, it is recommended that the project by Water PNG will match this report's plan.

The possible supply area for Nonga Northern Area according to the plan of this report is shown in Figure 16.7.2. In this area, around 200 housing units, a supermarket, a school, a church and a submarine base are located.



Source: JICA Expert Team

Figure 16.7.2 Water Supply Area for Nonga Northern Area

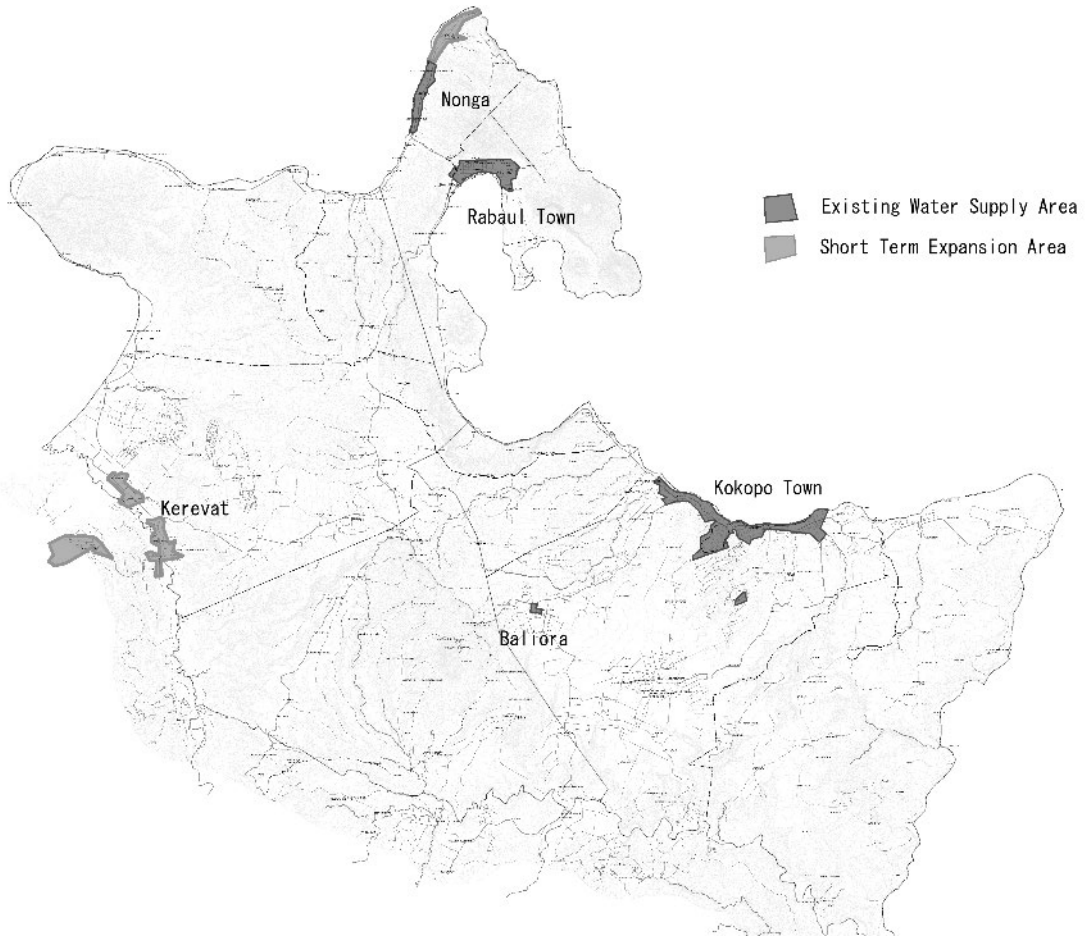
(6) The Results of Short-Term Expansion Plan

By the rehabilitation and improvement of the existing system, the total cost is calculated as shown in Table 16.7.5 and no further expansion can be made. However, some expansion will be made as shown in Figure 16.7.3 by Kenabat water supply plan by WB and Nonga Southern Area expansion plan by Water PNG.

Table 16.7.5 Costs and Contents of Rehabilitations and Improvements

Location	Contents	Costs ($)
Kokopo Borehole Field	Improvement of well system and introduction of automatic and monitoring system	1,224,000
Rabaul Town	Installation of high elevation reservoir, replacement of existing reservoir and new intake facilities, including introduction of automatic and monitoring system	1,920,000
Nonga Area	Installation of reservoir with elevated tank and new intake facilities, and introduction of automatic and monitoring system	1,584,000
Total		4,728,000

Source: JICA Expert Team



Source: JICA Expert Team

Figure 16.7.3 Target Areas for Water Supply Short-Term Projects

16.7.2 Middle-Term Projects

ENBPA formulated a development plan for the Kokopo-Tokua Corridor in 2016 east of Kokopo Town. From the report, Figure 16.7.4 shows urbanised areas, so a water supply plan for the urbanised areas shown in the figure should be formulated as middle-term expansion.

For Rabaul Town, because expansion of the water supply areas is possible due to the increase of water intake capacity and installation of high elevation reservoir by the short-term works, the water supply area will be expanded as much as possible.

For Nonga Area, an expansion of southern coastal areas is possible by the aforementioned rehabilitation and improvement and thus, this expansion should be done.

Currently, a port facing Ataliklikun Bay is planned and the water supply system for the port should be planned to include the surrounding residential areas.

Apart from these, a water supply system with a borehole for a police housing complex in Baliora Area is operated, but the capacity of the facilities is apparently excessive for the current supply area. There are many housing units nearby the system and the elevation of this area is 260-340 m. Accordingly, an expansion of the supply area will be planned as an example of water supply systems for high-elevation areas.

(1) [WS-06] Project for Development of Water Supply System for Kokopo Eastern Area

From the report of development plan for Kokopo-Tokua Corridor, a development map for a residential area is shown as in Figure 16.7.4. In the middle-term plan, the residential areas will be covered by the water supply area as shown in Figure 16.7.5.



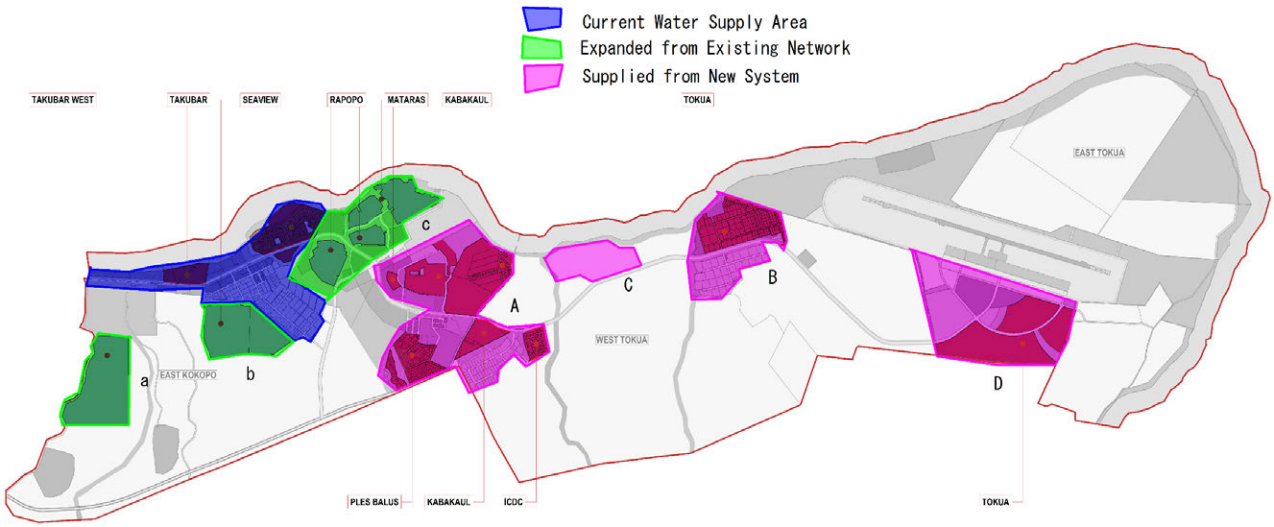
Source: PlanPac Group PNG, Kokopo-Tokua Corridor Subject Development Plan, 2016, ENBP

Figure 16.7.4 Planned Residential Area by ENBPA for Kokopo-Tokua Corridor

Though area C in Figure 16.7.5 is not included in urbanised areas, this area is already developed, and a factory and housing units are located there. Thus, this area is included in the supply area.

In Figure 16.7.5, a part of the area was already covered by the distribution network of Kokopo Town, and therefore the neighboring areas should be covered by expanded distribution pipes.

Other areas, A, B, C and D, will be supplied from new water supply systems, while area D of the surrounding Tokua Airport is relatively far from other areas and the airport has some operational boreholes. Therefore, a water supply system for areas A, B and C and another system for area D are planned in this chapter.



Source: Modified Figure 16.7.4 by JICA Expert Team

Figure 16.7.5 Expansion Plan of Water Supply Area for Kokopo-Tokua Corridor

1) Estimation of Water Consumption for Each Area

Numbers of each category of buildings estimated for each area are shown in Table 16.7.6. The consumption of housing units, shop, school and factory was decided referring to each category's consumption in Kokopo and Rabaul considering future demand increase. The consumption of airport is estimated at 30 thousand passengers each consuming 10 litres neglecting staff consumption. The results are shown in Table 16.7.6 and water consumption of each category is also estimated. In Table 16.7.6, water consumption for each area is calculated and the daily maximum values are used for the plans.

Table 16.7.6 Estimated Water Consumption for Each Area

Category		Number					Water Consumption (m^3/d)		
Area	Mark	Housing	Shop	School	Factory	Airport	Daily Average		Daily Max
Expansion Area	a	150	5	--	--	--	175	1,005	1,206
	b	250	5	2	5	--	415		
	c	250	5	2	5	--	415		
Areas with New Intake	A	300	10	1	20	--	770	1,325	1,590
	B	300	5	1	2	--	385		
	C	100	2	1	2	--	170		
	D	100	20	1	5	1	620	620	744
Consumption (m^3/no)		1	5	20	20	300			

Note: Daily maximum consumption =1.2 x average value
Source: JICA Expert Team

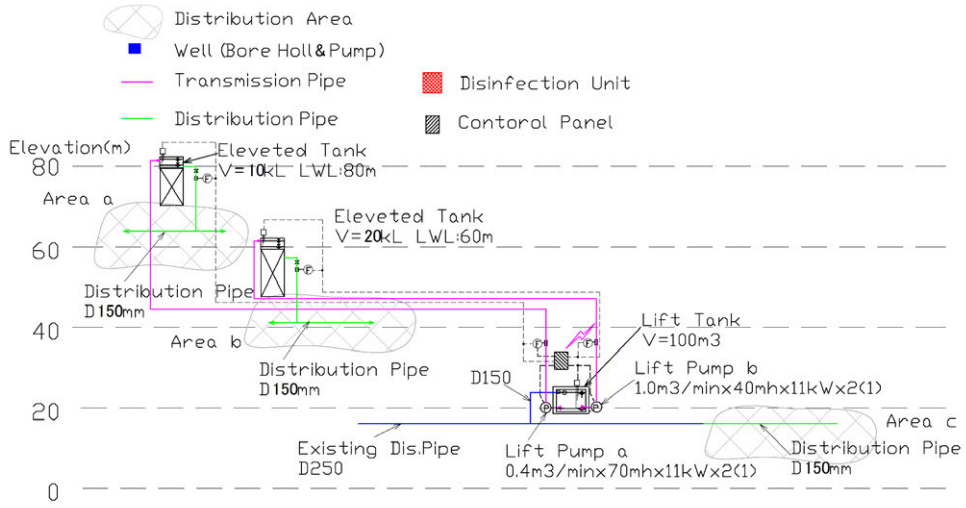
2) Water Supply System of Expansion Areas from the Existing Distribution Network

In the three Areas, Area c water can be distributed by gravity through the expanded distribution pipe due to the low elevation, but for Areas a and b, water cannot be distributed through the existing network because of the high elevation.

The water consumption of each area is shown in Table 16.7.6 and total consumption of the three areas is 1,206 m^3/d. This value is within the allowance of 1,223 m^3/d as shown in Table 16.5.1. However, if the allowance is not adequate in the future, additional boreholes shall be installed in the Borehole Field.

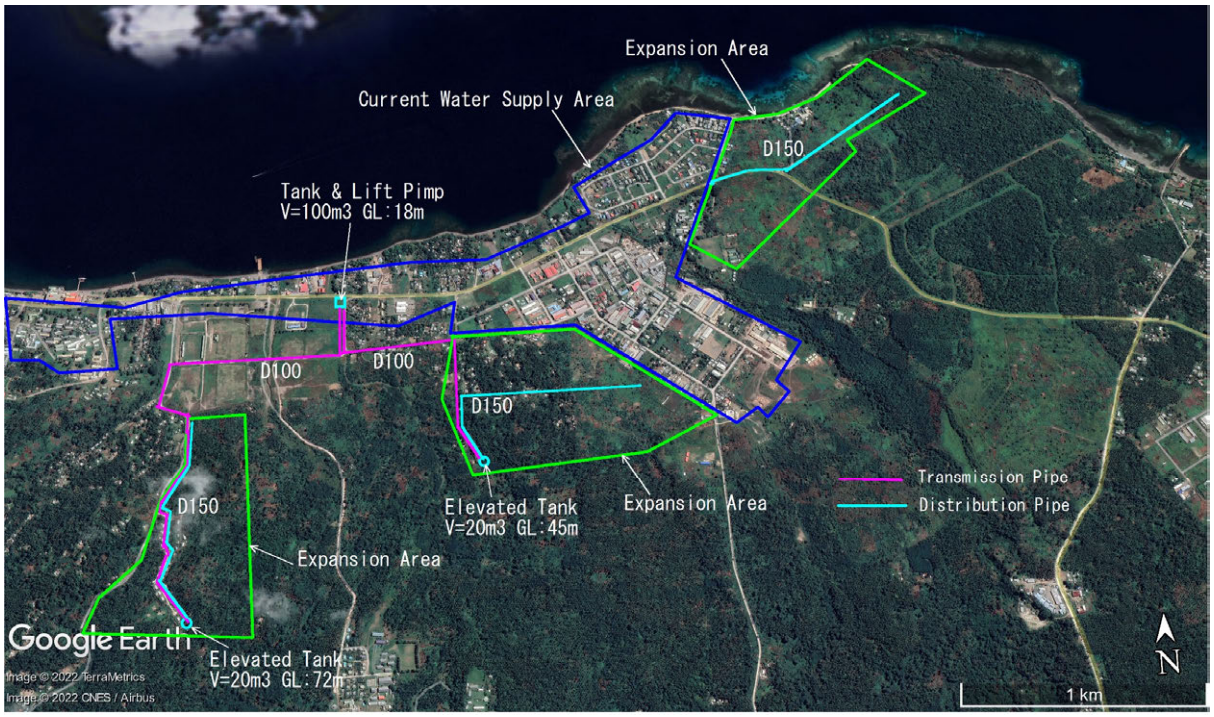
An elevated tank for the water distribution is necessary for Areas a and b and therefore, a lift tank supplied from existing distribution pipe and lift pumps needs to be installed as shown in Figure 16.7.6. By the lift pumps, water will be transmitted to elevated tanks at Area a and Area b respectively.

Through the system, water is supplied to Areas a and b from each elevated tank with enough pressure. The layout of the facilities is shown in Figure 16.7.7. The detailed contents and costs are shown in Table 16.7.8.



Source: JICA Expert Team

Figure 16.7.6 Composition of Water Supply System for Expanded Areas from Existing Network



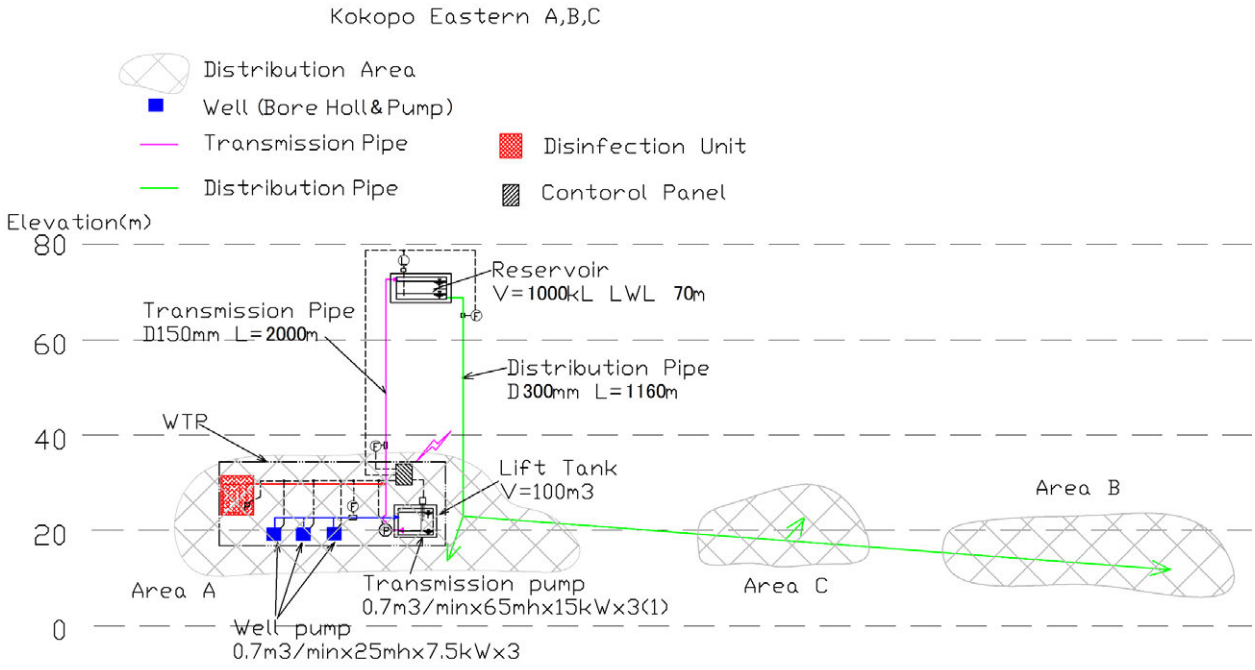
Source: JICA Expert Team

Figure 16.7.7 Layout of Water Supply System for Expanded Areas from Existing Network

3) Water Supply System for Area A, B and C

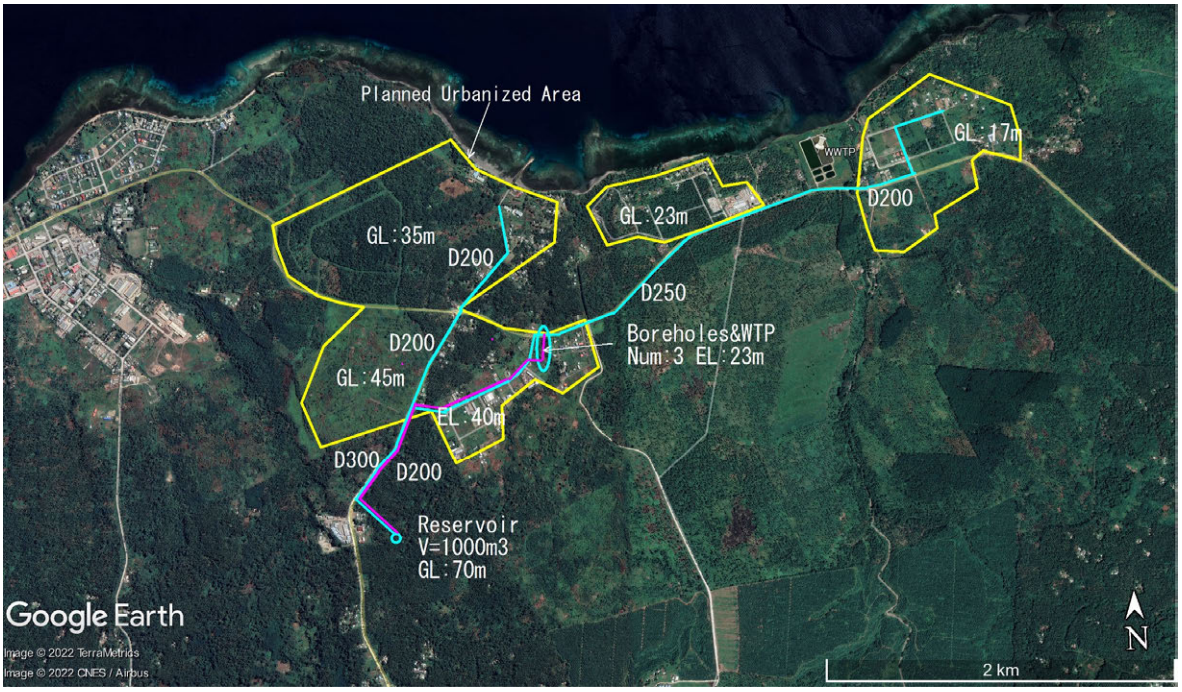
The necessary water distribution capacity for this water supply system is 1,590 m^3/d as shown in Table 16.7.6.

This area is an ideal landform for groundwater resource and there are high-elevation areas for reservoir construction. Accordingly, the system will be composed of an intake site of borehole and WTP, a reservoir, transmission pipe and distribution network as shown in Figure 16.7.8. The layout is shown in Figure 16.7.9. The detailed contents and costs are shown in Table 16.7.8.



Source: JICA Expert Team

Figure 16.7.8 Composition of Water Supply System for Areas A, B and C



Source: JICA Expert Team

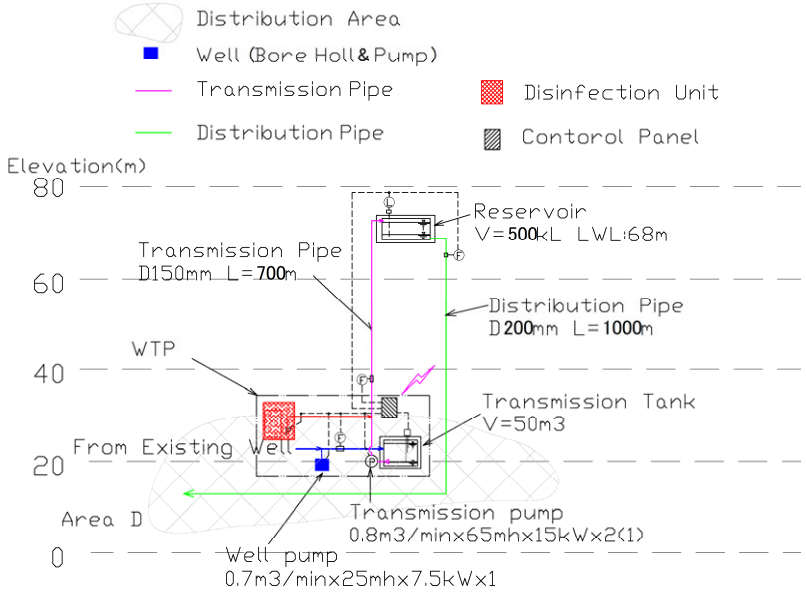
Figure 16.7.9 Layout of Water Supply System for Areas A, B and C

4) Water Supply System for Area D

The necessary water distribution capacity for this water supply system is 620 m^3/d as shown in Table 16.7.6.

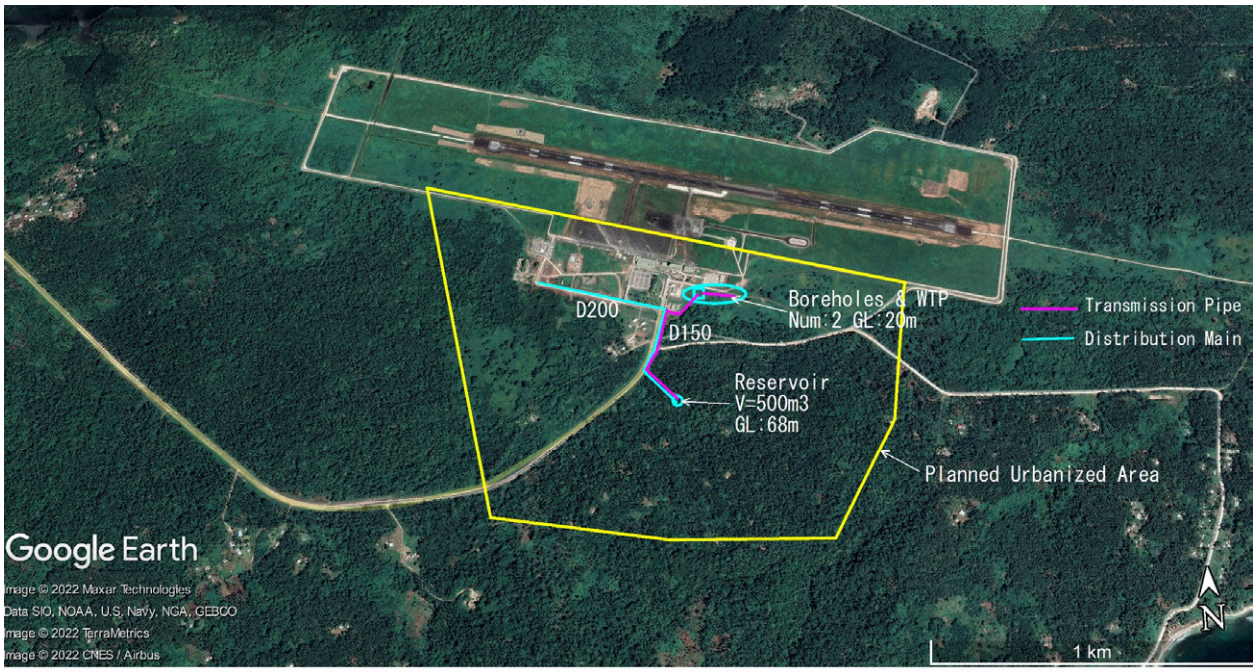
In Area D, the elevation of the airport area is less than 20 m, and that of the southern mountain reaches 90 m. However, since the development area may not be expanded to such high-elevation areas, the ground elevation of a reservoir is decided as shown in Figure 16.7.10, and its position is nearby the terminal building as shown in Figure 16.7.11.

This supply system is composed of one well, a transmission tank, transmission pumps, a reservoir and related pipes as shown in the figures, but the operating well by the airport will be used for the system. The detailed contents and costs are shown in Table 16.7.8.



Source: JICA Expert Team

Figure 16.7.10 Composition of Water Supply System for Area D



Source: JICA Expert Team

Figure 16.7.11 Layout of Water Supply System for Area D

5) Contents of Kokopo Eastern Area expansion

The detailed contents and costs for Kokopo Eastern Expansion Area are shown in Table 16.7.8. The costs for each area are summarised in Table 16.7.7.

Table 16.7.7 Estimated Cost for Kokopo Eastern Area

Area	Water Source	Costs ($)
Expansion Area from Existing Network	Existing Distribution Pipe	1,920,000
Areas with New Intake A, B, C	New Wells	4,680,000
Area with New Intake D	A new Well	1,800,000
Total		8,400,000

Source: JICA Expert Team

Table 16.7.8 Contents of Water Supply System for Kokopo Eastern Areas

Category	Name		Specifications	No.	Unit	Unit Price ($)	Total Cost($)
Expansion Area from Existing Network	Lift Pump Site	Lift Tank	Concrete	100	m^3	350	35,000
		Pump House	Brick	30	m^2	1,200	36,000
		Lift Pimp	D50x11kW	2	no	4,000	8,000
			D80x11kW	2	no	5,000	10,000
		Site work	Pump Yard	100	m^2	100	10,000
	Elevated Tank	Elevated Tank	$20m^3$ FRP	1	no	50,000	50,000
			$10m^3$ FRP	1	no	30,000	30,000
		Site work	Each $30m^2$	2	no	5,000	10,000
	Pipe Work	Pipe Work in the Site		1	no		20,000
		Transmission Pipe	D100mm	3730	m	40	149,200
		Distribution Main Pipe	D150mm	3500	m	60	210,000
		Distribution Branch Pipe	D100-20mm	1	no		500,000
	Electrical Works			1	no		500,000
	Miscellaneous items			1	no		31,800
	Sub-Total						1,600,000
	Indirect Cost		20%				320,000
	Total						1,920,000
Areas with New Intake A,B,C	Intake Site	Borehole L=50m		3	no	150,000	450,000
		Well Pump with Pipe	7.5kW	3	no	25,000	75,000
		Stand-by Well Pump	7.5kW	3	no	8,000	24,000
		Transmission Tank	RC	100	m^3	400	40,000
		House for Pump and Other	Brick	100	m^2	1,200	120,000
		Lift Pump	15kW	2	no	600	1,200
		WTP site		100	m^2	100	10,000
		Disinfection Unit		1	no	50,000	50,000
		Pipe works		1	no		20,000
		Site Works	Each $64m^2$	3	no	5,000	15,000
	Reservoir	Reservoir	RC	1,000	m^3	250	250,000
		Road for Construction		1	no		50,000
		Pipe works		1	no		30,000
		Site Works		400	m^2	100	40,000
	Transmission Pipe		D200mm	2,000	m	80	160,000
	Distribution Main Pipe		D300mm	1,160	m	160	185,600
			D250mm	2,380	m	120	285,600
			D200mm	3,240	m	80	46,600
	Distribution Branch Pipe for 1st Stage		D150-20mm	1	no		1,000,000
	Electrical Works			1	no		1,000,000
	Miscellaneous items			1	no		47,000
	Sub- Total						3,900,000
	Indirect Cost		20%				780,000
	Total						4,680,000
Area with New Intake D	Lift Pump Site	Borehole L=50m		1	no	150,000	150,000
		Well Pump with Pipe	7.5kW	1	no	25,000	25,000
		Stand-by well Pump		1	no	8,000	8,000
		Transmission Tank	RC	50	m^3	400	20,000
		House for Pump and Other	Brick	50	m^2	1,200	60,000
		Lift Pump	15kW	2	no	600	1,200
		WTP site		100	m^2	100	10,000
		Disinfection Unit		1	no	40,000	40,000
		Pipe works		1	no		15,000
	Reservoir	Reservoir	RC	500	m^3	350	175,000
		Road for Construction		1	no		50,000
		Pipe works		1	no		30,000
		Site Works		400	m^2	100	40,000
	Pipe Work	Pipe Work in the Site		1	no		30,000
		Transmission Pipe	D150mm	700	m	40	28,000
		Distribution Main Pipe	D200mm	1000	m	80	80,000
		Distribution Branch Pipe	D100-20mm	1	no		200,000
	Electrical Works			1	no		500,000
	Miscellaneous items			1	no		37,800
	Sub-Total						1,500,000
	Indirect Cost		20%				300,000
	Total						1,800,000
Gross Total							8,400,000

Source: JICA Expert Team

(2) [WS-07] Project for Expansion of Water Supply System for Rabaul Town Surrounding Area

In the short-term expansion plan, the water supply capacity of Rabaul Town will be increased by the installation of a new intake facility and the pressure of distribution pipes will be raised by the construction of a high-elevation reservoir.

Accordingly, water supply areas surrounding Rabaul Town can be expanded as shown Figure 16.7.12.

The buildings in the target areas as counted by Google Maps are shown Table 16.7.9.

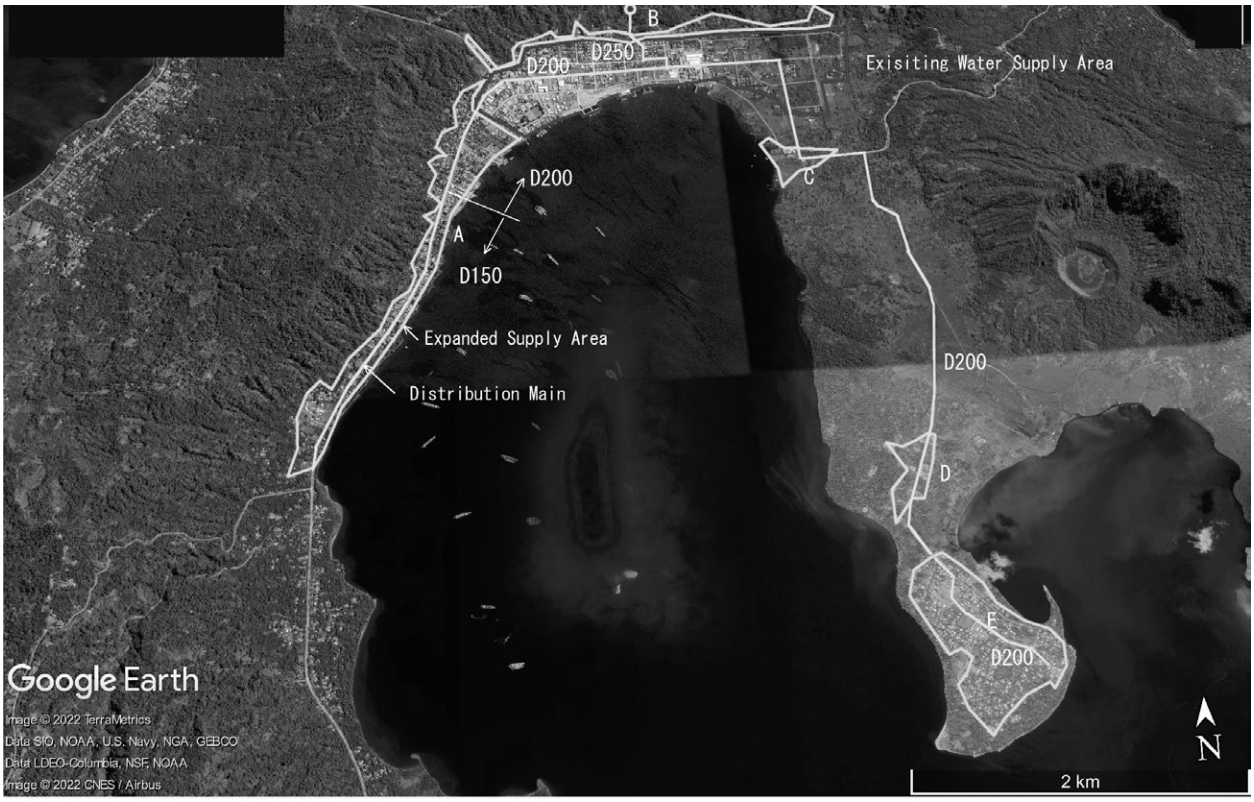
The consumption of housing unit, shop, school and factory was decided by referring to each category's consumption in Kokopo and Rabaul considering future demand increase. The calculation results are shown in Table 16.7.10.

Table 16.7.9 Estimated Water Consumption of Expansion Areas

Category		Number				Water Consumption (m^3/d)		
Area	Mark	Housing	Shop	Factory	School	Daily Average		Daily Max
Rabaul	Area	350	15	3	2	525	525	630
	B	30				30	30	36
	C	20	1	1		45	440	528
	D	10				10		
	E	300	5	1	2	385		
Consumption (m^3/no)		1	5	20	20	Total	995	1,194

Note: Daily maximum consumption =1.2 x average value
Source: JICA Expert Team

From Table 16.6.1, the maximum water consumption for Rabaul Town is 820 m^3/d, while the yield capacity of existing well is 1,300 m^3/d and the same intake capacity is expected for the new well. Then, the total yield capacity including short-term works is expected to be 2,600 m^3/d.



Source: JICA Expert Team

Figure 16.7.12 Expansion Plan for Rabaul Town and Surrounding Areas

In this case, the total consumption of 2,185 (891+1,194) m^3/d is covered by the well's yield capacity.

When the yield capacity reaches the expected figure, over 400 m^3 of allowance can be procured even with the expansion as shown in Figure 16.7.12.

On the other hand, a tuna processing factory is planned in Rabaul Port, for which the water consumption is said to be 10-12 m^3 per tuna tonnage. The planned factory can use the above water volume for the processing, and therefore if SEZ is applied in Rabaul Town, this allowance can be used.

The contents and costs of the expansion are shown in Table 16.7.10.

Table 16.7.10 Contents and Costs of Expansion for Surrounding Rabaul Area

Category	Name		Specifications	No.	Unit	Unit Price ($)	Total Cost($)
Rabaul	Pipe Work	Distribution Main Pipe	D200mm	9,500	m	80	760,000
			D150mm	2,580	m	60	154,800
		Distribution Branch Pipe	D100-20mm	1	no		1,200,000
	Miscellaneous items			1	no		85,200
	Sub-Total						2,200,000
	Indirect Cost		20%				440,000
	Total						2,640,000

Source: JICA Expert Team

(3) [WS-08] Project for Expansion of Water Supply System for Southern Nonga Coastal Areas

By the short-term expansion works, the water supply capacity of Nonga Area will be increased by the installation of a new intake facility and the pressure of distribution pipes will be increased by the construction of an elevated tank.

In addition, new distribution pipes to extend to southern coastal areas are installed in the works.

Accordingly, water supply areas of southern Nonga can be expanded as shown Figure 16.7.13.

The number of buildings counted by using Google Maps are shown in Table 16.7.11. The estimated water consumption of expansion areas is calculated in Table 16.7.11 as well as Rabaul Town, but since the scale of factories and schools are small, the consumptions of these were estimated to be half.



Source: JICA Expert Team

Figure 16.7.13 Expansion Plan for Southern Nonga Coastal Area

As shown in Table 16.6.1, the maximum water consumption for Nonga Area is 460 m^3/d, while the yield capacity of the existing well is 700 m^3/d and the new well's capacity was measured to be 700 m^3/d. Then, the total yield capacity including short-term works is expected to be 1,400 m^3/d.

In this case, the total consumption of 1,102 (502+600) m^3/d is covered by the yield capacity and 298 m^3/d of allowance can be procured even with the expansion shown in Figure 16.7.13.

The contents and costs of the expansion are shown in Table 16.7.12.

Table 16.7.11 Estimated Water Consumption of Expansion Areas

Category	Number				Water Consumption (m^3/d)	
Area	Housing	Shop	Factory	School	Daily Average	Daily Max
Nonga	360	10	5	4	500	600
Consumption (m^3/no)	1	5	10	10		

Note: Daily maximum consumption =1.2 x average value
Source: JICA Expert Team

Table 16.7.12 Contents and Costs of Expansion for Nonga Southern Coastal Area

Category	Name		Specifications	No.	Unit	Unit Price ($)	Total Cost($)
Nonga Southern Coastal Area	Pipe Work	Distribution Main Pipe	D200mm	2,400	m	80	192,000
			D150mm	2,600	m	60	156,000
			D100mm	1,000	m	40	46,600
		Distribution Branch Pipe	D150-20mm	1	no		500,000
	Miscellaneous items			1	no		5,400
	Sub- Total						900,000
	Indirect Cost		20%				180,000
	Total						1,080,000

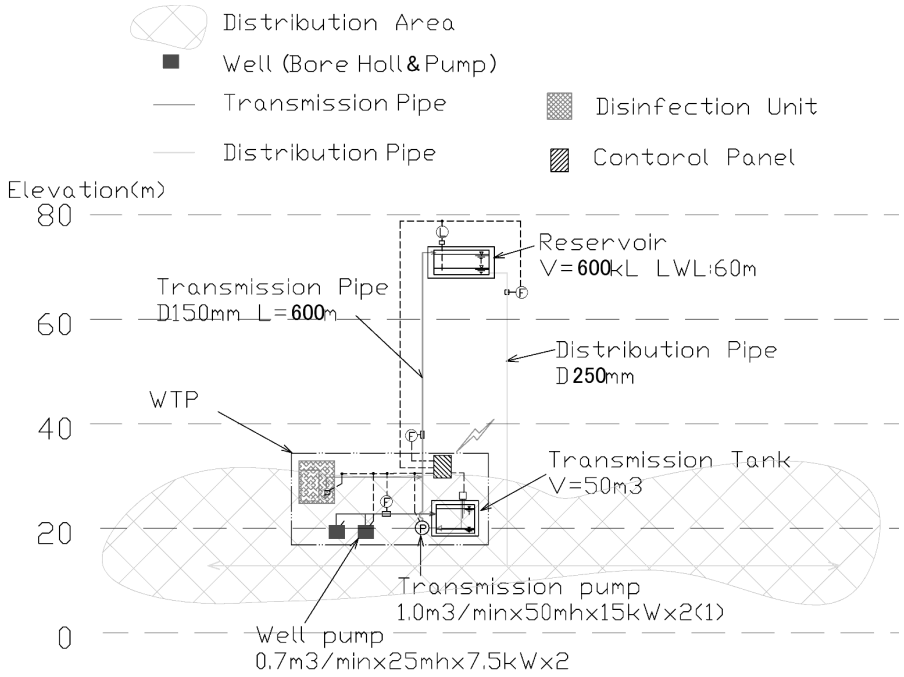
Source: JICA Expert Team

(4) [WS-09] Project for Development of Water Supply System for Kerevat Agro-Industry SEZ, Ataliklikun New Port and Surrounding Areas

A water supply system for the planned Ataliklikun New Port is necessary and because surrounding areas will be urbanised, these areas should be covered by the water supply system.

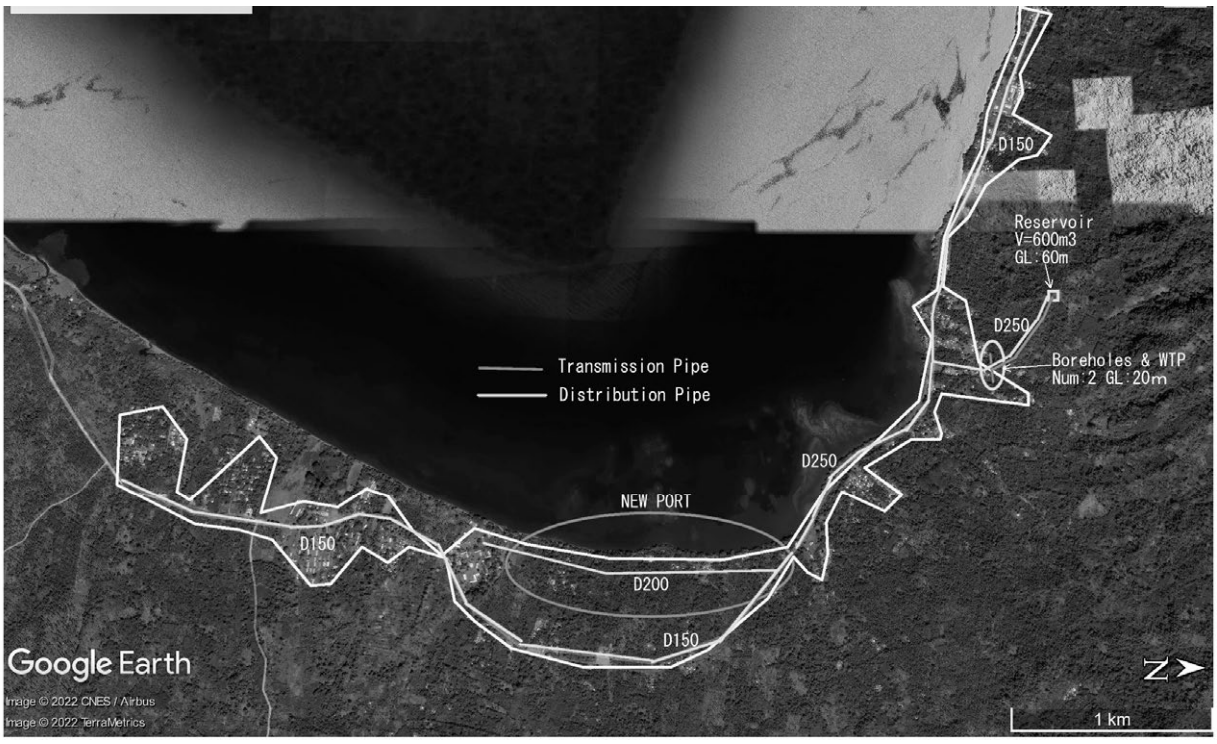
The planned composition of the system is shown in Figure 16.7.14 and the layout is shown in Figure 16.7.15.

Estimated water consumption of the water supply system is calculated in Table 16.7.13 as well as Nonga Area, and the contents and costs are shown in Table 16.7.14. The consumption of the new port is estimated to be 500 m^3/d because current water consumption of the entire Rabaul Town is 820 m^3/d including much domestic usage.



Source: JICA Expert Team

Figure 16.7.14 Composition of Water Supply System of Ataliklikun New Port and Surrounding Area



Source: JICA Expert Team

Figure 16.7.15 Construction Plan for Ataliklikun New Port and Surrounding Area

Table 16.7.13 Estimated Water Consumption of Ataliklikun New Port and Surrounding Area

Category	Number					Water Consumption (m^3/d)	
Area	Housing	Shop	Factory	School	Port	Daily Average	Daily Max
Ataliklikun Port	320	10	5	6	1	980	1,176
Consumption (m^3/no)	1	5	10	10	500		

Note: Daily maximum consumption =1.2 x average value
Source: JICA Expert Team

Table 16.7.14 Contents and Costs of Project for Ataliklikun New Port and Surrounding Area

Category	Name		Specifications	No.	Unit	Unit Price ($)	Total Cost($)
Ataliklikun	Lift Pump Site	Borehole L=50m		2	no	150,000	300,000
		Well Pump with Pipe	7.5kW	2	no	25,000	50,000
		Stand-by well Pump		2	no	8,000	16,000
		Transmission Tank	RC	50	m^3	400	20,000
		House for Pump and Other	Brick	50	m^2	1,200	60,000
		Lift Pump	15kW	2	no	600	1,200
		WTP site		100	m^2	100	10,000
		Disinfection Unit		1	no	40,000	40,000
		Pipe works		1	no		15,000
	Reservoir	Reservoir	RC	600	m^3	350	210,000
		Road for Construction		1	no		50,000
		Pipe works		1	no		30,000
		Site Works		400	m^2	100	40,000
	Pipe Work	Pipe Work in the Site		1	no		30,000
		Transmission Pipe	D150mm	700	m	40	28,000
		Distribution Main Pipe	D250mm	2300		120	276,000
			D200mm	1400		80	112,000
			D150mm	6000	m	60	360,000
		Distribution Branch Pipe	D100-20mm	1	no		500,000
	Electrical Works			1	no		600,000
	Miscellaneous items			1	no		51,800
	Sub-Total						2,800,000
	Indirect Cost		20%				560,000
	Total						3,360,000

Source: JICA Expert Team

(5) [WS-10] Project for Expansion of Water Supply System for Baliora Area

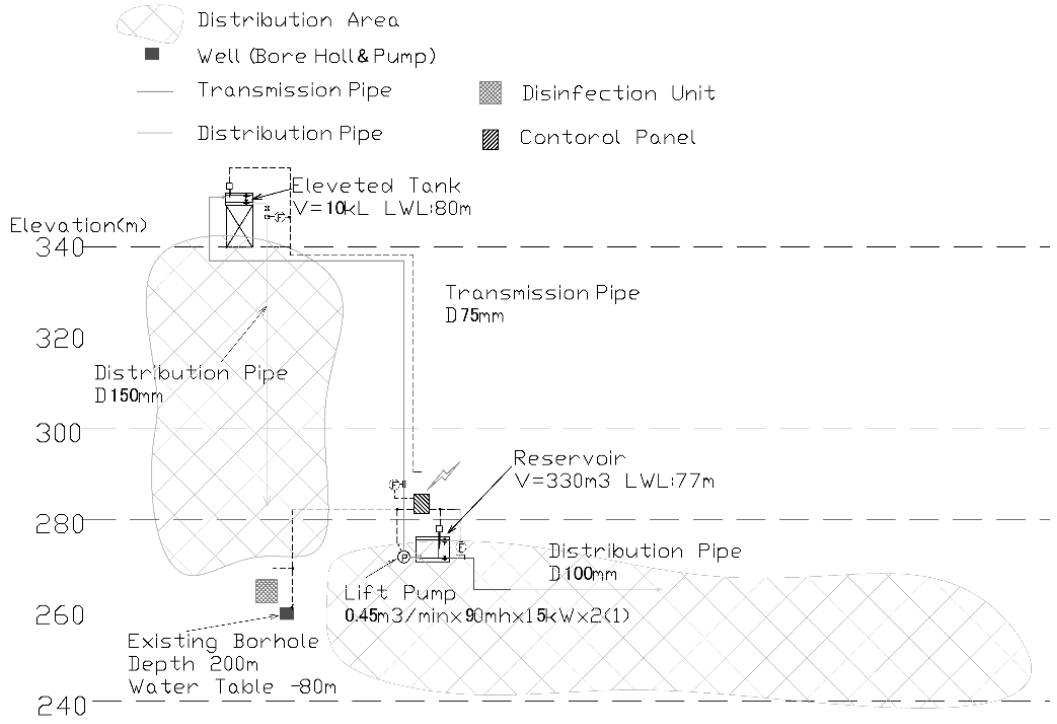
At Baliora Area, a water supply system was constructed after the volcanic eruption, while the well intake capacity is unknown due to lack of a flowmeter.

Because the diameter of well pump was 65 mm and the reservoir capacity is 330 m^3, the estimated yield capacity is around 600 m^3/d, while 90 units of housing with a small school are located in the supply area. The consumption of the existing supply area is estimated to be around 100 m^3/d.

Accordingly, an expansion plan for the area as an example of a system at a high-elevation area is recommended as follows.

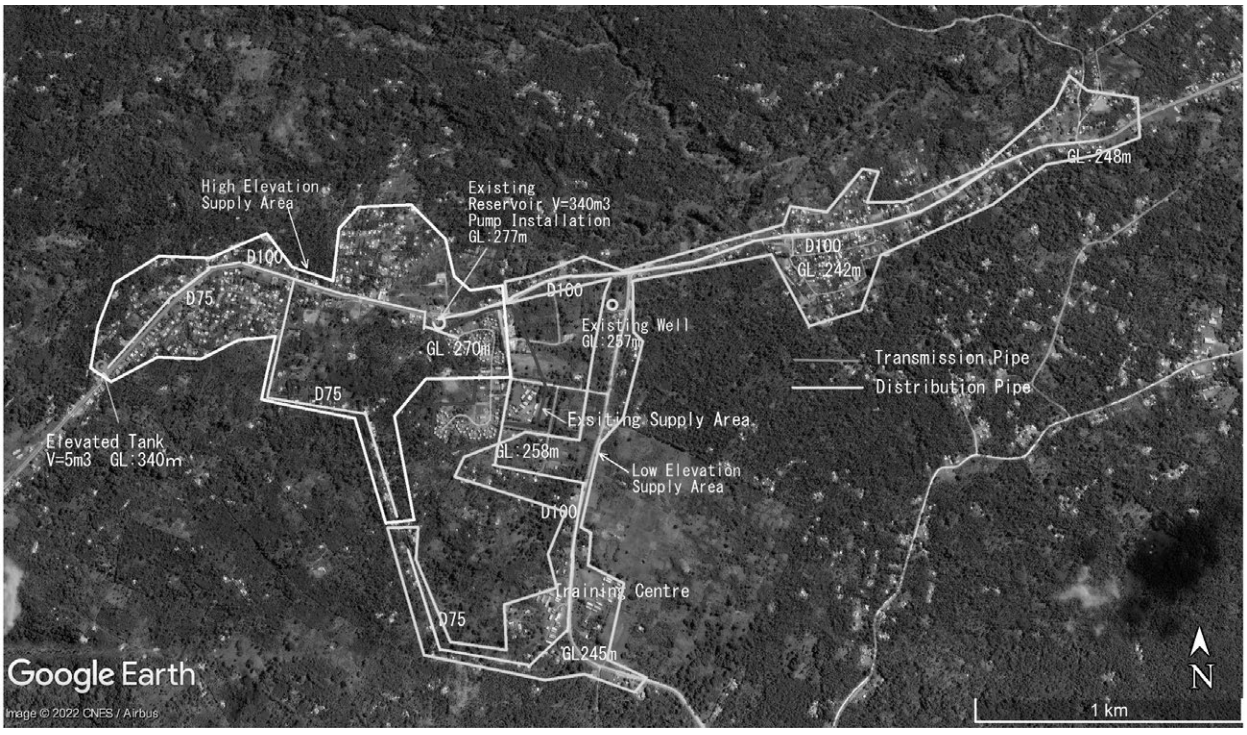
The composition of the plan is shown in Figure 16.7.16 and the layout plan is shown in Figure 16.7.17. Since the level difference of the area is very large, the distribution area is divided into high and low-elevation areas. The number of buildings are counted using Google Maps as shown in Table 16.7.15 and consumptions of each building refer to the values of Nonga Area.

The estimated water consumption of expansion and existing areas is calculated in Table 16.7.15.



Source: JICA Expert Team

Figure 16.7.16 Composition of Water Supply System of Baliora Expansion System



Source: JICA Expert Team

Figure 16.7.17 Expansion Plan for Baliora Water Supply System

Table 16.7.15 Estimated Water Consumption of Expansion and Existing Areas

Category		Number				Water Consumption (m^3/d)		
Area	Area	Housing	Shop	Factory	School	Daily Average		Daily Max
Baliora	High	180	3	1	1	215	215	258
	Low	200	3	1	2	275	315	378
Consumption (m^3/no)		1	5	10	10	Total	530	636

Note: Daily maximum consumption =1.2 x average value
Source: JICA Expert Team

As mentioned above, the estimated yield capacity of well was 600 m^3/d, and if the figure is correct, the planned expansion can be realised. The contents and costs are shown in Table 16.7.16.

Table 16.7.16 Contents and Costs of Expansion for Baliora Area

Category	Name		Specifications	No.	Unit	Unit Price ($)	Total Cost($)
Baliora	Pump Work	Pump House	Brick	30	m^2	1,200	36,000
		Lift Pump	15kW	2	no	600	1,200
		Pump site		50	m^2	100	5,000
		Disinfection Unit		1	no	40,000	40,000
		Pipe works		1	no		15,000
	Reservoir	Elevated Tank	10m3 FRP	10	m^3		40,000
		Pipe works		1	no		10,000
		Site Works		40	m^2	100	4,000
	Pipe Work	Pipe Work in the Site		1	no		30,000
		Transmission Pipe	D75mm	1600	m	35	56,000
		Distribution Main Pipe	D100mm	5550	m	40	222,000
			D75mm	2170		35	75,950
		Distribution Branch Pipe	D100-20mm	1	no		300,000
	Electrical Works			1	no		300,000
	Miscellaneous items			1	no		64,850
	Sub-Total						1,200,000
	Indirect Cost		20%				240,000
	Total						1,440,000

Source: JICA Expert Team

(6) Results of Middle-Term Expansion

The costs of the Middle-term expansion plan are summarised in Table 16.7.17.

Table 16.7.17 Costs and Contents of Middle-Term Expansion Plan

Place	Contents	Cost($)
Kokopo Eastern Area	Water supply system to 3 areas distributed from existing network ann 4 areas distributed by 2 new supply systems	8,400,000
Surrounding Rabaul Town	Distribution pipes to surrounding Simpson Bay distributed from improved Rabaul Town water supply system	2,640,000
Nonga Southern Coastal Area	Distribution pipes to Nonga southern coastal areas distributed improved Nonga water supply system	1,080,000
Atliklikun New Port and Surrounding Area	Water supply system to Atliklikun New Port and Surrounding Area	3,360,000
Baliora Surrouding Area	Remodeled water supply system for Baliora surounding areas	1,440,000
Total		16,920,000

Source: JICA Expert Team

16.7.3 Summarised Short-Term and Middle-Term Expansion Work

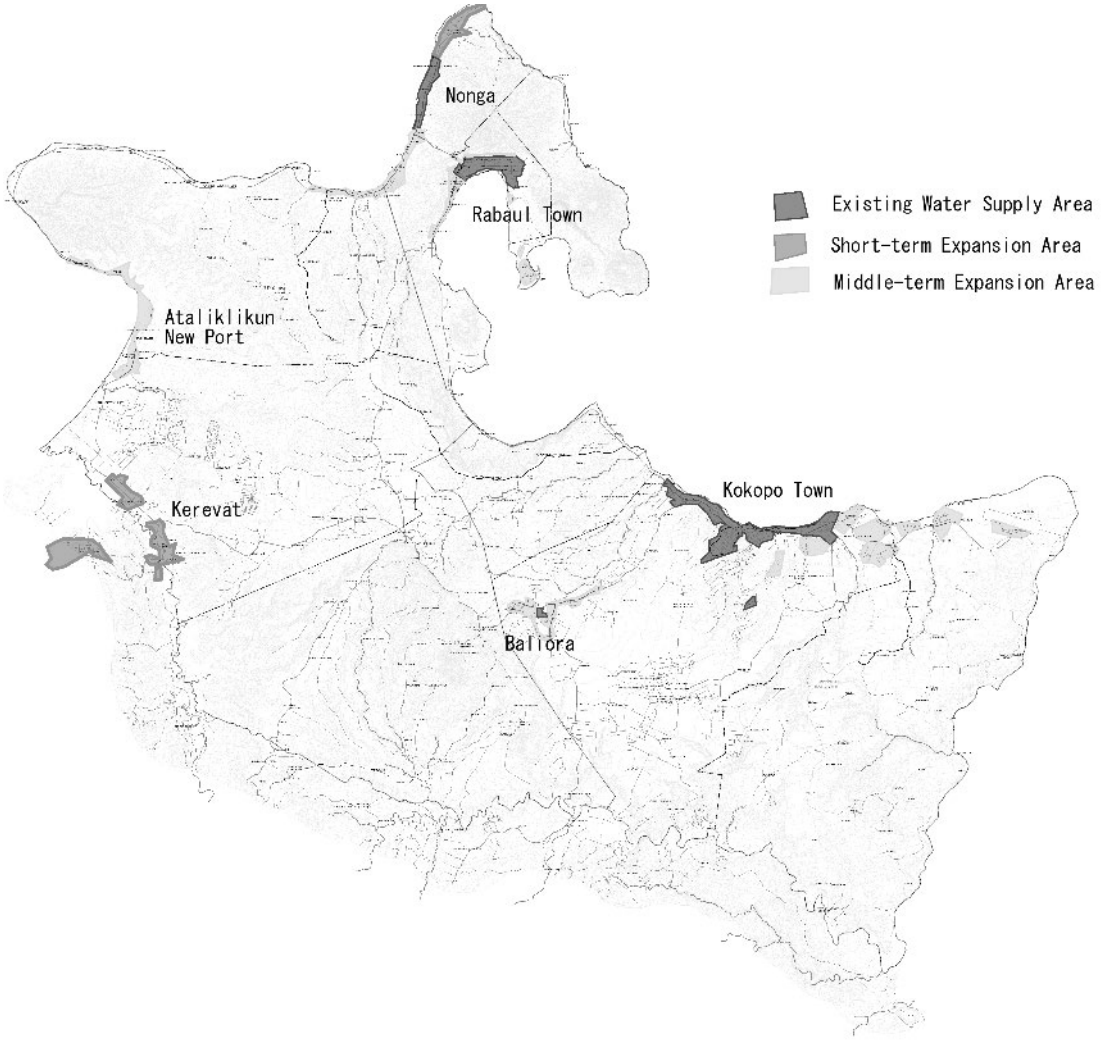
The short-term and middle-term works are summarised in Table 16.7.18.

In the short term and middle term, the expansion areas will increase as shown in Figure 16.7.18.

Table 16.7.18 Summarised Works in Short Term and Middle Term

Place/Item	Short-term Expansion Plan		Middle-term Expansion Plan	
	Contents	Costs($)		Costs($)
Kokopo Town	Borehole Field Improvement Improvements of well system and introduction of automatic and monitoring system	1,224,000	Expansion for Eastern Area Water supply system to 3 areas distributed from existing network and 4 areas distributed by 2 new supply systems	8,400,000
Rabaul Town	Improvement & Rehabilitations Installation of high elevation reservoir and new intake facilities, and introduction of automatic and monitoring system	1,920,000	Expansion for Surrounding Area Distribution pipes to surrounding Simpson Bay distributed from improved Rabaul Town water supply system	2,640,000
Nonga Area	Improvement & Rehabilitations Installation of reservoir with elevated tank and new intake facilities, and introduction of automatic and monitoring system	1,584,000	Expansion to Nonga Southern Area Distribution pipes to Nonga southern coastal areas distributed improved Nonga water supply system	1,080,000
	Expansion of Northern Area Installation of new intake facility by well, reservoir and distribution pipes to Northern Area	by Water PNG		
Kerabat Town	Construction of Water Supply System Installation of new intake facility by well /spring, reservoirs and distribution pipes	by World Bank		
Atliklikun New Port and Surrounding Area			Construction of Water Supply System Installation of new intake facility by well, reservoir and distribution pipes	3,360,000
Baliora Surrounding Area			Expansion of Water Supply Area Installation of lift pump, elevated tank and distribution pipes	1,440,000
Total		4,728,000		16,920,000

Source: JICA Expert Team



Source: JICA Expert Team

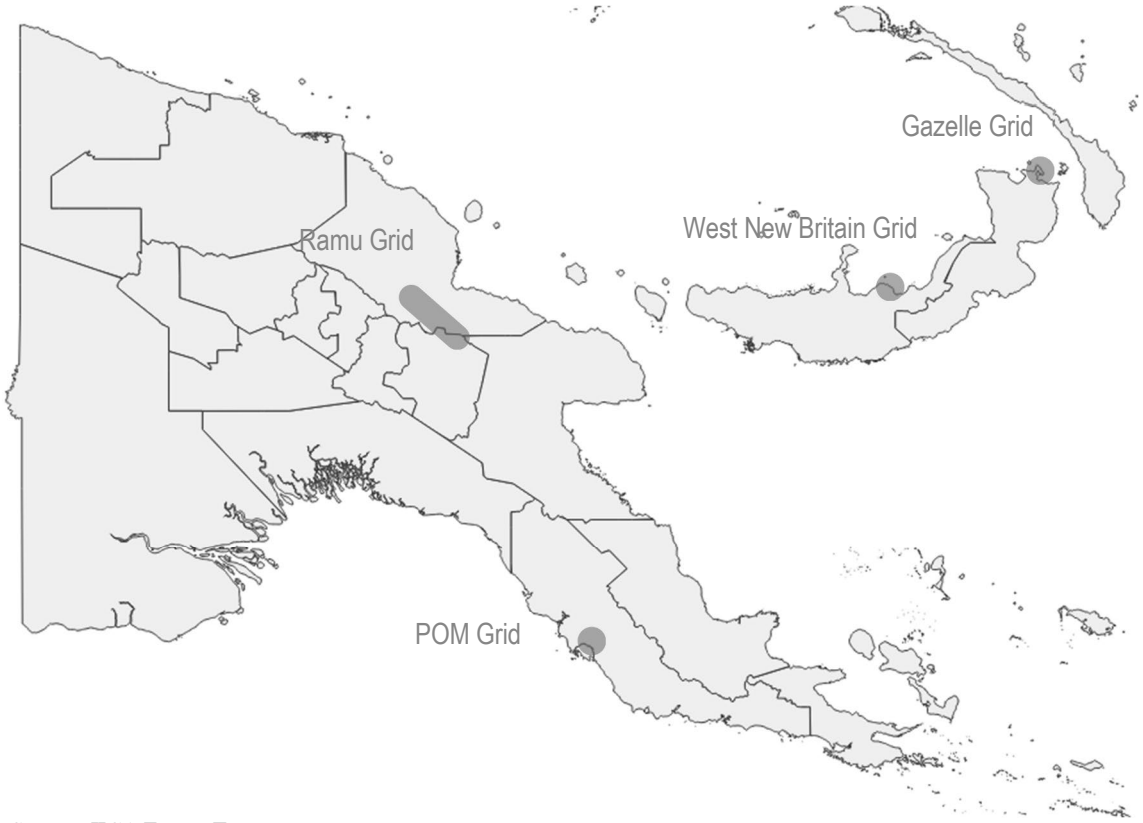
Figure 16.7.18 Water Supply Expansion Areas by Short-Term and Middle-Term Projects

Chapter 17 Development Plan for Power Supply

17.1 Present Situation of Power Supply

(1) Power Grid in Northeast Gazelle Peninsula

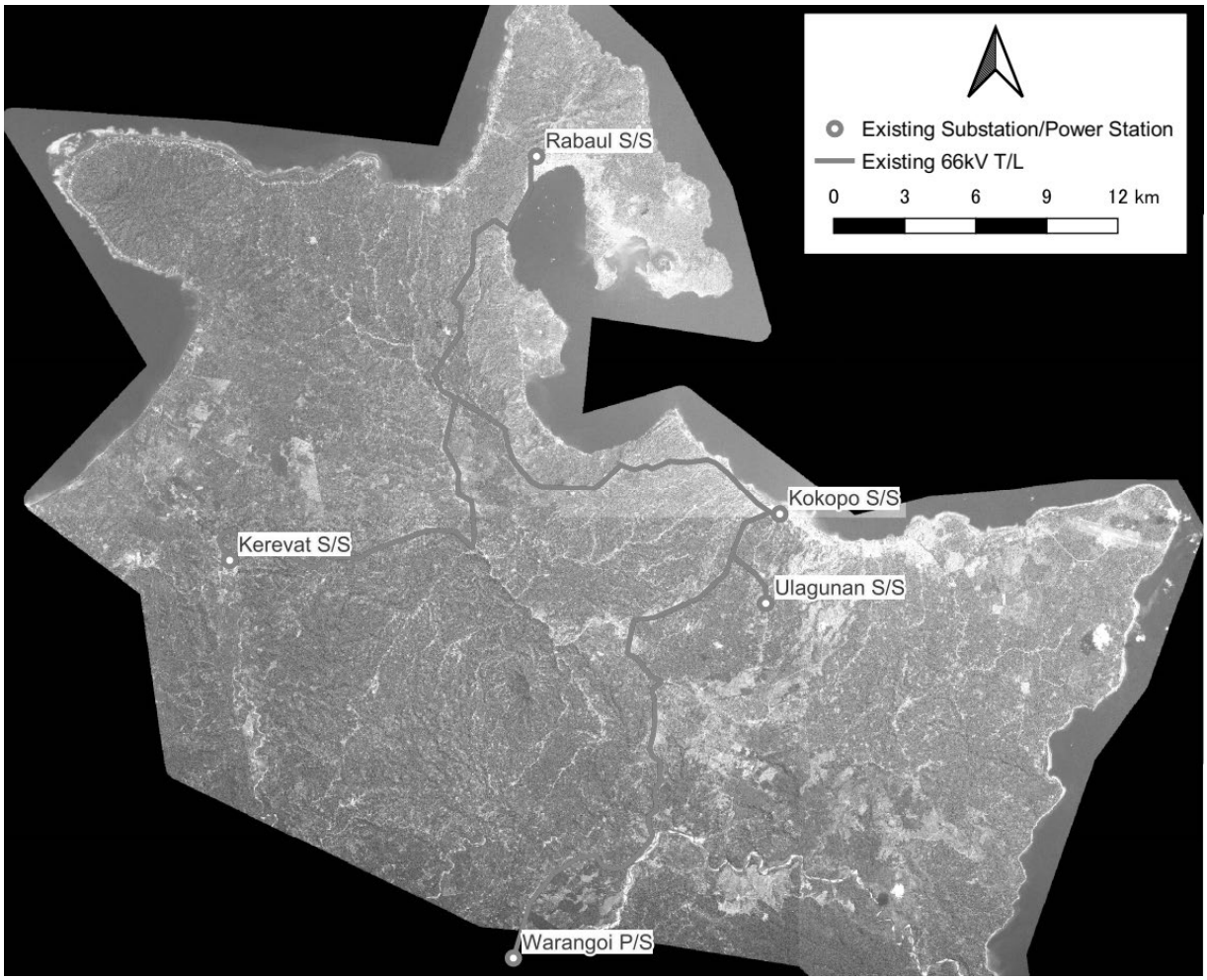
In Papua New Guinea, there are four main power grids established, namely: Ramu Grid and Port Moresby Grid (POM Grid) in New Guinea Island, and West New Britain Grid and Gazelle Grid in New Britain Island. See Figure 17.1.1.



Source: JICA Expert Team

Figure 17.1.1 Power Grids in PNG

In Northeast Gazelle Peninsula, power is supplied from Gazelle Grid, under administration of PNG Power Ltd. (PNG Power or PPL). The Gazelle Grid is mainly composed of one hydropower plant called Warangoi Hydropower Station (Warangoi P/S), four substations, and 66kV transmission lines, which are mutually connected. Also, middle voltage (22kV) and low voltage (415/240V) distribution networks are established at the secondary side of the substations, through which electricity is supplied for residential, commercial, and industrial uses. Figure 17.1.2 shows the grid map that indicates the 66kV transmission lines, key substations, and a power station in Northeast Gazelle Peninsula.



Source: JICA Expert Team

Figure 17.1.2 Grid Map for Northeast Gazelle Peninsula (Gazelle Grid)

(2) Power Generation

1) Warangoi Hydropower Station

Warangoi P/S plays an important role in supplying power as the main power resource in the Gazelle Grid. In December 2021, the rehabilitation of the power plant was completed through ADB financial assistance and since then, it has been in operation. This plant is a run-of-river type power plant and Francis water turbine with a double runner is applied. Also, an effective head is 46 m, and the rated output is 5MW per unit, and two units are installed. With the system rehabilitated, a new SCADA (Supervisory Control and Data Acquisition) system has been introduced for manipulating disconnectors and switchgears at the substations, and it enables to conduct load shedding by switching off 22kV feeders when the demand-supply balance of the Gazelle Grid cannot be maintained properly.

2) Diesel Generators

In addition to Warangoi P/S, small diesel power generators are installed at Kerevat and Ulagunan Substations (Kerevat S/S and Ulagunan S/S) for supplemental power supply in case needed. The capacity breakdown of the existing power facilities in the Gazelle Grid is shown in Table 17.1.1. The total installed capacity of all power plants is estimated to be around 26MW. However, it was confirmed through interviews with PNG Power site engineers that several units are under maintenance and repair, and they are facing difficulties in procuring spare parts. For instance, out of six units at Ulagunan S/S, four units are being overhauled and repaired, two of which are not expected to be restored due to the lack of spare parts. Available units are #3 and #6 only, whose

output is limited. To compensate for this lack of power generation, the diesel generators leased from Aggreko, which is a supplier of temporal power generation based in the U.K., are temporarily set in the premises of the substation. One unit has 0.9MW output and a total of six units are in operation. On the other hand, at Kerevat S/S, two units of diesel generators procured from Caterpillar Inc. are installed and operated on a priority basis, since these units are more robust than the ones at Ulagunan S/S in terms of durability. The total capacity of the available generators is around 17MW.

Table 17.1.1 Capacity Breakdown of the Existing Power Plants

Name of Plant Plant Location	Generation Type	Unit#	Installed Capacity [MW]	Available Capacity [MW]	Remarks
Warangoi P/S	Hydro	1	5.0	5.0	
		2	5.0	5.0	
Ulagunan S/S	Diesel	1	1.486	---	*Under Overhaul*
		2	1.486	---	*Under Overhaul*
		3	1.486	0.8	*Output Limited*
		4	1.36	---	*Under Overhaul*
		5	1.36	---	*Under Overhaul*
		6	1.36	0.5	*Output Limited*
(Leased from Aggreko)	Diesel	1	1.0	0.80	
		2	1.0	0.85	
		3	1.0	0.85	
		4	1.0	0.85	
		5	1.0	0.85	
		6	1.0	0.85	
Kerevat S/S	Diesel	6	1.15	0.70	
		7	1.15	0.70	
Total			**26.838**	**17.75**	

Source: PNG Power

(3) Transmission Lines

In Northeast Gazelle Peninsula, most transmission lines are seriously aged having been constructed in the 1990s, and more than 20 years have passed since then. Power conductors are supported mostly by wooden poles, although concrete poles that are relatively new are used as well. The voltage class of transmission lines is 66kV only. It does not satisfy the N-1[1] rule which is the design standard all over the world, and this means that power outage is caused by one line fault only. Also, since no ground wires are put at the top of transmission towers, they are vulnerable to thunder lightning, and this tends to cause ground/short-circuit line faults. Furthermore, leaning utility poles and cracked wooden poles, shoes hanging from the overhead wires are often observed. Proper maintenance is required for maintaining power facilities. Table 17.1.2 shows the design voltage, capacity, and line length of transmission lines.

[1] N-1 rule: The criterion applied when the power system is designed — even if system component, e.g., single circuit of transmission lines, one transformer, one bus-bar, fails and shut down, the power outage does not occur—such a reliable power system is realised based on the design criterion called “N-1 rule”.



Source: JICA Expert Team

Figure 17.1.3 Existing 66kV Transmission Line (552) in Talakua

Table 17.1.2 Design Voltage, Capacity, and Line Length of Transmission Lines

Name of Transmission Line	Design Voltage [kV]	Installed Capacity [MVA]	Limited Capacity [MVA]	Line Length [km]
Warangoi - Kokopo	66	44	29	31.0
Kokopo - Navunaram	66	44	19	16.5
Kerevat - Navunaram	66	44	21	16.0
Rabaul - Navunaram	66	44	13	12.0
Bitavanar - Ulagunan	66	*Under confirmation*		

Source: PNG Power

(4) Substation

1) Kokopo S/S

Originally, two units of 15MVA transformers were installed to supply power to Kokopo District. However, one unit was removed and taken to Rabaul S/S (remains for replacement) when its transformer was damaged caused by the eruption of volcanos that happened in 1994. Since then, only one unit has been available in Kokopo. It is the used unit removed from POM and its manufactured year is 2006. Unfortunately, it was not connected to the grid and is under maintenance for repair as of March 2022. According to PNG Power, its OLTC (On-load Tap Changer) was broken down due to the earthquake that occurred on February 20th, 2022. Furthermore, the protection relay system was not in operation although it was updated in 2005. It does not seem to have been maintained properly. Even though the transformer is recovered, it would not be used due to the malfunction of a protection relay system. Accordingly, it seems that the full rehabilitation of most substation facilities is required for getting back to the original configuration.

2) Ulagunan S/S

Originally, two transformers were installed at Ulagunan S/S. Presently, however, one unit is not in operation because it is required to change the insulation oil due to its breakdown. Since there is no specific schedule for the replacement of oil, it has been separated from the grid and has not been in operation for a long time. The remaining unit, which was manufactured in China in 2014, is in operation.

3) Kerevat S/S

One transformer with a capacity of 10MVA is installed at Kerevat S/S. The transformer tripping was caused in 2021 due to unknown reasons. The soundness at the middle voltage side (22kV) was confirmed, and the high voltage side (66kV) is scheduled to be checked as soon as possible. However, any methodology for the restoration of the transformer itself has not been found yet.

4) Rabaul S/S

Due to the volcanic eruption in 1994, the existing transformer was completely broken down. For this reason, the transformer being used at Kokopo S/S, was removed to Rabaul S/S, and currently continues to be used. However, it was manufactured in the 1970s and has been seriously rusted. Therefore, it would be desirable to replace it immediately. This Rabaul S/S is located 26 km away from PNG Power Kokopo Office in Kokopo Town. It takes time for maintenance staff and operators to travel to Rabaul S/S from PNG Power Kokopo Office. In order to save such traveling time and take prompt actions such as switching circuit breakers and relay settings, one operator is stationed for system operation during day time only.

The outline of transformers in each substation is shown in Table 17.1.3.

Table 17.1.3 Outline of Transformers in Substations at Gazelle Grid

Name of Substation	Unit#	Rated Capacity [MVA]	Status	Remarks
Kokopo S/S	1	---	---	Removed to Rabaul S/S after volcano erruption
	2	15	*Not Available*	Under Repair[1]
Ulagunan S/S	1	15	*Not Available*	Required for Change of Insulation Oil
	2	15	Available	
Kerevat S/S	1	10	*Not Available*	Under Inspection[2]
Rabaul S/S	1	15	Available	Originally, Used at Kokopo S/S
Total		**70**		

1: Due to the earthquake that occurred in February 2022, OLTC(On-load Tap Changer) was mechanically broken down.
2: Due to unidentified reasons, a transformer tripping was caused in 2021. A health check is required. The methodology of recovery is being studied.

Considering that the available transformers are two units out of five units, as shown in Table 10.3, it is considered that power for the consumers is mainly supplied through the 22kV distribution network, and there is a possibility that power quality, namely, supply voltage, is not so well maintained in their operation.

(5) Distribution System

The distribution system is established at the secondary side of substations. Voltage classes are middle voltage (22kV) and low voltage (415/240V). Wooden and steel poles are commonly used. Most of the poles were constructed in the 1980s and their replacements do not seem to have proceeded on time. Due to inadequate maintenance conditions, power outages frequently occur because of incidents, such as disconnections of wires and the collapse of poles. Occasionally, blackouts are caused, and it takes a long time to recover the power supply.

Shown in Table 17.1.4 is the peak load, line length, and installed capacity of the existing 22kV feeders in the Northeast Gazelle Peninsula. It is found that Kokopo Feeder 5 is under the heaviest load condition out of all the feeders, and its load ratio was 84.2% in 2021. The 2nd heaviest loaded feeder is Kokopo Feeder 2, and its load ratio is recorded to be 58.8%. Rabaul Feeder 2 is also showing almost the same load ratio, which is 53.5%. These feeders would be the candidate for future upgrading when considering the demand growth. On the other hand, Warangoi Hydro Power Plant had been under rehabilitation financed by ADB and had not been in operation in 2020 and 2019. This means that the power was not supplied sufficiently through the entire power grid. Accordingly, the load data for each feeder tends to be lower than the one in 2021, comparatively.

Table 17.1.4 Peak Load, Line Length, and Installed Capacity of 22kV Distribution Feeders

Feeder Name	Peak Load [MW] Load Ratio [%]						Total Length	Installed Capacity
	2021		2020		2019		[km]	[MW]
Kokopo Feeder 1	0.68	21.4%	0.64	20.0%	0.38	12.0%	16.3	3.18
Kokopo Feeder 2	3.30	58.8%	1.68	29.9%	1.76	31.3%	17.4	5.61
Kokopo Feeder 4	0.75	13.4%	0.27	4.8%	0.31	5.6%	15.2	5.61
Kokopo Feeder 5	3.15	84.2%	1.13	30.2%	1.18	31.5%	3.2	3.74
Rabaul Feeder 1	0.76	31.3%	0.41	16.8%	0.41	16.8%	16.5	2.43
Rabaul Feeder 2	1.30	53.5%	1.09	44.8%	0.37	15.4%	2.9	2.43
Rabaul Feeder 3	0.35	14.4%	0.24	9.8%	0.24	9.8%	4.4	2.43
Kerevat Feeder 1	0.40	16.5%	--	--	--	--	28.0	2.43
Kerevat Feeder 2	0.48	19.7%	0.22	9.0%	0.24	9.9%	29.0	2.43
Kerevat Feeder 3	0.50	8.9%	--	--	--	--	15.0	5.61
Warangoi Feeder 1	0.38	6.8%	1.71	30.5%	0.30	5.3%	28.4	5.61
Total	12.05		7.37		5.19			

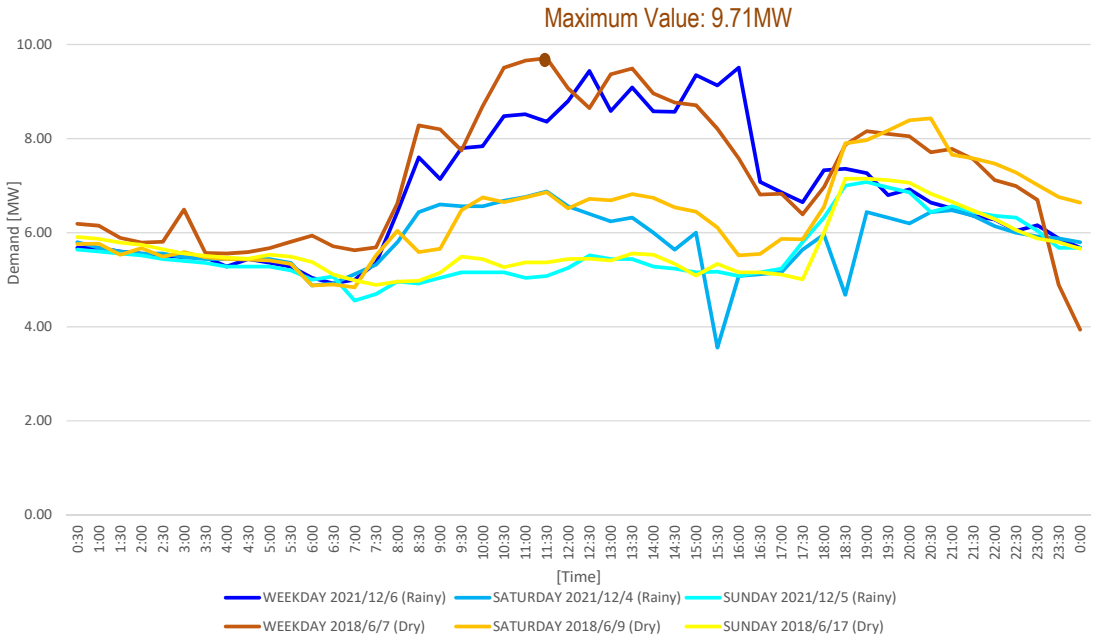
Source: PNG Power

(6) Electrification Rate

According to PNG Power, the electrification rate for PNG is roughly 60% on a nationwide basis. This electrification rate is also found in the World Bank database. This figure is the one obtained on the condition that off-grid solar products are considered. The grid-connected electrification rate, however, is approximately 15% in PNG in 2021. As for Northeast Gazelle Peninsula, it is approximately 13% only and relatively lower than any other area in PNG.

(7) Power Demand

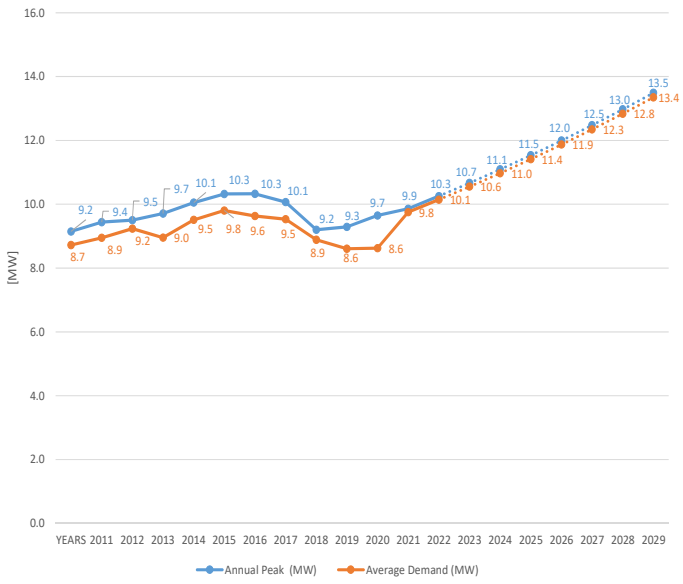
According to the typical daily load curve of power demand provided by PNG Power, it is found that power tends to be consumed largely during the daytime on weekdays and in the evening on weekends. Also, no outstanding difference in power consumption between the rainy season and the dry season is seen. However, the peak demand during the dry season is a bit larger than during the rainy season. Figure 17.1.4 shows the daily load curves for weekdays and weekends during both the rainy season and dry season. It is found that the peak demand on weekdays under the dry season was recorded to be 9.71MW in the daily peak load data as a maximum value.



Source: PNG Power

Figure 17.1.4 Typical Daily Load Curve (Rainy Season and Dry Season)

Figure 17.1.5 shows the yearly maximum peak demand and average demand for the Gazelle Grid. The actual record between 2011 and 2022, and forecasted demand from 2023 to 2030, are shown here. The actual growth rates are in a range between -9% and 4% from 2011 to 2022. A high growth rate of 4% is estimated in the future from 2023 to 2030 by PNG Power.



YEARS	Annual Peak (MW)	Average Demand (MW)	Growth Rate (%)
2011	9.1500	8.723	3.17
2012	9.4400	8.948	0.64
2013	9.5000	9.236	2.21
2014	9.7100	8.957	3.50
2015	10.0500	9.512	2.69
2016	10.3200	9.803	0.10
2017	10.3300	9.631	-2.52
2018	10.0700	9.536	-8.64
2019	9.2000	8.888	0.98
2020	9.2900	8.604	3.88
2021	9.6500	8.624	2.18
2022	9.8600	9.755	4.00
2023	10.2544	10.145	4.00
2024	10.6646	10.551	4.00
2025	11.0912	10.973	4.00
2026	11.5348	11.412	4.00
2027	11.9962	11.868	4.00
2028	12.4760	12.343	4.00
2029	12.9751	12.837	4.00
2030	13.4941	13.350	---

Source: PNG Power

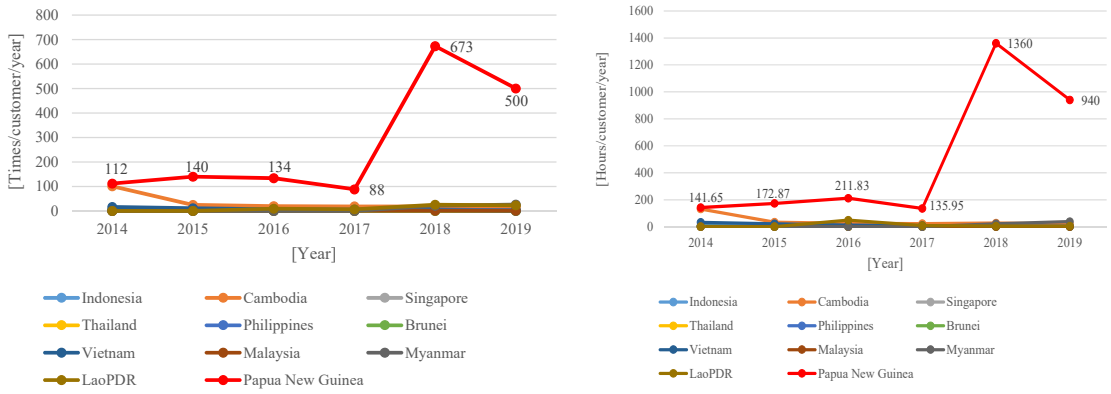
Figure 17.1.5 Yearly Maximum Peak Load (2011-2022) and Forecasted Demand (2023-2029)

In 2016, 2017, and 2022, the annual peak demands were the highest ever recorded, similarly at 10.3MW. The power growth rate is closely related to economic and social development. Therefore, if it steadily grows as predicted, the annual peak load will reach 13.5MW in 2030. Since the total available power output is currently around 17MW, the power demand is covered by the current power generation, numerically. However, considering that one unit of generators at Warangoi P/S is forced to be on stand-by condition due to the water shortage and some diesel generators require

maintenance outages to be caused by troubles and faults, there is a possibility that the demand-supply balance could not be maintained properly.

(8) Power Outage

As an index that shows the duration and frequency of power outages per year per customer, SAIDI (System Average Interruption Duration Index) and SAIFI (System Average Interruption Frequency Index) are well known in the world. Figure 17.1.6 shows both SAIDI and SAIFI for ASEAN countries and Papua New Guinea, which are publicized through World Bank Data Base. It is found that there is a big gap between ASEAN countries and Papua New Guinea on these indices.

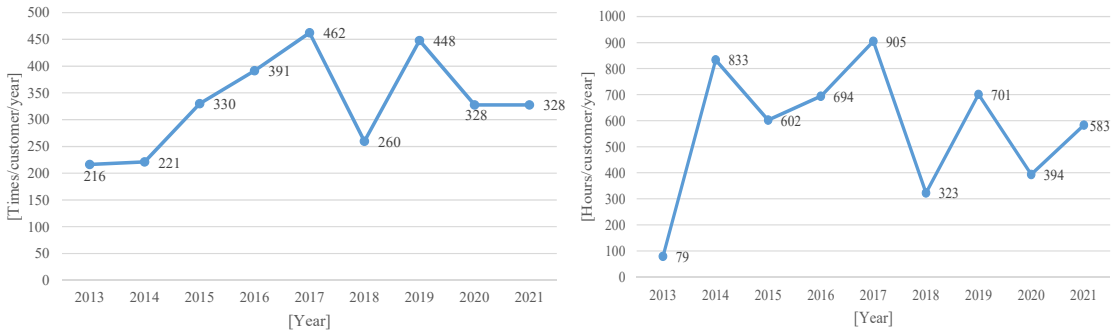


SAIFI SAIDI

Source: World Bank Data Base

Figure 17.1.6 SAIFI and SAIDI for ASEAN Countries and Papua New Guinea

Next, SAIDI and SAIFI only for the Gazelle Grid are shown in Figure 17.1.7.



SAIFI SAIDI

Source: PNG Power

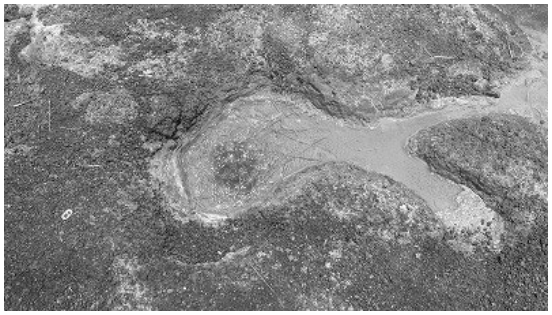
Figure 17.1.7 SAIFI and SAIDI for the Gazelle Grid (2013 – 2021)

Comparing Figure 17.1.6 and Figure 17.1.7, the values of SAIFI and SAIDI for the whole of PNG and Gazelle Grid are relatively higher than the ones for ASEAN countries.

(9) Geothermal Resource Development

PNG is characterized by volcanic islands with potential geothermal resources. Mineral Resources Authority (MRA) organized geothermal technical teams and started a preliminary study targeting potential several sites including Rabaul District. The preliminary study is composed of four technical fields, namely, “geochemistry”, “geology”, “geophysics”, and “hydrology”. Though most component studies have been temporarily suspended due to the impact of COVID-19, MRA predicts that only the geophysical study would be completed by the end of 2022. The official geothermal resource development policy has not yet been developed. As part of private sector participation, Fortescue Future Industries (hereinafter, referred as “FFI”), which is a subsidy of

Fortesque Metals that is an Australian leading company in the iron ore industry, is partnering with PNG regarding the development of renewable energy including geothermal power. Presently, FFI is conducting feasibility studies to form several hydropower projects and geothermal energy projects in PNG.

Source: JICA Expert Team

Figure 17.1.8 Potential Sites for Geothermal Resource Development in Northeast Gazelle Peninsula

17.2 Issues on Power Supply

(1) Frequent Power Outage

The situation on power outage in Northeast Gazelle Peninsula according to the personnel of LLGs, engineers of PNG Power and others are as follows:

- Gazelle Grid is shut down sometimes, causing blackout.
- It takes a couple of days, sometimes, one week for the power to resume.
- Power outages, occasionally, occur five times a week. In the worst case in the past, there was a blackout that continued for a month.

Based on the above situation and statistical data, such as SADI and SAIFI shown in Figure 17.1.7, reducing power outages is a critical issue in promoting the development of Northeast Gazelle Peninsula.

(2) Shortage of Power Output of Warangoi Hydro Power Station

According to PNG Power, recently the water flow seemingly has become insufficient even during the rainy season. Although Warangoi hydropower plant is completely rehabilitated and ready to run in good condition, one unit out of two generators is sometimes forced to halt due to the water shortage. Since the output is 5MW for one unit, its impact is very huge considering the whole power demand, approx. 10MW, in the Gazelle Grid. What is more serious, sand and stones flown from the upper stream of the river are accumulating and affecting water storage, which is sometimes causing the generation restriction.



Source: JICA Expert Team

Figure 17.2.1 Reservoir with Sand and Stones Carried Away from the Upper Stream in Warangoi Hydropower Plant

(3) Shortage of Power Output of Diesel Generators

As mentioned in Section 17.1-(2)-2), existing diesel generators cannot fully produce output due to the lack of spare parts and unfavourable conditions. For these reasons, power generation is not sufficient, and it is necessary to improve and enforce the capacity of power generation to meet growing demand.

(4) Inadequate Maintenance of Power Facilities

It is observed that most of the power facilities are not maintained properly. In addition, most of them are ageing, being procured from the 1980s to the 1990s, and requiring to be replaced. However, they have not been replaced and continue to be used under seriously aged and damaged conditions. Furthermore, there are many sites where trees under naked distribution lines are not trimmed, and this can cause the ground fault of distribution lines. The transmission lines are operated with less capacity, and the conductors cannot be utilised in full capacity. This situation means that proper maintenance work has not been conducted for a long time.



Untrimmed trees where naked distribution wires are passing through



Reclining pole with broken insulators and supportive wire



Shoes hung over the transmission lines



Old and damaged wooden pole

Source: JICA Expert Team

Figure 17.2.2 Conditions of Power Facilities

(5) Inadequate Storage Conditions for Spare Parts and Equipment for Replacement

It was observed that new insulators and wooden cross-arms for distribution lines were just left outside the warehouse. This is not a favourable condition since such kind of storage causes the acceleration of equipment ageing due to exposure to direct sunlight and rain.







Source: JICA Expert Team

Figure 17.2.3 Replacement Parts Stocked Outside the Warehouse

(6) Environmental Impact of Diesel Generators

There are commercial facilities, accommodation facilities, factories, etc. which installed diesel generators in their premises in preparation for power outages. Since diesel generators emit not only greenhouse gases, such as CO_2 and NOx, but also PM (particular matter), their excessive installation is not favourable from an environmental point of view. Furthermore, they make so much noise while running, and consequently, will cause noise problems in urban areas.



Source: JICA Expert Team

Figure 17.2.4 Diesel Generator Installed in a Beach Resort Hotel in Kokopo

17.3 Objectives of Power Supply Development

The goal of development of power supply is to provide stable and reliable power required for sustainable socioeconomic activities in Northeast Gazelle Peninsula, as well as to contribute to the promotion of the development of the economic sectors.

In order to achieve a stable and reliable power supply for promoting social and economic development, reducing power outages is of the highest priority and strongly required for Northeast Gazelle Peninsula. In order to solve this problem, the following development directions should be sought:

- To rehabilitate existing power facilities including reinforcement of high priority transmission lines, substations, and distribution lines
- To satisfy short-term needs to provide supplemental power supply by strengthening diesel power generators at Kokopo S/S, Rabaul S/S, and Kerevat S/S in Kokopo Town, Rabaul Town, and Kerevat Town, in which economic sector development is promoted by establishing Special Economic Zones and industrial parks
- To satisfy medium and long-term needs, reduce dependence on diesel power generators, and develop alternative energy resources, such as geothermal and solar energy resources, to diversify power sources in response not only to the demand growth in urban areas but also to the need for rural electrification
- To reinforce the maintenance capability of power facilities of PNG Power

17.4 Strategies for Development of Power Supply

In cooperation with the previously mentioned existing power development plans, the development strategies for power supply in this NEGID-Plan are composed of (1) Strategy for Power Generation Development and (2) Strategy for Transmission, Substation and Distribution.

17.4.1 Strategy for Power Generation Development

If 5MW mega-solar power plant and 7MW Upper Warangoi hydropower plant are established in accordance with the said PDP, the total generation capacity will reach approximately 29MW and

should be able to numerically cover the future peak demand forecasted. However, it is also predicted that several generation units might be shut down due to unforeseen technical problems and/or ageing facilities and equipment. Thus, the further addition of generation plants should be recommended in preparation for the future unforeseen reduction in supply capacity. It is also important to utilise carbon-neutral energy resources for generation development in accordance with the principles of NEP 2017-2027. The following renewable energy development plan is suggested:

- Development plan for geothermal power plant: Since there is a big potential for geothermal energy resources in the Northeast Gazelle Peninsula, the development of a geothermal power plant which is well known as one of the typical renewable energy resources—once it is developed, it enables stable power supply—is highly recommended to supply base load.

17.4.2 Strategy for Transmission, Substation, and Distribution Development

In the transmission and distribution sector in the Northeast Gazelle Peninsula, the development plan led by the Asian Development Bank (ADB) has a key role to improve Gazelle Grid. Hence, the following development plans should be promoted:

- Rehabilitation of the existing 66kV transmission lines and substations not to be covered by ADB assistance: Since the power is supplied through the power network, the partial rehabilitation and reinforcement will be insufficient. Thus, the power facilities not covered by ADB assistance will require rehabilitation.
- Reinforcement of back-bone lines (66kV Transmission Lines 552 and 553): To promote the development of the Northeast Gazelle Peninsula, the reinforcement of these back-bone lines is essential.
- Duplexing of the existing 66kV transmission lines (From single circuit to double circuit): In order to improve supply reliability and to meet the N-1 rule, this duplexing of lines is required.
- Rehabilitation of the existing 22kV distribution lines: The 22kV distribution lines are entirely facing ageing problems as well. Replacement and rehabilitation are required on a prioritisation basis.

17.5 Power Supply Projects

17.5.1 Important Power Supply Projects

The Gazelle Grid entirely requires rehabilitation and replacement of each piece of equipment due to ageing. Therefore, all the important projects listed below will be required and it will be desirable to proceed with the replacement and rehabilitation work. Based on the present situation, the following important rehabilitation projects were recommended for implementation over the next approximately 10 years (by 2032):

(1) Power Generation

[PW-01] Ulagunan Diesel Generators Rehabilitation Project: As shown in Table 17.1.1, the number of available units at Ulagunan S/S is two only out of six units. Furthermore, even available units cannot produce rated output due to technical problems. The remaining four units are facing difficulty in procuring spare parts due to their unavailability. It is recommended that these generators are replaced with new ones, of which spare parts are available.

(2) 66kV Transmission Line

[PW-02] 66kV Transmission Line 552 and 553 Rehabilitation Project: These lines are important called the “Back-bone Line” connecting Kokopo and Rabaul. It was observed that some

of the transmission poles were inclined and insulators were remarkably broken, in spite of the fact that these lines have an important role in power supply.

[PW-03] 66kV Transmission Line 554 Rehabilitation Project: Navunarum T-off line segment is supposed to be replaced by ADB's rehabilitation project. This line is connected to Vunakanau Switchyard which is to be constructed as well. However, 66kV transmission line 554 will not be covered. Therefore, it will be important to rehabilitate this line to ensure the power supply from Vnakanau Switchyard.



Source: JICA Expert Team

Figure 17.5.1 Navunaran T-Branch Line Segment and 66kV Transmission Line 554

(3) 66/22kV Substation

[PW-04] Kokopo Substation Rehabilitation Project In this substation, the protection relay system does not work properly. Due to technical problems, power outages are caused frequently by malfunction and unnecessary functions of the system. In order to ensure the reliability of the power supply, this rehabilitation project will be essential.

[PW-05] Rabaul Substation Rehabilitation Project Likewise, it seems that the protection relay system does not work properly at this substation. Also, disconnectors, bus-bar, etc. installed in the 1970s are still continuously being used. When a volcanic eruption occurred in 1994, most of this equipment was buried in volcanic ash and dust. However, they were washed and being used up to now. The only transformer is a second-hand unit removed from Kokopo S/S after the volcanic eruption in 1994. In preparation for probable volcanic eruption in the future, it will be important to rehabilitate this substation, and worth considering a shift to an indoor substation.



Source: JICA Expert Team

Figure 17.5.2 Transformer and Bus-Bar at Rabaul S/S

(4) 22kV Distribution Line

[PW-06] Kokopo Feeder 2 Rehabilitation Project: This feeder is the longest distribution line, and Tokua Airport is connected at the end of the line. Accordingly, the voltage drop might be one

of the technical concerns. Also, it was frequently observed that ground clearance was not secured sufficiently at various locations. According to PPL, the clearance of HV and LV should be more than 6m and 5.5m in consideration of regulation. Since the insulation wires are adopted, they do not cause an electric shock to the objects and persons which directly touch them. However, this status should be improved from a safety point of view. Specifically, it will be recommended to shorten the span among poles, improve the line sag and lift the wire at the higher position by replacing existing poles by taller poles.



Source: JICA Expert Team

Figure 17.5.3 End Terminal of Kokopo Feeder 2 (Connection with Tokua Airport)



Source: JICA Expert Team

Figure 17.5.4 Insufficient Ground Clearance (Kokopo Feeder 2)

[PW-07] 22kV Kerevat 1 Feeder and 22kV Rabaul 1 Feeder Rehabilitation This distribution line has the role of supplying power along the north coastal road in the northern-west part of the Northeast Gazelle Peninsula, which is expected to become a more important line for regional development intending a shift of port function. Normally, this line is segregated at the ABS (Air Break Switch) installed at Livuan. The distribution line originating from its ABS to Kerevat S/S direction is called “Kerevat Feeder 1”, and the one originating from its ABS to Rabaul S/S direction is called “Rabaul S/S”. These lines function as interconnection lines for Kerevat S/S and Rabaul S/S.

(5) Alternative Power Resources

[PW-08] Project to Promote the Development of Alternative Sources of Power through Both Private and Public Investment :

The study is to promote private investment and public investment in power generation by alternative sources of energy, such as solar and geothermal.

17.5.2 Priority Projects of Power Supply

(1) Policy to Select Priority Projects

Considering the fact that ADB's assistance will highly contribute to the improvement of Gazelle Grid, the following key points are considered to select priority projects:

- To contribute to the acceleration of regional development along coastal areas connecting Kokopo and Rabaul and around Ataliklikun Bay which is expected to be developed as a key alternative place that has a port function
- Not to overlap with ADB's projects
- Combining more than two important projects to form a priority project, where necessary, in order to achieve an effective implementation impact.

(2) Selected Priority Projects

Based on the above selection policy, one important project on transmission, one important project on electricity distribution, and one important project on power generation were selected as priority projects as follows:

- [PW-02A] 66kV Transmission Lines 552 and 553 Rehabilitation Project including the Rehabilitation of Kokopo and Rabaul Substations
- [PW-07] 22kV Kerevat 1 Feeder and 22kV Rabaul 1 Feeder Rehabilitation Project
- [PW-08] Project to Promote the Development of Alternative Sources of Power through Both Private and Public Investments

(3) Profiles of Priority Projects

The respective priority project for 66kV Transmission Lines including key Substations, "Kokopo S/S" and "Rabaul S/S", and 22kV Distribution Lines are proposed as follows:

66kV Transmission Lines and 66/22kV Substations

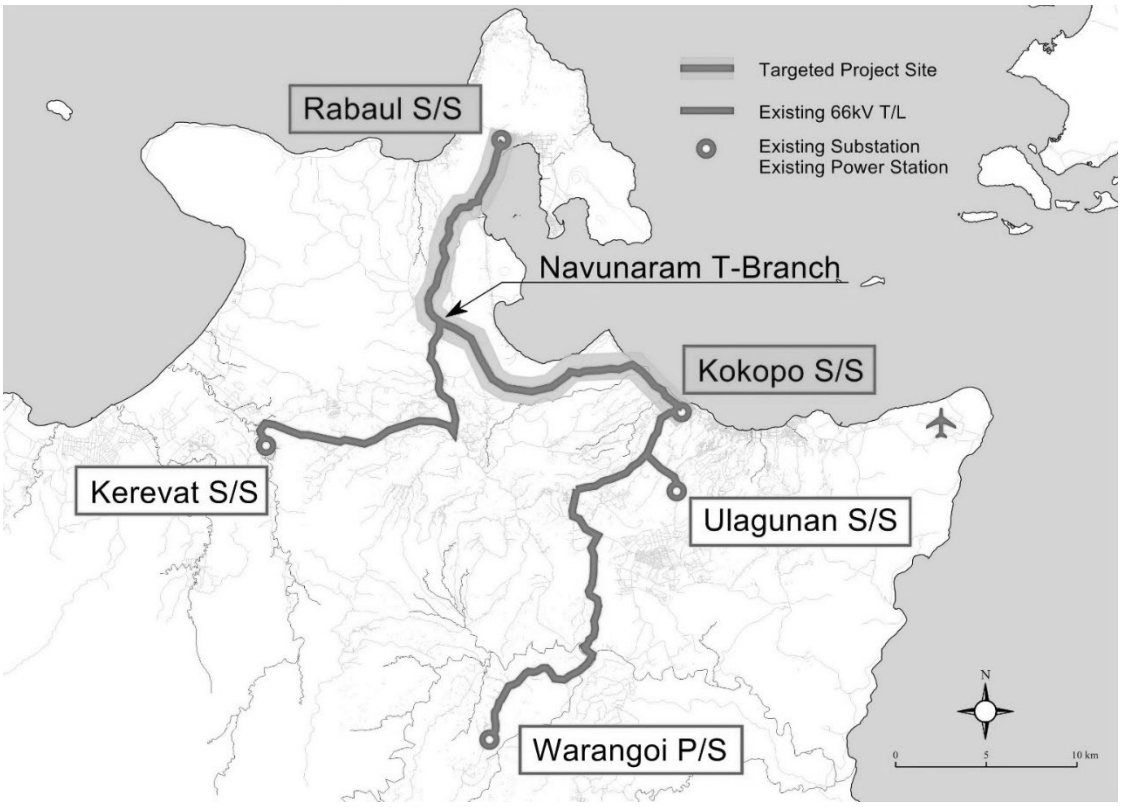
1) Project Name

[PW-02A] 66kV Transmission Lines 552 and 553 Rehabilitation Project including the Rehabilitation of Kokopo and Rabaul Substations

This project is formulated by combining the important projects of [PW-02], [PW-04], and [PW-05].

2) Project Location

The project site will be the right-of-way of the existing 66kV transmission line connecting Kokopo S/S and Rabaul S/S, extending over the coastal area from Kokopo to Rabaul through Rakandakanda with a length of 44km, as shown in Figure 17.5.5.



Source: JICA Expert Team

Figure 17.5.5 Project Site of the Priority Project for 66kV Transmission Lines

3) Project Objectives

The objectives of the Project are as follows:

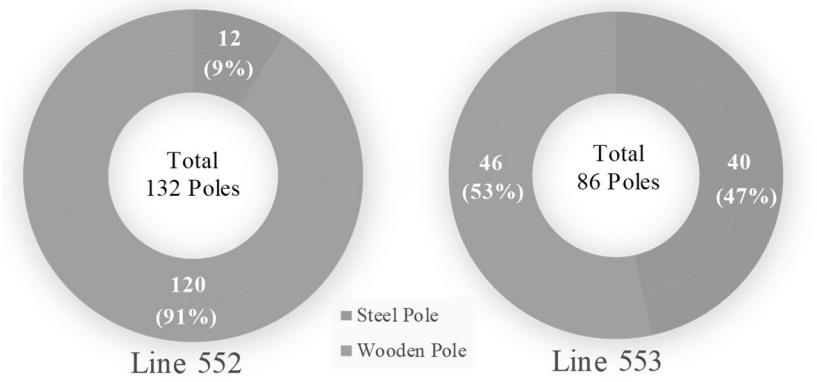
- To stabilise the power supply in the Gazelle Grid
- To increase the capacity of power transmission to supply stable power for Kokopo Town and Rabaul Town where economic sector development is to be promoted

4) Project Description (Contents of the Project)

Most of the equipment composing power facilities—wooden poles, transformers, isolators, switchgears, insulators, and other accessories—are seriously aged, deteriorated, and damaged due to volcanic ashes or improper maintenance. Therefore, the following basic plan will be recommended as a priority project:

- To rehabilitate 66kV Transmission Lines 552 and 553 (transmission poles, insulators, wires, etc.) from Kokopo S/S to Rabaul S/S, excluding the line segment established at Navunaram T-Branch
- To rehabilitate Kokopo S/S and Rabaul S/S including protection relays

As shown in Figure 17.5.6, wooden poles account for more than 90% of all the existing poles (132 poles) for Transmission Line 552, and all of them are not new wooden poles. Therefore, it will be required to immediately replace them with new poles, specifically, steel poles that PPL intends to procure new poles or new transmission towers that are already introduced to the power grid in New Guinea Island.



Source: JICA Expert Team

Figure 17.5.6 Ratios of Wooden Poles and Steel Poles Used for Transmission Lines 552 and 553

Under the project design stage, the following change of specification and configuration should be studied through the system analysis:

- To change the specification of the transmission line from a single circuit to a double circuit to satisfy the N-1 rule
- To install two units of transformers at the respective substations to satisfy the N-1 rule

Also, it will be required to closely coordinate with ADB's transmission line and substation construction project to minimise power failure areas during the construction period.

5) Project Cost

In the "15 Year PDP", the project cost for this upgrading is estimated at 10 million PGK on the condition that the length of 44km will be upgraded. No specific conditions are unclear for this estimation. On the other hand, it is generally estimated that the unit cost for 66kV transmission lines is assumed to be 500,000 PGK/km in PNG. Therefore, the project cost related to 66kV transmission lines will be roughly around 22 million PGK. On the other hand, approximately, a total of 40 million PGK is estimated for the rehabilitation of both Kokopo S/S and Rabaul S/S.

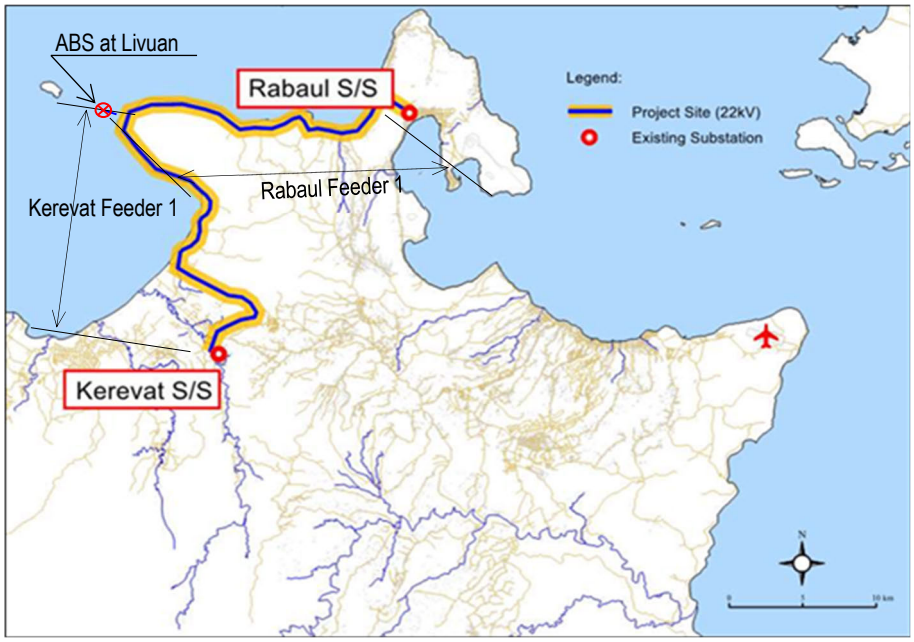
22kV Distribution Lines

1) Project Name

[PW-07] 22kV Kerevat 1 Feeder and 22kV Rabaul 1 Feeder Rehabilitation Project

2) Project Location

The project site will be the right-of-way of 22kV Kerevat Feeder 1 and Rabaul Feeder 1 which are connecting Kerevat S/S and Rabaul S/S as shown in Figure 17.5.7.



Source: JICA Expert Team

Figure 17.5.7 Project Site of Priority Project for 22kV Distribution Lines

3) Project Objectives

The objectives of the project are as follows:

- To reinforce the distribution line by relocating and rehabilitating its equipment
- To improve the capacity of distribution lines in preparation for future demand growth

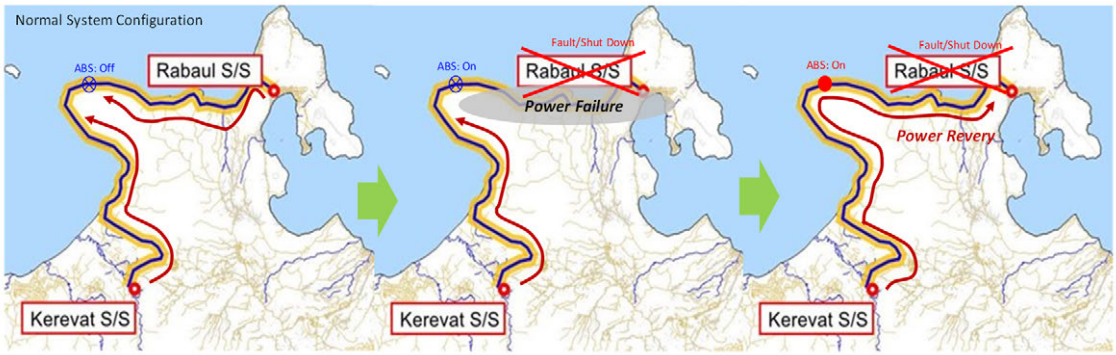
4) Project Description (Contents of the Project)

This distribution line has the role of supplying power along the north coastal road in the northern-west part of the Northeast Gazelle Peninsula, which is expected to become a more important line for regional development intending a shift of port function. Normally, this line is segregated at the ABS (Air Break Switch) installed at Livuan. The distribution line originating from its ABS to Kerevat S/S direction is called “Kerevat Feeder 1”, and the one originating from its ABS to Rabaul S/S direction is called “Rabaul S/S”. These lines function as interconnection lines for Kerevat S/S and Rabaul S/S. When the shutdown on the side of Kerevat S/S or Rabaul S/S occurs, the power supply is stopped, and the power outage happens consequently in the area to which the power is supplied through this line. However, it is possible to re-supply the power by turning on the ABS from the live system. Its power recovery process is illustrated in Figure 17.5.9 and Figure 17.5.10.



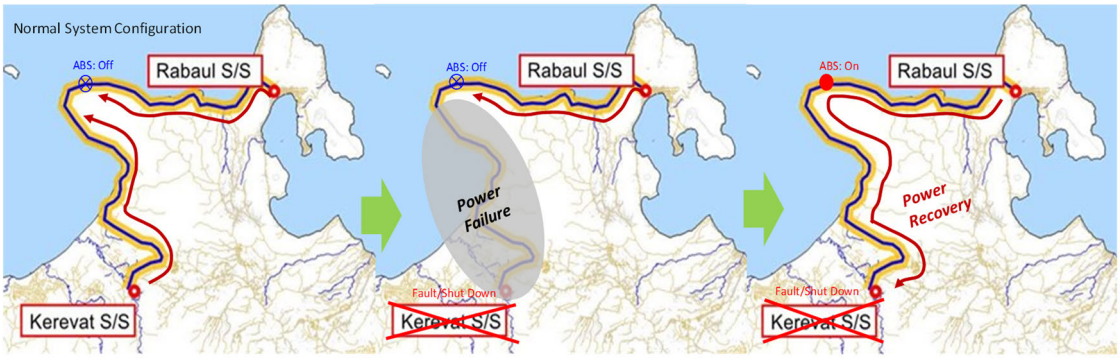
Source: JICA Expert Team

Figure 17.5.8 Distribution Pole with ABS and Its Operation Handle at Livuan



Source: JICA Expert Team

Figure 17.5.9 Power Recovery Process (In Case of Rabaul S/S Shutdown)



Source: JICA Expert Team

Figure 17.5.10 Power Recovery Process (In Case of Kerevat S/S Shutdown)

However, this feeder is characterised by serious ageing problems. As shown in Figure 17.5.12, poles built along the coastal area are existing on a less-solid ground condition caused by presence of seawater, and several of them require relocation to solid ground. Also, there is a risk that the poles will be hit by high tide or tsunami since they are right near the seaside line. Furthermore, this feeder is also passing through vegetation areas, and it makes maintenance work difficult. From this environmental condition, it will be strongly required to relocate.



Inclined Wooden Pole



Broken Arm and Insulators



Weak Ground Condition



Wooden Poles in the Vegetation Area

Source: JICA Expert Team

Figure 17.5.11 Present 22kV Kerevat Feeder 1 and Rabaul Feeder 1 at Liguan



Source: JICA Expert Team

Figure 17.5.12 Wooden Poles Built Near Coastal Line at Mailivuan

5) Project Cost

According to LCPDP, the unit cost for 22kV distribution lines is estimated at 65,000 PGK/km. Considering that the line length targeted is around 42km, the cost for this project will be 2.73 million PGK in total.

(4) Alternative Sources of Power Generation

1) Project Name

[PW-08] Project to Promote the Development of Alternative Sources of Power through Both Private and Public Investments

2) Project Location

The whole of the Northeast Gazelle Peninsula

3) Project Objectives

To promote private investment and public investment in power generation by alternative sources of energy, such as solar and geothermal

4) Project Description

This is an investment promotion activities to be done by Division of Policy, Planning and Research, ENBPA.

17.5.3 Alternative Options for Priority Project

Based on the development strategy stated in Section 17.4, the provision of a boom truck with a bucket will be suggested as an optional component. This provision will surely contribute to the improvement of PPL's O&M capability, such as recovery work during disaster, and the usual maintenance work. Considering the business scale of PPL Kokopo Office, provision of a few trucks will be sufficient. The procurement cost will be estimated at 180 thousand USD/unit.



Source: JICA Expert Team

Figure 17.5.13 Boom Truck with Bucket

Chapter 18 Phased Implementation Plan of High-Priority and Priority Projects for Infrastructure Development in Northeast Gazelle Peninsula

18.1 Introduction

In this chapter, selection of projects is conducted in four steps as shown in Figure 18.1.1.

The first step is to identify important projects for each infrastructure sector.

The second step is to select high-priority projects and priority projects out of the identified important projects from the perspective of the formulated regional development strategies for the Northeast Gazelle Peninsula.

The third step is to prepare a phased implementation plan for high-priority and priority projects from an overall regional development perspective.

Th fourth step is furthermore to select candidate projects for a pre-feasibility study, out of which one project will be selected for conducting a pre-feasibility study in the NEGID-Plan.

In the following sections of this chapter, each of these steps is described.



Source: JICA Expert Team

Figure 18.1.1 Four Steps for Selection of Projects

18.2 Identified Important Projects by Infrastructure Sector

In Northeast Gazelle Peninsula, a variety of projects or actions in infrastructure sectors have been proposed by the past and current provincial development plans as discussed in Appendix C. Those proposed projects are necessary and useful for sustaining socio-economic activities and promoting socio-economic development in the region.

In each infrastructure sector, the following types of projects are formulated in NEGID-Plan:

- Those projects for rehabilitating aged or deteriorated infrastructure to sustain socio-economic activities in the region,
- Those projects for increasing the capacity of infrastructure function in response to increased demand,

- Those projects for extending service areas of infrastructure in response to extended distribution of population distribution or economic activities, or
- Those projects for infrastructure provision to withstand disasters.

Table 18.2.1 Important Projects Identified for Each Infrastructure Sector

Infrastructure Sectors	Important Projects	
Regional Infrastructure		
Trunk Roads	[TR-01] Project for Strengthening of Kokopo-Rabaul Coastal Road [TR-02] Project for Upgrading of Rabaul-Kurakakaul-Rakunai Road (Alternative Road to the Kokopo-Rabaul Coastal Road and to Kokopo-Rabaul Top Road)	[TR-03] Project for Upgrading of North Coast Road between Kabaira (Ataliklikun Bay) and Kerevat Town [TR-04] Project for Upgrading of Kurakakaul-Kabaira (Ataliklikun Bay) Section of North Coast Road [TR-05] Project for Upgrading of Malakuna-Putput Road [TR-06] Project for Upgrading of Kabakaul-Toma Road
Ports	[SP-01] Project for Rehabilitation of Rabaul Port Infrastructure [SP-02] Project for Upgrading of Rabaul Port Berth 2 [SP-03] Project for Basic Study on New Port Development in Ataliklikun Bay including the following aspects: - Oceanographic Survey, Topographic Survey - Survey for Land Acquisition - Environmental Survey - Study of Fixing Port Location - Feasibility Study (Economic and Financial)	[SP-04] Project for Development of Berth specially for Fishing Vessels (for providing water, fuels and others) [SP-05] Project for Construction of New Port in Ataliklikun Bay
Airports	[AP-01] Project for Redevelopment of Tokua Airport Phase 1 (Upgrading of the Capacity and the Status of Tokua Airport to International Airport Phase 1) [AP-02] Project for Redevelopment of Tokua Airport Phase 2 (Upgrading of the Capacity and the Status of Tokua Airport to International Airport Phase 2)	[AP-03] Project for Promotion of Investment in Airport City Precincts Adjacent to the Prospective Upgraded Tokua Airport
Urban Infrastructure		
Urban Roads	[UR-01] Project for Rehabilitation of Port Access Road in Rabaul Town (1.8 km) including Improvement of Drainage Network in Rabaul Town [UR-02] Project for Rehabilitation of Mango Avenue (1.1 km) and Blanche Street (0.9 km) in Rabaul Town	[UR-03] Project for Development of Southern Section (2.5 km) of Kokopo Town Ring Road [UR-04] Project for Development of Kokopo Town Bypass Road (6.5 km)
Water Supply	[WS-01] Project for Rehabilitation and Improvement for Kokopo Borehole Field [WS-02] Project for Rehabilitation and Improvement for Rabaul Town Area [WS-03] Project for Rehabilitation and Improvement for Nonga Area [WS-04] Project for Development of Water Supply System for Kerevat Area [WS-05] Project for Expansion of Water Supply Area for Nonga Northern Area	[WS-06] Project of Development of Water Supply System for Kokopo Eastern Area [WS-07] Project of Expansion of Water Supply System for Rabaul Town Surrounding Area [WS-08] Project of Expansion of Water Supply System for Southern Nonga Coastal Areas [WS-09] Project of Development of Water Supply System for Gazelle Agro-Industry SEZ, Ataliklikun New Port and Surrounding Areas [WS-10] Project for Expansion of Water Supply System for Baliora Area
Power Supply	[PW-01] Ulagunan Diesel Generators Rehabilitation Project	[PW-05] Rabaul Substation Rehabilitation Project

	[PW-02] 66kV Transmission Lines 552 and 553 Rehabilitation Project [PW-03] 66kV Transmission Lines 554 Rehabilitation Project [PW-04] Kokopo Substation Rehabilitation Project	[PW-06] Kokopo Feeder 2 Rehabilitation Project [PW-07] 22kV Kerevat 1 Feeder and 22kV Rabaul 1 Feeder Rehabilitation Project [PW-08] Project to Promote the Development of Alternative Sources of Power through Both Private and Public Investments

Source: JICA Expert Team

18.3 Selection High Priority Projects and Priority Projects by Infrastructure Sector for NEGID-Plan

In the NEGID-Plan, among the important projects identified by infrastructure sector as shown in the previous section, "priority projects" for achieving the defined vision and for implementing regional development strategies clarified in Chapter 6 in Part IV of this Final Report are selected by using the following criteria:

- Those infrastructure projects which are intended to promote regional development in respect of the following directions (one of the following conditions should be satisfied to be a priority projects):
  - To expanding the production of existing economic sectors,
  - To support the promotion of value-added economic sectors based on regionally available resources,
  - To contribute the enhancement of disaster resilience in the region, or
  - To contribute the transformation of regional spatial structure so as to promote the enhancement of disaster resilience and development of economic development.
- Moreover, while satisfying one of the above conditions, those infrastructure projects should be technically matured and well understood by relevant stakeholders.

The criteria to select "high-priority projects" out of such priority projects selected are as follows:

- Those priority projects which are highly critical in the following points in line with the formulated regional development strategies described in Part IV:
  - To initiate significant efforts at development of economic sectors, enhancement of disaster resilience, or transformation of regional spatial structure
  - To break through difficult problems on development of economic sectors, enhancement of disaster resilience, or transformation of regional spatial structure
  - To create synergies for development of economic sectors, enhancement of disaster resilience, or transformation of regional spatial structure by implementing in conjunction with different infrastructure development

Table 18.3.1 Selected High-Priority Projects and Priority Projects for Infrastructure Development Plan in Northeast Gazelle Peninsula

Infrastructure Sectors	High Priority Projects	Priority Projects
Regional Infrastructure		
Trunk Roads	[TR-01] Project for Strengthening of Kokopo-Rabaul Coastal Road [TR-02] Project for Upgrading of Rabaul-Kurakakaul-Rakunai Road (Alternative Road to the Kokopo-Rabaul Coastal Road and to Kokopo-Rabaul Top Road)	[TR-03] Project for Upgrading of North Coast Road between Kabaira (Ataliklikun Bay) and Kerevat Town

Ports	[SP-01] Project for Rehabilitation of Rabaul Port Infrastructure [SP-02] Project for Upgrading of Rabaul Port Berth 2 [SP-03] Project for Basic Study on New Port Development in Ataliklikun Bay including the following aspects: - Oceanographic Survey, Topographic Survey - Survey for Land Acquisition - Environmental Survey - Study of Fixing Port Location - Feasibility Study (Economic and Financial)	[SP-04] Project for Development of Berth specially for Fishing Vessels (for providing water, fuels and others) [SP-05] Project for Construction of New Port in Ataliklikun Bay
Airports	[AP-01] Project for Redevelopment of Tokua Airport Phase 1 (Upgrading of the Capacity and the Status of Tokua Airport to International Airport Phase 1)	[AP-03] Project for Promotion of Investment in Airport City Precincts Adjacent to the Prospective Upgraded Tokua Airport
Urban Infrastructure		
Urban Roads	[UR-01] Project for Rehabilitation of Port Access Road in Rabaul Town (1.8 km) including Improvement of Drainage Network in Rabaul Town [UR-02] Project for Rehabilitation of Mango Avenue (1.1 km) and Blanche Street (0.9 km) in Rabaul Town	[UR-03] Project for Development of Southern Section (3.7 km) of Kokopo Town Ring Road [UR-04] Project for Development of Kokopo Town Bypass Road (6.5 km)
Water Supply	[WS-01] Project for Improvement and Rehabilitation for Kokopo Borehole Field [WS-02] Project for Improvement and Rehabilitation for Rabaul Town Area	[WS-03] Project for Improvement and Rehabilitation for Nonga Area [WS-04] Project for Water Supply Plan for Kerevat Area [WS-06] Project of Water Supply for Kokopo Eastern Area [WS-07] Project of Expansion for Rabaul Town Surrounding Area [WS-09] Project of Construction of Water Supply System for Ataliklikun New Port and Surrounding Areas
Power Supply	[PW-02A] 66kV Transmission Lines 552 and 553 Rehabilitation Project including the Rehabilitation of Kokopo and Rabaul Substations	[PW-02] 22kV Kerevat 1 Feeder and 22kV Rabaul 1 Feeder Rehabilitation Project [PW-08] Project to Promote the Development of Alternative Sources of Power through Both Private and Public Investments

Source: JICA Expert Team

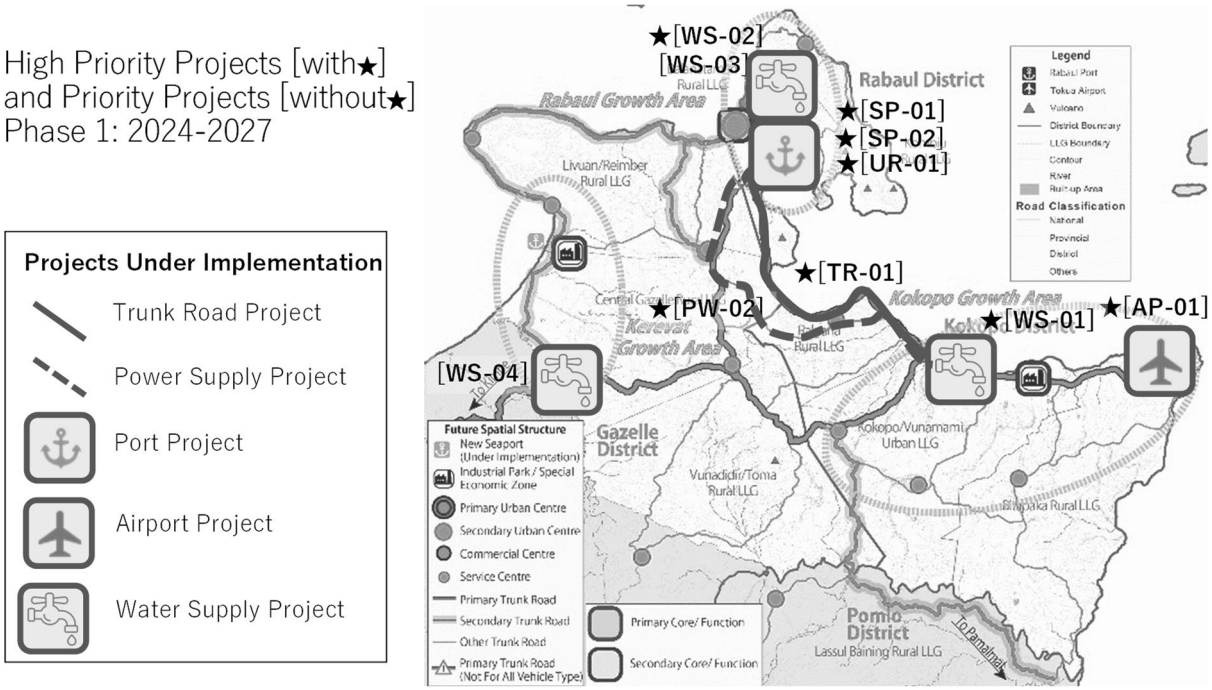
18.4 Phased Implementation Plan for High-Priority Projects and Priority Projects

As illustrated in the diagram of relationships among different aspects in regional development shown in Figure 4.2.1, the transformation of the spatial structure of the region needs to be promoted in order to develop the region's economic sectors and strengthen its disaster resilience. In other words, infrastructure development needs to be promoted for economic sectors development and disaster resilience strengthening, and at the same time for the transformation of the spatial structure.

A plan should be prepared to show how the High-Priority and Priority Projects selected in the previous section are to be implemented, in phases, within the timeframe.

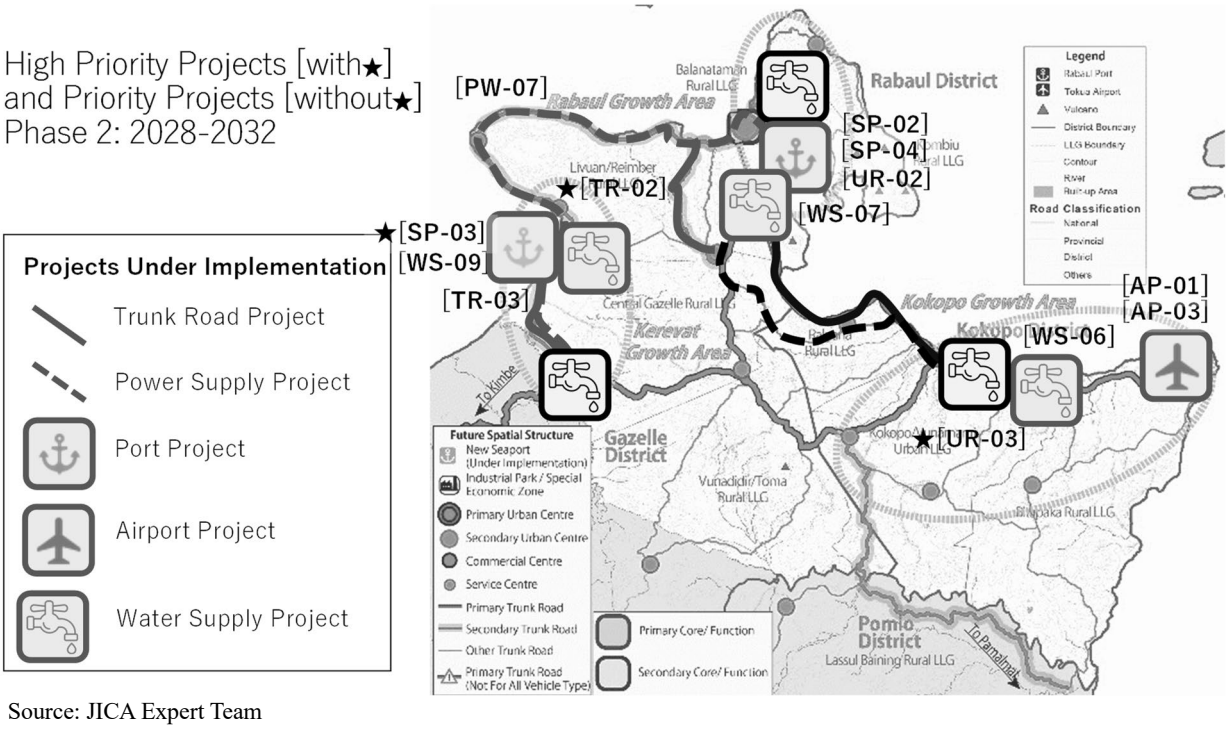
In preparation of such a phased implementation plan for high-priority and priority projects for infrastructure development, an integrated and multi-sectoral approach for infrastructure development is used rather than planning for individual infrastructure sectors.

A proposed phased implementation plan for high-priority and priority projects for infrastructure development is shown in Figure 18.4.1 and Figure 18.4.2. Furthermore, the high-priority and priority projects including the other important projects are listed by phase in Table 18.4.1, Table 18.4.2 and Table 18.4.3.



Source: JICA Expert Team

Figure 18.4.1 Phased Implementation Plan for High-Priority and Priority Projects for Infrastructure Development (Phase 1: 2024-2027)



Source: JICA Expert Team

Figure 18.4.2 Phased Implementation Plan for High-Priority and Priority Projects for Infrastructure Development (Phase 2: 2028-2032)

Table 18.4.1 List of Projects in Phase 1 (2024-2027)

No.	Priority	Trunk Road Projects
TR-01	High Priority	Project for Strengthening of Kokopo-Rabaul Coastal Road
No.	**Priority**	**Port Projects**
SP-01	High Priority	Project for Rehabilitation of Rabaul Port Infrastructure
SP-02	High Priority	Project for Upgrading of Rabaul Port Berth 2
No.	**Priority**	**Airport Projects**
AP-01	High Priority	Project for Redevelopment of Tokua Airport Phase 1 (Upgrading of the Capacity and the Status of Tokua Airport to International Airport Phase 1)
No.	**Priority**	**Urban Road Projects**
UR-01	High Priority	Project for Rehabilitation of Port Access Road in Rabaul Town including Improvement of Drainage Network in Rabaul Town
No.	**Priority**	**Water Supply Projects**
WS-01	High Priority	Project for Rehabilitation and Improvement for Kokopo Borehole Field
WS-02	High Priority	Project for Rehabilitation and Improvement of Water Supply System for Rabaul Town Area
WS-03	Priority	Project for Rehabilitation and Improvement of Water Supply System for Nonga Area
WS-04	Priority	Project for Development of Water Supply System for Kerevat Area
No.	**Priority**	**Power Supply**
PW-01	-	Ulagunan Diesel Generators Rehabilitation Project
PW-02A	High Priority	66kV Transmission Lines 552 and 553 Rehabilitation Project including the Rehabilitation of Kokopo and Rabaul Substations
PW-03	-	66kV Transmission Line 554 Rehabilitation Project
PW-04	-	[Combined into PW-02A] Kokopo Substation Rehabilitation Project
PW-05	-	[Combined into PW-02A] Rabaul Substation Rehabilitation Project
PW-08	Priority	Project to Promote the Development of Alternative Sources of Power through Both Private and Public Investments

Source: JICA Expert Team

Table 18.4.2 List of Projects in Phase 2 (2028-2032)

No.	Priority	Trunk Road Projects
TR-02	High Priority	Project for Upgrading of Rabaul-Kurakakaul-Rakunai Road (Alternative Road to the Kokopo-Rabaul Coastal Road and to Kokopo-Rabaul Top Road
TR-03	Priority	Project for Upgrading of North Coast Road between Kabaira (Ataliklikun Bay) and Kerevat Town
No.	**Priority**	**Port Projects**
SP-02	High Priority	Project for Upgrading of Rabaul Port Berth 2 (Continuing from Phase 1)
SP-03	High Priority	Project for Basic Study on New Port Development in Ataliklikun Bay
SP-04	Priority	Project for Development of Berth specially for Fishing Vessels (for providing water, fuel, and others)
No.	**Priority**	**Airport Projects**
AP-01	High Priority	Project for Redevelopment of Tokua Airport Phase 1 (Upgrading of the Capacity and the Status of Tokua Airport to International Airport Phase 1) (Continuing from Phase 1)
AP-03	Priority	Project for Promotion of Investment in Airport City Precincts Adjacent to the Prospective Upgraded Tokua Airport
No.	**Priority**	**Urban Road Projects**
UR-02	Priority	Project for Rehabilitation of Mango Avenue (1.1 km) and Blanche Street (0.9 km) in Rabaul Town
UR-03	High Priority	Project for Development of Southern Section (3.7 km) of Kokopo Town Ring Road
No.	**Priority**	**Water Supply Projects**
WS-05	-	Project for Expansion of Water Supply System for Nonga Northern Area
WS-06	Priority	Project for Development of Water Supply System for Kokopo Eastern Area
WS-07	Priority	Project for Expansion of Water Supply System for Rabaul Town Surrounding Area
WS-08	-	Project for Expansion of Water Supply System for Southern Nonga Coastal Areas
WS-09	Priority	Project for Development of Water Supply System for Gazelle Agro-Industry SEZ, Ataliklikun New Port and Surrounding Areas
WS-10	-	Project for Expansion of Water Supply System for Baliora Area
No.	**Priority**	**Power Supply Projects**
PW-06	-	Kokopo Feeder 2 Rehabilitation Project
PW-07	Priority	22kV Kerevat 1 Feeder and 22kV Rabaul 1 Feeder Rehabilitation Project
PW-08	Priority	Project to Promote the Development of Alternative Sources of Power through Both Private and Public Investments

Source: JICA Expert Team

Table 18.4.3 List of Projects in Phases 3 and 4 (2033-2042)

No.	Priority	Trunk Road Projects
TR-04	-	Project for Upgrading of Kurakakaul-Kabaira (Ataliklikun Bay) Section of North Coast Road
TR-05	-	Project for Upgrading of Malakuna-Putput Road
TR-06	-	Project for Upgrading of Kabakaul-Toma Road
No.	**Priority**	**Port Projects**
SP-05	-	Project for Construction of New Port in a Ataliklikun Bay
No.	**Priority**	**Airport Projects**
AP-02	Priority	Project for Promotion of Investment in Airport City Precincts Adjacent to the Prospective Upgraded Tokua Airport (Continuing from Phase 2)
AP-03	-	Project for Redevelopment of Tokua Airport Phase 2 (Upgrading of the Capacity and the Status of Tokua Airport to International Airport Phase 2)
No.	**Priority**	**Urban Road Projects**
UR-04	-	Project for Development of Kokopo Town Bypass Road (6.5 km)

Source: JICA Expert Team

18.5 Selection of Candidates for Pre-Feasibility Studies in NEGID-Plan

(1) Selection Criteria for Candidates for Pre-Feasibility Studies

The selection of one candidate for pre-feasibility study is determined by the following criteria/factors:

- The candidate projects should be one of the high priority projects which satisfy the criteria for selecting the high priority projects as shown in Section 18.3.
- The candidate projects should not have any commitments for assistance from donors/development partners.
- The candidate projects should be one of the highest priority orders expressed by ENBPA.

(2) Donors' Commitment to the High Priority Projects

Considering the strategical importance of high priority projects in implementing the regional development strategies in Northeast Gazelle Peninsula (as described in Section 18.3), it is strongly recommended that pre-feasibility studies or full-scale feasibility studies should be conducted in a timely manner (without delay) for the all selected high-priority projects.

A feasibility study has been conducted for [AP-01] by JICA, and a financial assistance to [SP-01] and [SP-02] is under consideration by international donor agencies.[1]

[AP-01] Project for Redevelopment of Tokua Airport Phase 1 (Upgrading of the Capacity and the Status of Tokua Airport to International Airport Phase 1)

[SP-01] Project for Rehabilitation of Rabaul Port Infrastructure

[SP-02] Project for Upgrading of Rabaul Port Berth 2

The following urban road project consists of both road maintenance and Rabaul Town drainage network improvements, although the road maintenance (pavement portion) was funded by the ENBPA budget and Rabaul District budget in FY2023, while the rehabilitation work was delayed and implemented in May 2024:

[UR-01] Project for Rehabilitation of Port Access Road in Rabaul Town (1.8 km) including Improvement of Drainage Network in Rabaul Town

Therefore, it is considered that these four projects do not require any pre-feasibility studies or full-scale feasibility studies.

[1] It was under consideration by EU and AFD as of March 2024.

As a result, the following eight projects are candidate projects for pre-feasibility studies. The three candidate projects are for regional infrastructure. The other five projects are for urban infrastructure.

The following three candidate projects (regional infrastructure) for pre-feasibility studies are as follows:

★ [TR-01] Project for Strengthening of Kokopo-Rabaul Coastal Road (to be Implemented in Phase 1)

★[TR-02] Project for Upgrading of Rabaul-Kurakakaul-Rakunai Road (Alternative Road to the Kokopo-Rabaul Coastal Road and to Kokopo-Rabaul Top Road) (to be Implemented in Phase 2)

★[SP-03] Project for Basic Study on New Port Development in Ataliklikun Bay (To be Implemented in Phase 2)

The following four candidate projects (urban infrastructure) for pre-feasibility studies are as follows:

★[UR-03] Project for Development of Southern Section (3.7 km) of Kokopo Town Ring Road (to be Implemented in Phase 2)

★[WS-01] Project for Improvement and Rehabilitation for Kokopo Borehole Field (To be Implemented in Phase 1)

★[WS-02] Project for Improvement and Rehabilitation of Water Supply System for Rabaul Town Area (To be Implemented in Phase 1)

★[PW-02A] 66kV Transmission Lines 552 and 553 Rehabilitation Project including the Rehabilitation of Kokopo and Rabaul Substaions (To be Implemented in Phase 1)

(3) ENBPA's Preference (Priority Orders) over Some High Priority Projects

Among these seven high-priority projects, four high-priority projects are to be implemented in Phase 1 (2024-2027), as shown in Table 18.4.1.

Moreover, through a discussion session with core members of PIU of ENBP, their priority orders among the high-priority projects have been identified as follows:

No.1 Urgency: [TR-01]: To be Implemented in Phase 1: No Donor's Commitment Yet

No.2 Urgency: [SP-01]: To be Implemented in Phase 1: Donor's Commitment

No.3 Urgency: [SP-03]: To be Implemented in Phase 2: No Donor's Commitment Yet

No.4 Urgency: [SP-02]: To be Implemented in Phase 1: Donor's Commitment

No.5 Urgency: [PW-02A]: To be Implemented in Phase 1: No Donor's Commitment Yet

No.6 Urgency: [WS-02] : To be Implemented in Phase 1: No Donor's Commitment Yet

In consideration of all above factors, [TR-01] "**Project for Strengthening of Kokopo-Rabaul Coastal Road" is considered the most suitable for conducting a pre-feasibility study.**

Chapter 19 Profiles of Eleven High-Priority Projects for Northeast Gazelle Peninsula

19.1 List of High Priority Projects

Eleven high-priority projects for infrastructure development for Northeast Gazelle Peninsula are listed as shown Table 19.1.1.

Table 19.1.1 List of High Priority Projects

No.	Project Code	Project Name	Executing Agency	Project Costs (PGK million)
1	TR-01	Project for Strengthening of Kokopo-Rabaul Coastal Road	Department of Works and Highways	PGK 57 million
2	TR-02	Project for Upgrading of Rabaul-Kurakakaul-Rakunai Road (Alternative Road to the Kokopo-Rabaul Coastal Road and to Kokopo-Rabaul Top Road)	Division of Infrastructure Development, ENBPA	PGK 90 million
3	SP-01	Project for Rehabilitation of Rabaul Port Infrastructure	PNG Ports Corporation Ltd.	PGK 85 million
4	SP-02	Project for Upgrading of Rabaul Port Berth 2	PNG Ports Corporation Ltd.	PGK 80 million
5	SP-03	Project for Basic Study on New Port Development in Ataliklikun Bay	Department of Transport PNG Ports Corporation Ltd.	PGK 6 million
6	AP-01	Project for Redevelopment of Tokua Airport Phase 1	National Airport Corporation (NAC)	PGK 880 million
7	UR-01	Project for Rehabilitation of Port Access Road in Rabaul Town (including Drainage Facilities for Rabaul Town)	Division of Infrastructure Development, ENBPA Rabaul District	PGK 42-55 million
8	UR-03	Project for Development of Southern Section of Kokopo Town Ring Road	Division of Infrastructure Development, ENBPA Kokopo City	PGK 26 million
9	WS-01	Project for Rehabilitation and Improvement for Kokopo Borehole Field	Water PNG Corporation Ltd.	PGK 5 million
10	WS-02	Project for Rehabilitation and Improvement of Water Supply System for Rabaul Town Area	Water PNG Corporation Ltd.	PGK 8 million
11	PW-02A	66kV Transmission Lines 552 and 553 Rehabilitation Project including the Rehabilitation of Kokopo and Rabaul Substations	PNG Power Corporation Ltd.	PGK 62 million
			Total	PGK 1,341 – 1,354 million

Note: The Project Codes in the above table are the same as those for the projects described in Part VII (Chapters 12 through Chapter 17).
Source: JICA Expert Team

19.2 Profile of Project for Strengthening of Kokopo-Rabaul Coastal Road [TR-01]

(1) Rational

Kokopo-Rabaul Coastal Road is the most important economic trunk road in Northeast Gazelle Peninsula region. This road connects Rabaul Port and not only Kokopo Town, Tokua Airport but also Gazelle District including Kerevat, Pomio District including Warangoi.

However, Kokopo-Rabaul Coastal Road is often closed during heavy rain or flood every year, although this road is only a trunk road connecting Kokopo and Rabaul which all types of vehicles including heavy vehicles can use. It is a serious issue for regional road network.

Kokopo-Rabaul Costal Road has also a risk to be closed by slope failure caused by volcanic ash deposited on the slope land surface along the road. There are many road portions where drainage for rainwater is not well installed. There is also a section in a low-lying area that is prone to sediment disaster.

The mountain side road (locally called Top Road, or Kokopo-Rabaul Top Road), which serves as an alternative road (from the viewpoint of redundancy) of the Kokopo-Rabaul Coastal Road, also has the status of national road, and is in good pavement condition. However, the section going up inland from Burmah Junction, which is the intersection with the coastal road, is a steep, narrow and winding road. Lorries carrying heavy containers or fuels from Rabaul Port or Rabaul Fuel Depot to Kokopo Town cannot pass it.

Considering the above, it is necessary to upgrade the Kokopo-Rabaul Coastal Road which is resilient to disasters and can open to traffic at all times.

- Location: Tunnel Hill to Kokopo Secondary School
- Length: Approximately 24.2 km



Source: JICA Expert Team

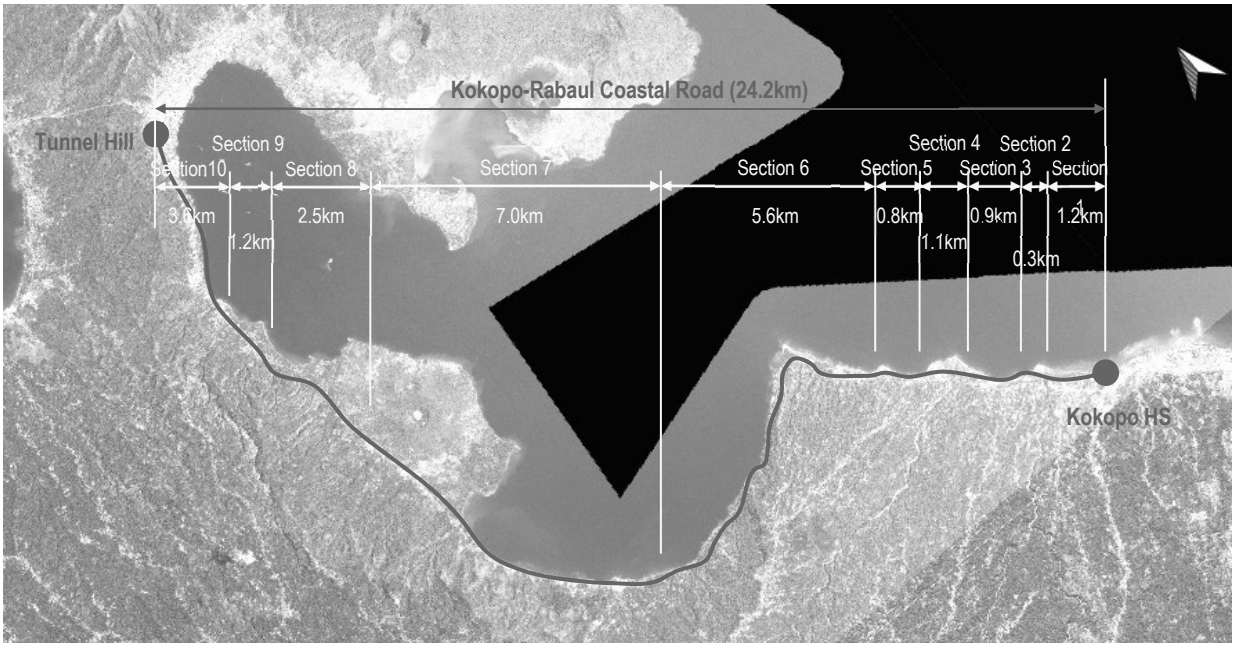
Figure 19.2.1 Location Map of Kokopo-Rabaul Coastal Road Rehabilitation Project

(2) Objectives

- To support sustainability of socio-economic activities of people and economic sectors of the region
- To enhance the disaster resilience

(3) Project Description

24.2 km of Kokopo-Rabaul Coastal Road is divided into 10 sections as shown in Figure 19.2.2. It was determined based on the conditions.

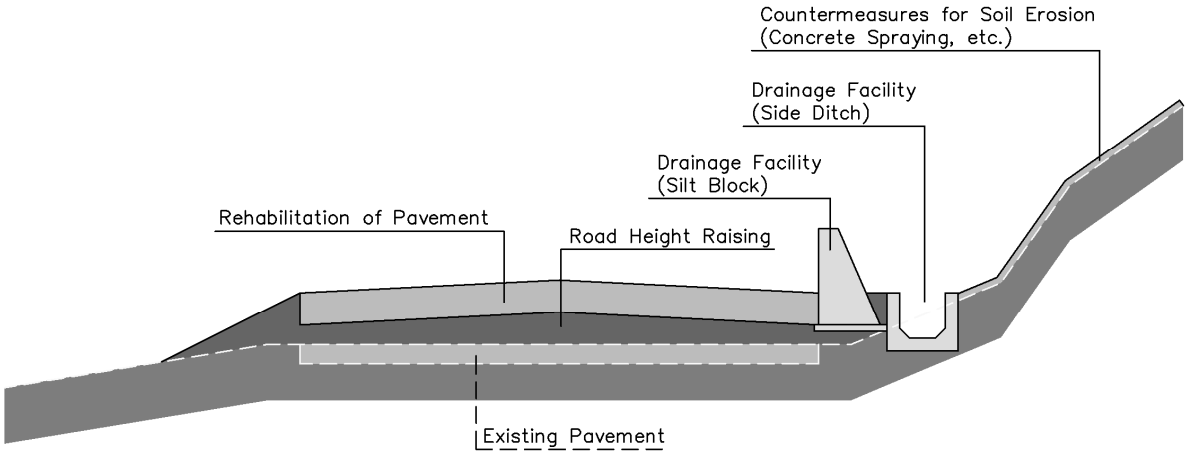


Source: JICA Expert Team

Figure 19.2.2 Road Sections of Kokopo-Rabaul Coastal Road

1) Rehabilitation of Pavement

All roads in New Britain Island have been paved with Double Bituminous Surface Treatment (DBST). As DBST does not have enough durability against water and heavy load, some road sections have been severely damaged. Since the cost of asphalt concrete pavement is very high, as there is no asphalt plant in New Britain Island. For this project, DBST is to be used for the rehabilitation because of limited project budgets. .



Source: JICA Expert Team

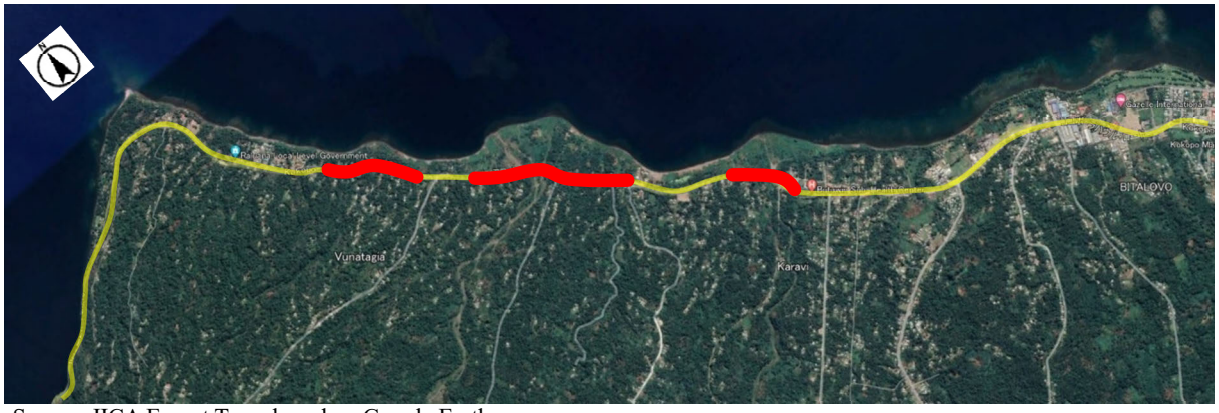
Figure 19.2.3 Cross Section of Kokopo-Rabaul Coastal Road Rehabilitation Project

2) Road Height Raising

Water remains on the road surface at low-lying sections in Kokopo-Rabaul Coastal Road during rain. This is one of the causes of severe pavement damage.

It is proposed that Coastal Road should be raised at those low-lying sections. It is also proposed to provide sufficient cross fall to discharge surface water properly.

About 2km section between Vunatagia an Karavi might need to be raised according to the results of the field survey (see the red line sections in Figure 19.2.4). However, the location of road height raising should be determined based on the hydrological survey and analysis results in a prospective feasibility study.



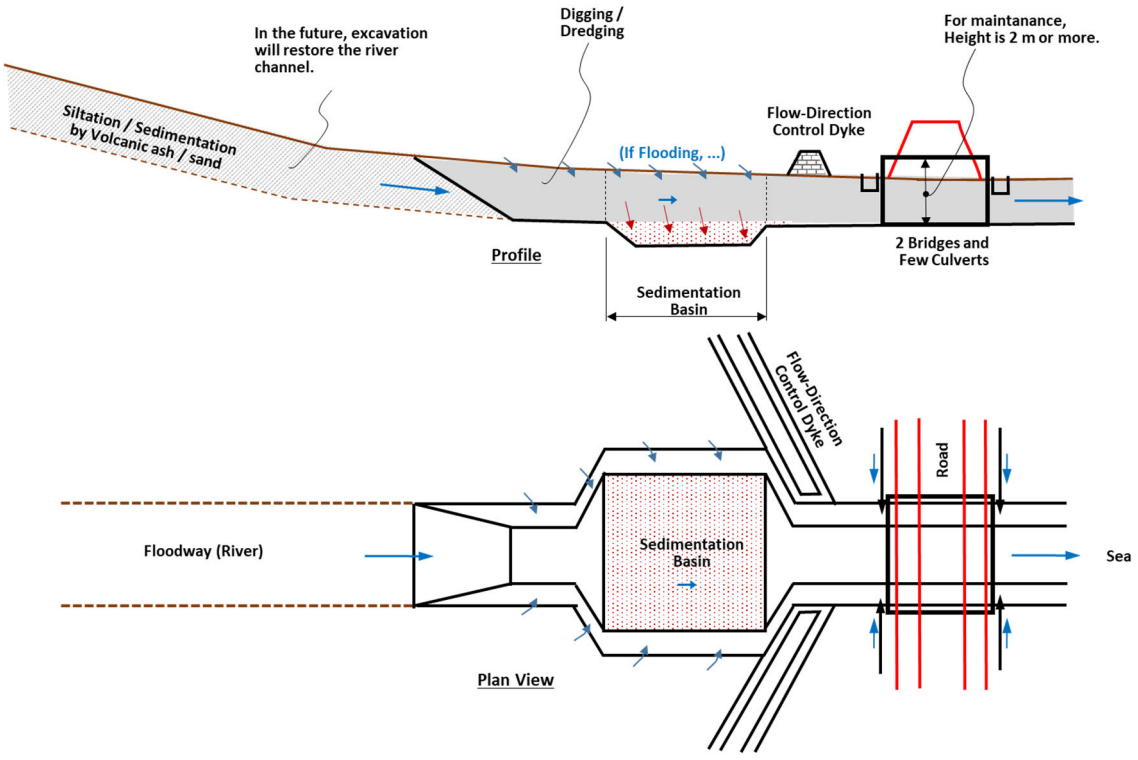
Source: JICA Expert Team based on Google Earth

Figure 19.2.4 Location of Road Height Raising (Proposed)

3) Construction of Drainage Facilities

Currently Kokopo-Rabaul Coastal Road has side drainage ditches and cross drainage culverts at some limited sections. And those drainage facilities have not been functioning properly due to lack of maintenance.

It is proposed that side drainage ditches and drainage culverts should be constructed in the whole sections in order to discharge road surface water properly, as well as to avoid flowing of water from the roadside areas onto the road surface during rain.



Source: JICA Expert Team

Figure 19.2.5 Image of Sedimentation Basin

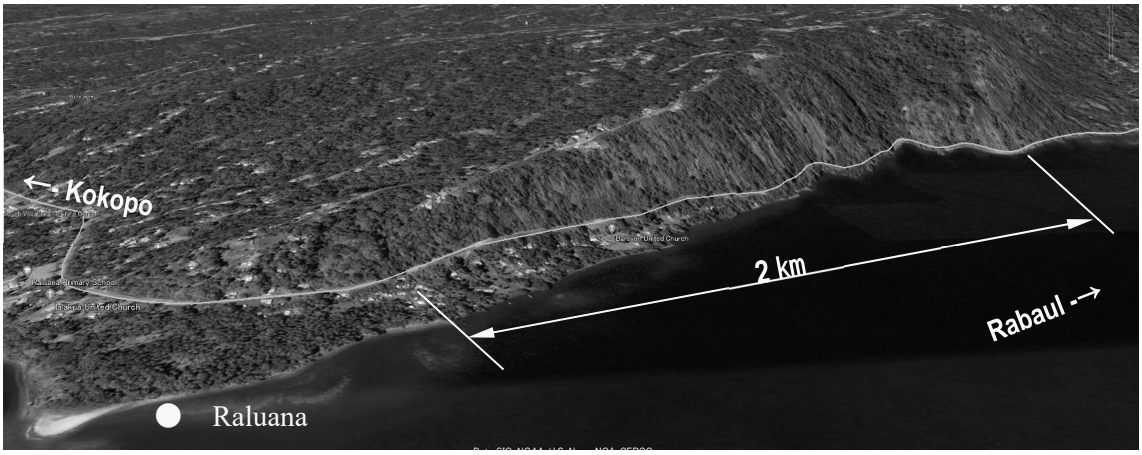
4) Construction of Countermeasures for Soil Erosion

The mountain body is thought to be composed mainly of pumiceous pyroclastic flow deposits ejected by the Rabaul volcanic activity more than 10,000 years ago, and is in a consolidated condition. However, it is vulnerable to weathering, and the surface of the outcrops has been softened by weathering.

Along the Kokopo-Rabaul Road from Kokopo City to Raluana Point, there are several small cliffs 5 to 10 metres high that were cut almost vertically from the foot of the mountain when the road was constructed, and the total length of these cliffs is about 1 km. Because the cut slope is nearly vertical, there is no concentrated flow of rainwater, and the whole surface has gradually set back due to weathering. The top is overhanging with rooted vegetation remaining (right picture). The stripped sediment accumulates at the bottom of the cliff and fills the roadside ditches in many places.



The steep cliffs of the caldera wall of the Rabaul Caldera are close to the road in the section of about 2 km from Raluana Point towards Rabaul (below picture). The average slope is about 45 degrees, and it can be roughly classified into two cases: one with a cut slope along the road with vegetation covering the slope above, and the other with a gentle slope (with collapsed soil) covered with vegetation below and a steep cliff rising high in the back. The steep slopes along the road were cut during road construction, but above are natural slopes where gully-like ditches have developed due to erosion over the years and discharge from the ridge road above.



Source: JICA Expert Team

Figure 19.2.6 Terrain from Raluana Point towards Rabaul

Erosion control measures require a method that covers the entire slope surface that stops the weathering process and prevents direct erosion of the ground by water flow.

Specifically, concrete spraying construction method is suitable as slope protection works.

As an alternative method, there are products that do not require skilled labour, such as concrete canvas, which can be installed simply by fastening a sheet on the slope and applying water to solidify it.

(4) Expected Benefits

It is expected that the strengthening of Kokopo-Rabaul Coastal Road through proposed interventions, such as road height raising, drainage facilities (side ditches, cross culverts and sedimentation basins), and silt block, would generate the following benefits:

- To save travel time
- To save vehicle operation costs
- To save the maintenance and rehabilitation costs of removal soils from road surface
- To reduce the duration of road closure due to soil coverage of the road surface

(5) Executing Agency and Related Institute

- Department of Works and Highways, in coordination with Division of Infrastructure Development, ENBPA

(6) Estimated Project Cost

Construction costs of the Project Road are shown in Table 19.2.1. It shows construction costs of all road sections as well as alternative implementation schemes (selection of road sections to be included in the project).

Table 19.2.1 Construction Cost of the Project Road

Alternative Implementation Scheme	Construction Cost (PGK)	Section									
		1	2	3	4	5	6	7	8	9	10
			Bridge Sediment Pond		Bridge Sediment Pond				Road Height Raising	Bridge Sedime nt Pond	
All Road Sections (without 10)	PGK 187 million (L=20.4km)	✓	✓	✓	✓	✓	✓	✓	✓	✓	-
Road Sections including bridges, sediment pond and road height raising (Section 2, 4, 8, 9)	PGK 92 million (L=5.1km)		✓		✓				✓	✓	-
Road Sections including bridges and sediment pond (Section 2, 4, 9)	PGK 66 million (L=2.4km)		✓		✓					✓	-
Road Sections including bridges and sediment pond for only around beginning section and in between (Section 2, 3, 4)	PGK 57 million (L=2.3km)		✓		✓						-
Road Sections including bridges and sediment pond for only around beginning section (Section 2, 4)	PGK 50 million (L=1.4km)		✓		✓						-

Note: ✓= The intervention applies to the selected section.
Source: JICA Expert Team

(7) Implementation Schedule

- 2 years for construction

(8) Necessary Actions for Implementation / Critical Factor

- Coordination with Connect PNG Programme for Roads

(9) Related Plans and Projects

- Connect PNG Programme for Roads

(10) Social and Environmental Impacts

Since the project is to use land areas on and along the existing road, any relocation of human settlements and any environmental impact would not be expected. However, sedimentation ponds are to be located outside the existing road areas. Those lands for sedimentation ponds might be customary lands.

19.3 Profile of Project for Upgrading of Rabaul-Kurakakaul-Rakunai Road (Alternative Road to the Kokopo-Rabaul Coastal Road and to Kokopo-Rabaul Top Road) [TR-02]

(1) Rational

In the event of large-scale volcanic eruption in Rabaul Area, it is necessary to secure emergency road routes. The risk of road closures caused by large volcanic ash deposits is high on the sections of the Kokopo-Rabaul Coastal Road near Vulcan Volcano. However, road sections with such high disaster risk have not been developed to increase resilience against such disaster.

At present, the trunk road network near Vulcan Volcano is not well prepared in the event of large volcanic eruption in the future. Securing redundancy considering the event of such disaster is necessary for roads that are important backbones of the region. For example, it is necessary to increase preparedness so that road connectivity from Rabaul Port to various parts of the region can be secured even in the event of future large-scale volcanic eruption. Relief supplies for disaster emergency response should arrive at Rabaul Port. The region's fuel depots are also adjacent to Rabaul Port. It is important to develop alternative routes for transporting fuel from the fuel depots adjacent to Rabaul Port to various parts of the region, as well as for transporting emergency supplies. Therefore, it is important to upgrade Rabaul-Kurakakaul-Rakunai Road to a Secondary Trunk Road by 2032, as an alternative road to the Kokopo-Rabaul Coastal Road.

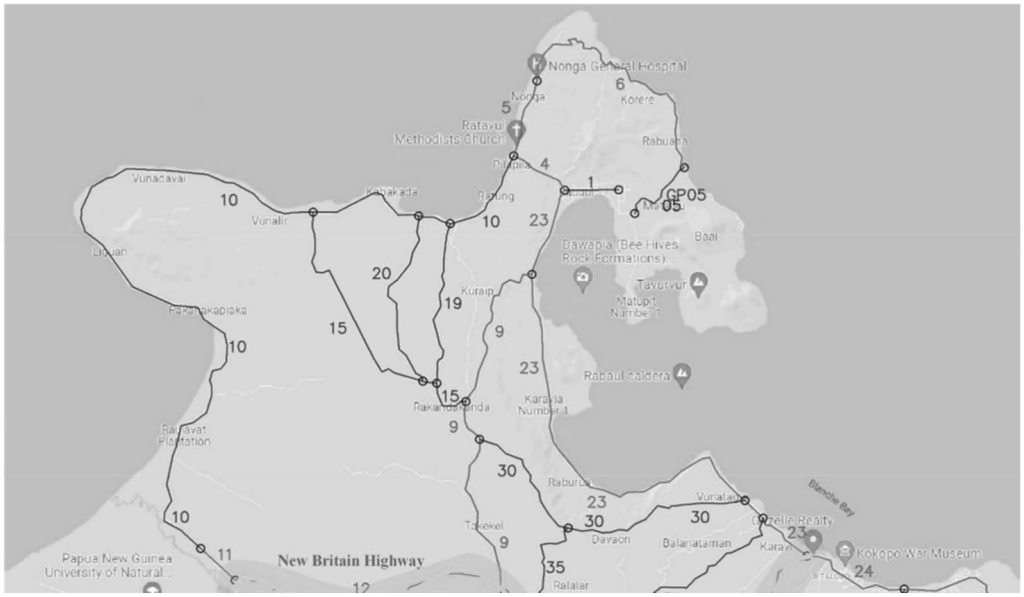


Figure 19.3.1 Rabaul-Kurakakaul-Rakunai Road (Consisting of Trunk Roads No.4, Part of No.10, and No.20 and No.15)

(2) Objectives

- To develop an alternative route from Rabaul Port to various parts of the region by upgrading Rabaul-Kurakakaul-Rakunai Road to a Secondary Trunk Road by 2032

(3) Project Description

This project road is composed of the following four sections:

- Tunnel Hill Road (Trunk Road No. 4 as shown in Figure 19.3.1)
- Part of North Coast Road (Trunk Road No.10 as shown in Figure 19.3.1)
- Ramalmal Road (Trunk Road No.20 as shown in Figure 19.3.1)

This Project is composed of the rehabilitation works of these roads.

Tunnel Hill Road (Trunk Road No.4) is kept in good condition at most sections, but there are some potholes. The following rehabilitation works should be made for Tunnel Hill Road:

- Providing DBST with sufficient cross fall
- Installing roadside drainage and cross drainage culvert

North Coast Road (Trunk Road No.10) is mostly kept in good condition but is not sealed at some sections. The following rehabilitation works should be made for North Coast Road:

- Providing DBST with sufficient cross fall
- Installing roadside drainage and cross drainage culvert

Ramalmal Road (Trunk Road No.20) is mostly severely damaged and has narrow width and steep gradient at some sections. The following rehabilitation works should be made for Ramalmal Road:

- Providing DBST with sufficient cross fall
- Installing roadside drainage and cross drainage culvert
- Widening the road at narrow section
- Changing alignment to reduce the gradient at steep gradient sections
- Providing countermeasures for soil erosion

(4) Expected Benefits

In case of heavy volcanic eruption near Rabaul, the floodway near and slopes along Kokopo-Rabaul Coastal Road would receive thick volcanic ashfall. As a result, landslides and soil erosion would destroy downstream roads like Kokopo-Rabaul Coastal road.

The project road, alternative road to Kokopo-Rabaul Coastal Road, will be able to avoid the total closure to the access roads to Rabaul Port and Kokopo City Centre.

(5) Executing Agency and Related Institute

- Division of Infrastructure Development, ENBPA, in coordination with Department of Works and Highways

(6) Estimated Project Cost

- PGK 90 million

(7) Implementation Schedule

- 2 years for construction

(8) Necessary Actions for Implementation / Critical Factor

- None.

(9) Related Plans and Projects

- Connect PNG Progrramme for Roads

(10) Social and Environmental Impacts

- Small.

19.4 Profile of Project for Rehabilitation of Rabaul Port Infrastructure [SP-01]

(1) Rational

The infrastructure of Rabaul Port is ageing and deteriorating. Major rehabilitation works have not been done for Rabaul Port in the last 35 years. "Berth 1" was constructed in 1964, and its last rehabilitation was done in 1984. "Berth 2" was constructed in 1968, and its rehabilitation was conducted in 1983. The requirement for major rehabilitation works of the two berths, sheds, utilities, and other buildings was described in the 2014 condition assessment study. However, no actions have been taken in response to these recommendations for repair and restoration.

Due to the deterioration of the structural elements (e.g., piles), loading restrictions are in effect for Berth 1 and Berth 2. Hence, the port operations only allow light equipment like trailers and forklifts to the deck structure of Berth 2. The fenders, bollards, kerbs, pavements, and other utilities are in poor condition in both berths.

Siltation causes a significant loss of revenue for PNG Ports by maintenance activities of the silt curtain.

It is considered that the existing Rabaul Port should continue to be utilised even if a new port will be developed in the future, probably after 2042. Overviewing the existing condition of the port facilities and increase of cargoes like demand forecast, the aged and damaged facilities have to be repaired and properly maintained. Such rehabilitation should consider its lifetime to be more than 30 years.

(2) Objectives

- To sustain the function and capacity of a main port of Northeast Gazelle Peninsula, as well as ENBP.
- To support the exporting and importing of a variety of commodities and goods for sustaining the regional economy of Northeast Gazelle Peninsula, as well as ENBP.

(3) Project Description

- To strengthen the structural capacities of Berth 1 and Berth 2
- To allow heavy equipment on the decks for increased efficiency by lifting loading restrictions on the facilities
- To fix the drainage problems
- To repair decks, approach structures, and piles of both berths
- To restore utilities (power, water supply, etc.), aids-to-navigation, pavements, and other miscellaneous items (fenders, bollards, kerbs, etc.)
- To renovate the buildings and sheds due to structural damages
- To provide an alternative discharge location for the drainage outflow to avoid siltation at Berth 1

(4) Expected Benefits

- To avoid full closure or partial closure of existing berths of Rabaul Port due to serious aging and deterioration.
- To sustain the operation of Rabaul Port in export and import of commodities and goods for supporting socio-economic activities in Northeast Gazelle Peninsula.

(5) Executing Agency and Related Institute

- PNG Ports Corporation Ltd.

(6) Estimated Project Cost

- 19.2 mil AUD for a useful life of 10 years (Source: Rabaul Port Detailed Infrastructure Master Plan, Prepared by PNG Ports Corporation Ltd.)
- Since the rehabilitation work for Rabaul Port infrastructure should be designed and implemented for a useful life of 30 years as described in the rational section above, the cost for this project would be much more than 19.2 million AUD.

(7) Implementation Schedule

- The following works are to be carried out during the phase of 2023-2032:
  - Detailed Design
  - Tendering for the Project
  - Implementation of Rehabilitation Work
- 1 year for construction

(8) Necessary Actions for Implementation / Critical Factor

- Coordination with this Project (Rehabilitation of Rabaul Port Infrastructure) for Upgrading of Rabaul Port Berth 2 is essential.

(9) Related Plans and Projects

- Rabaul Port Master Plan 2014
- Rabaul Port Detailed Infrastructure Master Plan, February 2021

(10) Social and Environmental Impacts

- Since the work for this project of rehabilitation is to be done within the designated port area, no large social and environmental impacts are expected.

19.5 Profile of Project for Upgrading of Rabaul Port Berth 2 [SP-02]

(1) Rational

The port demand is estimated to increase by about 2.8 times of the present cargo volume. Considering the berth occupancy rate of Berth 1 and Berth 2 is about 50% at present, upgrading of port must be needed. In order to handle such increase of cargoes, one more berth will be required.

However, it should be considered that the cargoes of Rabaul Port are assumed to decrease after new port development. Hence, it will not be necessary to invest large cost for this upgrading. It is recommended to implement the upgrading plan (Proposal-3) proposed in the Detailed Master Plan 2021 by PNG Ports.

Due to the earthquake hazard, the containers are not stacked high in Rabaul Port. Therefore, the available area in Rabaul Port is required to be utilised efficiently.

Overseas Container, General, and Tanker vessels occupy Berth 2 most of the time.

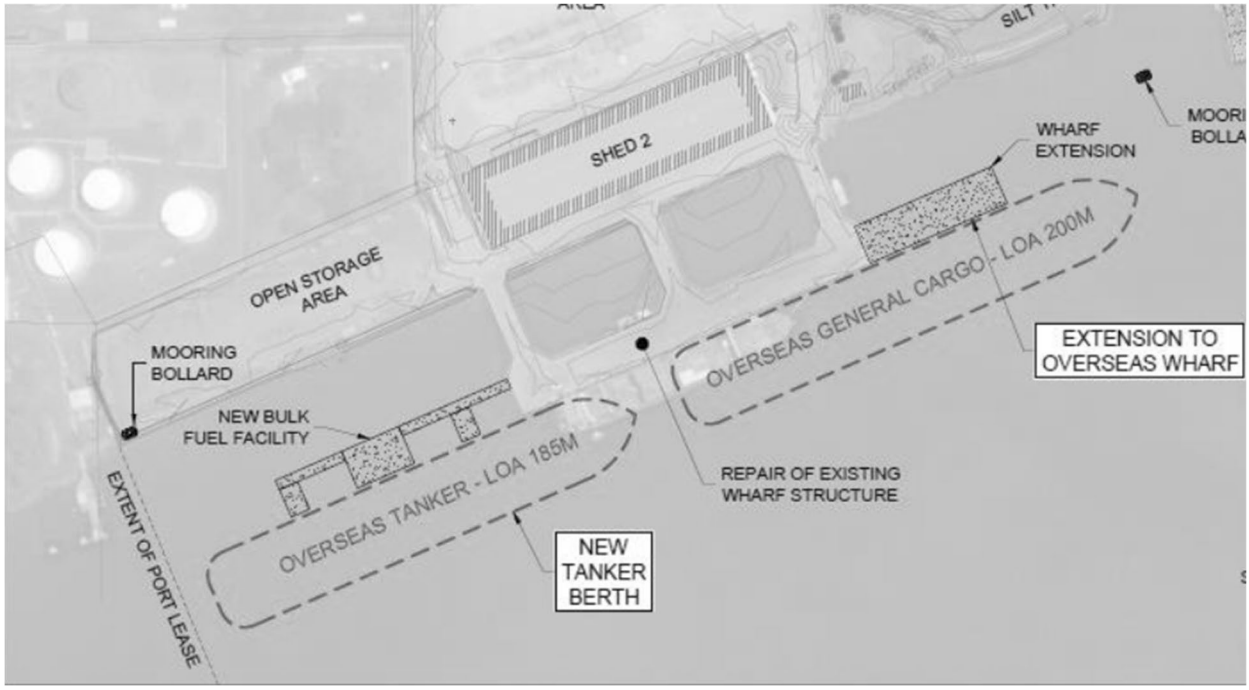
In Rabaul Port, cruise ship operations (e.g., customs, immigration) are handled with temporary facilities. To amplify the tourism potential of Rabaul, a state-of-the-art cruise ship terminal for passengers is recommended to be developed.

(2) Objectives

- To allow more vessels simultaneously in Rabaul Port

(3) Project Description

- To expand the cargo handling capacity of Berth 2 by extending the length of the wharf as shown in Figure 19.5.1 in accordance with the increase in port demand



Source: PNG Ports, 2021, Rabaul Port Detailed Infrastructure Master Plan

Figure 19.5.1 Conceptual Plan for New Tanker Berth and Extension of Berth 2

(4) Expected Benefits

- The berth extension may provide enough time to continue the port operations for another 10-20 years.

(5) Executing Agency and Related Institute

- PNG Ports Corporation Ltd.

(6) Estimated Project Cost

- AUD 22 million for the new tanker berth and berth 2 extension for a useful life of 10 years (Source: Rabaul Port Detailed Infrastructure Master Plan, Prepared by PNG Ports Corporation Ltd.)
- Since this upgrading work for Rabaul Port berth 2 should be designed and implemented for a useful life of 30 years as described in the rational section above, the cost for this project would be much more than 22 million AUD.

(7) Implementation Schedule

- The period of 2023-2032
  - Detailed Design
  - Tendering for the Project
  - Implementation of Upgrading Work
- 2 years for construction

(8) Necessary Actions for Implementation / Critical Factor

- The necessary rehabilitation work for Rabaul Port infrastructure and this project for upgrading of Rabaul Port Berth 2 should be well coordinated.

(9) Related Plans and Projects

- Rabaul Port Master Plan 2014
- Rabaul Port Detailed Infrastructure Master Plan, February 2021

(10) Social and Environmental Impacts

Since the work proposed for this project is to be done within the declared port area of Rabaul Port, there would be no social and environmental impacts by this project.

19.6 Profile of Project for Basic Study on New Port Development in Ataliklikun Bay [SP-03]

(1) Rational

Although Northeast Gazelle Peninsula is prone to various disasters, port location and regional disaster prevention measures have not been sufficiently considered from the perspective of comprehensive and long-term future disaster risk reduction.

There was a discussion within PNG Ports Corporation Ltd. and their port consultants about relocating Rabaul Port. The 2014 Rabaul Port Master Plan, and the 2021 Rabaul Port Detailed Infrastructure Master Plan set out policies for relocation to an area near Kabakaul Bay in Kokopo.

However, in the process of formulating these master plans, stakeholder discussion and coordination has not yet been conducted concerning the relocation of Rabaul Port to Kokopo.

At present, Rabaul is functioning as oil storage and distribution centre of the region. This function must be maintained and strengthened near a new port to be established in a low disaster risk area in the middle and long terms. On the other hand, cruise ships need to call at Rabaul because cruise ship tourists are attracted to Rabaul volcanos and war relics remaining near Rabaul Town.

The relocation of main regional port functions from Rabaul Port to a low disaster risk area needs scientific data of oceanographic situation, marine biology, terrestrial environment and topography to examine and determine suitable places for a new port development.

(2) Objectives

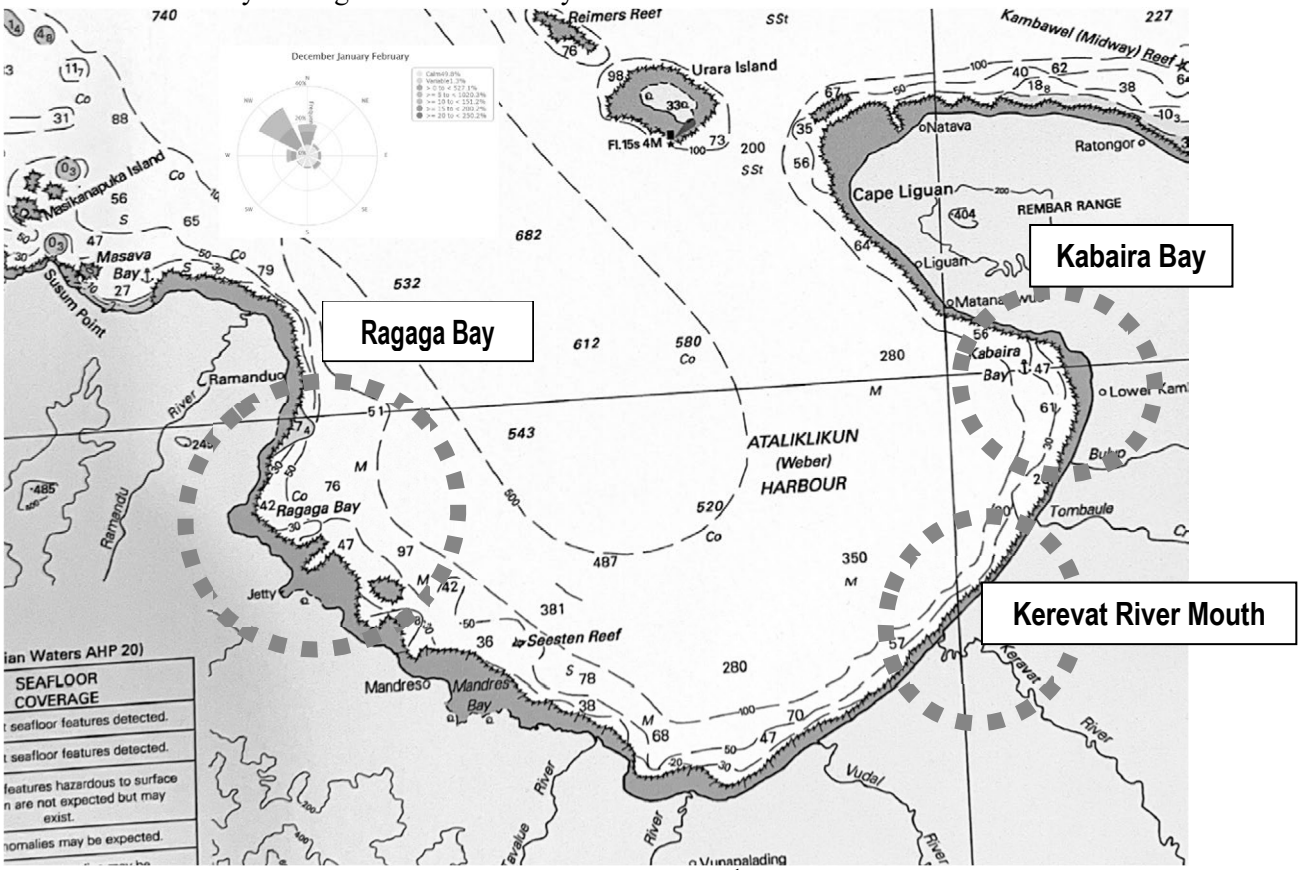
- To select preferable sites for constructing a new port as a regional main port for Northeast Gazelle Peninsula from various perspectives by conducting comparative evaluations of alternative locations for relocating Rabaul Port's regional main port functions based on scientific data on oceanography, topography, land availability, and terrestrial environment/
- To seek consensus about possible locations of a new regional main port by conducting stakeholder consultation and coordination including residents, civil organisations, environmental NGOs, and academic personnel, as well as national, provincial, district and local government officers.

(3) Project Description

To conduct a basic study including the following surveys and analyses at three candidate locations in Ataliklikun Bay Area as shown Figure 19.6.1.

- Oceanographic Survey
- Topographic Survey

- Survey for Land Acquisition
- Terrestrial Environmental Survey
- Study of Fixing Port Location
- Feasibility Study (Economic and Financial)
- To conduct stakeholder coordination and consultation for seeking consensus about a new port location by sharing the scientific study results mentioned above.



Source: JICA Expert Team, based on the Australian Hydrographic Office, 7th February 2020, Nautical Chart PNG 545 – Rabaul to Cape Lambert,

Figure 19.6.1 Three Candidate Locations in Ataliklikun Bay Area

(4) Expected Benefits

- In the super-long term (beyond 2042), relocation of regional main port functions to safer areas

(5) Executing Agency and Related Institute

- PNG Ports Corporation Ltd.
- Department of Transport

(6) Estimated Project Cost

- Survey and Feasibility Study: PGK 6 million (USD 1.6 million)

(7) Implementation Schedule

- This basic study project should be conducted as soon as possible within the first 5 years from now.

(8) Necessary Actions for Implementation / Critical Factor

- Coordination between Department of Transport and PNG Ports Corporation Ltd. is required.

(9) Related Plans and Projects

- ENBP Economic Development Plan 2003-2030
- Rabaul Port Master Plan 2014
- Rabaul Port Detailed Infrastructure Master Plan, February 2021

(10) Social and Environmental Impacts

- A relatively large impact by the construction and operation of a new regional main port on marine environment is expected in Ataliklikun Bay, However, since the Ataliklikun Bay Area is very wide, it might be possible to reduce environmental risks and limit impact areas by a new port by adequate layout planning of wise utilization of Ataliklikun Bay Area.

19.7 Profile of Project for Redevelopment of Tokua Airport Phase 1 [AP-01]

(1) Rational

The current capacity of facilities at Tokua Airport is not sufficient for accommodating the increasing number of passengers. The demand forecasts for years 2026, 2031, 2036 and 2041 were prepared by "Preparatory Survey for Tokua Airport Redevelopment Project". It is estimated that the number of domestic passengers is to increase to 367,300 in 2031 and 543,200 in 2041, whereas the number of international passengers is to become 45,300 in 2031 and 142,200 in 2041.

The current Tokua Airport does not have any facilities to keep cargoes that need to be refrigerated.

With the completion of the preparatory survey by JICA, both governments of PNG and Japan intend to move to the next stage of project implementation. However, the actual schedule for the implementation of the upgrading project of Tokua Airport is uncertain due to the current high debt sustainability situation of PNG government (a high percentage of external debt to GDP).

However, it is still expected that the Short-Term Development Plan of Tokua Airport be completed by 2031. With the implementation of the Short-Term Development Plan, Tokua Airport is planned to become an international airport to export fresh food and vegetables to Guam, the Philippines and Japan, and to accommodate an increasing number of international tourists and business travellers, not only for ENBP, but also for its surrounding islands, such as New Ireland and Bougainville.

In order to upgrade Tokua Airport to an international airport, it is necessary to extend the runway length and apron area, install new taxiways, and construct a new passenger terminal building and a control tower. If a new terminal is constructed and regular international flights are in service, it will be possible to increase concession incomes and operate duty-free shops. To that end, it is necessary to increase the building capacity for accommodating commercial facilities.

It is necessary to take necessary actions to attract foreign and domestic investments not only in tourism sectors, but also in tuna processing industries and other fresh food sectors. Tourism sector investments should be promoted not only in ENBP but also in New Ireland and Bougainville. For supporting tuna processing industries, infrastructure development for water supply and power supply are essential.

(2) Objectives

- To increase capacity and improve safety of Tokua Airport to meet the growth of air traffic demand at the airport by constructing a new terminal building, extending the runway etc.
- To upgrade the current airport to the status of international airport

(3) Project Description

The project content is to upgrade Tokua Airport to fulfil the requirement as shown in Table 19.7.1.

Table 19.7.1 Required Facilities at Tokua Airport Redevelopment Phase 1

	Facility	Short Term Development Plan (2031)
1	Runway length, Width	2,600 m, B=45m
	Category	Non-precision
2	Runway strip length, Width	2,720 m, B=280m
3	Taxiway type, Width	2 x stab, B=25m
4	Aircraft parking apron (New)	B737-8 x 1, B767-300ER x 1
	Aircraft parking apron (Existing)	F70 x 1, ATR72 x 1, DH-8 x 1, General Aviation
5	Parking	116 lots
6	Access road	2 lanes
7	Passenger terminal building	6,003 m^2 (in 2036)
8	Cargo terminal building	660 m^2
9	ATC tower	320 m^2
10	Others	• Utilities: Electricity, Water Supply and Sewage, etc. will be enhanced in accordance with each demand. • Navigation Aids: GNSS, Air Traffic Control System and Aeronautical Ground Lighting System will be constructed. • Rescue and Firefighting: Cat-6 level will be considered. • Aviation fuel facility will be constructed by the supplier.

Source: NAC/JICA

The preparatory survey was completed in January 2021 by JICA.

(4) Expected Benefits

- To improve efficiency of operation of Tokua Airport
- To secure the ability of Tokua Airport to operate larger aircraft capable of longer-range flights.
- To accommodate international flights with international business visitors and tourists, as well as international cargo flights carrying refrigerated tuna fillets to international markets

(5) Executing Agency and Related Institute

- National Airport Corporation (NAC)

(6) Estimated Project Cost

- Approx. PGK 880 million (JPY 35.2 billion, 1PGK = 40.0 JPY were used as exchange rates.)

(7) Implementation Schedule

- About 30 months from the commencement of the construction until the end of the construction

(8) Necessary Actions for Implementation / Critical Factor

- Coordination with Tokua Airpot City Development and Tourism SEZ

(9) Related Plans and Projects

- Tokua Airport City Development Plan
- ENBP Tourism SEZ

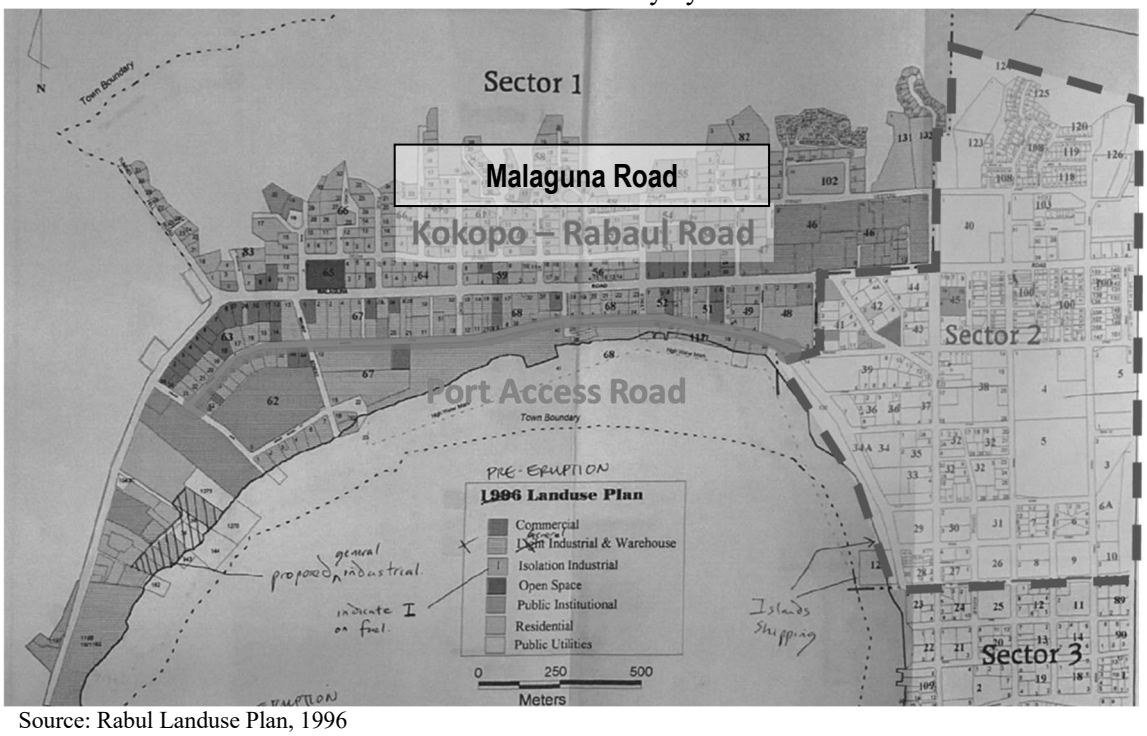
(10) Social and Environmental Impacts

Marine environmental impact of downstream of the small river initiated from the Tokua airport area is to be managed.

19.8 Profile of Project for Rehabilitation of Port Access Road in Rabaul Town (including Drainage Facilities for Rabaul Town) [UR-01]

(1) Rational

- In Sector 1 of Rabaul Town, "Kokopo - Rabaul Road (Malaguna Road)" and "Port Access Road" are major urban roads in the currently urbanized area.
- However, the condition of Port Access Road is very poor due to drainage problems. This road should be rehabilitated by solving the drainage facility network to deal with sediments from the northern hill of the town.
- By providing necessary access not only for the existing urban area, but also for restored and expanded urban areas, the function of Rabaul Port could be well functioning and tourist attractions in Rabaul Town could be accessed easily by tourists.



Source: Rabul Landuse Plan, 1996

Figure 19.8.1 Major Urban Roads in Sector 1 of Rabaul Town

(2) Objectives

- To enhance the port's function
- To reduce vehicle operation costs for transporting cargo to and from the port
  - By managing sediments from the northern hill of Rabaul Town for solving drainage network problems of Port Access Road and Rabaul Port

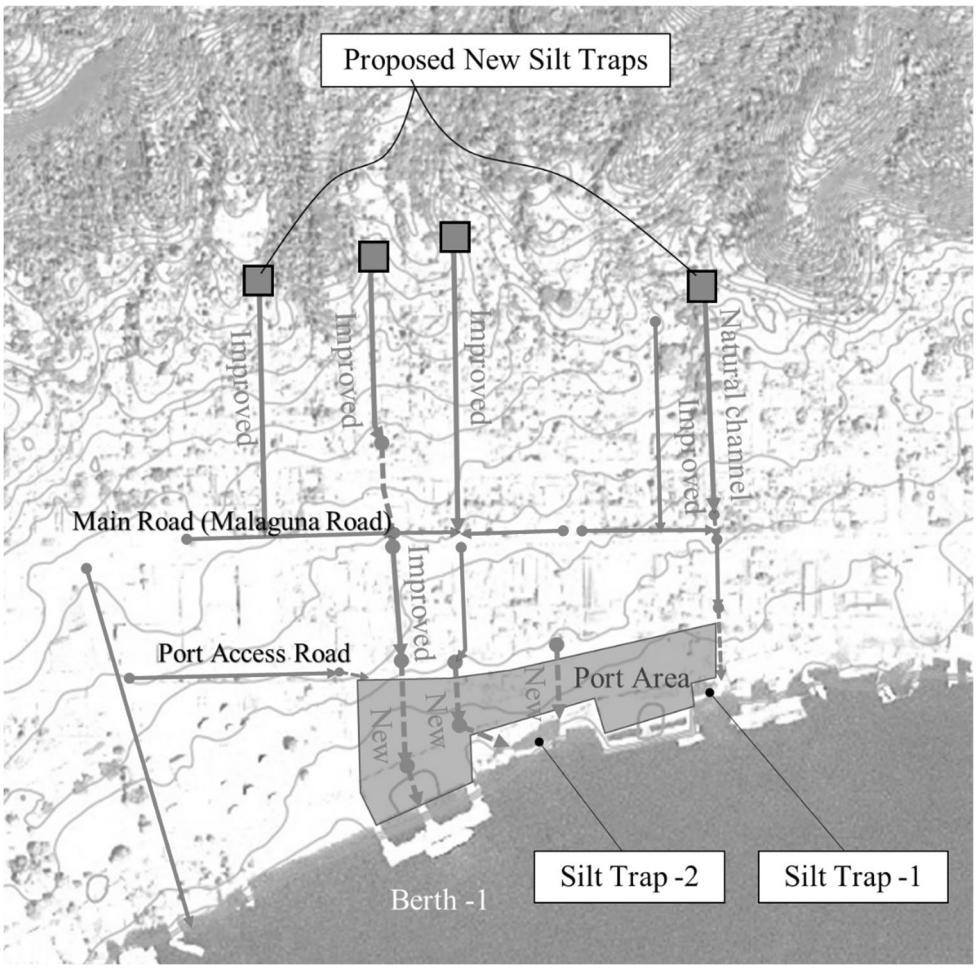
(3) Project Description

- To rehabilitate 1.8km of Port Access Road
- To manage sediments from the northern hill of Rabaul Town for reducing the concentration of sediments to the Port Access Road and Rabaul Port area

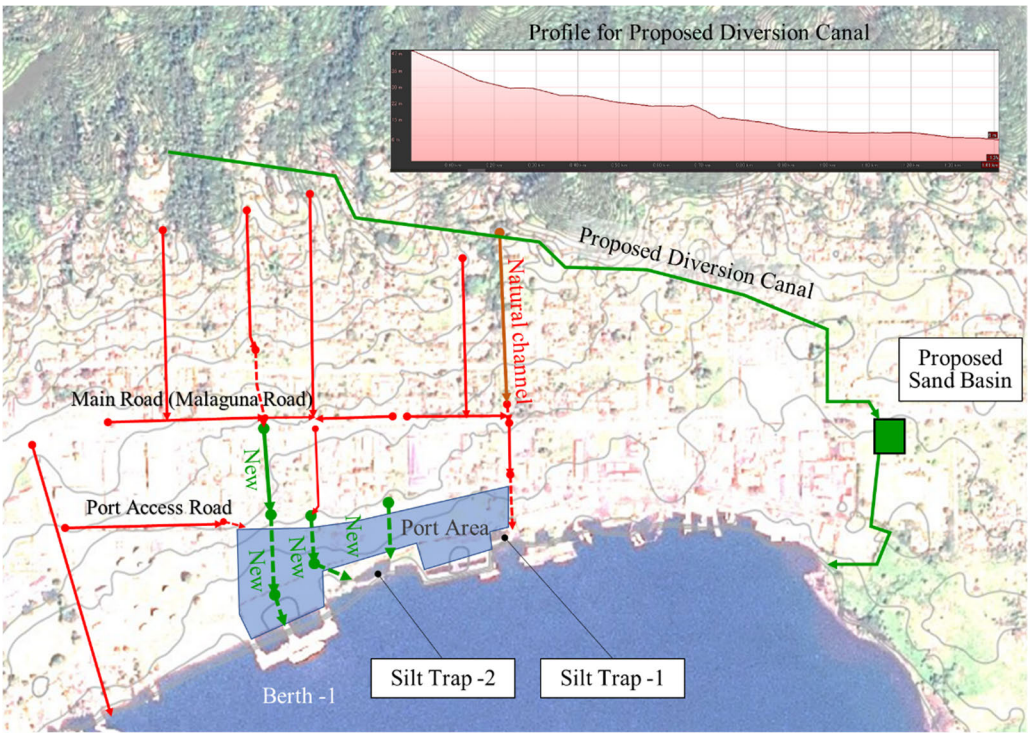
There are the following two different types of improving the drainage network in Rabaul Town:

- [Improvement Plan 1] Installation of four new silt traps at the foot of the slope behind Rabaul Town where there is a lot of sediment runoff, so that sediment will be captured. Improved drainage channel is connected from the new silt traps to Malaguna Road is necessary. (See Improvement Plan 1 in Figure 19.8.2.)

- [Improvement Plan 2] A new diversion channel is to be installed from the westernmost point at the foot of slope behind Rabaul Town where there are lots of sediment runoff, and the stormwater flows down to the easternmost sand basin, which also has a stormwater reservoir function for flood control. A new drainage channel is also necessary from the sand basin to the sea. (See Improvement Plan 2 in Figure 19.8.2.)



Improvement Plan 1



Improvement Plan 2

Note: Study to determine the location for sand basin is necessary to consider the suitable location not only based on the geographical analysis, but also with the perspective of urban development in Rabaul.
Source: JICA Expert Team

Figure 19.8.2 Proposed Two Improvement Plans for Drainage Network in Rabaul Town

(4) Expected Benefits

- The function of Rabaul Port could be well functioning and tourist attractions in Rabaul Town could be accessed easily by tourists.

(5) Executing Agency and Related Institute

- Division of Infrastructure Development, ENBPA

(6) Estimated Project Cost

- Project Cost for Rehabilitation of Port Access Road: PGK 20 million
- PGK 22 million ~ PGK 35 million depending on what drainage facilities are to be provided for capturing soils and silts from hills behind Rabaul Town.
- Total Project Cost: PGK 42 ~ 55 million

(7) Implementation Schedule

- Between 2024-2032

(8) Necessary Actions for Implementation / Critical Factor

- Coordination with Rabaul Port Office of PNG Ports Corporation Ltd.

(9) Related Plans and Projects

- None

(10) Social and Environmental Impacts

- Small

19.9 Profile of Project for Development of Southern Section of Kokopo Town Ring Road [UR-03]

(1) Rational

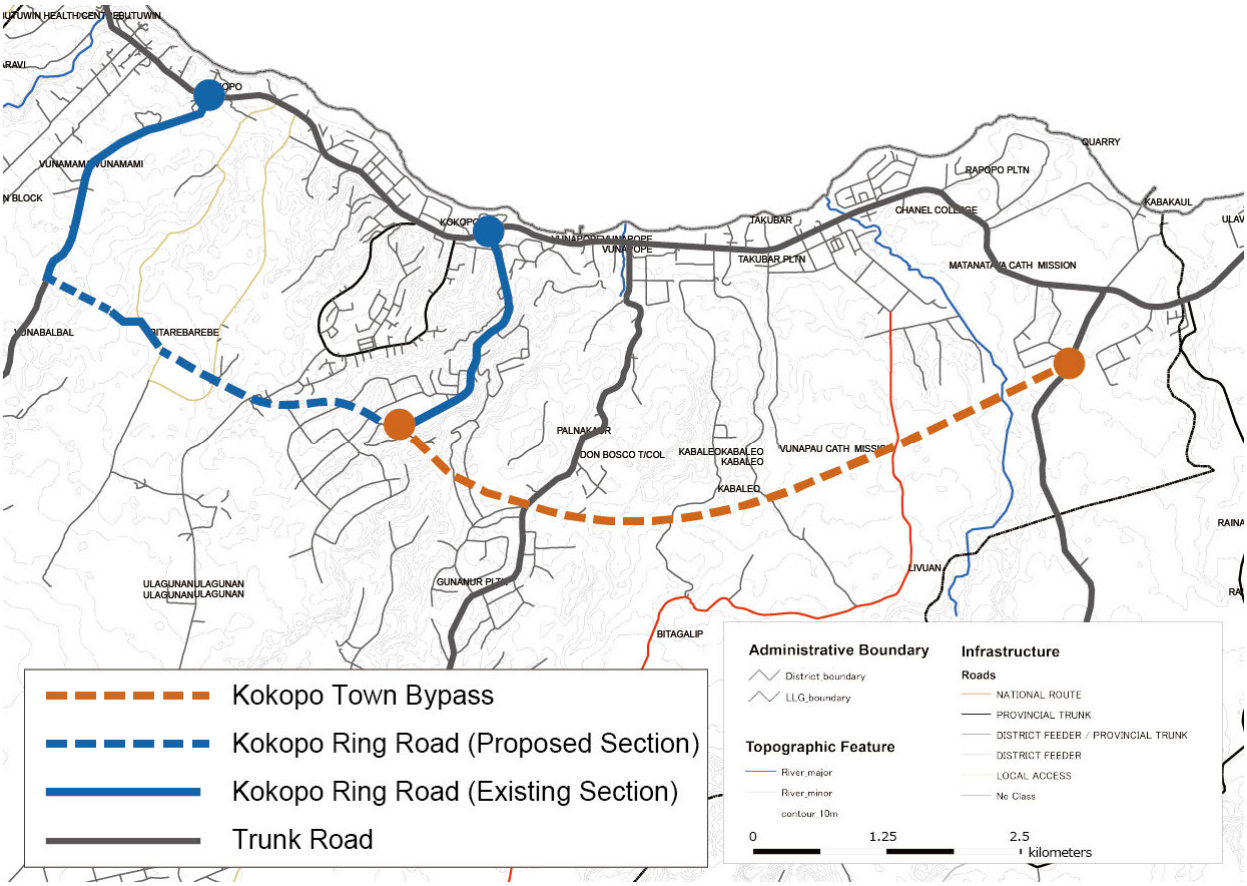
The urban expansion in Kokopo has occurred along the coast to the south-east from Kokopo Town toward Tokua Area to limited extension. However, Kokopo Town with the status of Kokopo City is expected to play an important role as a prime business and tourist centre not only for ENBP, but also for the Islands Region. It is necessary to upgrade the urban functions of the Kokopo Town and to expand urban areas for accommodating more urban facilities (including office buildings and tourist/business hotels) and residences.

(2) Objectives

- To support the expansion of urban areas in primary centres and secondary centres by extending and upgrading urban roads
- To improve redundancy of urban roads, especially Kokopo-Tokua
- To improve the resilience of urban roads against disasters by implementing disaster risk reduction measures

(3) Project Description

- To develop 2.5km of Southern Section of Kokopo Town Ring Road as shown in Figure 19.9.1.



Source: JICA Expert Team, based on Kokopo - Tokua Corridor Subject Development Plan 2016

Figure 19.9.1 Integrated Kokopo Ring Road and Kokopo Town Bypass in Kokopo-Tokua Urban Corridor

(4) Expected Benefits

Accessibility and mobility with primary and secondary centres / functions in urban areas will be improved.

(5) Executing Agency and Related Institute

- Division of Infrastructure Development, ENBPA in coordination with Department of Works and Highways

(6) Estimated Project Cost

PGK 17.5 million

(7) Implementation Schedule

- In the period of 2024-2032
- 1 year for construction

(8) Necessary Actions for Implementation / Critical Factor

- Coordination with Division of Physical Planning for setting a wide planning area by considering the construction of the southern section of the Kokopo Town Ring Road.

(9) Related Plans and Projects

- Kokopo - Tokua Corridor Subject Development Plan 2016

(10) Social and Environmental Impacts

- Some relocation of existing residents might be necessary for land acquisition

19.10 Profile of Project for Rehabilitation and Improvement for Kokopo Borehole Field [WS-01]

(1) Rational

The facilities for Kokopo water supply were constructed after the volcanic eruption in 1994, and therefore, facilities have been used for around 25 years. The deterioration for most of the facilities is not so serious, but some system compositions are extremely inefficient, and some improvements are urgently necessary.

Lack of monitoring facilities and auto-operation system of pumps for all facilities, and inadequate composition of facilities, such as well pumps and pressure pipes for Vunabosco Borehole Field are major problems for Kokopo water supply system.

Intake system must be improved in order to solve the above problems by introduction of monitoring and auto-operation.

(2) Objectives

- To improve the efficiency and sustainability of water supply system
  - By improvement of well system (boreholes and water pumps) for water supply
  - By introducing automatic and monitoring system for water supply

(3) Project Description

- Installation of a tank and pumps for the transmission from borehole fields to Raniolo reservoirs
- Introduction of automatic pump operation coping with the water level of receiving tanks
- Introduction observatory instrumentations and monitoring system

(4) Expected Benefits

- The total yield capacity will be recovered to the original capability.
- Because operators and managers of Water PNG Kokopo Office can grasp the operation status of the borehole field, they can manage the operation of the system properly.
- The total power consumption at the borehole field will be reduced drastically.
- Current abbreviated lifespan of well pumps will be lengthened due to avoiding long-time continuous operation.
- The groundwater resource at the borehole field will be saved matching the water demand of Kokopo Town.

(5) Executing Agency and Related Institute

- Water PNG Corporation Ltd.

(6) Estimated Project Cost

- PGK 4 million (Approx. 1.22 million USD)

The detail costs are shown in Table 19.11.1.

Table 19.10.1 Project Contents and Costs of Rehabilitation and Improvement for Borehole Field of Kokopo

Name		Specifications	Quantity	Unit	Unit Price($)	Total Cost($)
Transmission Tank		Concrete	256	m^3	300	76,800
Pump House		Concrete	32	m^2	1,200	38,400
Stand-by well Pumps		7 units 7.0-30kW	1	no		100,000
Disinfection Unit		Tank Pump and Panel	1	no		30,000
Transmission Pump	for Town	D125mmx15kW	3	no	5,000	15,000
	for Village	D65mmx3.7kW	2	no	2,500	5,000
Pipe Connection and Installations			1	no		50,000
Miscellaneous Items			1	no		14,800
Sub-Total						330,000
Control Panel at WTP			1	lot		134,160
Monitoring Panel at Raniola	With transmitter to Water PNG		1	set		125,400
Monitoring unit	at Water PNG Office		1	set		136,800
Generator for transmission pump		100kVA	1	set		136,800
Flow-meter	for well pumps	D100	2	no	11400	22,800
	for trans. Pump	D200	1	no		15,960
	for Dis. of town	D150	1	no		14,250
	for dis. of village	D50	1	no		6,840
Level Meter-Pressure type		0-5m	2	no	6840	13,680
Signal-line (newly)	wells to panel		1.6	km	15000	24,000
	Raniolo to WTP		2.9	km	15000	43,500
	Village tank to panel		0.5	km	15000	7,500
Miscellaneous Items			1	no.		8,310
Sub-total						690,000
Indirect Cost		20%	1	no		204,000
Total						1,224,000

Source: JICA Expert Team

(7) Implementation Schedule

- Between 2024-2027
- 1 year for construction of equipment installation

(8) Necessary Actions for Implementation / Critical Factor

- None

(9) Related Plans and Projects

- Kokopo - Tokua Corridor Subject Development Plan 2016

(10) Social and Environmental Impacts

- The project might need to consider the impact of pumping up of an extra volume of groundwater for rehabilitation and improvement of Kokopo Borehole Field.

19.11 Profile of Project for Rehabilitation and Improvement of Water Supply System for Rabaul Town Area [WS-02]

(1) Rational

Many low-pressure users exist in Rabaul Town.

When water is supplied to cruise ships from Redlight Reservoir, for which the volume is a maximum 250 m3/time, all users' water supply conditions in the town worsen greatly.

Because of manual operation of the intake site and no monitoring system at Redlight Reservoir, much water has been discharged and power wasting has occurred.

Sometimes the water supply to Rabaul Town is stopped because of the breakdown of the sole pump and generator at Wisdom Intake.

The steel reservoir at Redlight Site is already corroded and has started to leak.

(2) Objectives

- To improve the efficiency of water supply system in terms of water and electricity
- To solve problems on low water pressure areas
- To solve water shortage for local population caused by supplying water to cruise ships
- To solve the high risk of whole water stoppage to the Rabaul Town by breakdown of intake facilities

(3) Project Description

This project is composed of the following components:

- Installation of high elevation reservoir and new distribution pipes
- Replacement of existing reservoir and installation of new intake facilities
- Introduction of automatic and monitoring system of pump operation and receiving tank water levels

(4) Expected Benefits

- The total yield capacity will be doubled due to the construction a new intake facility.
- The water supply to the town will not stop due to machine troubles because of the dual intake system.

- Because operators and managers of Water PNG Kokopo office and Rabaul office can grasp the operation status of their water supply system, they can manage the operation of the system properly.
- The Redlight Reservoir can be used without concerns for breakdown due to the rehabilitation.
- The power consumption of well pumps will be reduced due to the reduction in operation time.
- The short lifespan of well pumps will be solved due to avoidance of long-time continuous operation.
- User complaints about low pressure will be solved due to the construction of a high elevation reservoir and installation of distribution pipes for high elevation areas.
- The distribution can be expanded to high elevation areas and far away areas.
- Water distribution trouble in the town by supplying water to cruise ships will be solved due to installation of an exclusive pipe.
- The groundwater resource for the town will be saved matching the water demand of Rabaul Town.

(5) Executing Agency and Related Institute

- Water PNG Corporation Ltd.

(6) Estimated Project Cost

- PGK 7 million (Approx. USD 1.92 million)
- The detail costs are shown in Table 19.11.1.

Table 19.11.1 Project Contents and Costs of Rehabilitation and Improvement for Water Supply System of Rabaul Town Area

Name		Specifications	No.	Unit	unit Price($)	Total Cost($)
Red-light replaced reservoir		Concrete	650	m^3	300	195,000
Red-light reservoir abandon		Steel	1	no		30,000
New reservoir		Concrete	190	m^3	400	76,000
Disinfection Unit for Wisdom		Tank,Pump and Panel	2	no	30,000	30,000
Transmission Pump	for New Reservoir	D80mmx11kW	2	no	4,000	8,000
Borehole(200mmx50m)			1	no		100,000
Borehole Pump & others		11kW	1	no		20,000
Stand-by Well Pump		11kW	2	no	6,000	12,000
Pump House			40	m^2	1,500	60,000
New Intake Site Work			200	m^2	200	40,000
Disinfection Unit for New Intake			1	no		30,000
Water supply pipe	to ship	D200m	1,000	m	80	80,000
Intake pipe	New intake to Red-light	D150	170	m	60	10,200
Transmission pipe	Redlight to new Res.	D150	270	m	60	16,200
Distribution Pipe	New Res. To town	D200m	570	m	80	45,600
Distribution Pipe	in town	D100	2,770	m	50	138,500
Miscellaneous Items			1	no.		8,500
Sub-Total						900,000
Control Panel	For Wisdom Intake site		1	no		62,960
	For New Intake site with transmitter		1	no		74,360
	For Redlight Reservoir Site		1	no		62,960
Monitoring Panel	at New Reservoir		1	no		125,400
Monitoring unit	at Water PNG Office in Kokopo		1	no		50,000
	at Water PNG Office in Rabaul		1	no		50,000
Generator for new intake & Redlight Reservoir		50kVA	2	no	70,000	140,000
Flow-meter	for well pump in Wisdom	D100	2	no	11,400	22,800
	for well pump in new intake	D100	1	no		11,400
	for Trans. to new reservoir	D150	1	no		14,250
	for distribution to town	D200	1	no		15,960
	for dis. to high elevation town	D50	1	no		6,840
Level Meter	for Redlight & new reservoir 0-5m		2	no	6,840	13,680
Signal-line (sole)	Wisdom to Redlight		370	m	15	5,550
Signal-line (with Pipe inst.)	New intake to Red-light		170	m	15	2,550
	Redlight to new Reservoir		270	m	15	4,050
Miscellaneous items						37,240
Sub-total						700,000
Indirect Cost		20%				320,000
Total						1,920,000

Source: JICA Expert Team

(7) Implementation Schedule

- Between 2024-2027
- 1 year for construction and equipment installation

(8) Necessary Actions for Implementation / Critical Factor

- None

(9) Related Plans and Projects

- None

(10) Social and Environmental Impacts

- Impact on the groundwater needs to be considered.

19.12 Profile of 66kV Transmission Lines 552 and 553 Rehabilitation Project including the Rehabilitation of Kokopo and Rabaul Substations [PW-02A]

(1) Rationale

66kV Transmission Line 552 and 553 are the "Back-bone Line" connecting Kokopo and Rabaul, as shown in Figure 19.12.1.

However, some of the transmission poles were inclined and insulators were remarkably broken, in spite of the fact that these lines have an important role in power supply.

Most of the equipment composing power facilities—wooden poles, transformers, isolators, switchgears, insulators, and other accessories—are seriously aged, deteriorated, and damaged due to volcanic ashes or improper maintenance.

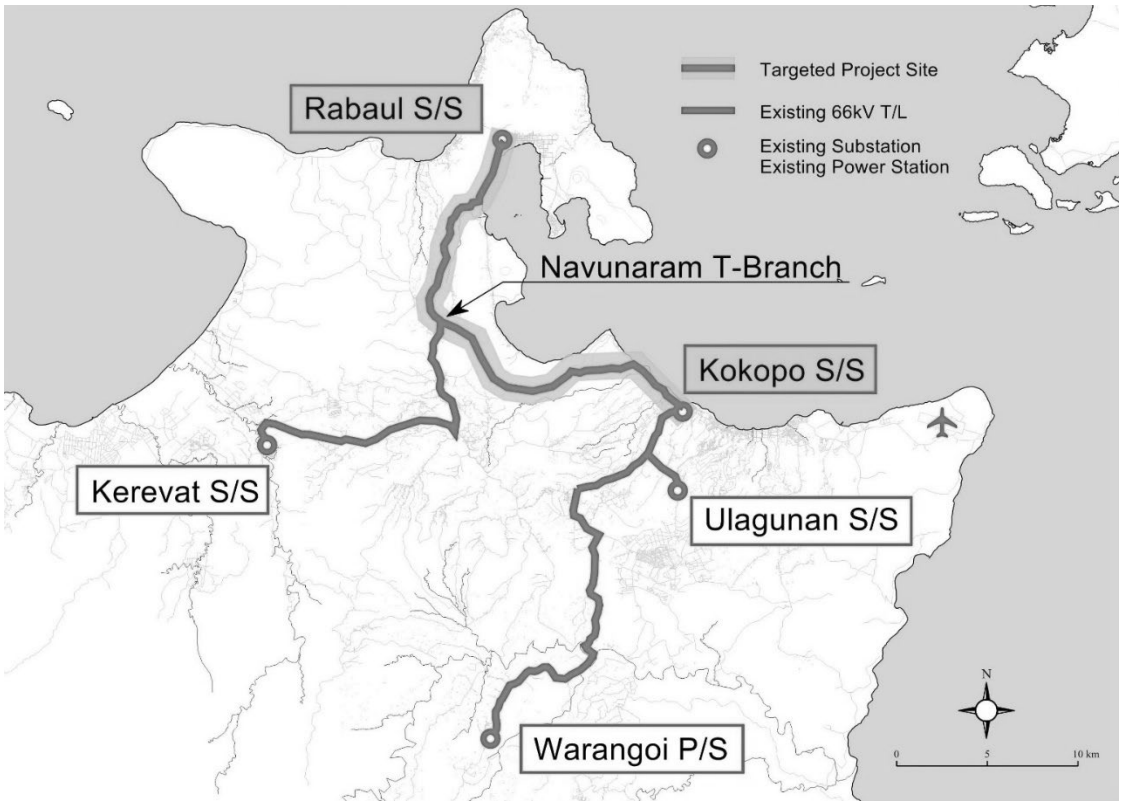
To promote the development of the Kokopo and Rabaul Region, the reinforcement of these back-bone lines is essential.

(2) Objectives

- To stabilise the power supply in the Gazelle Grid for Northeast Gazelle Peninsula
- To strengthen the capacity of supplemental power generation to supply stable power for Kokopo Town, Rabaul Town, and Kerevat Town where economic sector development is to be promoted

(3) Project Description

The project site will be the right-of-way of the existing 66kV transmission line connecting Kokopo Substation (S/S) and Rabaul Substation (S/S), extending over the coastal area from Kokopo to Rabaul through Rakandakanda with a length of 44km, as shown in Figure 19.12.1.



Source: JICA Expert Team

Figure 19.12.1 Project Site of the Priority Project for 66kV Transmission Lines

The following basic plan is recommended:

- To rehabilitate 66kV Transmission Lines 552 and 553 (transmission poles, insulators, wires, etc.) from Kokopo S/S to Rabaul S/S, excluding the line segment established at Navunaram T-Branch
- To rehabilitate Kokopo S/S, Rabaul S/S, and Kerevat S/S including protection relays and supplemental diesel power generators

Wooden poles account for more than 90% of all the existing poles (132 poles) for Transmission Line 552, and all of them are not new wooden poles. Therefore, it will be required to immediately replace them with new poles, specifically, steel poles that PPL intends to procure new poles or new transmission towers that are already introduced to the power grid in New Guinea Island.

Under the project design stage, the following change of specification and configuration should be studied through the system analysis:

- To change the specification of the transmission line from a single circuit to a double circuit to satisfy the N-1 rule
- To install two units of transformers at the respective substations to satisfy the N-1 rule

Also, it will be required to closely coordinate with ADB's transmission line and substation construction project to minimise power failure areas during the construction period.

(4) Expected Benefits

- To provide stable electricity to towns and semi-urban areas
- To maintain the quality of life with stable electricity supply in wide areas

(5) Executing Agency and Related Institute

- PNG Power Corporation Ltd.

(6) Estimated Project Cost

- PGK 22 million for upgrading of the transmission line (44km)
- Approximately, a total of 40 million PGK is estimated for the rehabilitation of both Kokopo S/S and Rabaul S/S.

(7) Implementation Schedule

- 5 years for construction and equipment installation

(8) Necessary Actions for Implementation / Critical Factor

- None

(9) Related Plans and Projects

- None

(10) Social and Environmental Impacts

- Low impact because the transmission lines will use the lands for the existing transmission lines.

PART VIII

STRATEGIC ENVIRONMENTAL ASSESSMENT

Chapter 20 Strategic Environmental Assessment

20.1 SEA for NEGID-Plan

20.1.1 Background of SEA for NEGID-Plan

A Strategic Environmental Assessment (SEA) is an environmental study at policy, planning, and programme (PPP) levels. It has a profound significance in the plans for proactive environmental and social considerations at higher levels of decision-making processes by providing early warning on environmental and social impacts, and from broad and long-term perspectives. Therefore, SEA will be conducted in the process of the formulation of Infrastructure Development Plan for Northeast Gazelle Peninsula in the Project.

PNG has no act nor guidelines for SEA. Therefore, in this Planning Project, the SEA will be conducted based on JICA Guidelines for Environmental and Social Considerations. The SEA results will be reflected in the land use policy and infrastructure development plan to be formulated in the Planning Project.

20.1.2 Objectives of SEA for NEGID-Plan

The objectives of SEA for NEGID-Plan are as follows:

- To identify and assess potential impacts induced by implementing the Infrastructure Development Plan for Northeast Gazelle Peninsula
- To evaluate options from the technical, financial and environmental points of view taking into consideration views and comments from stakeholders
- To select an optimal option for the Project and propose mitigation measures to avoid, reduce and mitigate any impacts

20.1.3 Process of SEA for NEGID-Plan

1) Screening

The activities in the screening process are as follows:

- To review the existing development plans (upper level/related plans), development projects, studies, and policies
- To examine the issues on environmental and social aspects for infrastructure development planning
- To confirm legal frameworks and concerned institutions of the Government of PNG on environmental and social considerations
  - Laws, regulations, and standards related to environmental and social considerations (environmental impact assessment, resettlement, public participation, information disclosure, and others)

  - Gaps between the JICA Guidelines for Environmental and Social Considerations (January 2022)[1] and the legal framework of PNG on environmental and social considerations
  - Outlines of respective agencies and institutions responsible for the implementation of the Project
- To examine the methods to implement the SEA for the Project
- To examine the plans, and configure alternatives, which are subject to the SEA
- To study the baseline situation on environmental and social aspects of the planning areas subject to the SEA
  - Study on the marine environment will be conducted to supplement the baseline study

2) Scoping

Extremely important items on environmental and social impacts and the evaluation methods at the time of decision making such as PPP levels will be identified.

3) Assessment

The following activities for the preparation of SEA Report will be conducted:

- To predict the environmental and social impacts of each alternative based on the results of scoping
- To compare and evaluate the alternatives including "without project" option from viewpoint of technical, financial, and impacts on the environment and social aspects, and select the optimal plan
- To study the mitigation measures in the optimal plan (to be avoided, minimised, and compensated)
- To study the monitoring method based on the mitigation measures

4) Consultations

The following stakeholder meetings will be organised during the SEA process:

- 1st stakeholder meeting: Explanation of the Project outline and Project schedule, pre-scoping, and exchange of opinions
- 2nd stakeholder meeting: Assessment of draft development vision, development policies, spatial structure, and development strategies

5) Approval

ENBPA is responsible for the approval of SEA Report.

6) Monitoring and Evaluation

Monitoring and evaluation are to be conducted by ENBPA during the plan implementation.

20.2 Institutional Frameworks for SEA

The SEA for this Planning Project is to be conducted by the provincial government of East New Britain and JICA Expert Team as part of the Project. The main actors of ENBPA who will conduct the SEA are the PIU members of this Project.

TWG for Environmental and Social Consideration will be monitoring the conduct of the SEA and will approve the SEA Report. The members of the TWG for Environmental and Social

[1] https://www.jica.go.jp/english/our_work/social_environmental/guideline/c8h0vm0000013gbd-att/guideline_03.pdf

Considerations are listed below:

- ENBPA
  - DPA-Corporate Services
  - Division of Policy Planning and Research
  - Division of Lands and Physical Planning
  - Division of Technical Services
  - Natural Resources, Management and Development Unit
  - Division of Community Development
  - Division of Response & Management
- Kokopo District Administration
- Rabaul District Administration
- Gazelle District Administration
- NGOs
  - Wide Bay Conservation Association
  - OISCA PNG
  - FORCERT
- CEPA
- Climate Change and Development Authority
- PNG Forestry Authority
- JICA Expert Team

20.3 Progress of SEA Study

(1) Screening

The legal framework and institution of the Government of PNG on environmental and social considerations and JICA's guidelines for environmental and social consideration have been reviewed, and the method for implementing the SEA in NEGID-Plan has been considered by the JICA Expert Team.

The first TWG Meeting for Environmental and Social Considerations was held on 15th December 2021 to explain the objectives and methodology of SEA and its process.

(2) The First Stakeholder Meeting for Pre-Scoping

The stakeholder meeting held on 5th April 2022 was utilised as an opportunity for pre-scoping.

1) Purpose

The purposes of the stakeholder meeting were as follows.

- To kick off a series of stakeholder meetings by involving government officers, private sectors, civil society organizations, universities and researchers in Northeast Gazelle Peninsula
- To listen to views and opinions on the present situation of development in Northeast Gazelle Peninsula
- To start considering the future of Northeast Gazelle Peninsula

The following contents were explained and discussed in the Stakeholder Meeting by the agenda shown in Table 20.3.1.

- Outline of the Project (Goals and objectives of the project, Institutional organization of the project, Study area, Study description, Implementation schedule)

- Group Discussion (Objectives of group discussion, Method of group discussion, Questions to participants)

Table 20.3.1 Agenda of the First Stakeholder Meeting

Time	Items
9:00 - 9:30	Registration
9:30 - 9:35	Opening Remarks by East New Britain Provincial Administration
9:35 - 9:45	Self-Introduction
9:45 - 9:50	Objectives of the First Stakeholder Meeting by the JICA Expert Team
9:50 - 10:00	Presentation on the Project for Kokopo-Rabaul Infrastructure Development Plan by the NEGID-Plan Project Implementation Unit
10:00 - 10:15	Presentation on Topics for Group Discussion by the JICA Expert Team
10:15 - 10:40	Breaking into Groups and Morning Tea
10:40 - 12:10	Group Discussion
12:10 - 12:25	Wrap up
12:25 - 12:35	Presentation by Group A
12:35 - 12:45	Presentation by Group B
12:45 - 12:55	Presentation by Group C
12:55 - 13:00	Closing Remark by ENBPA
13:00 - 14:00	Lunch

Source: JICA Expert Team

2) Invitees

Based on the discussion with the PIU Core Group members, East New Britain Provincial Administration invited the stakeholders for the First Stakeholder Meeting as shown in Table 20.3.2. The stakeholders were considered including national governments and agencies, local governments, academia, representatives from Non-Government Organisations (NGOs), and representatives from the private sector.

Table 20.3.2 List of Invitees to the First Stakeholder Meeting

Government Entities	Non-Government Entities
1. Deputy Provincial Administrator – Corporate Services, ENBPA 2. Deputy Provincial Administrator – D&LLG Services, ENBPA 3. Advisor – Division of Policy Planning and Research, ENBPA 4. Provincial Planner – Division of Policy Planning and Research, ENBPA 5. Programs Officer-Infrastructure – Division of Policy Planning and Research, ENBPA 6. Social Planner – Division of Policy Planning and Research, ENBPA 7. Advisor – Division of Lands and Physical Planning, ENBPA 8. Physical Planner – Division of Lands and Physical Planning, ENBPA 9. Technical Officer – Division of Lands and Physical Planning, ENBPA 10. Acting Advisor – Division of Technical Services, ENBPA 11. Civil Engineer – Division of Technical Services, ENBPA 12. Advisor – Division if Agriculture and Livestock, ENBPA 13. Program Officer – Agriculture – Division if Agriculture and Livestock, ENBPA 14. Program Officer – Livestock – Division if Agriculture and Livestock, ENBPA 15. Advisor – Division of Commerce and Industry, ENBPA 16. Industrial Development Officer – Division of Commerce and Industry, ENBPA	42. Airport Manager, Tokua Airport – National Airport Corporation 43. Acting Managing Director – National Airport Corporation 44. Chief Executive Officer – National Airport Corporation 45. Business Manager, Kokopo – PNG Power 46. Business Manager, Rabaul Port – PNG Power 47. Business Manager, Kokopo – Water PNG 48. Regional Manager – Telikom PNG 49. Principal Planner, Islands Regional Office – Development of Lands and Physical Planning 50. Regional Works Manager, ENBP Office – Development of Works 51. Officer in Charge, ENBP Office – National Maritime Safety Authority 52. Director – Rabaul Volcano Observatory 53. Regional Centre Manager – National Agriculture Research Institute 54. Area Manager, Island Region – National Forest Authority 55. Senior Project Officer – Cocoa Board 56. Senior Agronomist – Coca & Coconut Research Institute 57. Group Executive Chairman – East New Britain Development Corporation

17. Culture & Tourism Development Officer – Division of Commerce and Industry, ENBPA 18. Advisor – Division of Fisheries & Marine Resources, ENBPA 19. Forestry and Environmental Coordinator – Natural Resources, Management and Development Unit, ENBPA 20. Advisor – Division of Community Development, ENBPA 21. Director of Disaster and Emergency – Division of Response & Management, ENBPA 22. District Administrator – Kokopo District 23. Civil Engineer – Kokopo District 24. Town Manager of Kokopo/Vunamami LLG – Kokopo District 25. Civil Works Engineer of Kokopo/Vunamami LLG – Kokopo District 26. Manager of Bitapaka LLG – Kokopo District 27. Manager of Raluana LLG – Kokopo District 28. District Administrator – Rabaul District 29. Civil Engineer – Rabaul District 30. Town Manager of Rabaul LLG– Rabaul District 31. Civil Development Planner of Rabaul LLG – Rabaul District 32. Civil Works Engineer of Rabaul LLG– Rabaul District 33. Manager of Balanataman LLG – Rabaul District 34. Manager of Kombiu LLG – Rabaul District 35. District Administrator – Gazelle District 36. Civil Engineer – Gazelle District 37. Manager of Central Gazelle LLG – Gazelle District 38. Manager of Vunadidir/Toma LLG – Gazelle District 39. Manager of Livuan/Reimber LLG 40. Provincial Civil Engineer – Development of Works 41. Officer in Charge, Islands Regional Office – Department of Transport	58. President – ENB Chamber of Commerce 59. General Manager – Rabaul Hotel 60. General Manager – Kokopo Beach Bangalow Resort 61. CEO – Tourism Promotion Authority Office 62. General Manager – Gazelle International Hotel 63. General Manager – Rapopo Plantation Resort 64. General Manager – Vanmark Shipping 65. General Manager – Coastal Shipping 66. General Manager – Rabaul Shipping 67. General Manager – Islands Petroleum 68. Manager, Rabaul Depot – Puma Energy 69. CEO – Tzen Plantation PNG Limited 70. General Manager – 3A Composites PNG Ltd 71. General Manager – CPL Coconut Oil Mill 72. Director – Open Bay Timber 73. Operations Manager, Kokopo Branch Office – Digicel PNG 74. Executive Director – Water Bay Conservation Association 75. Manager – FORCERT 76. Director, Rabaul Office – OISCA 77. Director, Kokopo Open Campus – University of PNG 78. Dean, School of Natural Resources – University of Natural Resources & Environment 79. Dean, School of Sustainable Resources Management – University of Natural Resources & Environment 80. Chairman, Rabaul Branch – Institution of Engineers PNG 81. New Britain New Ireland Mission Head Quarters - Seventh Day Adventist of Papua New Guinea 82. New Britain Region - United Church of Papua New Guinea 83. Ecclesiastical Province of Rabaul - Catholic Church of Papua New Guinea 84. East New Britain Circuit – Evangelical Lutheran Church of Papua New Guinea 85. East New Britain - Baptist Union of Papua New Guinea

Source: JICA Expert Team

3) Participants

A total of 51 persons consisting of 28 from the local government, and 23 from the local stakeholders (non-government) participated in the meeting as shown in Table 20.3.3. Among them, 11 persons were female, and 40 persons were male.

Table 20.3.3 Types of Participants

Organization	Male	Female	Total
Local Government	19	9	28
Local Stakeholder	21	2	23
Total	40	11	51

Source: JICA Expert Team

4) Group Discussion

In the group discussion, major concerns related to natural and social environment in Kokopo District, Rabaul District and Gazelle District were discussed among others. The main concerns raised by the participants are listed below.

- Due to climate change, the locals are experiencing higher rainfall which causes soil erosion and siltation in Rabaul Port.
- Siltation on the reefs and changes in the seabed impact the environment and marine ecosystem.

(3) The Second Stakeholder Meeting for Assessment

The stakeholder meeting held on 28th November 2022 was utilised as an opportunity for assessing the future and spatial development proposed for Northeast Gazelle Peninsula.

1) Purpose

The purposes of the stakeholder meeting were as follows.

- To explain the preliminary future and spatial development options for Northeast Gazelle Peninsula
- To listen to views and opinions on the proposed spatial development options in terms of environmental, social and economic impact

The following contents were explained and discussed in the Second Stakeholder Meeting by the agenda shown in Table 20.3.4.

- Outline of the Project (Goals and objectives of the project, Study area, Study description, Implementation schedule)
- Progress of the Study
- Environmental and Social Consideration in the Project (Purpose of SEA, Tiers of SEA and EIA, Fundamental differences between SEA and EIA, SEA Approaches, Process of SEA)

Table 20.3.4 Agenda of the Second Stakeholder Meeting

Time	Items
9:30 - 10:00	Registration
10:00 - 10:05	Opening Remarks by Representative of East New Britain Province
10:05 - 10:20	Self-Introduction
10:20 - 10:25	Presentation on the Overview of the Project by ENBPA
10:25 - 10:30	Presentation on the Present Situation of Northeast Gazelle Peninsula by ENBPA
10:30 - 10:55	Preliminary Future Vision and Spatial Development Options for Northeast Gazelle Peninsula by JICA Expert Team
10:55 - 11:10	Presentation on Strategic Environmental Assessment by JICA Expert Team
11:10 - 11:25	AM Tea
11:25 - 11:50	Questions and Answers
11:50 - 12:50	Group Discussion
12:50 - 13:50	Lunch
13:50 - 14:05	Presentation by Group A
14:05 - 14:20	Presentation by Group B
14:20 - 14:30	Closing Remark by ENBPA

Source: JICA Expert Team

2) Invitees

Based on the discussion with the PIU Core Group members, East New Britain Provincial Administration invited the stakeholders for the Second Stakeholder Meeting as shown in Table 20.3.5. The stakeholders were considered including national governments and agencies, local governments, academia, representatives from Non-Government Organisations (NGOs), and representatives from the private sector.

Table 20.3.5 List of Invitees to the Second Stakeholder Meeting

Government Entities	Non-Government Entities
1. Deputy Provincial Administrator – Corporate Services, ENBPA 2. Deputy Provincial Administrator – D&LLG Services, ENBPA 3. Advisor – Division of Policy Planning and Research, ENBPA 4. Provincial Planner – Division of Policy Planning and Research, ENBPA 5. Social Planner – Division of Policy Planning and Research, ENBPA 6. Advisor – Division of Lands and Physical Planning, ENBPA 7. Physical Planner – Division of Lands and Physical Planning, ENBPA 8. Technical Officer – Division of Lands and Physical Planning, ENBPA 9. Acting Advisor – Division of Technical Services, ENBPA 10. Civil Engineer – Division of Technical Services, ENBPA 11. Advisor – Division if Agriculture and Livestock, ENBPA 12. Program Officer – Agriculture – Division if Agriculture and Livestock, ENBPA 13. Program Officer – Livestock – Division if Agriculture and Livestock, ENBPA 14. Advisor – Division of Commerce and Industry, ENBPA 15. Industrial Development Officer – Division of Commerce and Industry, ENBPA 16. Culture & Tourism Development Officer – Division of Commerce and Industry, ENBPA 17. Advisor – Division of Fisheries & Marine Resources, ENBPA 18. Forestry and Environmental Coordinator – Natural Resources, Management and Development Unit, ENBPA 19. Advisor – Division of Community Development, ENBPA 20. Director of Disaster and Emergency – Division of Response & Management, ENBPA 21. District Administrator – Kokopo District 22. Civil Engineer – Kokopo District 23. Town Manager of Kokopo/Vunamami LLG – Kokopo District 24. Civil Works Engineer of Kokopo/Vunamami LLG – Kokopo District 25. Manager of Bitapaka LLG – Kokopo District 26. Manager of Raluana LLG – Kokopo District 27. District Administrator – Rabaul District 28. Civil Engineer – Rabaul District 29. Town Manager of Rabaul LLG– Rabaul District 30. Civil Development Planner of Rabaul LLG – Rabaul District 31. Civil Works Engineer of Rabaul LLG– Rabaul District 32. Manager of Balanataman LLG – Rabaul District 33. Manager of Kombiu LLG – Rabaul District 34. District Administrator – Gazelle District 35. Civil Engineer – Gazelle District 36. Manager of Central Gazelle LLG – Gazelle District 37. Manager of Vunadidir/Toma LLG – Gazelle District 38. Provincial Civil Engineer – Development of Works 39. Officer in Charge, Islands Regional Office – Department of Transport 40. Officer in Charge, Islands Regional Office- Department of Agriculture and Livestock	41. Airport Manager, Tokua Airport – National Airport Corporation 42. Business Manager, Kokopo – PNG Power 43. Business Manager, Rabaul Port – PNG Power 44. Business Manager, Kokopo – Water PNG 45. Regional Manager – Telikom PNG 46. Principal Planner, Islands Regional Office – Development of Lands and Physical Planning 47. Regional Works Manager, ENBP Office – Development of Works 48. Officer in Charge, ENBP Office – National Maritime Safety Authority 49. Director – Rabaul Volcano Observatory 50. Regional Centre Manager – National Agriculture Research Institute 51. Area Manager, Island Region – National Forest Authority 52. Senior Project Officer – Cocoa Board 53. Senior Agronomist – Coca & Coconut Research Institute 54. Group Executive Chairman – East New Britain Development Corporation 55. President – ENB Chamber of Commerce 56. General Manager – Rabaul Hotel 57. General Manager – Kokopo Beach Bangalow Resort 58. CEO – Tourism Promotion Authority Office 59. General Manager – Gazelle International Hotel 60. General Manager – Rapopo Plantation Resort 61. General Manager – Vanmark Shipping 62. General Manager – Coastal Shipping 63. General Manager – Rabaul Shipping 64. General Manager – Islands Petroleum 65. Manager, Rabaul Depot – Puma Energy 66. CEO – Tzen Plantation PNG Limited 67. General Manager – 3A Composites PNG Ltd 68. General Manager – CPL Coconut Oil Mill 69. Director – Open Bay Timber 70. Operations Manager, Kokopo Branch Office – Digicel PNG 71. Executive Director – Water Bay Conservation Association 72. Manager – FORCERT 73. Director, Rabaul Office – OISCA 74. Director, Kokopo Open Campus – University of PNG 75. Dean, School of Natural Resources – University of Natural Resources & Environment 76. Dean, School of Sustainable Resources Management – University of Natural Resources & Environment 77. Chairman, Rabaul Branch – Institution of Engineers PNG

Source: JICA Expert Team

3) Participants

A total of 33 persons consisting of 26 from the local government and seven from the local stakeholders (non-government) participated in the meeting as shown in Table 20.3.6. Among them, 5 persons were female, and 28 persons were male.

Table 20.3.6 Types of Participants Attending the Second Stakeholders Meeting

Organization	Male	Female	Total
Local Government	23	3	26
Local Stakeholder	5	2	7
Total	28	5	33

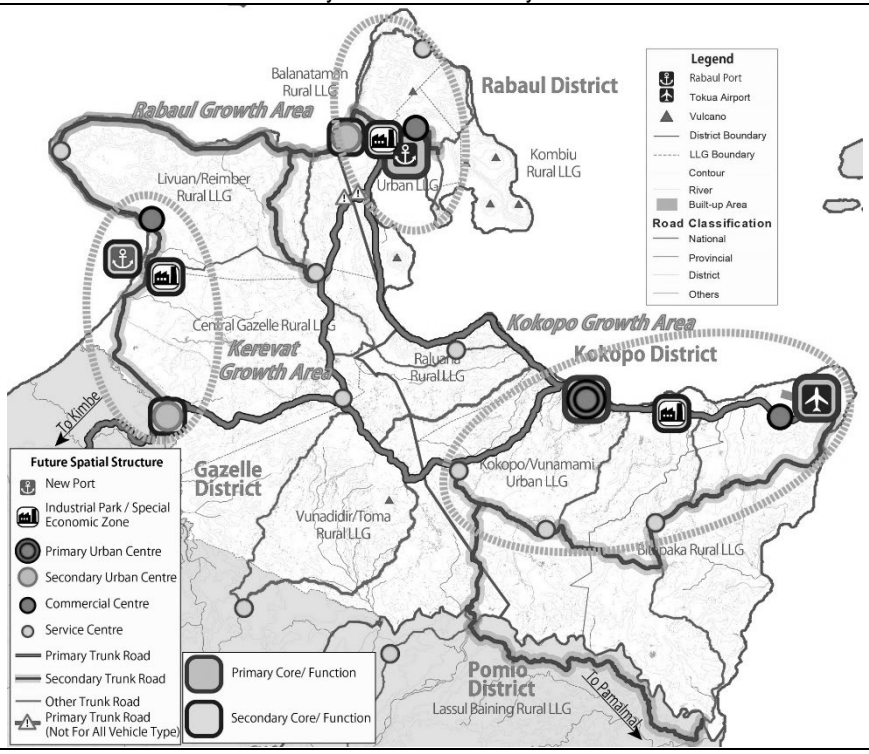
Source: JICA Expert Team

4) Group Discussion

After the presentation about outline of the project, progress of the study, and SEA in the project from ENBPA Officer and JICA Expert Team, group discussion was held in two groups about likely impacts due to the spatial development options for Northeast Gazelle Peninsula proposed by the JICA Expert Team in Progress Report. The participants were allocated to two groups. JICA Expert Members and ENBPA Officers also participated in each group to facilitate the discussion. One group consisted of about 17 persons including JICA Expert Members and ENBPA Officers.

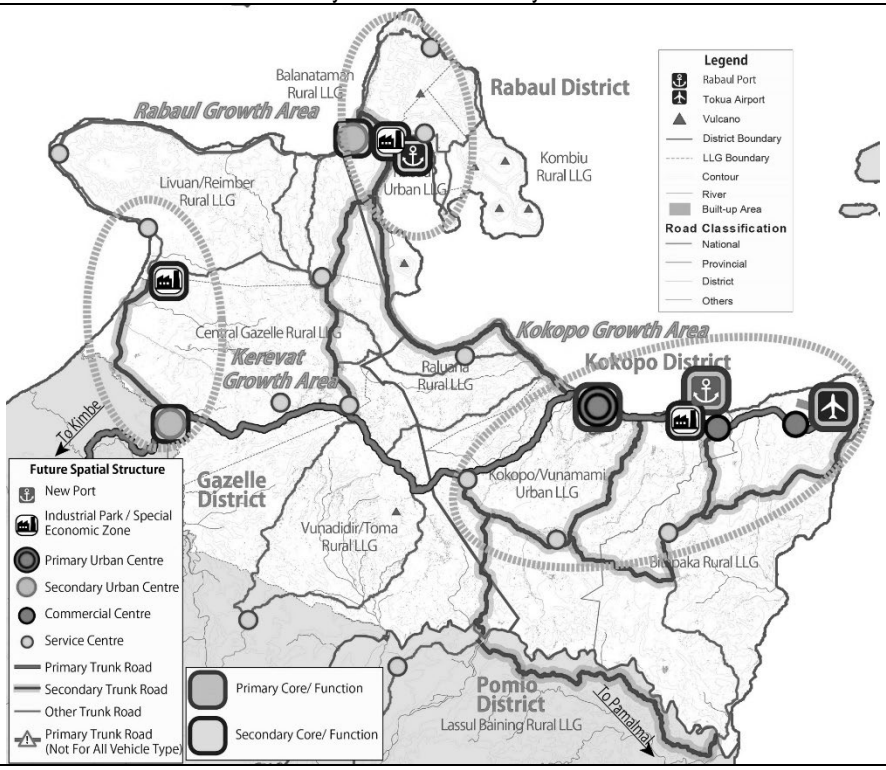
Three scenarios of spatial development for Northeast Gazelle Peninsula are described as Table 20.3.7 to Table 20.3.9.

Table 20.3.7 Alternative Scenarios for Northeast Gazelle Peninsula: Scenario 1

Development at Growth Areas	This scenario aims **to keep Rabaul Port as the Primary Gateway** and to prepare **a new port at Ataliklikun Bay for the Gazelle Agro-Processing SEZ, which will also function as the alternative port in case Rabaul Port cannot be used in case volcano eruption**, etc. There will be Primary or Secondary Gateways in each Growth Area. Commercial centres are also developed or established in each Growth Area.
Future Regional Structure and Phased Development	• Rabaul Port will be rehabilitated and upgraded by 2032 and continue to function as the main regional port. • A new port at Ataliklikun Bay will be developed by 2042. • The roads between Kokopo and Rabaul will remain as the primary trunk roads connecting the primary gateways and primary cores. • The coastal road between Rabaul and Kokopo will be rehabilitated and/or upgraded. • The road between Rabaul Growth Area and Kerevat Growth Area will be connected by secondary trunk road connecting primary core/gateway and secondary core/gateway. • The road from Kerevat to Ataliklikun Bay becomes secondary trunk road.
Future Regional Structure in 2052	

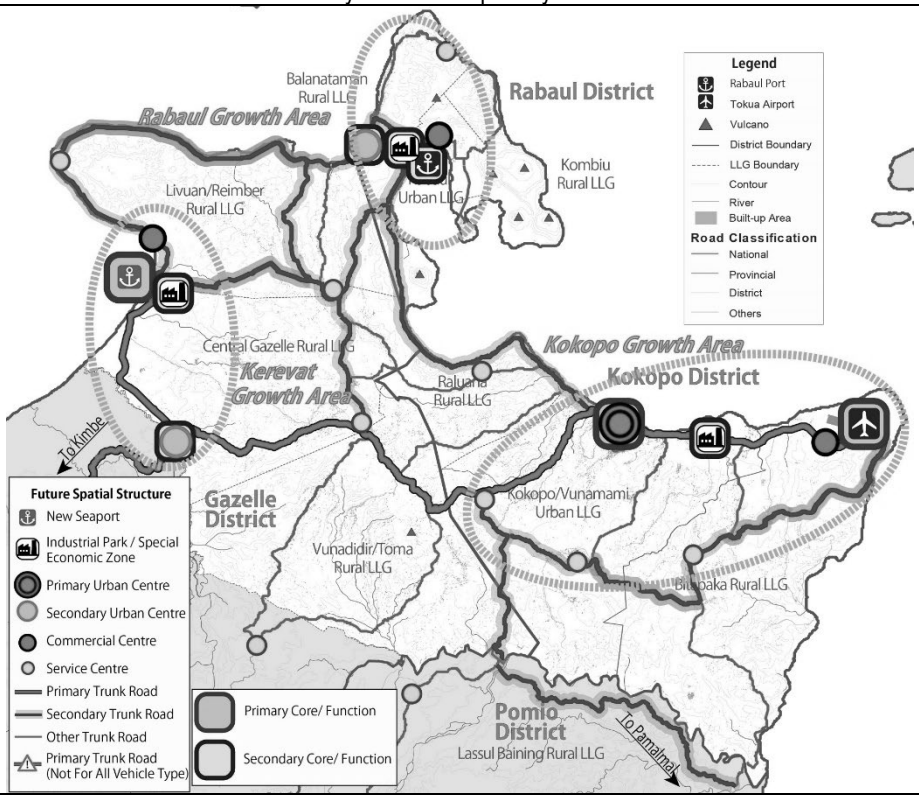
Source: JICA Expert Team

Table 20.3.8 Alternative Scenarios for Northeast Gazelle Peninsula: Scenario 2

Development at Growth Areas	In this scenario, **all major functions (Primary Gateways and Primary Urban Core) will be concentrated in Kokopo Growth Area**. Kerevat Growth Area will not develop as much as the other scenarios with only new SEZ. Commercial centres are developed or established at Kurakakaul and Tokua in Kokopo Growth Area.
Future Regional Structure and Phased Development	• Rabaul Port will be rehabilitated. • A new container port will be developed at Kabakaul Plantation in Kokopo District for handling container cargo and bulk cargo by 2032 and becomes the Primary Gateway. • Part of the port function (handling bulk fuel, cruise ship calls, and fishing reefer ship calls) will remain in Rabaul. Rabaul Port will become secondary gateway. • The coastal road between Rabaul and Kokopo will be rehabilitated. • The coastal road between Rabaul and Kokopo and Vunadidir to Burma Road will become secondary trunk road connecting primary core/gateway and secondary core/gateway. • The road from Kerevat to Ataliklikun Bay becomes secondary trunk road.
Future Regional Structure in 2052	

Source: JICA Expert Team

Table 20.3.9 Alternative Scenarios for Northeast Gazelle Peninsula: Scenario 3

Development at Growth Areas	**This scenario aims balanced development in each Growth Area.** **Rabaul Port will continue to function as the main port until around 2040,** while **a new port at Ataliklikun Bay will be developed for the Gazelle Agro-Processing SEZ**, which will also function as the alternative port in case Rabaul Port cannot be used in case volcano eruption, etc. There will be Primary or Secondary Gateways in each Growth Area. Commercial centres are also developed or established in each Growth Area.
Future Regional Structure and Phased Development	• Rabaul Port will be rehabilitated and upgraded by 2032 and continue to be the main port until 2042. • A new port at Ataliklikun Bay will be developed by 2042, while securing land for further development. • The function of handling container cargo and bulk cargo will shift to the new port at Ataliklikun Bay from Rabaul by 2052, while part of the port function (handling bulk fuel, cruise ship calls, and fishing reefer ship calls) will remain in Rabaul. • The coastal road between Rabaul and Kokopo will be rehabilitated and/or upgrade. • The coastal road between Rabaul and Kokopo and Vunadidir to Burma Road will become secondary trunk road connecting primary core/gateway and secondary core/gateway. • The road between Rabaul Growth Area and Kerevat Growth Area will be connected by secondary trunk road connecting primary core/gateway and secondary core/gateway. • The road from Kerevat to Ataliklikun Bay will become primary trunk road.
Future Regional Structure in 2052	

Source: JICA Expert Team

The assessment of each scenario was done using the 13 perspectives categorised by environmental and natural resource, economic development, and social environment and culture as shown Table 20.3.10.

Table 20.3.10 Categorised Perspectives for Assessment

Environment and Natural Resource	• Effect to the natural resources (water, biodiversity, climate etc.) • Pollution (air, noise, odor) and Solid Waste (industrial waste etc.) • Disaster Risk and Resilience
Economic Development	• Improvement of Existing Infrastructure • Development of Economic Activities (agriculture, tourism, manufacturing, etc.) • Creation and Attraction of Investment • Improvement of Standard of Living of People
Social Environment and Culture	• Impact on the Lands and its Usage • Improvement of Access to Services (power supply, water supply, health care, education, etc.) • Security • Demographic • Impact on Culture and Customs • Worship Sites and Religious Sites

Source: JICA Expert Team

The participants were asked to discuss likely positive and negative impacts in terms of the perspectives.

5) Result of Group Discussion

After the group discussion, each group presented the results of the discussion about likely impacts. Likely impacts raised by participants in each group are summarised in Table 20.3.11 to Table 20.3.13.

Some environmental impacts such as natural resources and pollution were raised as concern for all scenarios. In Scenario 1 and Scenario 2, traffic congestion was also raised as possible negative impact. Regarding social environment and culture, possibility of affecting worship sites and religious sites were indicated by both groups for all scenarios. The necessity of increase in law-and-order issues were raised for Scenario 1 and Scenario 2, whereas there was opinion on Scenario 3 that the issues will improve if development is balanced in each growth area.

Table 20.3.11 Results of Group Discussions: Likely Impacts Due to Scenario 1

Scenario 1			
Categories		Positive Impacts	Negative Impacts
Environment and Natural Resource	Effect to the natural resources (water, biodiversity, climate etc.)	・ Alternative water sources will be identified and developed	・ Change vegetation (Trees cut down, loss of birds, insects, other vegetation) ・ Increase of carbon dioxide emission ・ Sea pollution would affect the marine biodiversity ・ Change in landscape ・ Coastal / Marine erosion
	Pollution (air, noise, odor) and Solid Waste (industrial waste etc.)		・ Noise pollution ・ Dust pollution ・ Industrial & commercial waste (oil) to the coast ・ Coastal erosion ・ Waste or spillage from vessels spread widely affecting coastal villages ・ Villages who depend entirely depend on sea will be affected. ・ Pollution to natural habitat
	Disaster Risk and Resilience	・ Better mitigation measures upstream ・ Silt traps to be constructed ・ Infrastructure be designed and build to be disaster resilient to volcanoes,	・ Soil erosion ・ Reforestation to combat siltation

		earthquakes, rise in sea level, flooding, landslides, etc.	
Economic Development	Improvement of Existing Infrastructure	・ Less time to travel to schools and hospitals ・ Create employment ・ Population may increase along the coastal road ・ Existing Infrastructure would be improved to meet user demand (bridges, drains, roads, etc.) ・ Less time to bring goods to markets etc. ・ Rehabilitation of roads, and facilities for water and power supply.	
	Development of Economic Activities (agriculture, tourism, manufacturing, etc.)	・ Boast in tourism sector ・ Boast in agriculture sector ・ Proper design for bus stop and bus stop shelters	・ Population be exposed to manufacturing specialty
	Creation and Attraction of Investment	・ Opportunity for local businesses ・ New job and investment opportunities with introduction of SEZ ・ Population growth/ fair distribution of employment opportunities ・ Improvement of beachfronts for tourism	・ Traffic congestion
	Improvement of Standard of Living of People	・ Improvement of standard of living ・ Income from regular job ・ Informal market generating additional income ・ Increase and improvement in social services i.e. health, education, etc. ・ Local participation in spin off benefits	
Social Environment and Culture	Impact on the Lands and its Usage		・ Government may need to acquire land and locals displaced may need to resettle ・ Loss of land to landowner if acquired for development
	Improvement of Access to Services (power supply, water supply, health care, education, etc.)	・ Improvement to water and power supply facilities following the trunk roads. ・ Contribution to improvement of living standards ・ Improvement of access to education and health for people living within the area. ・ Less time to travel to clinic/health facilities and/or schools ・ Widening of physical planning area will have an eventual effect on provision of necessary utilities and social services	
	Security		・ Law and order Issues will rise if people migrate into the development area. ・ Need to boast police services in Kerevat and along the coast road between Kerevat and Rabaul as well as Kerevat and Kokopo.
	Demographic	・ Population within the planning area especially along the infrastructure such as trunk roads will increase	

	Impact on Culture and Customs	• Introduction of new way of living, culture and custom	• Less use of shell money as legal currency • Young generation not attending churches/ Introduction to foreign religion • Impacts on cultures and traditions with the influx of people from outside moving into the area • Introduction of new way of living, culture and custom
	Worship Sites and Religious Sites		• Sacred sites/ religious sites/ cemeteries etc. might be affected if they are located where infrastructure is proposed to be constructed

Source: JICA Expert Team

Table 20.3.12 Results of Group Discussions: Likely Impacts Due to Scenario 2

Scenario 2			
Categories		Positive Impacts	Negative Impacts
Environment and Natural Resource	Effect to the natural resources (water, biodiversity, climate etc.)		• Sea pollution will affect the marine biodiversity hotspots • Water well will be disturbed • Locals depends heavily on sea • Vessels' discharge into the sea is a concern • Impact on fishing grounds • Impact on dolphin breeding areas • Coastal / marine erosion
	Pollution (air, noise, odor) and Solid Waste (industrial waste etc.)		• Noise pollution • Vessel discharge • Air pollution • Sea pollution would affect the biodiversity hotspots
	Disaster Risk and Resilience		• Kokopo has the risk of tsunami as per the geoscience report • Flooding, soil erosion • Kokopo is subject to all natural disasters and may not be the convenient location to accommodate cargo movement to Kerevat and Rabaul centres.
Economic Development	Improvement of Existing Infrastructure	• Both coastal roads from Kokopo to Rabaul and Kokopo to Kerevat will be improved • Improvement to the road would add value to the customary landowners to venture into economic activities.	
	Development of Economic Activities (agriculture, tourism, manufacturing, etc.)	• Boast in tourism and agriculture sector • Population may be exposed to manufacturing specialty	• Traffic congestion with the balsa and oil palm industries already existing.
	Creation and Attraction of Investment	• Convenience in commercial and industrial industries • Port will be developed next to tourism activities • Guest house adjacent to the location	
	Improvement of Standard of Living of People	• Close proximity to health and education services as well as Tokua Airport • Living standards will be increased	

Social Environment and Culture	Impact on the Lands and its Usage		• Land within Kokopo, especially land from Kokopo to Tokua are mostly privately owned and are difficult to acquire • Resettlement of block holders would require land acquisition • Loss of land to landowner if acquired for development
	Improvement of Access to Services (power supply, water supply, health care, education, etc.)	• Power supply is available • Increase health and education services • Water supply to Kabakaul area and adjoining areas	
	Security	• Boast police power within Kokopo and improve court infrastructure	• Law and order issues will increase if people migrate into the proposed new container depot in Kokopo and development area
	Demographic	• Population Increase in the growth centres • Population within the planning area, especially along the infrastructure such as trunk roads will increase • Transport and truck Service will be extended to Kabakaul • More activities	
	Impact on Culture and Customs		• Less use of shell money as legal currency • Young generation may not attend churches • Introduction of foreign religion • Impacts on cultures and traditions with the influx of people from outside moving into the area
	Worship Sites and Religious Sites		• Sacred sites/ religious sites/ cemeteries etc. might be affected if they are located where infrastructure is proposed to be constructed.

Source: JICA Expert Team

Table 20.3.13 Results of Group Discussions: Likely Impacts Due to Scenario 3

Scenario 3			
Categories		Positive Impacts	Negative Impacts
Environment and Natural Resource	Effect to the natural resources (water, biodiversity, climate etc.)	• Alternative water sources to be identified and developed.	• Change in vegetation and landscape due to development on Ataliklikun Bay • Increase of carbon emission • Marine pollution • Impacts on fishing grounds • Impacts on dolphin breeding areas • Sea pollution will affect the marine biodiversity hotspots • Coastal / marine erosion • Water wells might be disturbed
	Pollution (air, noise, odor) and Solid Waste (industrial waste etc.)		• Waste or spillage from vessels may affect coastal villages in close proximity • Air pollution • Sea pollution • Noise pollution
	Disaster Risk and Resilience	• Flood control is necessary upstream • Flood control along the Kokopo-Rabaul Road	

		・ Infrastructure designed and built with improved to be disaster resistant	
Economic Development	Improvement of Existing Infrastructure	・ Improvement of the North Coast Road to cater for the large container trucks ・ Coastal road from Rabaul to Kerevat will be improved to primary road	
	Development of Economic Activities (agriculture, tourism, manufacturing, etc.)	・ Manufacturing and other introduced economic activities ・ Creation of job opportunities ・ Tourism activities on the North Coast Road and Kokopo-Rabaul Road	
	Creation and Attraction of Investment	・ Concentrated employment, specialized trade and professional jobs may be provided ・ Increase in job opportunities ・ Increase in market demands	
	Improvement of Standard of Living of People	・ Income from regular jobs ・ Increase in SME ・ General improvement to the living standards	
Social Environment and Culture	Impact on the Lands and its Usage		・ Private landowners may need to release their land for residential and commercial development ・ Land acquisition issues depending on where the port at Ataliklikun Bay will be located
	Improvement of Access to Services (power supply, water supply, health care, education, etc.)	・ Improvement and extension of power and water supply ・ Increase in access to health and education services. ・ Possibility of developing geothermal power for electricity supply	
	Security	・ Law & order issues will improve if development is balanced in each growth area	・ Law and order issues will rise ・ Need to boast police service in Kerevat and along the coast road between Kerevat & Rabaul as well as Kerevat to Kokopo
	Demographic	・ Pomio District and WNBP will be connected via New Britain Highway ・ More population settlement in newly developed areas in Gazelle District ・ Increase in demand	
	Impact on Culture and Customs	・ Have an impact on cultures and customs	・ Less use of shell money as legal currency ・ Have an impact on cultures and customs ・ Young generation not attending churches/ Introduction of foreign religion.
	Worship Sites and Religious Sites		・ Sacred sites on customary land may be disturbed

Source: JICA Expert Team

20.4 Scoping

Scoping was conducted based on the environmental and social conditions of the study area, and the results of the First Stakeholder Consultation Meeting, the discussion among the participants.

Since the purpose of this scoping is to consider environmental and social impacts at the planning stage of regional infrastructure development plan, at the so-called master plan level, the likely impacts were expected fundamentally in the long-term, cumulatively, or in a broader area.

Table 20.4.1 Scoping of the Significant Environmental and Social Issues

Item	No.	Likely Impacts	Ranking		Description of Impact/Issues	Key Issues requiring further assessment
			Positive Impacts	Negative Impacts		
Pollution	1	Air Pollution	+1	-1	・ Infrastructure development can increase fossil-fuel based vehicle transportation, which has negative impacts on air quality, including increased carbon dioxide emissions. However, the size of the economy and population are not large and the impact of air pollution shall be limited. ・ Volcanic ash origin soils, Dystrandepts is the most widely distributed in the Project Area and the weathered unconsolidated matrix is floating through the air as wind dust. Road pavement associated with infrastructure development is expected to reduce dust and have a positive impact on air pollution.	-
	2	Water Pollution	+1	-1	・ With the improvement and expansion of water supply system, urban population relying on groundwater will increase instead of using rainwater which can accumulate volcanic ash. ・ Industrial wastewater	-
	3	Noise and Vibration	0	-1	・ Environmental noise and vibration, mainly due to increased motorised traffic can become a problem, especially in the three growth areas and communities along the trunk roads.	-
	4	Soil Contamina-tion	0	-2	・ Oil palm plantation is increasing in East New Britain Province and chemical fertilizer is used for growing oil palm. The soil including chemical fertilizer can also flow into the sea.	Marine environment
	5	Waste	0	-2	・ Industrial waste from the industrial areas and special economic zones will increase with development and it could become a problem if not properly disposed of. ・ Kokopo Growth Area and Rabaul Growth Area have waste disposal sites, but Kerevat Growth Area does not have designated waste disposal sites.	Waste management
	6	Ground Subsidence	0	-1	・ Basic requirements of the infrastructure of water supply are not satisfied and groundwater withdrawal is necessary. However, the groundwater is sufficient in the region.	-
	7	Offensive Odour	0	-1	・ Offensive odours are likely to be generated from wastes generated from processing industries and plants. This is a particular problem if the waste is not properly managed at the landfill or wastewater/sewage treatment plants where it is disposed of.	Waste management
	8	Bottom sediment	0	-1	・ Increased runoff from infrastructure development and the associated soil therein, can affect bottom sediment of surface water systems. Additionally, industrial development within the industrial park and special economic zones could lead to increased wastewater discharge into surface water resources which in turn could lead to deterioration of the quality of surface water resources (bottom sediment).	Marine Environment
Ground Subsidence	9	Protected Areas	0	0	・ There were no observable native floral or faunal species, nor landmarks and culturally significant sites which must be protected, nor there are flagship terrestrial floral and faunal species of conservation concern in Northeast Gazelle Peninsula. However, there are two protected areas acknowledged by Conservation and Environmental Protection Agency (CEPA) and ENBPA, which are Talele Island Reserve Area and Nanuk Provincial Park/Recreational Area in the surrounding water of Northeast Gazelle Peninsula, but no development is envisaged in these areas.	-

Item	No.	Likely Impacts	Ranking		Description of Impact/Issues	Key Issues requiring further assessment
			Positive Impacts	Negative Impacts		
	10	Flora, Fauna, and Biodiversity	0	-3	・ The coastal area of Northeast Gazelle Peninsula has mangrove, coral reef, and also is a habitat for dolphins, turtles and dugongs. There are visitors who come to Kokopo to enjoy such natural environment. Infrastructure development can reduce biodiversity by disrupting breeding patterns and affecting feeding grounds.	Flora and fauna outside protected areas
	11	Hydrological Situation	0	-2	・ There are several floodways in the Northeast Gazelle Peninsula which flow into the sea, and when there is heavy rain falls, the strata formed by the volcanic ash are scraped away. Loss of upland forests, which reduce water retention capacities in upland areas and the loss of natural drainage areas may be caused by land use change.	Natural drainage management
	12	Topography and Geographical features	+1	0	・ Flat land is limited in Northeast Gazelle Peninsula, and development can be concentrated in areas with flat land. However, infrastructure development can improve the accessibility to land in Northeast Gazelle Peninsula and potential area for land development may increase.	-
Social Environment	13	Involuntary Resettlement	0	-1	・ There is a risk of person being physically displaced to make way for infrastructure projects.	Land ownership
	14	The poor people	+2	-1	・ Due to infrastructure development, the poor people / vulnerable groups may be displaced from prime areas, if no social safeguards are put in place for the vulnerable poor communities. ・ Infrastructure development can have a positive impact on the poor people if it creates positive conditions for economic activity, such as improved access to urban areas.	Population of vulnerable groups
	15	Indigenous and ethnic people	0	-1	・ Ethnic migration and mixtures due to infrastructure development may cause conflict among the ethnic groups.	-
	16	Local economy such as employment and livelihood, etc.	+3	0	・ Improved access to markets and ports through development of road infrastructure could improve local economies, including agribusiness.	-
	17	Land use and utilisation of local resources	+2	-1	・ To secure the construction space and the construction works can change the existing land uses. ・ The expected infrastructure developments could change the current land use patterns. More effective land use and local resource use are expected. ・ There are customary lands in Northeast Gazelle Peninsula which may be difficult to acquire for infrastructure development.	Land ownership
	18	Water Usage or Water Rights and Rights of Common	+2	0	・ Basic requirements of the infrastructure of water supply are not satisfied, and there is a cultural acceptance of the situation of lack of water supply. Expected infrastructure development will have a positive impact on water usage or water right, especially in the urban areas.	Water supply demand
	19	Existing social infrastructure and services	+3	0	・ Improvement and extension of power supply, increase in access to health and education services are expected.	-

Item	No.	Likely Impacts	Ranking		Description of Impact/Issues	Key Issues requiring further assessment
			Positive Impacts	Negative Impacts		
	20	Social institutions such as social infrastructure and local decision-making institutions	+3	0	・ The East New Britain Provincial Administration has the experience of not being able to be the main decision maker when the volcanic disaster happened in 1994, and the reconstruction was done lead by the donors. By having a long-term Infrastructure Development Plan which shows the direction for regional development, it will assist the local government to take lead at the reconstruction stage in case there is another disaster in the region.	-
	21	Misdistribution of benefits and damage	0	0	・ No particular impact is expected as the infrastructure development is aimed at developing infrastructure in harmony with industry and the environment.	-
	22	Local conflict of interests	0	-1	・ Land acquisition is critical for infrastructure development, and in areas where there is no sufficient information on land tenure, local conflicts can arise if land is not properly acquired and managed.	Land acquisition system
	23	Cultural heritage	+1	-1	・ There are no significant archaeological or historical sites in the area. However, there is a mask festival held every year. ・ Northeast Gazelle Peninsula is known as a tourist destination with a World War II legacy, and, if not properly managed, could degrade the attractiveness and have a negative impact on tourism resources. ・ Impact on culture and traditions of the influx of people from outside, including from abroad, as a result of infrastructure development.	Increase in Tourists
	24	Landscape	+1	-1	・ The various industries in Northeast Gazelle Peninsula are all supported by the natural environment. In particular, tourism is based on the natural landscape of volcanoes and the coastal and marine environment, including coral reefs. Therefore, development on Ataliklikun Bay could distort vegetation and landscape.	Landscape
	25	Gender	+1	0	・ East New Britain Province has the tradition of matrilineality, where the land is inherited from the mother. ・ The vendors at the market are usually female. The improvement of road network may ease the accessibility of those women to the market.	-
	26	Children's rights	+1	-1	・ With the development of adequate road infrastructure, children will have better access to schools, hospitals and other facilities. ・ Islands Region has above national average literacy rate since the many of the residents are small holders of cacao and coconut farm, which is the source of education cost. If such land is sold for other purposes, such stable income may decrease.	-
	27	Hazards (Risk), Infectious diseases such as HIV/AIDS	+2	-2	・ Infrastructure development will provide adequate drainage systems and reduce the risk of flooding and landslides. ・ Deforestation and loss of surface cover for infrastructure development, housing development can cause soil erosion. ・ Northeast Gazelle Peninsula has the risk of earthquake, volcano eruption and tsunami among the other disasters. Infrastructure development plan should decrease the risk of such disaster.	Disaster prevention
	28	Working conditions	+2	0	・ There will be creation of more employment opportunities because of the infrastructural developments.	-

Item	No.	Likely Impacts	Ranking		Description of Impact/Issues	Key Issues requiring further assessment
			Positive Impacts	Negative Impacts		
Others	29	Accidents	+1	-1	・ Increased economic activity along the road network due to road infrastructure improvements may increase the risk of accidents to the surrounding communities. ・ Increased traffic volume and higher traffic speeds may increase accident risk.	Traffic accident
	30	Climate Change, Global Warming	0	-1	・ Due to climate change, the locals are experiencing higher rainfall which causes soil erosion and siltation in Rabaul Port.	Drainage management
	31	Marine Environment	+1	-2	・ Siltation of the reefs and changes in the seabed floors impact the environment and marine ecosystem. ・ Tourism is based on the coastal and marine environment, including coral reefs. Sea pollution will affect the marine biodiversity hotspots and tourism itself.	Marine environment

Source: JICA Expert Team

Based on the scoping result, the major issues that have been selected that require further assessment are as follows:

- Marine environment including the flora and fauna
- Drainage management
- Waste management
- Land acquisition and land ownership of land for infrastructure development

Marine environment survey has been conducted to understand the current situation of the marine environment of the potential areas for port development, and disaster risk analysis has also been conducted to understand the risk of disaster in the three growth areas.

20.5 Impact Assessment for Alternative Scenarios

Two impact assessments have been conducted to select the most appropriate scenario among the three alternative development scenarios taking into consideration of the impacts on the economic, environmental and social conditions. The three scenarios assessed are described in the Table 20.3.7, Table 20.3.8 and Table 20.3.9.

The first assessment is risk identification, and the second assessment is sustainable tests. The assessments have been done taking int account the group discussion result of the Second Stakeholders Meeting, Marine and Terrestrial Environmental Survey for Northeast Gazelle Peninsula and the disaster risk analysis.

20.5.1 Three Alternative Scenarios for Regional Spatial Development

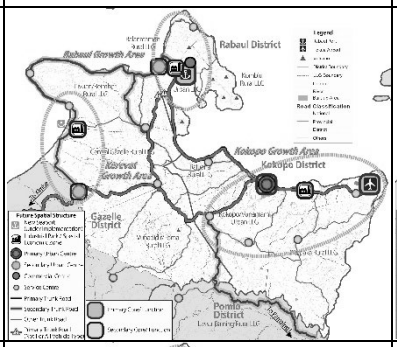
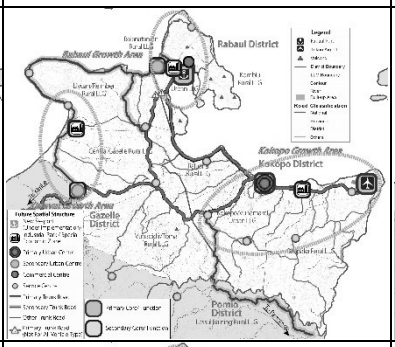
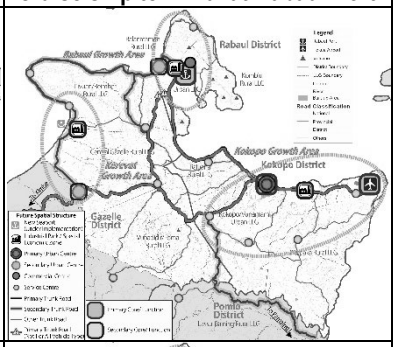
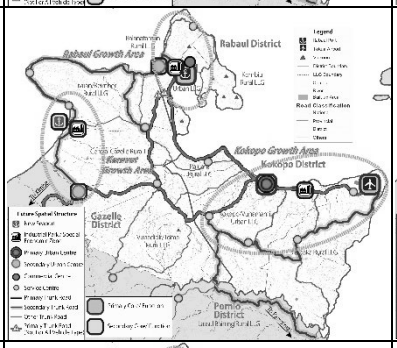
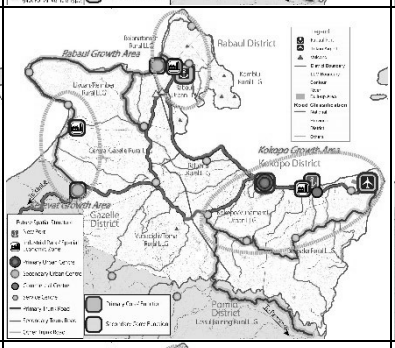
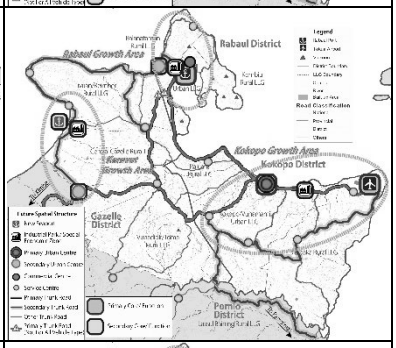
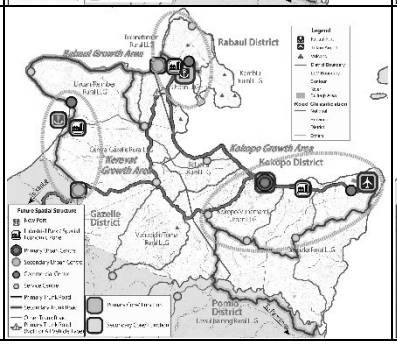
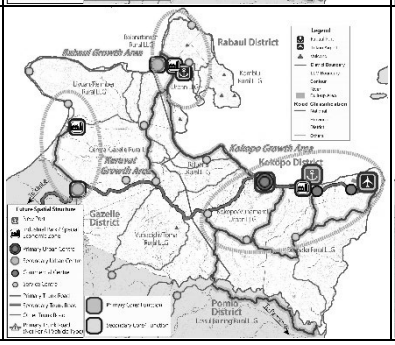
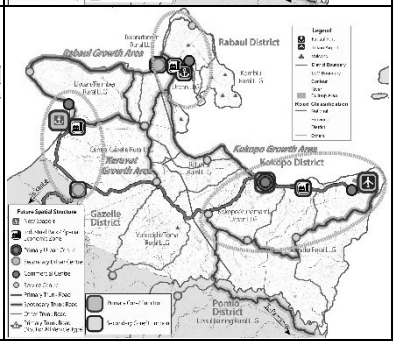
The spatial structures for years 2032, 2042 and 2052 of the three alternative scenarios for regional spatial development described in Section 9.2 are shown in Figure 20.5.1. Until 2032, these three alternative scenarios do not differ significantly, where the existing Rabaul Port will be rehabilitated, upgraded and used, but in alternative scenario 1 and 3, an alternative port for disaster response at Ataliklikun Bay will begin beyond 2032.

The alternative scenarios 1 and 3 are same in 2042, where a new port will be developed at Ataliklikun Bay and some functions will begin to be transferred to the new port. On the other hand, in alternative scenario 2, a new port will be developed at Watta Plantation in Kokopo and some functions, such as container handling, will be transferred to the new port. There is no difference in

road hierarchy among the three alternative scenarios, as Rabaul Port will continue to be the primary port in the region in all three alternative scenario until 2042.

In 2052, in alternative scenario 2 and 3, the new port will become the main port, and Rabaul Port will become a port for fishing ships and cruise ships. On the other hand, in alternative scenario 1, Rabaul Port will continue to function as the primary port. In scenarios 2 and 3, where the primary port functions are transferred to Ataliklikun Bay or Kokopo, the road between Kokopo and Rabaul, which has been maintained at high maintenance costs, will no longer need to be maintained as a primary trunk road and will become a secondary trunk road. Furthermore, in Scenario 2, the road between Rabaul and the Gazelle Agro-Industry SEZ, which is being considered for development along Ataliklikun Bay, will become a tertiary trunk road.

The location of the new port at Ataliklikun Bay will not be specified in this plan, as a more detailed survey will be required.

	Scenario 1: Ataliklikun Bay with Gazelle Agro-Processing SEZ and alternative port in case of disaster	**Scenario 2: Concentrated development in Kokopo Growth Area with the new port in Kokopo**	**Scenario 3: Balanced development in each Growth Area with new industrial port at Ataliklikun Bay and cruise ship terminal at Rabaul Port**
2032			
2042			
2052			

Source: JICA Expert Team

Figure 20.5.1 Alternative Scenarios for Regional Spatial Development

20.5.2 Risk Identification of Alternative Scenarios

Three development scenarios are assessed from the viewpoints of the economic and spatial, social and environmental aspects. Table 20.5.1 shows the results of the analysis.

Table 20.5.1 Evaluation of Alternative Development Scenarios

	Scenario 1: Ataliklikun Bay with Gazelle Agro-Processing SEZ and alternative port in case of disaster	Scenario 2: Concentrated development in Kokopo Growth Area with the new port in Kokopo	Scenario 3: Balanced development in each Growth Area with new industrial port at Ataliklikun Bay and cruise ship terminal at Rabaul Port
Economic and Spatial Benefit	・ The port development at Ataliklikun Bay will contribute to the investment coming to the proposed Gazelle Agro-Industry SEZ in Gazelle District. ・ Northeast Gazelle Peninsula is prone to various disaster. By having an alternative port function in Ataliklikun Bay will ・ Improvement to water and power supply facilities following the trunk roads. ・ The newly proposed SEZs in Rabaul and Gazelle District will contribute to improvement of living standards of the region.	・ The location of the port will be close the existing industrial areas in Kokopo, namely Takbar and Ulaveo, as well as the regional capital Kokopo. Therefore, it will be efficient and convenience for the existing commercial and industrial industries in Kokopo. ・ The newly proposed SEZs in Rabaul and Gazelle District will contribute to improvement of living standards of the region.	・ The three growth areas will have equal opportunities for economic growth. ・ The port development at Ataliklikun Bay will contribute to the investment coming to the proposed Gazelle Agro-Industry SEZ in Gazelle District. ・ Northeast Gazelle Peninsula is prone to various disaster. The land in Northeast Gazelle Peninsula is utilized widely and the risk of disaster can be dispersed, and the sustainability of local economies is expected to increase. ・ The newly proposed SEZs in Rabaul and Gazelle District will contribute to improvement of living standards of the region.
Social Impact	・ The manufacturing sector will provide more jobs. There will be more need for the population to be trained to work in manufacturing sector. ・ Since there will be people migrating to Kerevat area, there may be more risk of crimes and conflicts in Kerevat Growth Area. It will be necessary to increase the police service in Kerevat and along North Coast Road between Kerevat and Rabaul.	・ The manufacturing sector will provide more jobs. There will be more need for the population to be trained to work in manufacturing sector.	・ The manufacturing sector will provide more jobs. There will be more need for the population to be trained to work in manufacturing sector. ・ Since there will be people migrating to Kerevat area, there may be more risk of crimes and conflicts in Kerevat Growth Area. It will be necessary to increase the police service in Kerevat and along North Coast Road between Kerevat and Rabaul.
Environmental Impact	・ Dugongs are seen in Ataliklikun Bay, and they are feeding exclusively on seagrasses, which are observed in Kabaira Bay and Ragaga bay, Since the bay is large, depending on the location selected for the development of port within Ataliklikun Bay, it may not disturb the habitat of dugong, but careful study is necessary.	・ The new port development at Kokopo has the risk of polluting the sea around the dolphin's breading area. This will also impact the economy of Northeast Gazelle Peninsula which rely on tourism industry.	・ Dugongs are seen in Ataliklikun Bay, and they are feeding exclusively on seagrasses, which are observed in Kabaira Bay and Ragaga Bay, Since the bay is large, depending on the location selected for the development of port within Ataliklikun Bay, it may not disturb the habitat of dugong, but careful study is necessary.

Source: JICA Expert Team

20.5.3 Sustainable Tests of Alternative Scenarios

The sustainability of each scenario is assessed from the viewpoint of natural resources, social and cultural conditions and economic aspects. The results are shown in Table 20.5.2.

For the assessment of three alternative development scenarios, six scales of score (0 to 5) are created. The high score will show if three development scenarios support or are against the sustainability aims. The six scales of score are as follows:

- Scale 0: The scenario is not relevant.

- Scale 1: The scenario works strongly against the aims.
- Scale 2: The scenario works against the aims.
- Scale 3: The scenario on balance has neutral effect on the aims.
- Scale 4: The scenario supports the aims.
- Scale 5: The scenario strongly supports the aims.

The result of the sustainable test for alternative scenarios of regional spatial development is shown in Table 20.5.2. The result shows that alternative scenario 3 has the least number of scale 2 and the most number of scale 5. It can be said that alternative scenario 3 is the most sustainable scenario.

Table 20.5.2 Result of Sustainable Tests for Alternative Development Scenarios

	Performance																	
	Scenario 1						Scenario 2						Scenario 3					
Effect on Natural Resources																		
Protected areas and wildlife should be conserved, and these resources should be enhanced where practical.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Areas vulnerable to degradation should be avoided.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
The activity should encourage efficient energy use and maximize use of renewable energy rather than fossil fuels.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Discharges of pollutants and waste products to the atmosphere, water and land should be avoided or minimized.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Rivers and water bodies should retain their natural character	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Effect on Social and Cultural Conditions																		
Local character and cohesion of local communities should be enhanced where particular.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
The activity should benefit the work force, and local communities in terms of health and well-being, nutrition, shelter, education and cultural expression.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
The activity should empower women.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
The activity should create jobs for local people, particularly women and young people.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Active participation and involvement of local communities should be encouraged.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Activity should improve access to water.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Activity should improve access to transport.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Activity should improve sanitation.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Adverse and beneficial impacts from development should be distributed equitably and should not discriminate against any groups, especially vulnerable and excluded people.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Vulnerability and risk of disasters, crises, conflicts and epidemics should be reduced.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Effect on Economy																		
Economic development should be strong and stable.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
The use of raw materials and service from local industries where possible.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Development should encourage the local retention of capital and the development of downstream industries, utilizing local raw materials, products and labour.	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5

Source: JICA Expert Team

20.6 Mitigation Measures for Implementing Alternative Scenario 3 for Regional Spatial Development

Based on the above two analyses, Scenario 3 is selected as the desired development scenario for Northeast Gazelle Peninsula. However, the some of the development proposed in the infrastructure development plan includes projects that have negative impact on the environmental and social situation. In particular, the impact of the new port development and SEZ location on the marine

environment and the surrounding social environment should be thoroughly studied at an early stage, as shown in Table 20.5.1. Ataliklikun Bay is a very large bay, so it is necessary to select the most suitable site from multiple factors, and when the actual project is implemented, it is necessary to consider measures to ensure that surrounding residents are not left behind by the development and sufficient mitigation measures for natural environment.

In Scenario 3, development will be promoted especially in the Keravat Growth Area, and consideration should be given to the impact of development, while in Rabaul, which will cede its function as the primary port to the new port, it is expected that the surrounding logistics facilities will also be relocated to the area around the new port. It is desirable to consider the use of the site in line with the vision of the Rabaul Growth Area. Therefore, when ENBPA formulates future urban development plans for Kerevat and Rabaul, it is necessary to formulate them with such an super long-term perspective.

In that case, it is necessary to identify and designate solid waste disposal sites for the Kerevat Growth Area. The increase of development is also expected to increase the issue of waste management for both urban population and industrial waste. Especially for Kerevat Growth Area, it is necessary to identify and designate the landfill site. How to handle industrial waste must be considered in conjunction with the preparation of the SEZ.

20.7 IEE Study for High-Priority Projects

20.7.1 Target of the Initial Environmetal Evaluation (IEE) Study

The targets of IEE study are the 11 high-priority projects described in Chapter 19.

20.7.2 Phasing of the IEE Study

The IEE study for infrastructure development projects, typically encompasses three key phases: pre-construction, construction, and operation and maintenance. Each phase has distinct environmental aspects and concerns that need to be addressed. The range of activities within these phases includes:

Pre-Construction Phase: This phase involves conducting feasibility studies and planning, acquiring the necessary land, managing resettlement, carrying out environmental and social impact assessments, mobilizing required resources such as workforce, equipment, and materials, and arranging for the transport of construction materials.

Construction Phase: Activities in this phase encompass preparing the site, executing the construction work, ensuring quality control and safety, managing environmental factors, and engaging with stakeholders.

Operation and Maintenance Phase: This phase covers the commissioning and handover of the project, conducting routine maintenance, monitoring and evaluating the impacts on the environment and local communities, and sustaining relations with the community and stakeholders.

20.7.3 Result of the IEE Study

An Environmental Impact Matrix is a valuable tool for assessing the impacts of a project, both positive and negative. It serves as a comprehensive checklist that provides a structured analysis of how a project may affect a range of environmental and social factors.

Table 20.7.1 Environmental Impact Matrix for High Priority Projects

Environmental Parameters		Natural Environment													Social Environment												
Components	Phases	Air pollution	Water pollution	Soil pollution	Waste	Noise and vibration	Ground subsidence	Offensive odor	Topography and geology	Bottom sediment	Biodiversity and ecosystems	Hydrological phenomena	Accidents	Climate change	Involuntary resettlement	Local economies, such as employment and livelihood	Land use and utilization of local resources	Social institutions such as social infrastructure and local decision-making institutions	Existing social infrastructures and services	Socially vulnerable people (Indigenous people, ethnic minorities)	Socially vulnerable people (People in poverty, with disabilities, refugees and internally displaced	Misdistribution of benefits and damages	Local conflicts of interest	Gender	Children's rights	Cultural heritage	Infectious diseases such as HIV/AIDS
Trunk Road Projects																											
[TR-1] Strengthening of Kokopo-Rabaul Coastal Road	Pre-construction														B-					C	C		C			C	
	Construction	B-	B-		B-	B-			B-	C	B-	B-	B-			B+			B-						B-		B-
	Operation& Maintenance	C				C			B+		C		B+/-			B+	B+/-	B+	B+			C					
[TR-2] Upgrading of Rabaul-Kurakakaul-Rakunai Road (Alternative Road to the Kokopo-Rabaul Coastal Road and to Kokopo-Rabaul Top Road)	Pre-construction														B-					C	C		C			C	
	Construction	B-	C		B-	B-			B-	C	B-	C	B-			B+			B-						B-		B-
	Operation& Maintenance	C				C			B+		C		B+/-			B+	B+/-	B+	B+			C					
Port Projects																											
[SP-1]Rehabilitation of Rabaul Port Infrastructure	Pre-construction																									C	
	Construction	B-	B-		B-	B-			B-	B-	B-	C	B-			B+									B-		B-
	Operation& Maintenance	C	C			C					C	C		C		A+	C										
[SP-2] Upgrading of Rabaul Port Berth 2	Pre-construction																									C	
	Construction	B-	B-		B-	B-			B-	B-	B-	C	B-			B+									B-		B-
	Operation& Maintenance	C	C			C					C	C		C		A+	C										
[SP-3] Feasibility Study on New Port Development in Ataliklikun Bay	Pre-construction														B-					C	C		C			C	
	Construction	B-	B-	B-	B-	B-			A-	A-	A-	C	B-	C		B+			C						B-		B-
	Operation& Maintenance	C	C			C					C	C		C		A+	A+/-					C					
Airport Projects																											
[AP-1] Redevelopment of Tokua Airport Phase 1 (Upgrading of the Capacity and the Status of Tokua Airport to International Airport Phase 1)	Pre-construction														B-					C	C					C	
	Construction	B-	B-		B-	B-			C	C	B-	C	B-			B+									B-		B-
	Operation& Maintenance	C				B-					C			C		B+	B+/-					B-					
Urban Road Projects																											
[UR-1] Rehabilitation of Port Access Road in Rabaul Town (1.8 km)	Pre-construction														B-					C	C		C			C	
	Construction	B-	C		B-	B-			C	C	B-	C	B-			B+			B-						B-		B-
	Operation& Maintenance	C				C					C	C				B+	B+/-	B+	B+			C					
[UR-3] Development of Southern Section (2.5 km) of Kokopo Town Ring Road	Pre-construction														B-					C	C		C			C	
	Construction	B-	C		B-	B-			C	C	B-	C	B-			B+			B-						B-		B-
	Operation& Maintenance	C				C					C	C				B+	B+/-	B+	B+			C					
Water Supply Projects																											
[WS-1] Project for Improvement and Rehabilitation for Kokopo Borehole Field	Pre-construction														B-					C	C		C			C	
	Construction	B-			B-	B-	C				B-	C	B-			B+			B-						B-		B-
	Operation& Maintenance																		B+			C		C			
[WS-2] Project for Improvement and Rehabilitation for Rabaul Town Area	Pre-construction														B-					C	C		C			C	
	Construction	B-	B-		B-	B-	C		B-		B-	C	B-			B+			B-						B-		B-
	Operation& Maintenance																B+/-		B+			C		C			
Power Supply Projects																											
[PW-2] 66kV Transmission Lines 552 and 553 Rehabilitation Project	Pre-construction														B-					C	C		C			C	
	Construction	B-			B-	B-			B-		B-		B-			B+			B-						B-		B-
	Operation& Maintenance										C			C		B+	B+/-		B+			C					

A+/-: Significant (positive/negative) impact is expected; B+/-: Some (positive/negative) impact is expected;
C+/-: Extent of positive/negative impact is unknown (Examination is needed); Blank: No impact is expected

Source: JICA Expert Team

This matrix, particularly when aligned with JICA's 2004 Guidelines for Environmental and Social Consideration, comprehensively examines a wide range of factors. These elements are systematically identified during the different phases of a project: the pre-construction, the construction, and the operation and maintenance phase. The matrix effectively illustrates the environmental impacts, encompassing both ecological and social factors resulting from the implementation of the project. The specifics of these impacts are presented in a detailed table within the matrix below.

20.8 Recommendations from SEA

In the development proposed in the infrastructure development plan, there are projects that could have negative impact on the natural and social environments. Therefore, prior to implementing each project, it is important that Environmental Impact Assessment is conducted, and necessary mitigation measures are implemented. In addition to the EIA, detailed assessment is necessary for land acquisition for projects that need land acquisition.

The result of Initial Environmental Evaluation (IEE) for the 11 high priority projects planned to be implemented in the next 10 years are shown in Chapter 19.

PART IX

PRE-FEASIBILITY STUDY ON THE PROJECT FOR STRENGTHENING OF KOKOPO-RABAUL COASTAL ROAD

Chapter 21 Pre-Feasibility Study of the Project for Strengthening Kokopo-Rabaul Coastal Road

21.1 The Target Project for Pre-Feasibility Study

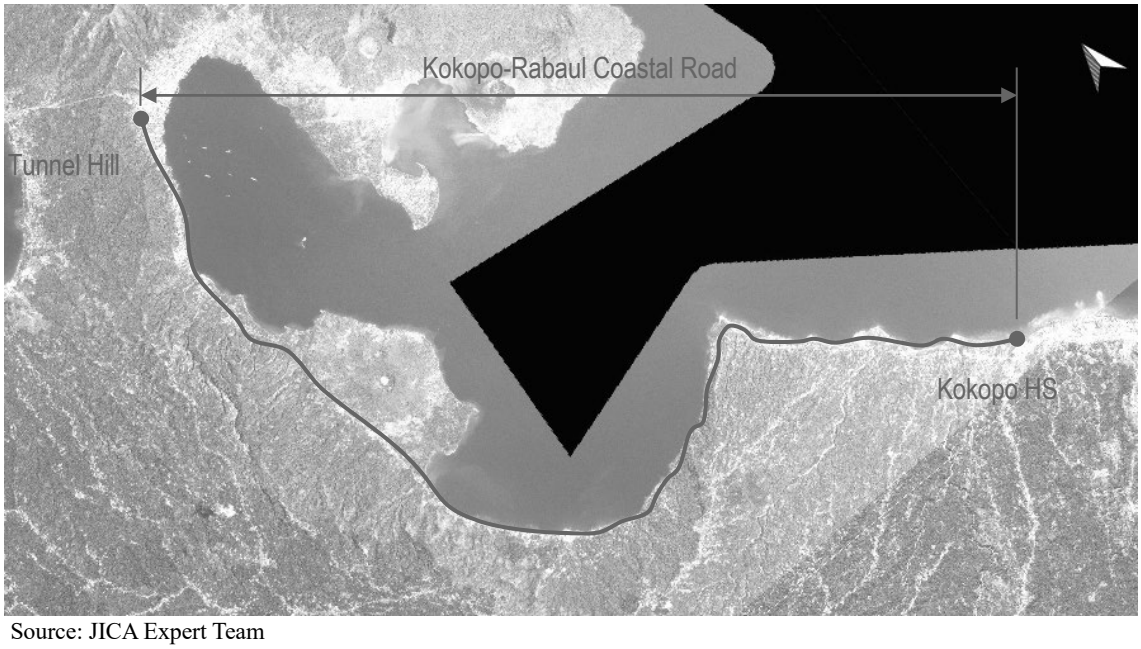
As stated in "Section 18.5. Selection of Candidates for Pre-Feasibility Study in NEGID-Plan", one of the high priority projects is selected for the conduct of a pre-feasibility study.

The selected target project for the pre-feasibility study is the Project for Strengthening Kokopo-Rabaul Coastal Road (hereinafter referred to as "the Project Road").

The outline of the Project Road is as follows:

1. Road Type: National Road
2. Road Length: 24.2 km
3. Start Point: Kokopo Secondary School
4. End Point: Tunnel Hill
5. Number of Lanes: 2 lanes
6. Pavement: Double Bituminous Surface Treatment (DBST). The project road is paved by DBST, except for an approximately 2 km long section near the Vulcan Volcano.

The location map of the project is shown in Figure 21.1.1.



Source: JICA Expert Team

Figure 21.1.1 Location Map of Kokopo-Rabaul Coastal Road

In this chapter on the pre-feasibility study, the entire section of the Project Road is covered in conduct of traffic volume forecast, preliminary design, cost estimation, economic cost-benefit analysis, and social and environmental considerations. Based on these analyses, target road sections and intervention components are recommended for actual implementation.

21.2 Rationale for the Target Project for Pre-Feasibility Study

21.2.1 Selection of the Target Road

In Northeast Gazelle Peninsula region, a variety of projects or actions in infrastructure sectors have been proposed by the past and current provincial development plans as discussed in Appendix C. Those proposed projects are necessary and useful for sustaining socio-economic activities and promoting socio-economic development in the region. In addition to these projects, NEGID-Plan has also identified high priority and priority projects according to the regional development strategies described in Part IV.

The high priority projects selected by NEGID-Plan satisfy the following criteria as described in Section18.3:

- To initiate significant efforts at development of economic sectors, enhancement of disaster resilience, or transformation of regional spatial structure
- To break through difficult problems on development of economic sectors, enhancement of disaster resilience, or transformation of regional spatial structure
- To create synergies for development of economic sectors, enhancement of disaster resilience, or transformation of regional spatial structure by implementing in conjunction with different infrastructure development

21.2.2 Necessity and Relevance of Strengthening Kokopo-Rabaul Coastal Road

(1) Importance of the Kokopo-Rabaul Coastal Road

The Kokopo-Rabaul Coastal Road is the most important trunk road linking the Rabaul Port to many centres in the Northeast Gazelle Peninsula Region, as shown below:

- Rabaul Por is the main port in the Northeast Gazelle Peninsula, responsible for the import and export of containers, bulk cargo and fuel.
- Cargo from Rabaul Port to all areas (except for Rabaul) in the region is transported by heavy vehicles using the Kokopo-Rabaul Coastal Road.
- As an alternative to the Kokopo-Rabaul Coastal Road, there is an inland road (locally called “Top Road”) between Burmah Junction and Kokopo Secondary School, but it has steep gradients and sharp bends and is not accessible to large heavy vehicles. (Fuel tankers can, however, be allowed on the road with leading cars in front and behind.)
- The Kokopo-Rabaul Coastal Road is an important regional arterial road linking Rabaul Port with Kokopo Town and Tokua Airport, as well as the Gazelle District (Kerevat Town) and Pomio District (Warangoi).
- The Gazelle and Pomio Districts also produce export-oriented agricultural and forest products, which need to be trucked by road to Rabaul Port. The Kokopo-Rabaul Coastal Road is used for this purpose, as it is the shortest route and allows the passage of large heavy vehicles.

(2) Vulnerability of the Kokopo-Rabaul Coastal Road

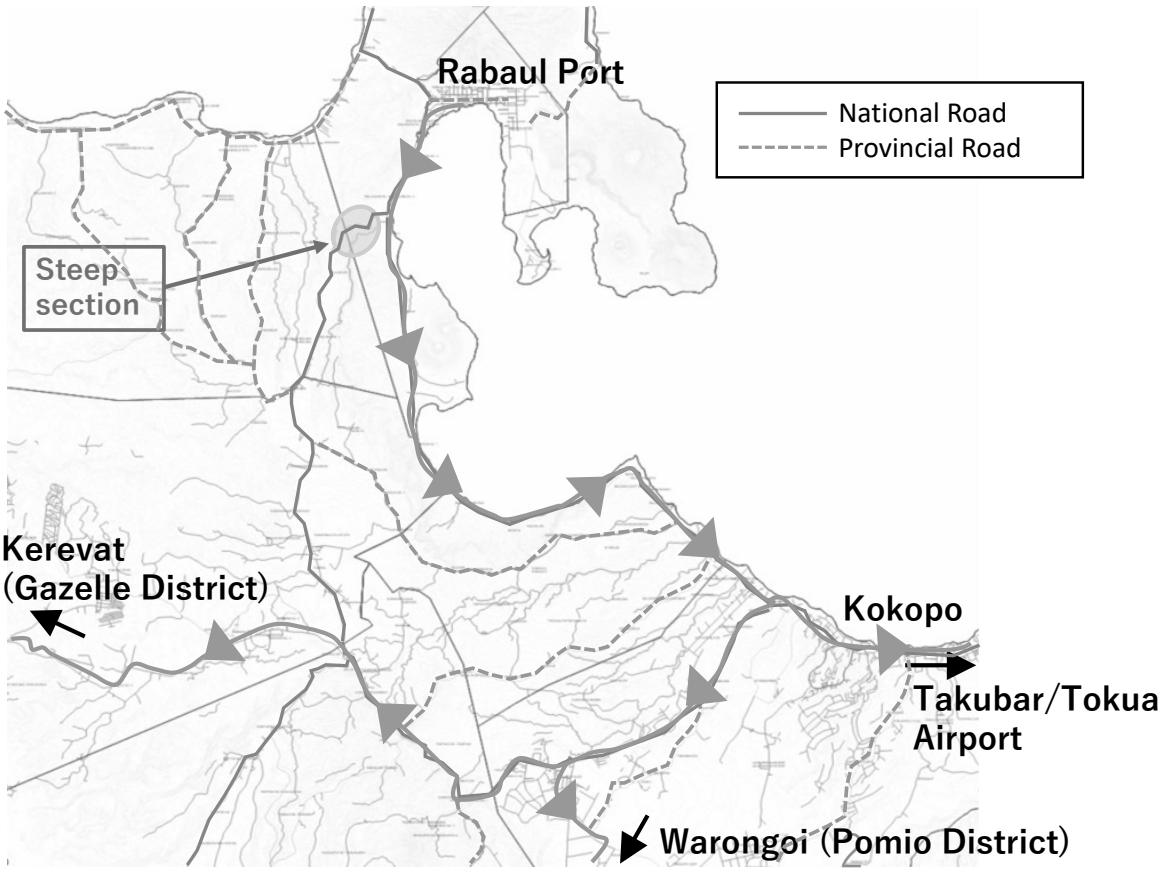
However, the Kokopo Rabaul Coastal Road is a coastal road formed by a submerged caldera created by major eruptions of volcanos in the region in the past. On the landward side of the road are the outer slopes of the caldera, which are covered with ash from past volcanic eruptions. Several floodways have formed, and the slopes are prone to collapse. As a result, several times a year, during heavy rainfall events, the slopes collapse and a large supply of sediment flows into the area, causing the coastal road to be closed to traffic.

- The area has weak ground due to soil deposits of volcanic ash. As a result, when it rains, the slopes are prone to landslides, which repeatedly cause damage to roads and bridges.
- In particular, the Kokopo-Rabaul Coastal Road, which connects Kokopo to Rabaul in the shortest distance, is often closed during the rainy season.
- Although there is an inland road for diversion, there are some steep sections that are impassable for large trailer vehicles carrying 40-feet containers.
- As a result, there is sometimes a physical cut-off between Rabaul Town, which has the ENBP's main port, and Kokopo Town, the administrative and economic centre of the province, resulting in disruption of logistics.

(3) Need to Strengthen the Kokopo-Rabaul Coastal Road

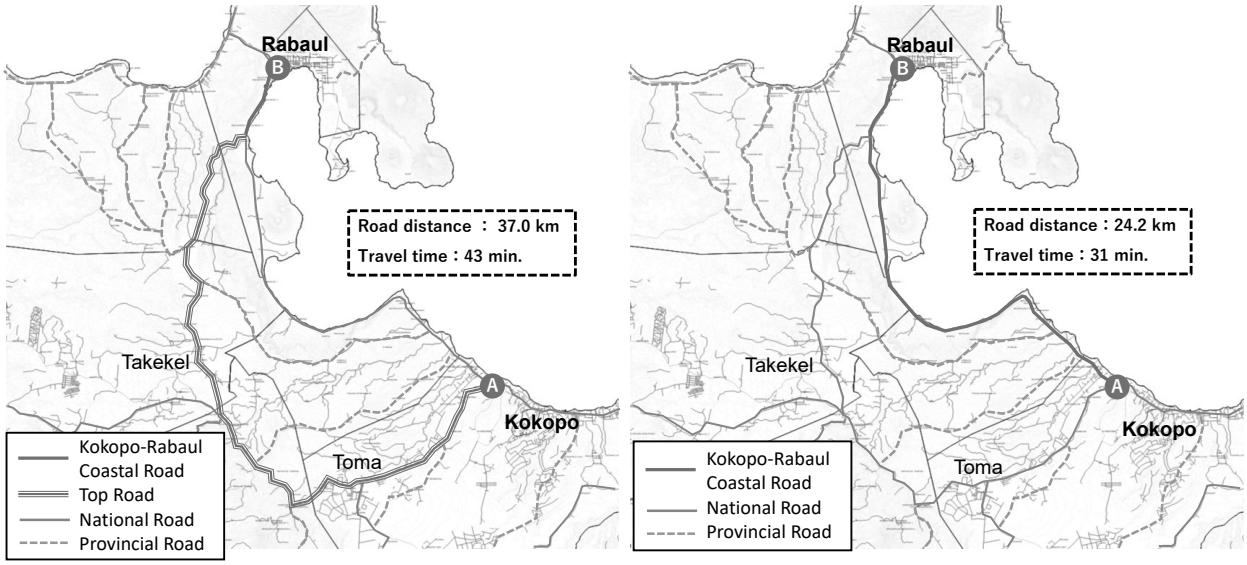
The Regional Development Scenario for Northeast Gazelle Peninsula indicates that it will take about 20 years for the cardo demand at Rabaul Port and the size of the regional economy in the Northeast Gazelle Peninsula to continue to grow in the future and for measures to move the Port of Rabaul away from the volcanic eruption hazard of Rabaul to as safe an area as possible to be feasible. In order to promote regional development and regional infrastructure development according to this scenario, it is first necessary to aim for sustainable development of the regional economy, centred on the Port of Rabaul, in the short to medium term.

To this end, the Kokopo-Rabaul Coastal Road, a regional trunk road connecting Rabaul Port to Kokopo, the largest administrative and commercial city in the region needs to be strengthened in terms of improving disaster resilience and ensuring mobility.



Source: JICA Expert Team

Figure 21.2.1 Logistics Route in Northeast Gazelle Peninsula Region



Source: JICA Expert Team

Figure 21.2.2 Kokopo-Rabaul Coastal Road and Top Road (Inland Road) in Northeast Gazelle Peninsula Region

21.2.3 Objectives of the Study

The objectives of the pre-feasibility study are as follows:

- To review existing conditions of the project road
- To prepare a road improvement plan by road section
- To conduct preliminary design for strengthening the project road
- To prepare preliminary cost estimates for strengthening the project road
- To conduct a study on environmental and social considerations
- To conduct an economic analysis based on future traffic demand forecast
- To select priority road sections for a further feasibility study

21.3 Future Traffic Demand Forecast

21.3.1 Methodology for Future Traffic Demand Forecast

The future traffic demand forecasts for passenger vehicles and cargo vehicles on Kokopo-Rabaul Coastal Road were made by applying different average annual growth rates to the current traffic volumes (passenger vehicle traffic volume and freight vehicle traffic volume) from the traffic volume surveys done in October 2023.

In Case 1 (Lower than Basic Growth Case), the annual average growth rates of passenger vehicle traffic volume and freight vehicle traffic volume were both estimated as if they were the same as the annual average growth rates of the population.

The annual average growth rates of passenger vehicle traffic in Case 2, Case 3 and Case 4 were based on the annual average population growth rates which were considered the same rates for Case 2, 1.5 times larger than the population growth rates for Case 3, and 2 times larger than the population growth rates. In other words, Case 1, Case 2 and Case 3 were cases where the elasticities of the average annual growth rate of the population and the average annual growth rate of the vehicle traffic volume were 1.0, 1.5 and 2.0.

The annual average growth rates of freight vehicle traffic were based on the annual average growth rate of Gross Regional Domestic Product (GRDP), considering the case where the elasticities of the annual average growth rates of GRDP and the annual average growth rates of freight vehicle traffic were 1.0, 2.0 and 2.5.

A summary of the methodology for setting the traffic volume of passenger vehicles and the traffic volume of cargo vehicles in Cases 1, 2, 3 and 4 is provided in Table 21.3.1.

Table 21.3.1 Four Growth Cases of Traffic Demand for Kokopo-Rabaul Coastal Road and Top Road

	Traffic Volume of Passenger Vehicles	Traffic Volume of Cargo Vehicles
Case 1 Lower than Basic Growth	**The same** as annual average population increase rates	**The same** as annual average population increase rates
Case 2 Basic Growth	**The same** as annual average population increase rates	**The same** as annual average GRDP increase rates
Case 3 Medium Growth	**1.5 times** larger than annual average population increase	**2.0 times** larger than annual average GRDP increase rates
Case 4 High Growth	**2.0 times** larger than annual average population increase rates	**2.5 times** larger than annual average GRDP increase rates

Source: JICA Expert Team

Since the conditions for Kokopo-Rabaul Coastal Road are to be improved largely by implementation of the Project, it is considered that vehicle traffic volume on Top Road will partly shift to the Coastal Road.

21.3.2 Future Frameworks of Population Growth and GRDP Growth in Northeast Gazelle Peninsula Region

(1) Population Growth Rates in the Region

Annual average population growth rates for the future until 2052 are set as a future socio-economic framework of the region as shown in Table 21.3.2.

Table 21.3.2 Population Increase Rates of Different Districts in Northeast Gazelle Peninsula Region

District	LLG	Population					Annual Growth Rate (%)			
		2011	2022	2027	2032	2042	2052	2022 - 2032	2023-2042	2042-2052
Kokopo	Bitapaka	23,116	30,400	34,000	37,800	45,200	52,300	2.20%	1.80%	1.47%
Kokopo	Kokopo/Vunamami	31,965	43,300	49,000	55,300	67,900	80,700	2.48%	2.07%	1.74%
Kokopo	Raluana	18,739	24,800	27,800	31,000	37,300	43,400	2.26%	1.87%	1.53%
Rabaul	Balanataman	19,621	25,900	29,000	32,300	38,700	44,900	2.23%	1.82%	1.50%
Rabaul	Kombiu	11,583	15,100	16,800	18,600	22,000	25,200	2.11%	1.69%	1.37%
Rabaul	Rabaul	4,785	6,400	7,200	8,400	10,600	12,900	2.76%	2.35%	1.98%
Gazelle	Central Gazelle	28,075	37,400	42,000	47,100	57,000	66,800	2.33%	1.93%	1.60%
Gazelle	Livuan	13,485	17,800	19,900	22,700	28,300	33,600	2.46%	2.23%	1.73%
Gazelle	Reimber	15,488	20,400	22,800	25,900	32,100	37,900	2.42%	2.17%	1.67%
Gazelle	Toma	17,080	22,300	24,800	27,500	32,600	37,400	2.12%	1.72%	1.38%
Gazelle	Vunadidir	14,808	19,400	21,600	24,000	28,500	32,800	2.15%	1.73%	1.42%
Northeast Gazelle Peninsula		198,745	263,100	294,900	330,600	400,200	467,900	**2.31%**	**1.93%**	**1.58%**
Outside Northeast Gazelle Peninsula		198,745	165,200	181,900	193,900	218,300	239,000	1.61%	1.19%	0.91%
East New Britain Province		328,369	428,300	476,800	524,500	618,500	706,900	2.05%	1.66%	1.34%

Source: JICA Expert Team

(2) GRDP Growth Rates in the Region

GRDP growth rates in Northeast Gazelle Peninsula Region are set as part of the future socio-economic framework as shown in Table 21.3.3.

Table 21.3.3 GRDP Projection of Northeast Gazelle Peninsula by Broad Economic Sectors in 2022-2052

(1) Value of GRDP by Broad Economic Sector in Northeast Gazelle Peninsula

Unit: Kina Million at Constant Prices (2013 prices)

Sector	2011	2017	2022	2027	2032	2037	2042	2052	Share (%) of GRDP in 2052	Annual Growth Rate (%) 2022-52
Agriculture, Forestry and Fishing	175	209	243	288	342	417	507	750	12.5	3.83
Mining and Quarrying	52	59	65	71	79	87	96	117	1.9	2.00
Industry	254	287	332	404	516	690	924	1,654	27.5	5.50
Services and others	646	749	868	1,056	1,316	1,680	2,144	3,493	58.1	4.75
Gross Regional Domestic Product (GRDP)	1,128	1,303	1,508	1,820	2,253	2,874	3,671	6,015	100.0	4.72

(2) Annual Growth Rate (%) of GRDP by Broad Economic Sector in Northeast Gazelle Peninsula

Sector	PNG (the whole country) 2011-2019	2011-2017	2017-2022	2022-2027	2027-2032	2032-2037	2037-2042	2042-2052
Agriculture, Forestry and Fishing	2.87	3.0	3.0	3.5	3.5	4.0	4.0	4.0
Mining and Quarrying	14.88	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Industry	-1.67	2.0	3.0	4.0	5.0	6.0	6.0	6.0
Services and Others	2.47	2.5	3.0	4.0	4.5	5.0	5.0	5.0
Gross Regional Domestic Product (GRDP)	5.17	2.4	3.0	3.8	4.4	5.0	5.0	5.1

(3) GRDP per Capita in Northeast Gazelle Peninsula

	Unit	2011	2022	2027	2032	2042	2052	Annual Growth Rate 2022-52
Population	Persons	198,745	263,100	294,900	330,600	400,200	467,900	1.94%
GRDP	Kina Million at Constant Price	1,128	1,508	1,820	2,253	3,671	6,015	4.72%
GRDP per Capita	Kina at Constant Price 2013	5,676	5,732	6,172	6,815	9,173	12,855	2.73%

Source: JICA Expert Team

21.3.3 Future Vehicle Traffic Volume on Kokopo-Rabaul Coastal Road and Top Road (Inland Road)

Using the methodology described in Section 21.3.1, the future vehicle traffic volumes on Kokopo-Rabaul Coastal Road and Top Road are estimated for Case 4 as shown in Table 21.3.6 and Table 21.3.7.

On the other hand, the baselines (in 2023 and 2020) of the present traffic volumes for Kokopo-Rabaul Coastal Road and Top Road volumes are shown in Table 21.3.4 and Table 21.3.5Table 21.3.4.

Table 21.3.4 Present Traffic Volume of Passengers, Passenger Vehicles, Cargos and Cargo Vehicles on Kokopo-Rabaul Coastal Road: Baseline

	Passenger Vehicle Traffic Volume (Both Directions, Vehicles/Day) Actual	**Cargo Vehicle Traffic Volume (Both Directions, Vehicles/Day) Actual**
2023 (1)	1,004	196
	Passenger Volume (Both Directions, Persons/Day) Estimated	**Cargo Volume (Both Directions, Tons/Day) Estimated**
2023 (2)	5,920	1,187
	Rabaul Port Total Cargo Handled (1,000 tons per Day) Actual	**Rabaul Port Toral Container Handled (TEUs) Actual**
2020 (3)	603.0	20,300

Source:
(1) JICA Expert Team's Traffic Count Survey in October 2023
(2) JICA Expert Team's Vehicle Occupation Survey in October 2023
(3) Rabaul Port Office of PNG Ports Corporation Ltd., 2202

Table 21.3.5 Present Traffic Volume of Passengers, Passenger Vehicles, Cargos and Cargo Vehicles on Top Road: Baseline

	Passenger Vehicle Traffic Volume (Both Directions, Vehicles/Day) Actual	**Cargo Vehicle Traffic Volume (Both Directions, Vehicles/Day) Actual**
2023 (1)	1,495	155
	Passenger Volume (Both Directions, Persons/Day) Estimated	**Cargo Volume (Both Directions, Tons/Day) Estimated**
2023 (2)	36,789	121

Source: 60.3
(1) JICA Expert Team's Traffic Count Survey in October 2023
(2) JICA Expert Team's Vehicle Occupation Survey in October 2023

Table 21.3.6 Future Traffic Volume of Passengers, Passenger Vehicles, Cargos and Cargo Vehicles on Kokopo-Rabaul Coastal Road: Case 4 with Project

	Passenger Vehicle Traffic Volume (Both Directions, Vehicles/Day)	Cargo Vehicle Traffic Volume (Both Directions, Vehicles/Day)
2048	6,302	1,233
	Passenger Volume (Both Directions, Persons/Day)	Cargo Volume (Both Directions, Tons/Day)
2048	304,362	7,746

Source: JICA Expert Team

Table 21.3.7 Future Traffic Volume of Passengers, Passenger Vehicles, Cargos and Cargo Vehicles on Top Road: Case 4 with Project

	Passenger Vehicle Traffic Volume (Both Directions, Vehicles/Day)	Cargo Vehicle Traffic Volume (Both Directions, Vehicles/Day)
2048	17,340	659
	Passenger Volume (Both Directions, Persons/Day)	Cargo Volume (Both Directions, Tons/Day)
2048	132,870	435

Source: JICA Expert Team

21.4 Present Road Conditions and Natural Conditions

21.4.1 Present Road Conditions

The Project Road is basically paved with Double Bituminous Surface Treatment (DBST). However, damages (such as potholes and cracks) are found in some sections.

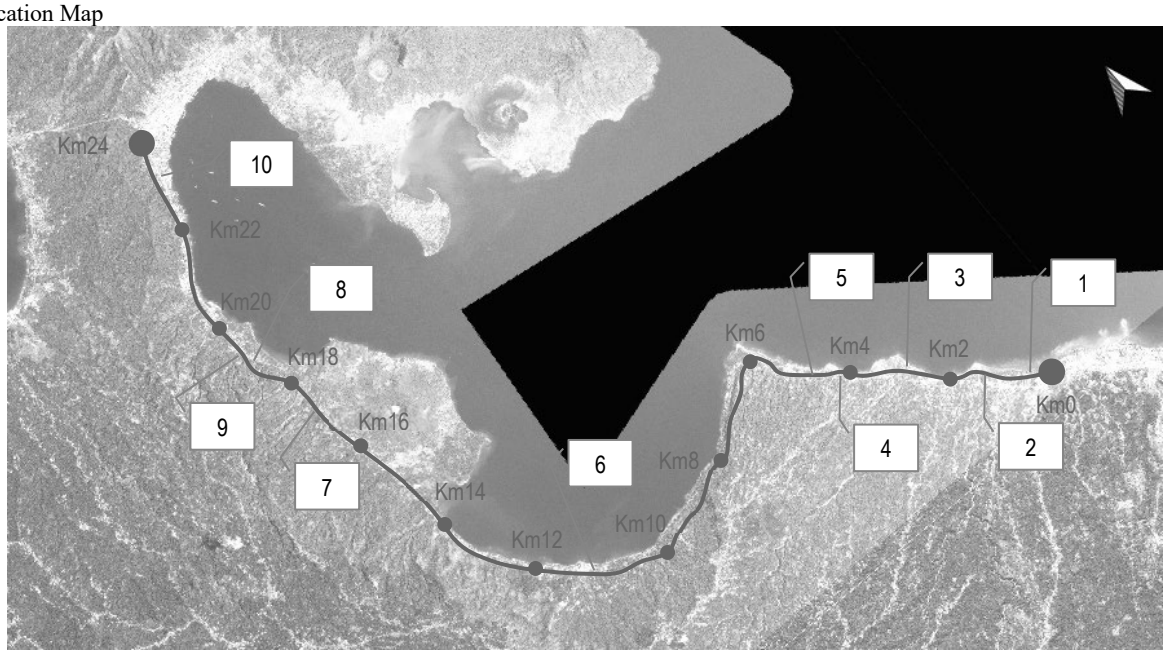
The Project Road has been damaged mainly by rainwater that remained on the road surface during rainy season. Drainage facilities, such as side ditches and cross culverts, are installed only in a few sections, but these have not functioned properly due to lack of maintenance.

Approximately 2 km-long section near Vulcan Volcano has not been paved after the 1994 volcanic eruption because donors, such as the World Bank and Australian Aid, consider it too costly to restore and maintain this road section due to its vulnerability to volcanic eruption.

Detailed road conditions are shown in Table 21.4.1.

Table 21.4.1 Road Conditions of Kokopo-Rabaul Coastal Road

Location Map



Location 1: at Km 0
Road condition is relatively good. However, potholes and cracks are found in some areas around Km 0.



Location 2: at Km 2
Four-cell box culvert in Km 2 originally had 3 m height, but it is fully filled with soil, grasses and uprooted trees at present.



Location 3: at Km 3
Soil and sand from the mountain remain on the road surface around Km 3.



Location 4: at KM 4
Soil, sand and uprooted trees from the mountain remain along the road around Km 4.



Location 5: at Km 4
Slope along the road collapsed around Km 4.



Location 6: at Km 11
The road is eroded by floodwater around Km 11.



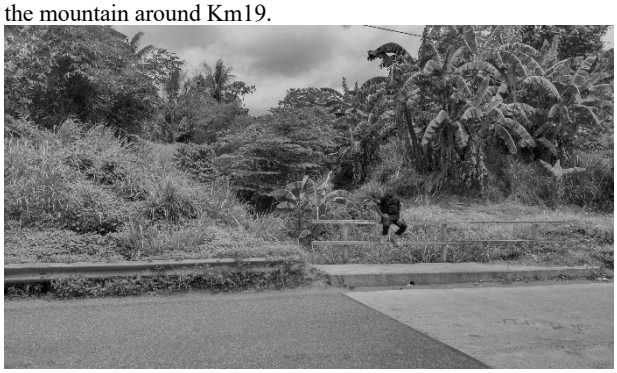
Location 7: at Km 17
The road is very much eroded by floodwater around Km 17.



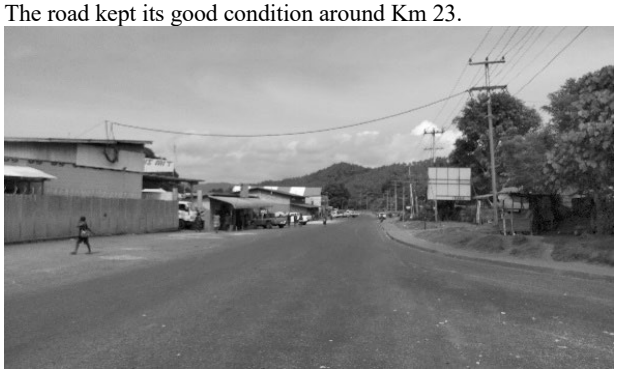
Location 8: at Km 19
The road is not paved around Km 19.



Location 9: at Km 19
Box culvert is filled with soil, grasses and uprooted trees from the mountain around Km19.



Location 10: at Km 23
The road kept its good condition around Km 23.



Source: JICA Expert Team

21.4.2 Present Drainage Conditions

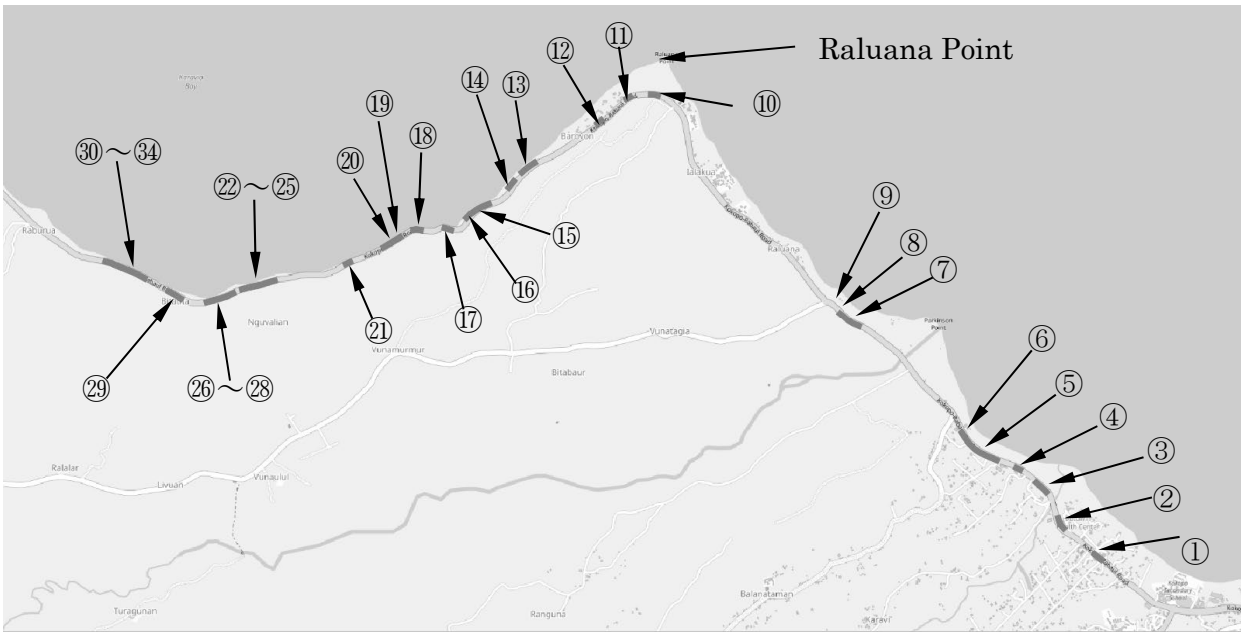
As a result of the JICA Expert Team's survey, the following flood/ drainage situation have been confirmed.

- Before the 1994 eruption, the natural channels within the study area maintained a groove-like shape. But after the eruption, the channels were gradually buried and lost this shape (i. e., the groove-like shape of the natural channels disappeared/buried as the ash within the catchment area eroded and was carried by rainwater and deposited).
- The status of the installed drainage facilities, such as U-shaped channels and culverts, is as follows: (1) drainage facilities near Rabaul's city centre are relatively well maintained, but drainage capacity of other areas is not very high and is not well maintained, (2) ditches and crossing culverts have been installed only in some sections of the Kokopo-Rabaul Coastal Road, but they are buried under the soil and are not functioning.
- As a result of siltation in the stream channel, stormwater from the floodway flows over the carriageway, accelerating the deterioration of the road pavement structure.
- Sediment generation and deposition during floods are the most serious problems in the study area. In particular, the coastline (delta) at the end of the flood flow channel in Calabi / Ralaguna / Rabulo is still changing and developing. Sediment deposition on the road around Raluana / Blue Lagoon / Malaguna / Rabaul town and road erosion around Vulcan are also problems.
- The results of the interviews and other information indicate that there are sections where large amounts of sediment have accumulated on the road, where the road has eroded, and where the road height has been changed by sediment.
  - Old building columns remained at the site, and historical Google Earth imagery indicates that 2.4 m of sediment has been deposited in the Languna Recreation Area in 17 years between 2005 and 2022. (**According to the interview with local informants**)
  - The results of the interviews with residents and the topographic analysis show that a section of the Balkan Earth Road has eroded downwards by up to approximately 2 m in 12 years between 2010 and 2022 (According to the **interview with local informants**).

21.4.3 Slope Conditions

This area consists of the volcaniclastic material (mainly pyroclastic flow deposits) erupted during the formation of Rabaul Volcano (Pleistocene to Holocene). The Kokopo-Rabaul Coastal Road on the east side of Raluana Point passes through the foot of the mountain slope, and cut slopes with a maximum height of about 10 m can be seen along the road. On the other hand, to the west of Cape Raluana, the Rabaul Caldera Wall looms over the coast, and steep cliffs more than 100 m high are distributed along the Kokopo-Rabaul Coastal Road.

Figure 21.4.1 shows the location of slopes where slope protection is determined to be necessary for road rehabilitation.



Source: JICA Expert Team

Figure 21.4.1 Location Map of Slopes to Be Protected

A summary of information for each slope is given in Appendix E. In addition, elastic wave velocity measurements and Schmidt Hammer tests were conducted as appropriate to determine the strength of the ground mass in a simplified method.

21.5 Review of Existing Plans and Projects

Tokua-Kokopo-Rabaul Road is the most important trunk road in the region under the government's Connect PNG Programme. In the Connect PNG Programme, upgrading of the road from Tokua Airport to Takubar and then to the Kokopo City is to be started through the ENBPA's budget in 2024.

Kokopo-Rabaul section, the western part of Tokua-Kokopo-Rabaul Road is also the target area of the Connect PNG Programme. It is important to also upgrade the west part of this Road (Kokopo - Rabaul) as Phase 2 project in order to provide proper road transport service in all road sections. The national government of PNG, as well as ENBPA, will have to find funds including international development partners' assistance.

21.6 Road Improvement Plan

21.6.1 Determination of Road Sections

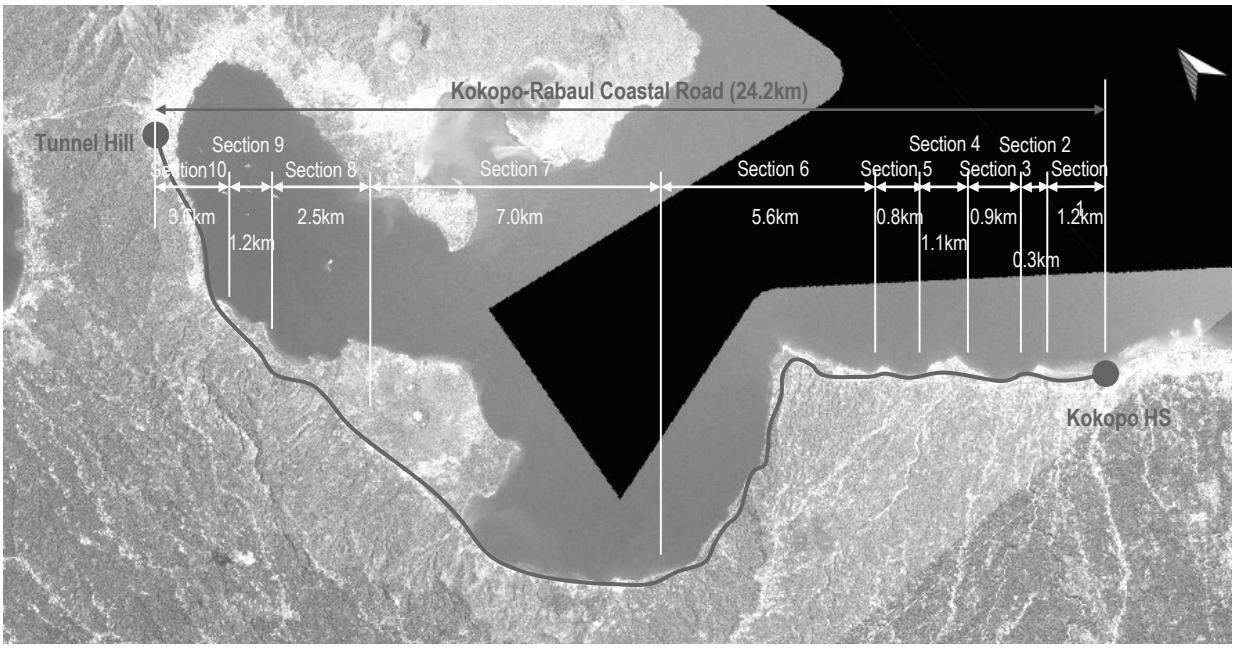
About 24.2 km of Kokopo-Rabaul Coastal Road is divided into 10 sections. This was determined based on the site survey results. Each section has different condition as shown in Table 21.6.1.

Table 21.6.1 Conditions of Road Sections

Section	Road Condition	Drainage Condition	Slope Condition
Section 1	**Fair** - Road surface is relatively good.	**Bad** - No drainage facilities are installed or properly functioning.	**Bad** - Mountain slope is located just along the road, but slope protection is not provided.
Section 2	**Bad** - Road surface is severely damaged.	**Very Bad** - No drainage facilities are installed or properly functioning. - Mudflow occurs on the road during heavy rain, but required facilities for this are not provided.	**Bad** - Mountain slope is located just along the road, but slope protection is not provided.
Section 3	**Fair** - Road surface is relatively good.	**Bad** - No drainage facilities are installed or properly functioning.	**Bad** Mountain slope is located just along the road, but slope protection is not provided.
Section 4	**Bad** - Road surface is severely damaged.	**Very Bad** - No drainage facilities are installed or properly functioning. - Mudflow occurs on the road during heavy rain, but required facilities for this are not provided.	**Fair** - Mountain slope is not located along the road.
Section 5	**Fair** - Road surface is relatively good.	**Bad** - No drainage facilities are installed or properly functioning.	**Bad** - Mountain slope is located just along the road, but slope protection is not provided.
Section 6	**Fair** - Road surface is relatively good.	**Bad** - No drainage facilities are installed or properly functioning.	**Bad** - Mountain slope is located just along the road, but slope protection is not provided.
Section 7	**Fair** - Road surface is relatively good.	**Bad** - No drainage facilities are installed or properly functioning.	**Fair** - Mountain slope is not located along the road.
Section 8	**Very Bad** - Road is not paved and severely eroded by floodwater.	**Bad** - No drainage facilities are installed or properly functioning.	**Fair** - Mountain slope is not located along the road.
Section 9	**Fair** - Road surface is relatively good.	**Very Bad** - No drainage facilities are installed or properly functioning. - Mudflow occurs on the road during heavy rain, but required facilities for this are not provided.	**Fair** - Mountain slope is not located along the road.
Section 10	**Fair** Road surface is relatively good.	**Fair** - Drainage facilities are relatively installed and functioning.	**Fair** - Mountain slope is not located along the road.

Source: JICA Expert Team

Road sections of Kokopo-Rabaul Coastal Road are shown in Figure 21.6.1.



Source: JICA Expert Team

Figure 21.6.1 Road Sections of Kokopo-Rabaul Coastal Road

21.6.2 Implementation Measure by Road Section

It is proposed that improvement measures shown in Table 21.6.2 will be conducted for each road section. These improvement measures were determined in consideration of road conditions for each road section.

Table 21.6.2 Improvement Measures for Road Sections

Section	Road Improvement	Drainage Improvement	Slope Improvement
Section 1	- DBST is provided. - Proper cross fall to discharge rainwater is provided.	- Side ditch is provided for both sides of the road. - Cross drainage culverts are installed at some points.	- Slope protection is provided.
Section 2	- DBST is provided. - Proper cross fall to discharge rainwater is provided. - Road height is raised to secure the waterway under the road. - Bridge is constructed to secure the waterway under the road.	- Side ditch is provided for both sides of the road. - Cross drainage culverts are installed at some points. - Sedimentation basin is constructed to catch sand / soil from the mountain during heavy rain.	- Slope protection is provided.
Section3	- DBST is provided. - Proper cross fall to discharge rainwater is provided.	- Side ditch is provided for both sides of the road. - Cross drainage culverts are installed at some points.	- Slope protection is provided.
Section 4	- DBST is provided. - Proper cross fall to discharge rainwater is provided. - Road height is raised to secure the waterway under the road. - Bridge is constructed to secure the waterway under the road.	- Side ditch is provided for both sides of the road. - Cross drainage culverts are installed at some points. - Sedimentation basin is constructed to catch sand/soil from the mountain during heavy rain.	-
Section 5	- DBST is provided. - Proper cross fall to discharge rainwater is provided.	- Side ditch is provided for both sides of the road. - Cross drainage culverts are installed at some points.	- Slope protection is provided.
Section 6	- DBST is provided. - Proper cross fall to discharge rainwater is provided.	- Side ditch is provided for both sides of the road. - Cross drainage culverts are installed at some points.	- Slope protection is provided.

Section 7	- DBST is provided. - Proper cross fall to discharge rainwater is provided.	- Side ditch is provided for both sides of the road. - Cross drainage culverts are installed at some points.	-
Section 8	- DBST is provided. - Proper cross fall to discharge rainwater is provided. - Road height is raised to secure the waterway under the road.	- Side ditch is provided for both sides of the road. - Cross drainage culverts are installed at some points. - Waterway is constructed along the mountain side of road to preventt inflow of the water from the mountain into the road.	-
Section 9	- DBST is provided. - Proper cross fall to discharge rainwater is provided. - Road height is raised to secure the waterway under the road. - Bridge is constructed to secure the waterway under the road.	- Side ditch is provided for both sides of the road. - Cross drainage culverts are installed at some points. - Sedimentation basin is constructed to catch sand/soil from the mountain during heavy rain.	-
Section 10	-	-	-

Source: JICA Expert Team

21.7 Preliminary Design

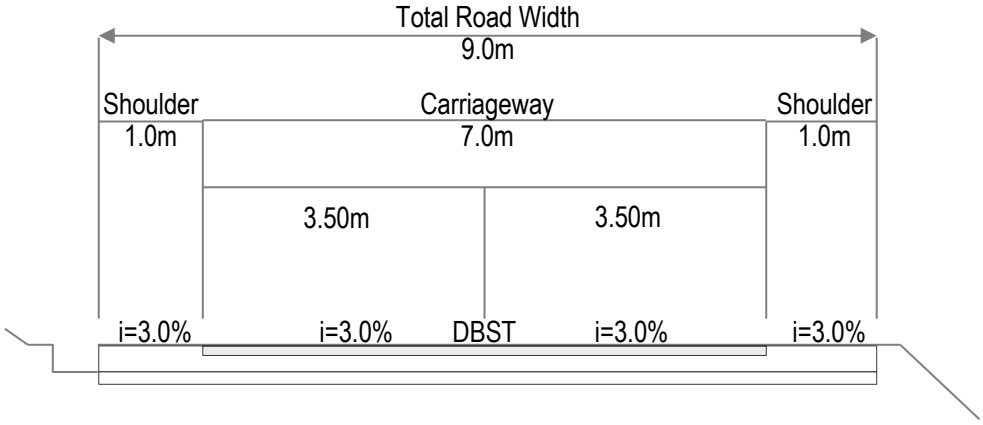
21.7.1 Preliminary Road Design

(1) Geometric Design

Horizontal alignment will follow the existing one. Also, the vertical alignment will basically follow the existing one, but road height will be raised at some sections considering the flood level and to install cross drainage culvert under the road.

(2) Cross-Section

Cross-section of the Project Road will be the same as the existing condition, as this project is carried out for the improvement of existing road and not for new road construction. Typical cross-section of the Project Road is shown in Figure 21.7.1. However, the width of shoulder will vary at each road section. The existing shoulder width will be followed.



Source: JICA Expert Team

Figure 21.7.1 Typical Cross-Section of the Project Road

(3) Pavement

DBST (Double Bituminous Surface Treatment) will be applied as the pavement of the Project Road based on the following aspects.

- It was considered to apply asphalt concrete pavement, as heavy vehicles use the project road. However, the traffic volume of such vehicles is not high.

- There is no asphalt plant in New Britain Island, thus construction cost for asphalt road becomes too high. Thus, this is not economically feasible.

Pavement structure was determined based on Road Note 31: A Guide to the Structural Design of Surfaced Roads in Tropical and Sub-Tropical Regions. Pavement structure of the Project Road is shown in Table 21.7.1 and Figure 21.7.2.

Table 21.7.1 Pavement Structure of the Project Road

Surface	DBST
Roadbase	200 mm (crushed rock)
Sub-base	250 mm (natural gravel)

Source: JICA Expert Team

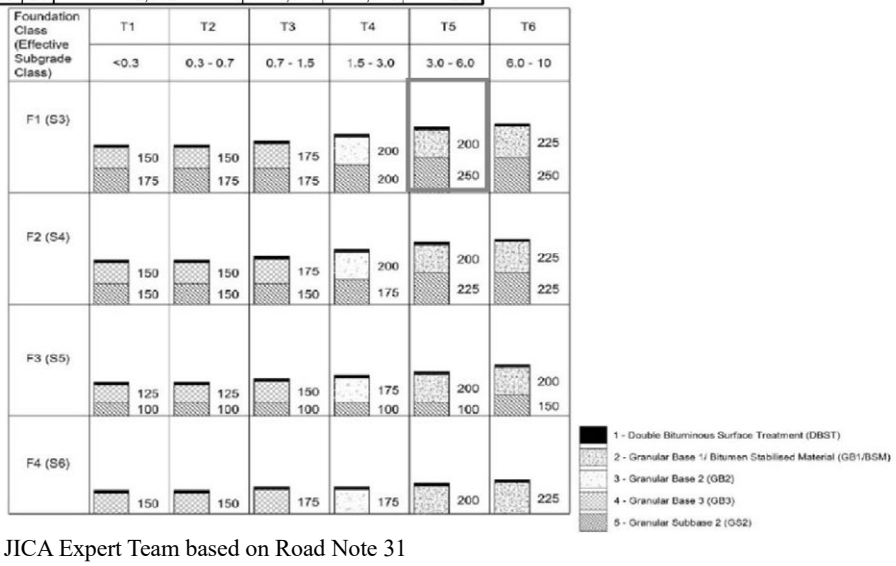
		Traffic Volume (veh/day/Direction) (Direction Ratio: 55%)	Passenger Car	Bus Truck	Trailer
		ESAL Factor	0.0083	1.00	3.00
		ESAL10years	0.02150	2.03302	1.34364
		ESAL15years	0.03648	3.44929	2.27966
		ESAL20years	0.05556	5.25284	3.47164
2024		932	476	374	82
2025		970	495	389	86
2026		1,008	515	404	89
2027		1,049	536	421	93
2028		1,092	558	438	96
2029	1	1,138	581	456	101
2030	2	1,187	606	476	105
2031	3	1,238	633	496	109
2032	4	1,292	660	518	114
2033	5	1,349	689	541	119
2034	6	1,407	719	564	124
2035	7	1,468	750	589	130
2036	8	1,534	783	615	135
2037	9	1,603	819	643	142
2038	10	1,677	857	672	148
2039	11	1,756	897	704	155
2040	12	1,840	940	738	162
2041	13	1,930	986	774	170
2042	14	2,026	1,035	812	179
2043	15	2,129	1,087	853	188
2044	16	2,232	1,140	895	197
2045	17	2,344	1,197	940	207
2046	18	2,464	1,259	988	218
2047	19	2,594	1,325	1,040	229
2048	20	2,692	1,375	1,079	238

ESAL10years	**3.39816**	→ T5
ESAL15years	5.76543	T5
ESAL20years	8.78004	T6

Key 1: Traffic and Subgrade Classes

Traffic Classes (10^6 ESA)		Subgrade Strength Classes (Lowest 10 percentile CBR per cent)	
T1	For T1 and some categories of T2, use the LVR Catalogue Chart F	S1	< 3
T2		S2	3, 4
T3	0.7 - 1.5	S3	5 - 7
T4	1.5 - 3.0	S4	8 - 14
T5	3.0 - 6.0	S5	15 - 30
T6	6.0 - 10	S6	> 30
T7	10 - 17		
T8	17 - 30		
T9	30 - 50		
T10	50 - 80*		

*The T10 designs are suitable for traffic of 80 MESA and are considered 'long life' pavements. They should be used for all higher traffic levels.



Source: JICA Expert Team based on Road Note 31

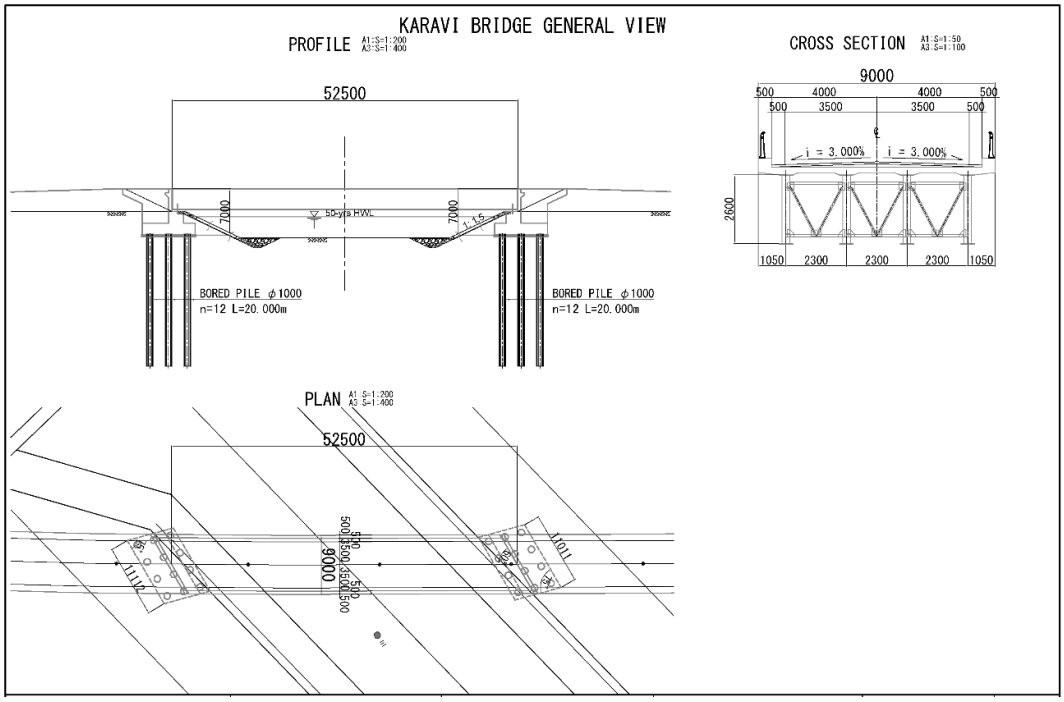
Figure 21.7.2 Calculation of Pavement Structure for Kokopo-Rabaul Coastal Road

(4) Bridges

Existing bridges or box culverts located in Road Section 2, 4 and 9 have been filled with soil and uprooted trees from the mountain during heavy flooding in the rainy season; thus, these are not functioning. Therefore, new bridges will be constructed in this project. Length, span and abutment

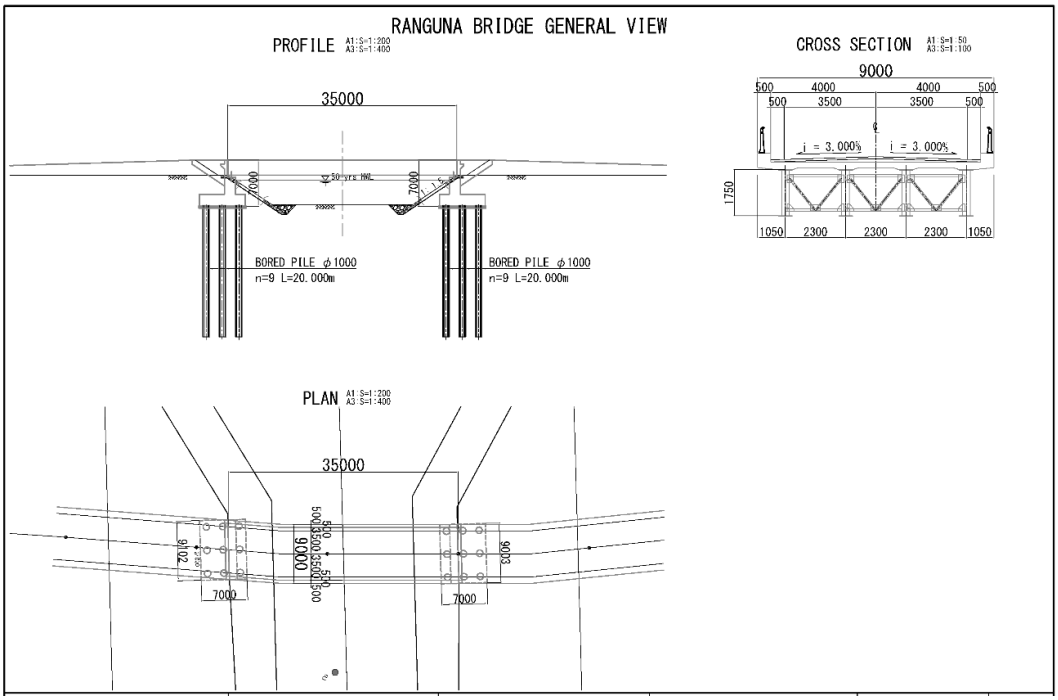
height were determined based on the simplified hydrological analysis. Steel I girder was selected in this pre-feasibility study as it is the popular superstructure type in New Britain Island.

The general views of bridges are shown in Figure 21.7.3, Figure 21.7.4 and Figure 21.7.5.



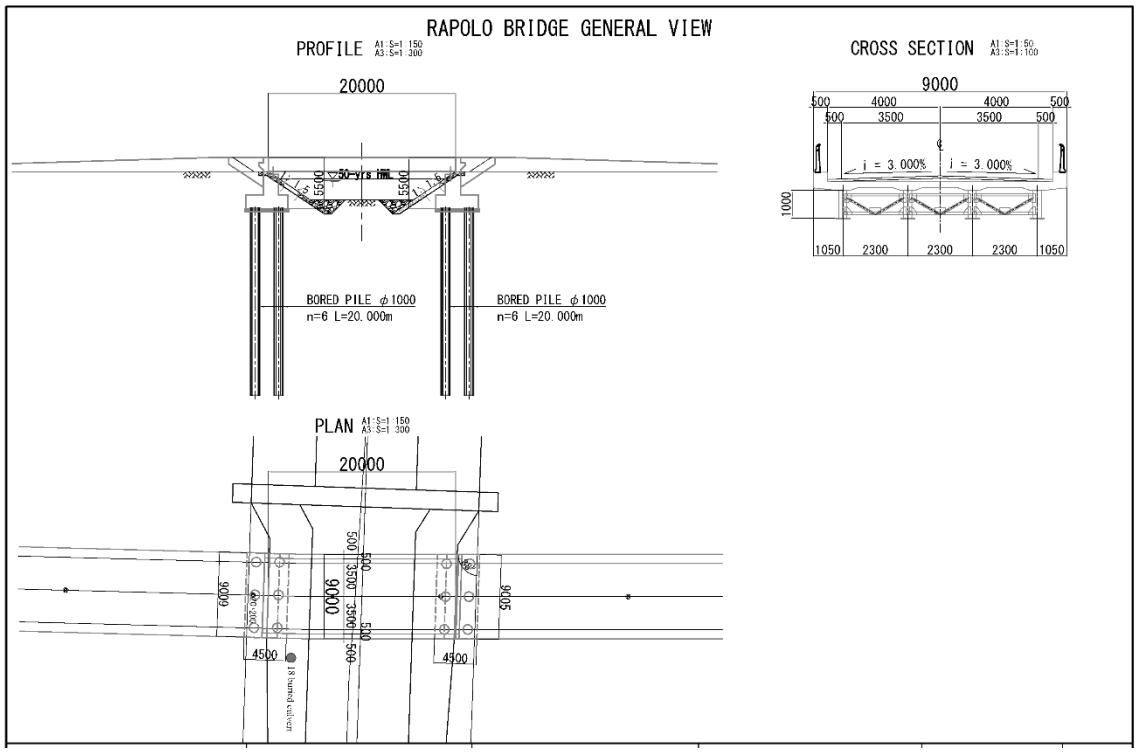
Source: JICA Expert Team

Figure 21.7.3 General View of Karavi Bridge (Section 2)



Source: JICA Expert Team

Figure 21.7.4 General View of Ranguna Bridge (Section 4)



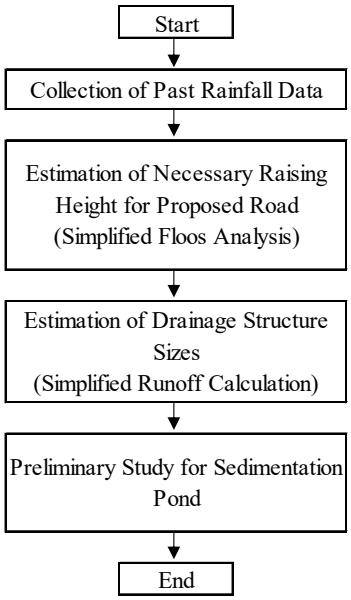
Source: JICA Expert Team

Figure 21.7.5 General View of Papolo Bridge (Section 9)

21.7.2 Preliminary Drainage Design

(1) Design Flow of Drainage Study

Preliminary design of drainage facilities for the Project Road will be based on the following study flow.



Source: JICA Expert Team

Figure 21.7.6 Drainage Study Flow in Preliminary Design for Kokopo-Rabaul Coastal Road

(2) Estimation of Probable Rainfall

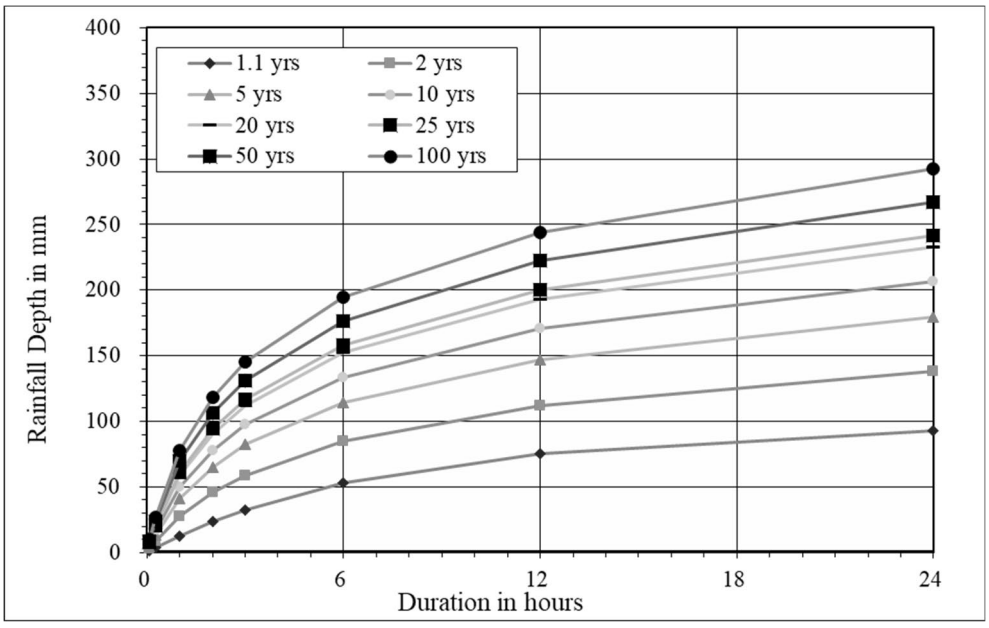
The JAXA 1 hour satellite rainfall (GSMaP) data for Rabaul from 2001 to 2021 were collected, the annual maximum rainfall data for 1, 3, 6, 12 and 24 hours were extracted and the probable

rainfall was calculated. (See Table 21.7.2 and Figure 21.7.7) From these probable rainfall amounts, a fitting analysis was performed to estimate the rainfall intensity formula. The most appropriate formula for rainfall intensity based on these probability rainfall data was selected to be the Cleveland type, and the various constants are shown in Table 21.7.3.

Table 21.7.2 Probable Rainfall in Rabaul

Organisation			JAXA				
Station ID			GSMaP				
Station Name			1hr Rain (21)	3hr Rain (21)	6hr Rain (21)	12hr Rain (21)	24hr Rain (21)
River Name			Rabaul	Rabaul	Rabaul	Rabaul	Rabaul
Long. (X)			152.1650	152.1650	152.1650	152.1650	152.1650
Lat. (Y)			-4.2000	-4.2000	-4.2000	-4.2000	-4.2000
Data No. of Extreme Value			21	21	21	21	21
Probable Discharge (m^3/s)	(Year)	(%)					
	1.1	90.9%	12.6	33.8	52.5	68.5	92.5
	2	50.0%	27.4	58.9	85.1	110.7	137.9
	3	33.3%	33.7	69.7	99.1	128.9	157.5
	5	20%	40.9	81.7	114.8	149.2	179.4
	10	10%	49.8	96.8	134.5	174.7	206.8
	20	5%	58.4	111.3	153.4	199.2	233.2
	25	4%	61.1	115.9	159.3	207.0	241.5
	30	3.33%	63.3	119.7	164.2	213.3	248.3
	50	2%	69.5	130.1	177.8	230.9	267.3
	80	1.25%	75.2	139.6	190.2	247.0	284.6
	100	1%	77.8	144.2	196.1	254.6	292.8
	150	0.667%	82.7	152.4	206.8	268.5	307.7
	200	0.5%	86.1	158.2	214.3	278.3	318.3
	300	0.333%	91.0	166.4	225.0	292.1	333.2
	400	0.25%	94.4	172.2	232.5	301.9	343.7
	500	0.20%	97.1	176.7	238.4	309.5	351.9
Probabilistic Distributed Model			Gumbel	Gumbel	Gumbel	Gumbel	Gumbel

Source: JICA Expert Team



Source: JICA Expert Team

Figure 21.7.7 Probable Rainfall Depth (mm) in Rabaul

Table 21.7.3 Rainfall Intensity in Rabaul

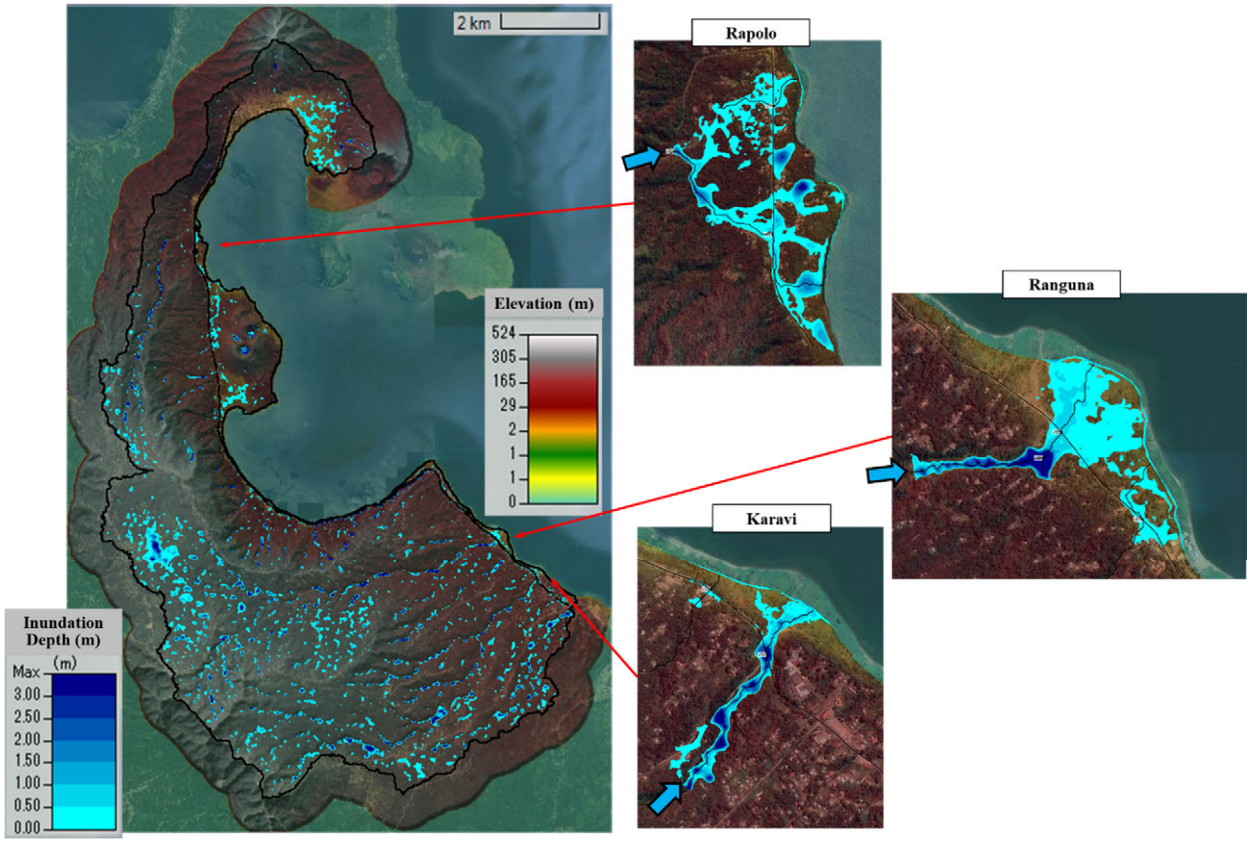
24hrs Probable Rainfall		Cleveland Equation			Rainfall Intensity (mm/hr)	
Return Period (year)	24hr Rain (21)	I = a / (t^n + b)				
		a	b	n	10 min.	1 hour
1.1	92.5	16971.8	1253.74	1.108	13.40	12.60
2	137.9	4211.1	116.48	0.883	33.93	27.40
3	157.5	4163.8	88.81	0.867	43.30	33.70
5	179.4	4228.6	70.49	0.853	54.48	40.90
10	206.8	4623.8	60.68	0.848	68.28	49.80
20	233.2	5040.4	54.59	0.844	81.86	58.40
25	241.5	5195.8	53.36	0.844	86.10	61.10
50	267.3	5672.5	50.09	0.843	99.42	69.50
100	292.8	6192.1	48.05	0.843	112.55	77.80

Source: JICA Expert Team

(3) Simplified Flood Analysis and Necessary Road Raising Heights

Simplified flood analysis was conducted to estimate the flood height above the road. A two-dimensional flood analysis was carried out using ALOS-DEM terrain with a simple 24-hour rainfall distribution over the target basin.

Based on the simplified flood analysis results, the height of the project road was estimated (equivalent to 50-year probability). Table 21.7.4 shows the road raising section and the average flood height for each section.



Source: JICA Expert Team

Figure 21.7.8 Simplified Flood Analysis for Kokopo-Rabaul Coastal Road

Table 21.7.4 Inundation Length along Proposed Kokopo-Rabaul Coastal Road

Road Improve-ment Section	BP	EP	Total Length (m)	Heightening Length (=Inundated Length) (m)	Rate of (Inundation Length / Total Length)	Average Heightening Height: $Z_{50\text{-}20}$ (m)	Maximum Inundation Height in Inundation Section (m)	Remarks
Section 1	0+000.0	1+182.7	1182.711	860.559	72.8%	0.287	0.0 ~ 1.454	
Section 2	1+182.7	1+483.1	300.348	263.800	87.8%	**0.527**	0.0 ~ 1.594	Karavi
Section 3	1+483.1	2+380.1	897.057	378.618	42.2%	0.170	0.0 ~ 0.332	
Section 4	2+380.1	3+430.2	1050.133	767.405	73.1%	0.294	0.0 ~ 0.780	Ranguna
Section 5	3+430.2	4+208.3	778.073	146.190	18.8%	0.036	0.0 ~ 0.165	
Section 6	4+208.3	7+849.8	3641.501	1232.730	33.9%	0.056	0.0 ~ 0.214	
Section 7	7+849.8	16+802.2	8952.373	2786.995	31.1%	0.111	0.0 ~ 0.604	
Section 8	16+802.2	19+247.3	2445.141	2445.141	100.0%	**2.000**	0.0 ~ 0.638	Estimated
Section 9	19+247.3	20+423.4	1176.105	1005.815	85.5%	**0.337**	0.0 ~ 0.471	Rapolo
Section 10	20+423.4	24+069.5	3646.060	2028.176	55.6%	0.125	0.0 ~ 0.306	

Source: JICA Expert Team

(4) Drainage Structure Sizes

The design scale of the drainage structure was determined by adding a freeboard to the rainfall return period shown in Table 21.7.5, with reference to the PNG design standards, etc.

Table 21.7.5 Design Scale and Freeboard

	Return Period (Return period)	Freeboard
Road Side Ditch	10 years	20% of Cross Section Height
Culvert	20 years	20% of Cross Section Height
Bridge Channel	50 years	0.8 m for Karavi and Ranguna, 0.6 m for Rapolo
Road Shoulder Height	50 years	0.3 m

Source: JICA Expert Team

Table 21.7.6 and Table 21.7.7 show the size, number and length of drainage structures estimated from the probable rainfall amount.

Table 21.7.6 Necessary Culvert Size and Numbers for Kokopo-Rabaul Coastal Road

Culvert Type	C90-1	Ia	Ib	Ic	II	III	IVa	III-2	IVb	IV-2	V-2	Subtotal
Width (m)	0.90	1.00	1.00	1.00	1.50	2.00	3.00	2.00	3.00	3.00	4.00	
Height (m)	0.90	1.00	1.50	2.00	2.00	2.00	2.00	2.00	3.00	3.00	4.00	
Cell No.	1	1	1	1	1	1	1	2	1	2	2	
Slope	0.60%	0.60%	0.50%	0.50%	0.40%	0.35%	0.25%	0.35%	0.20%	0.20%	0.10%	
Discharge Capacity (m3/s)	1.19	1.88	2.83	3.96	6.46	9.13	13.49	18.26	20.35	40.70	61.98	
Section 1	1							1				2
Section 2												
Section 3	4	1	1			1						7
Section 4	1									1		2
Section 5	4	1										5
Section 6	10	3			2	2						17
Section 7	19	6	3	2	6	3	2	2		2		45
Section 8	3	1	3	1			1	1				10
Section 9	1		1		1	1						4
Section 10	14	3	2	1	3							23
Total	57	15	10	4	12	7	3	4		3		115

Source: JICA Expert Team

Table 21.7.7 Necessary Road Side Ditch Length for Kokopo-Rabaul Coastal Road

Section ID	Unit	U 0.3m*0.3m	U 0.6m*0.6m	U 1.0m*1.0m	U 3.0m*2.0m
Section 1	m	1582.65	782.77		
Section 2	m	425.89	174.81		
Section 3	m	1408.93	385.18		
Section 4	m	1699.19	401.08		
Section 5	m	1145.39	410.76		
Section 6	m	4716.91	1616.27		
Section 7	m	11743.13	3994.24	50.00	62.20
Section 8	m	3745.02	977.46		167.80
Section 9	m	1838.64	513.57		
Section 10	m	5867.78	1424.33		
Total Length	m	34173.53	10680.47	50.00	230.00

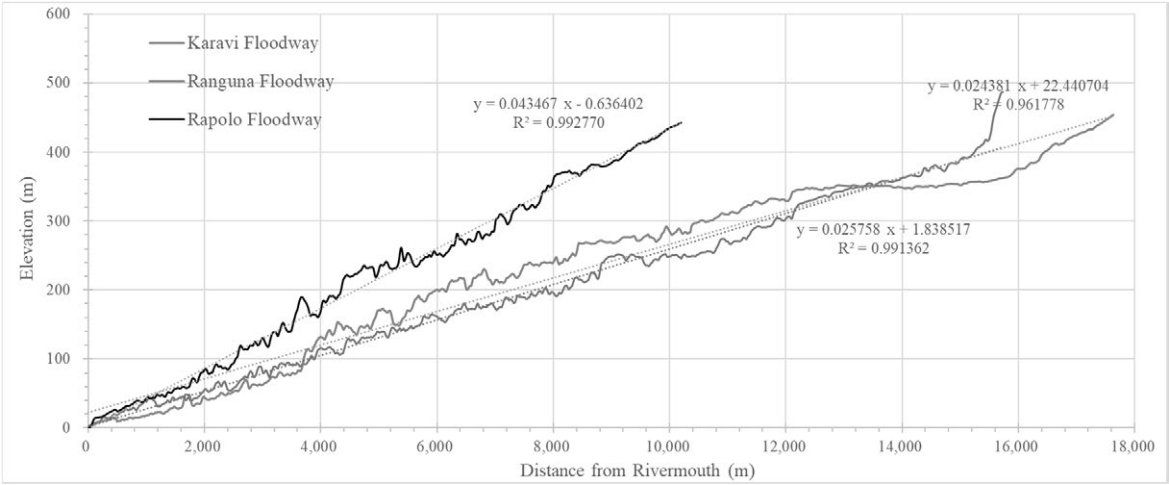
Source: JICA Expert Team

(5) Function and Size for Sediment Ponds

1) Design Concept

Most of the waterways in this study area are buried by discharged sediment (sediment yield) from within the basin, and do not form the drainage channel shape. Among these, the development of a delta at the river mouth due to the sediment discharged from the three floodways of Karavi, Ranguna, and Rapolo is remarkable. According to the interview survey result, approximately 2.4 m of soil and sand has been deposited on the crossing point with the project road and Ranguna floodway over 17 years from 2005 to 2022, and the road height has changed.

Figure 21.7.9 shows river profiles of the three floodways extracted from the DEM. When the longitudinal curve shapes of the three rivers are regressed, they are almost linearly regressed (linear function type). In rivers with a linear function type river profile, the riverbed slope does not change from upstream to downstream, and the river attractive force is maintained, so mass equilibrium is established in which the outflow and inflow of transported substances are balanced. The sediment is carried to the vicinity of the river mouth and an alluvial fan near the river mouth is developed.



Source: JICA Expert Team from ALOS DEM

Figure 21.7.9 River Profile of Three Floodways

For these three locations, which have relatively large catchments and large amounts of sediment runoff volume, in addition to planning the bridges, the sediment ponds are planned upstream of the bridges. The specifications of the sediment pond, such as cross-section, length, sediment capacity, etc., were determined based on the following concepts:

- The downstream waterway of the bridge is not to be buried by sediment run-off from upstream. To this end, as much sediment as possible is captured in the sediment pond and prevented from flowing into the downstream channel of the bridge.

- Although the particle size distribution of the sediment flowing from the upper reaches of the catchment basin is unknown as there are no test values, the target settling particle size for sedimentation in the sediment pond assumes to be 0.5 mm based on other examples. For particles smaller than 0.5 mm, the plan is to have a hydraulic cross-section that allows them to be washed away in downstream waterways.

2) Estimation of the Sediment Yields Produced from the Catchment Basin and Bedload Particle Size

In order to predict the sediment yield produced from the basin and the sediment yield deposited on the riverbed through sediment transport, large-scale surveys and analyses within the basin are required. However, there are no examples of such studies or investigations in this area.

Here, the annual sediment volume is estimated from the annual specific sediment yield based on the catchment area ratio, based on the literature described in Japan's "Collection of Hydraulic Formulae (Japan Society of Civil Engineers)".

This literature deals with the annual specific sediment yield, which is very useful index for the prediction of sedimentation, and also on the grain-size distribution of the sedimentation. Rearrangement of data on sedimentation considering dams in Japan shows that the specific sediment yields can be classified into some groups and these are closely related to catchment area for every group. (See Figure 21.7.10)

Many of the dams in Japan are located in mountain rivers with relatively steep slopes, and in this study, to avoid overestimation, the intermediate sediment yield value is used as shown in Figure 21.7.10 for estimation. (Specifically, the intermediate value between groups 3 and 4 is used.)

Table 21.7.8 shows the estimated average annual sediment yields for the three floodways.

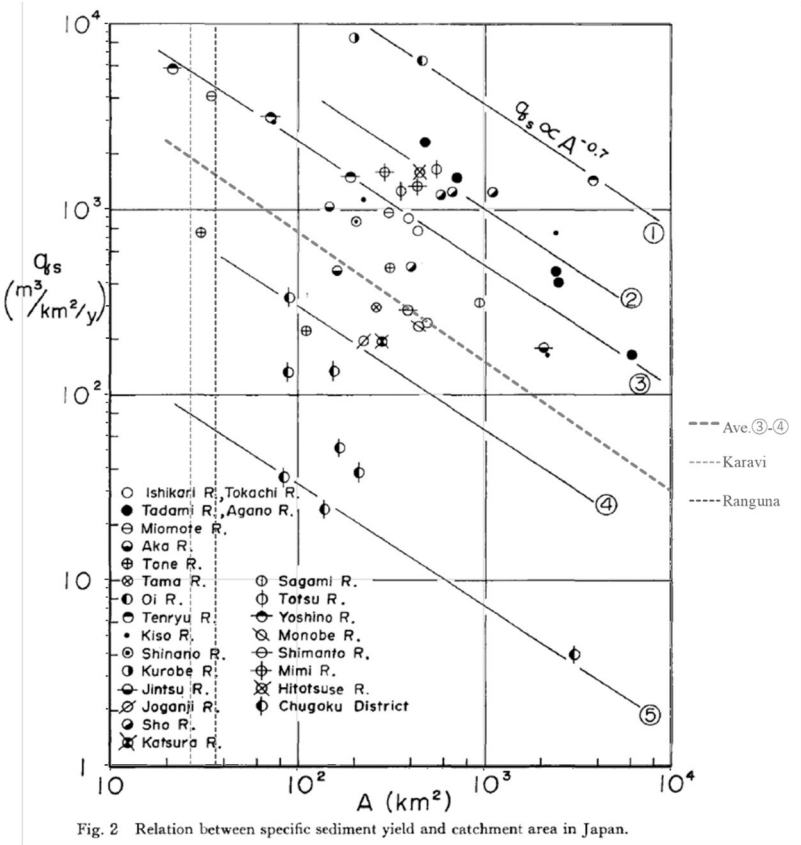


Fig. 2 Relation between specific sediment yield and catchment area in Japan.

Source: "Study on Sedimentation in Reservoirs" (K. Ashida and T. Okumura, 1974, Kyoto University, Japan)

Figure 21.7.10 Estimation of Annual Specific Sediment Yield

Table 21.7.8 Estimated Annual Specific Sediment Yields (qs) in Three Floodways

Floodway Name	Catchment Area	Annual Mean Sediment Runoff Discharge (m^3/year)	
	A (km^2)	qs	Vas (m^3)
		m^3/km^2/year	m^3/year
Karavi	27.00	1892	51,067
Ranguna	36.72	1525	56,005
Rapolo	6.99	2334	16,323

Source: JICA Expert Team

Although the particle size of the transported sediment changes depending on the scale of the flood and its water depth, it is indicated that the sediment can be washed away and transported up to the particle size shown in Table 21.7.9 by the riverbed slope of the three floodways.

Table 21.7.9 Movable Bedload Diameter in Three Floodways

Floodway Name	River Slope	Slope= tanθ	Hydraulic Radius (= Water Depth)	Attractive Force τ	Shear Stress Velocity	Movable Bedload (Sediment) Diameter (Iwagaki)	Remarks
	θ (deg)	S (m/m)	R (m)	τ0 (kg/cm^2)	u* (cm/s)	d (cm)	
			Assume				
Karavi	1.475	0.02576	0.30 ~ 1.00	0.757 ~ 2.524	27.52 ~ 50.24	**62.41 ~ 93.61**	
Ranguna	1.397	0.02438	0.30 ~ 1.00	0.717 ~ 2.389	26.77 ~ 48.88	**59.07 ~ 88.60**	
Rapolo	2.489	0.04347	0.30 ~ 1.00	1.278 ~ 4.260	35.75 ~ 65.27	**105.31 ~ 157.96**	

Note. Attractive Force: $\tau = \rho \cdot g \cdot R \cdot Ie = \rho \cdot u^{*2}$, Movable bedload diameter is calculated by Iwagaki formula.
The table above shows the movable bedload particle size assuming a water depth of 0.3 to 1.0 m. When the water depth is 1.0 m or more, particles with larger size than those in the table above are washed away.

Source: JICA Expert Team

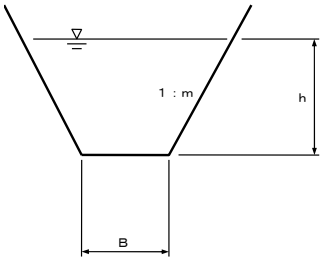
3) Cross-Section of Bridge Channel and Movable Bedload Diameter

The cross-section of the waterway connecting the bridge and the river mouth is determined by taking into account the 50-year flood level and the specified freeboard. In addition, the cross-section should be such that even at low flow rates, target settling particle size with a diameter of 0.5 mm or less for sedimentation in the sediment pond can be washed away. Table 21.7.10 shows the hydraulic calculation results for the cross-section of the bridge channel, and even at low flow rates (0.1 m^3/s), it is possible to wash away more than 0.5 mm.

Table 21.7.10 Hydraulic Cross-Section of Three Bridge Channels

Name	Dis-charge	Lower (Upper) Width	Height	Gradient of channel	Neutral depth	Area	Hydraulic radius	Water Velocity	Attractive Force	Shear stress velocity	Movable bedload diameter (Iwagaki)	Note
	Q(m^3/s)	B (m)	H (m)	I (m/m)	hn (m)	A(m^2)	R (m)	Vn (m/s)	τ0 (kg/cm^2)	u* (cm/s)	d (mm)	
Karavi Channel	263.16	23.00 (35.00)	4.00 (Free-board: 0.822)	0.00125 (=1/ 800)	3.404	95.68	2.71	2.75	0.332	18.228	41.07	100yrs
	233.57				3.178	88.24	2.56	2.65	0.314	17.712	38.78	50yrs
	204.00				2.938	80.53	2.40	2.53	0.294	17.137	36.30	25yrs
	194.54				2.859	78.00	2.34	2.49	0.287	16.938	35.46	20yrs
	164.74				2.595	69.79	2.16	2.36	0.264	16.254	32.66	10yrs
	134.23				2.302	60.90	1.95	2.20	0.238	15.438	29.46	5yrs
	44.42				1.198	29.70	1.09	1.50	0.133	11.541	16.46	1.1yrs
	10.00				0.492	11.68	0.47	0.86	0.058	7.599	7.14	
	1.00				0.124	2.87	0.12	0.35	0.015	3.873	2.11	
	0.10				0.031	0.72	0.03	0.14	0.004	1.949	**0.69**	
Ranguna Channel	313.69	21.50 (35.00)	4.50 (Free-board: 0.853)	0.00125 (=1/ 800))	3.900	106.66	3.00	2.94	0.367	19.168	45.42	100yrs
	278.91				3.647	98.37	2.84	2.84	0.348	18.648	42.99	50yrs
	244.03				3.379	89.77	2.67	2.72	0.326	18.069	40.36	25yrs
	232.85				3.289	86.94	2.61	2.68	0.319	17.868	39.46	20yrs
	197.65				2.993	77.78	2.41	2.54	0.295	17.178	36.47	10yrs

	161.60				2.663	67.90	2.18	2.38	0.267	16.354	33.06	5yrs
	55.55				1.423	33.62	1.26	1.65	0.155	12.437	19.12	1.1yrs
	10.00				0.512	11.40	0.49	0.88	0.060	7.735	7.40	
	1.00				0.129	2.80	0.13	0.36	0.016	3.949	2.17	
	0.10				0.032	0.70	0.03	0.14	0.004	1.989	**0.72**	
Rapolo Channel	87.75	11.00 (20.00)	3.00 (Free-board: 0.708)	0.00167 (=1/ 600)	2.457	36.09	1.82	2.43	0.297	17.228	36.69	100yrs
	77.53				2.292	33.10	1.72	2.34	0.281	16.752	34.69	50yrs
	67.32				2.117	30.01	1.61	2.24	0.263	16.219	32.52	25yrs
	64.06				2.058	28.99	1.57	2.21	0.257	16.034	31.78	20yrs
	53.77				1.863	25.70	1.45	2.09	0.237	15.392	29.29	10yrs
	43.27				1.645	22.15	1.31	1.95	0.214	14.619	26.42	5yrs
	12.74				0.805	9.83	0.71	1.30	0.115	10.746	14.27	1.1yrs
	5.00				0.462	5.40	0.43	0.93	0.070	8.347	8.61	
	1.00				0.177	1.99	0.17	0.50	0.028	5.284	3.45	
	0.10				0.044	0.49	0.04	0.20	0.007	2.682	**1.25**	



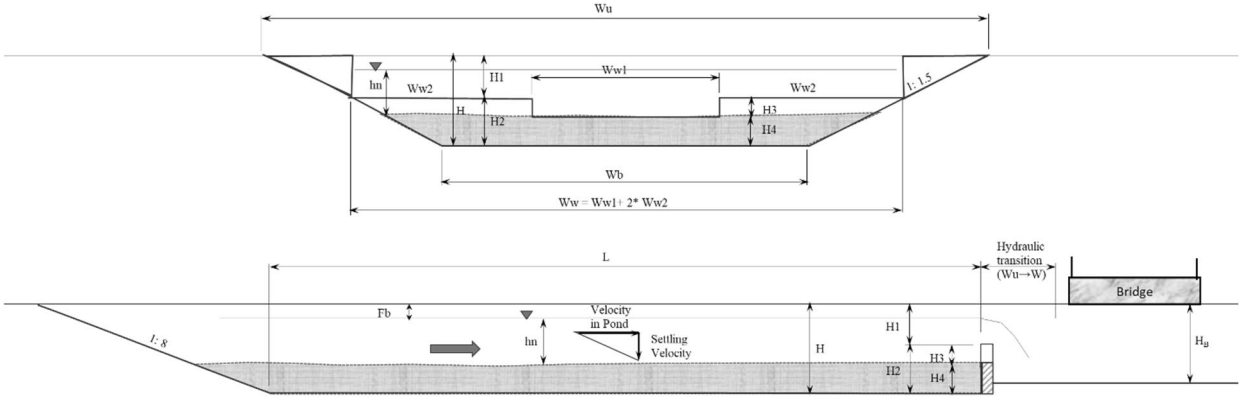
Source: JICA Expert Team

4) Cross-Section and Structure of Sediment Pond

The sediment ponds have a target settling particle size of 0.5 mm, and its sedimentation capacity is set by taking into account the annual number of sand removal operations and the construction cost of the sediment pond. An enclosing bund (similar to an erosion control dam structure) is installed at the downstream end of the sediment pond. For the sediment pond size, the amount of sediment that can be captured is determined from the length of the sediment pond, taking into consideration the average flow velocity of the sediment pond and the settling time of the target settling particles.

It is desirable to suppress the flow velocity within the cross-section of the sediment pond as much as possible and shorten the length of the sediment pond. (In order to suppress the flow velocity in the pond, it is necessary to widen the pond width and pond cross-sectional area.)

The sections of the assumed sediment pond are shown in Figure 21.7.11 and Table 21.7.11.



Source: JICA Expert Team

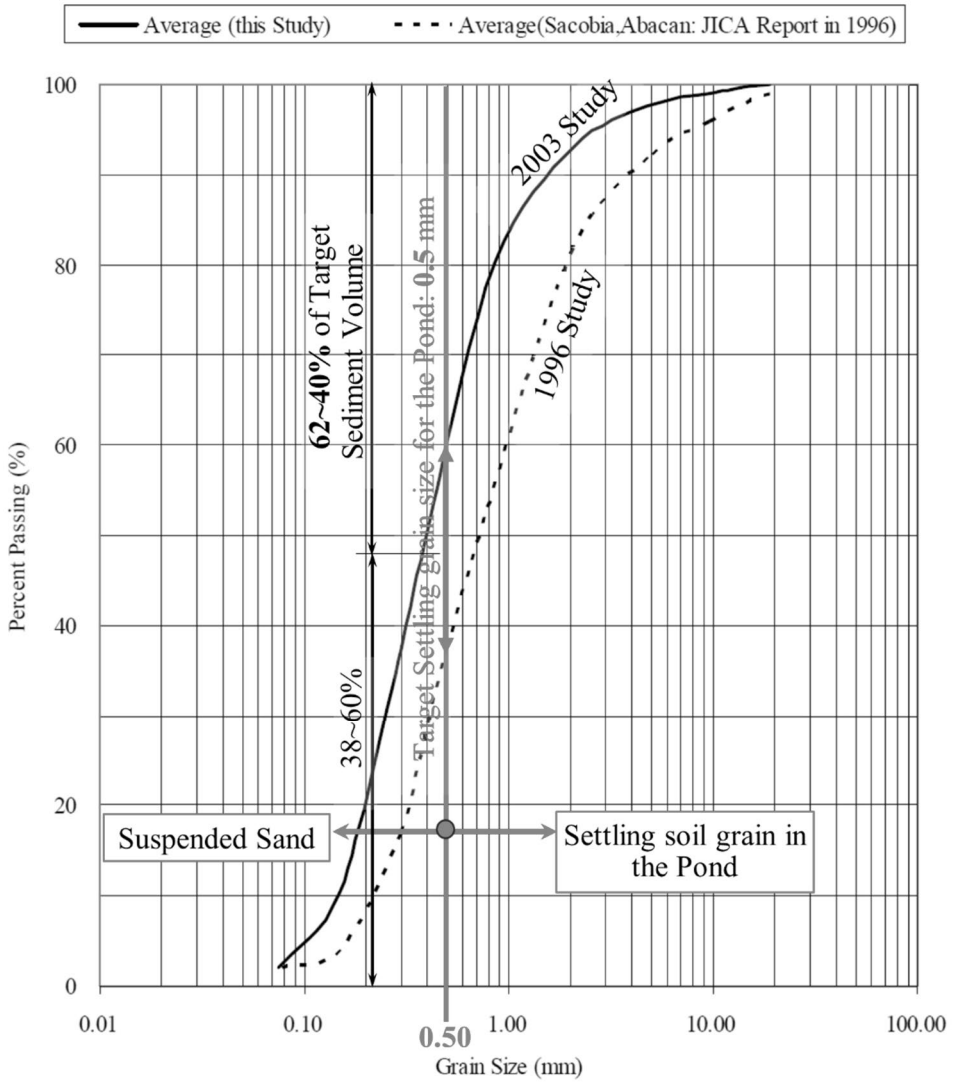
Figure 21.7.11 Cross-Section and Side View of Sediment Pond

Table 21.7.11 Cross-Sections for Three Sediment Ponds

Flood-way Name	Catch-ment Area	Dimension of Cross-Section of Sedimentation Pond										Water Depth above Sand Pit each Flood		Velocity each Probable Flood	
		Height 1	Height 2	Total Height	Height 3	Sedimen-tation depth	Upper Width	Bottom Width	Weir Total Width	Weir 1 Width	Weir 2 Width	50yrs Flood	1.1yrs Flood	50yrs Flood	1.1yrs Flood
	A (km^2)	H1 (m)	H2 (m)	H (m)	H3 (m)	H4 (m)	Wu (m)	Wb (m)	Ww (m)	Ww1 (m)	Ww2 (m)	h50 (m)	h1.1 (m)	v50 (m/s)	v1.1 (m/s)
Karavi	27.00	2.10	2.70	4.80	0.90	1.80	61.3	46.9	55.0	30.0	12.5	2.15	0.88	1.95	0.94
Ranguna	36.72	2.20	2.80	5.00	0.80	2.00	71.6	56.6	65.0	30.0	17.5	2.19	0.97	1.93	0.90
Rapolo	6.99	2.10	2.40	4.50	0.60	1.80	24.3	10.8	18.0	10.0	4.0	2.04	0.76	1.97	0.97

Source: JICA Expert Team

The target particle size for the sediment pond is set at 0.5 mm, but the amount of sediment yield shown in Table 21.7.8 is the total amount including all particle sizes. Although particles larger than 0.5 mm can be captured in this sediment pond, it is assumed that particles smaller than 0.5 mm will be transported to the downstream waterway. Although the particle size distribution of the sediment deposited on the riverbeds of the target rivers is unknown, based on the particle size distribution test results of other project cases where mudflow damage occurred, it is assumed that the target settling soil amount is approximately half of the total. See Figure 21.7.12.



Source: "The Study on Sabo and Flood Control for Western River Basins of Mount Pinatubo in the Republic of the Philippines" (2003, JICA)

Figure 21.7.12 Example of Grain Size Distribution of Riverbed Materials (Mudflow Occurrence Area)

For the annual sediment yields (Figure 21.7.9) and the sediment pond's cross-section determined in Figure 21.7.12, the sediment pond length from the annual number of sand removals was calculated. (See Table 21.7.12) After taking into account the length of the sedimentation pond, construction cost and its effects, the length of the sedimentation pond is proposed, assuming the "sand removal work four times a year." (See Table 21.7.13)

Table 21.7.12 Lengths and Sand Pit Volumes of Three Sediment Ponds

Floodway Name	Velocity in Sediment Pond		Movable Bedload (Sediment) Diameter (mm) for 1.1-Yr Flood	Annual Sediment Yield		1 Time/Year for Sand Removal Maintenance			
	Velocity of 50-Yr Flood: V50 (m/s)	Velocity of 1.1-Yr Flood: V1.1 (m/s)		Annual Mean Sediment Yield: Vas (m^3/year)	Estimated Yield: 50% * Vas (m^3/year)	Sediment Pond Length: L (m)	Sand Pit Volume: Va (m^3)	Average Sand Removal Ratio (%) More Than 0.5 mm Grain Size	
								50 yrs Flood	1.1 yr Flood
Karavi	1.12 ~ 1.95	0.33 ~ 0.94	0.64 ~ 7.58	51,067	25,533	**290.0**	25,891	78.1%	94.8%
Ranguna	1.06 ~ 1.93	0.31 ~ 0.90	0.55 ~ 6.64	56,005	28,003	**240.0**	28,608	74.6%	93.5%
Rapolo	1.22 ~ 1.97	0.34 ~ 0.97	0.76 ~ 8.59	16,323	8,162	**340.0**	8,262	80.6%	95.7%

Floodway Name	2 Times/Year for Sand Removal Maintenance				3 Times/Year for Sand Removal Maintenance				4 Times/Year for Sand Removal Maintenance			
	Sediment Pond Length: L (m)	Sand Pit Volume: Va (m^3)	Average Sand Removal Ratio (%) more than 0.5 mm grain size		Sediment Pond Length: L (m)	Sand Pit Volume: Va (m^3)	Average Sand Removal Ratio (%) more than 0.5 mm grain size		Sediment Pond Length: L (m)	Sand Pit Volume: Va (m3)	Average Sand Removal Ratio (%) More than 0.5 mm Grain Size	
			50 yr Flood	1.1 yr Flood			50 yr Flood	1.1 yr Flood			50 yr Flood	1.1 yr Flood
Karavi	**150.0**	13,392	64.8%	90.3%	**100.0**	8,928	55.1%	86.2%	**75.0**	6,696	48.0%	82.4%
Ranguna	**120.0**	14,304	59.5%	87.7%	**80.0**	9,536	49.5%	82.7%	**60.0**	7,152	42.3%	78.2%
Rapolo	**170.0**	4,131	67.5%	91.8%	**115.0**	2,795	58.4%	88.4%	**85.0**	2,066	50.9%	84.9%

Source: JICA Expert Team

Table 21.7.13 Approximate Construction Cost of Three Sediment Ponds

Floodway Name	Length (m) for Sediment Pond Sand Removal Maintenance				Approximate Construction Cost (JPY) Sand Removal Maintenance				Remarks
	1 time/ year	2 times/ year	3 times/ year	4 times/ year	1 time/ year	2 times/ year	3 times/ year	4 times/ year	
Karavi	290.0	150.0	100.0	75.0	572,321,379	390,194,288	310,701,960	282,192,087	
Ranguna	240.0	120.0	80.0	60.0	542,752,630	392,275,687	342,117,139	317,037,865	
Rapolo	340.0	170.0	115.0	85.0	387,509,360	237,596,553	183,191,187	158,276,937	
Σ Total Construction Cost (JPY)					1,502,583,369	1,020,066,528	836,010,286	757,506,888	

Source: JICA Expert Team

21.7.3 Preliminary Slope Protection Design

(1) Strength of the Ground

Geology of the Kokopo-Rabaul Road area is pyroclastic flow deposit mainly contain volcanic ash, with some part of welded. To evaluate ground stability, simple elastic wave investigation (7 slopes) and Schmidt hummer test (6 slopes) were conducted in the site survey.

Results were shown in Table 21.7.14.

Table 21.7.14 Test Results of On-Site Test

Slope No	Geology	Schmidt Hummer Test		Simple Elastic Waver Test			
		Rebounding Index : R	Compressive Strength: qu (kN/m2)	Wave Speed : Vp(m/s)		Thickness of the Surface Layer (m)	qu in Subsurfae layer: qu (kN/m2)
				Surface Layer	Subsurface Layer		
①	Pyroclastic flow deposit	—	—	388	483	0.35	691
⑤	Pyroclastic flow deposit	—	—	260	385	0.33	478
⑧	Pyroclastic flow deposit	—	—	240	357	0.49	423
⑬	Pyroclastic flow deposit	10	NA	233	370	0.56	448
⑮	Welded Tuff	35	26,450	467	556	NA	868
⑰	Welded Tuff	41	34,070	300	611	1.01	1,011
⑳	Pyroclastic flow deposit (Welded Tuff)	53 (Welded)	49,310	385	400	NA	509
㉑	Pyroclastic flow deposit	19	6,130	—	—	—	—
㉘	Pyroclastic flow deposit	11	NA	—	—	—	—

Source: JICA Expert Team

Results of the elastic wave investigation are used to evaluate slope stability and results of Schmidt Hammer test are used to consider the slope shaping method.

(2) Consideration of Slope Stability

Of the seven locations where simple elastic wave surveys were conducted, the results for the five locations conducted in pyroclastic flow deposits were obtained as primary wave velocity: Vp = 357 to 483 m/s, with an average of 399 m/s.

There is some of correlation between elastic wave velocity: Vp and compressive strength: qu. The report (Basic Research of Rock Strength, Public Works Research Institute) analyse the correlation by rock type and it shows correlation formula between Vp and qu of volcaniclastic rock. Correlation formula is shown in Formula-1.

Compression Strength are calculated by formula – 1 as 423～690 kN/m2, and average 507kN/m2.

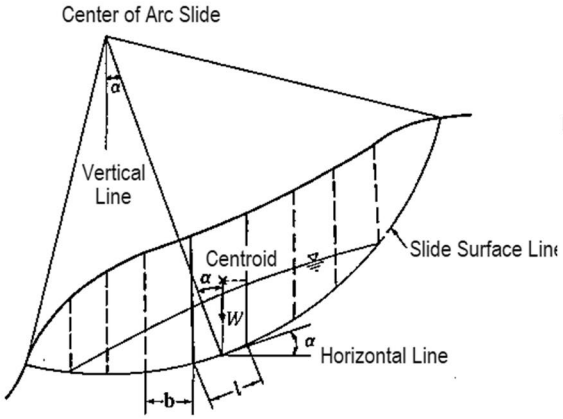
$$\text{Log qu} = 1.62 \text{ Log Vp} + 1.36 \quad \text{---------- (formula – 1)}$$

Here with, qu: Compression Strength kgf/cm^2

Vp: Primary wave velocity km/s

Two tests of seven were done on welded tuff and average Vp = 0.584km/s、estimated compressive strength qu ＝ 940kN/m^2.

Slope stability is considered by simplified land slide stability calculation method shown “Road Geotechnical Engineering – Geotechnical Cutting and Slope Stability Engineering Guide (Japan Road Association)”.



$$F_s = \Sigma\{c \cdot l + (W - u \cdot b)\cos\alpha \cdot \tan\phi\} / \Sigma W \cdot \sin\alpha \quad \cdots\cdots\cdots \text{(Formula - 2)}$$

Herein, F_s : Safety Factor

c : Viscosity (kN/m2)

ϕ : Angle of shearing resistance (degree)

l : Arc length of split piece (m)

u : Pore water pressure (kN/m2)

b : Width of split piece (m)

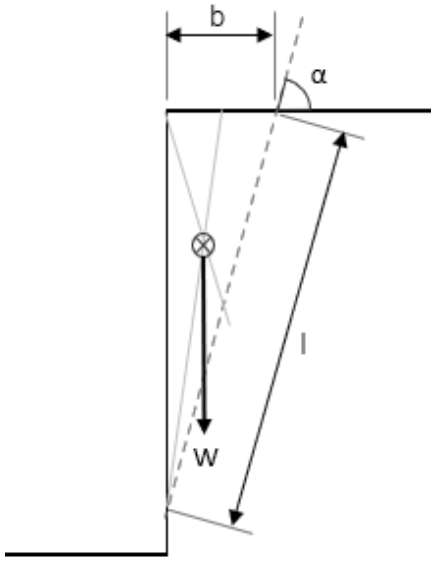
W : Weight of split piece (kN/m)

α : Angle formed by horizontal line and slide surface line (degree)

Figure 21.7.13 Simplified Land Slide Stability Calculation Method (Japan Road Association)

Condition of project area exist steep slopes and slope disaster pattern is not landslide but collapse as shown in Source: JICA Expert Team

Figure 21.7.14. Therefore, consideration was done by using one split piece of simplified method as Figure 21.7.13.



Red dot line shows slide line

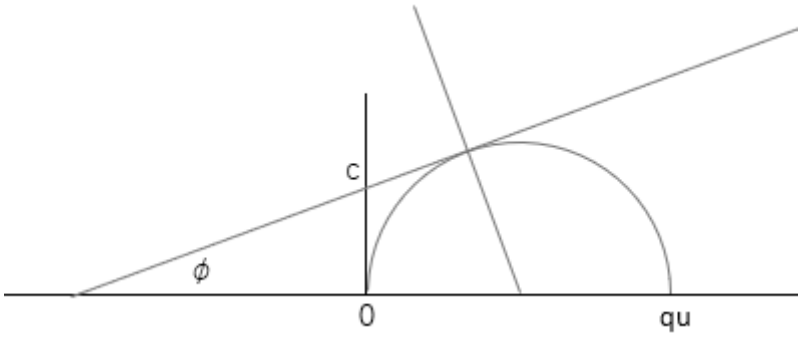
Source: JICA Expert Team

Figure 21.7.14 Consideration of Slope Stability

Ground parameters (c) were estimated from general value of volcaniclastic rock (φ＝21°) by used Figure 21.7.15. In addition, Calculation was done in hyghly dangerous case with slope height 15m and vertical slope. Results of calculation are shown in Table 21.7.15.

Table 21.7.15 Slope Safety Factor for Vertical Slope of Phyrocrastic Flow Deposit

Ground Parameter	Conpression Strength：qu =400kN/m2			Angle of Shearing Resistance：φ =21 degree			Viscosity： c =137kN/m2		
Angle of Collapse:α	85	80	75	70	65	60	55	50	45
Safety Factore: Fc	9.19	4.83	3.59	3.24	3.32	3.75	4.51	5.60	7.34



Source: JICA Expert Team

Figure 21.7.15 Relation between c and φ

From Table 21.7.15, lowest Fs = 3.24 is shown in 70 degree of collapse angle. Fc=3.24 shows high safety condition. Therefore, the risk to collapse is considered extremely low.

Soil disasters that occur in the area are so-called surface failures, which occur when the weathered surface layer contains water due to rainfall and the slope collapses when the surface layer can no

longer bear the weight of the water contain soil. Accordingly, before the installation of slope protection, weathered part (surface soil) must be removed.

(3) Selection of Slope Protection Method

Volcaniclastic Rock formed in Pliocene to Pleistocene by the activity of the Rabaul volcano are distributed in the project area and mainly consolidated pyroclastic flow deposit.

The lithology is massive and stable, with no cracks or other structural joints, but it is not highly consolidated and is easily affected by weathering and softening from the surface. Slope disasters can be roughly classified into collapse, rockfall, and landslide, but the slope disasters in this region can be classified as collapses. Slope failure mechanisms can be divided into two types.

(1) When the surface layer softened by weathering absorbs water during rainfall and can no longer bear the weight, the surface weathered portions detach and collapse (see Figure 21.7.16).

Some of the slopes has vegetation on the surface weathered layer and looks safety, however, surface failure happened unable to bear the weight, because of steep slope.

Remaining overhanging vegetation on top of the slope and it will be able to collapse in the future.



Source: JICA Expert Team

Figure 21.7.16 Collapsed Slope (Surface Failure)

(2) Slope under the condition that the water from the above slope flow down on the slope, gully-shaped erosion is developed (see Figure 21.7.17).

In some cases, drainage from the upper slopes has been artificially directed down the slopes, and as a result, erosion has progressed.



Source: JICA Expert Team

Figure 21.7.17 Gully-Shaped Erosion on the Slope by Concentrated Flow Water

Closed cover construction (sprayed frame construction, mortar/concrete shotcrete, etc.), which reduces the weathering process, is appropriate to prevent the collapse of slopes such as these.

Since the slopes are often steep, mortar/concrete spraying was determined to be the most appropriate method.

In addition, construction of mortar/concrete spraying, special machinery and mixing facility to make mortar/concrete are needed. Therefore, For ease of construction, concrete canvas is recommended that can be stopped on a slope and sprinkled with water to consolidate and settle it. Therefore, to facilitate construction, concrete canvases that can be solidified and fixed by stopping and sprinkling water on the slope are recommended in this project.

For implementation, slope protection will be installed after removal of surface weathered zone and overhanging part. Since volcaniclastic rock is high self-standing stability as described above, not necessary to use ground anchor, etc.

Vegetation work may also be considered for landscaping, but if implemented, it is preferable to consider it on gentle slopes of 60 degrees or less, since the slopes are steep and it is difficult to settle on a volcaniclastic rock.

(4) Ground Strength and Excavation Method

Formula to calculate compressive strength :Fc from Schmidt hammer rebound index :R is shown in below.

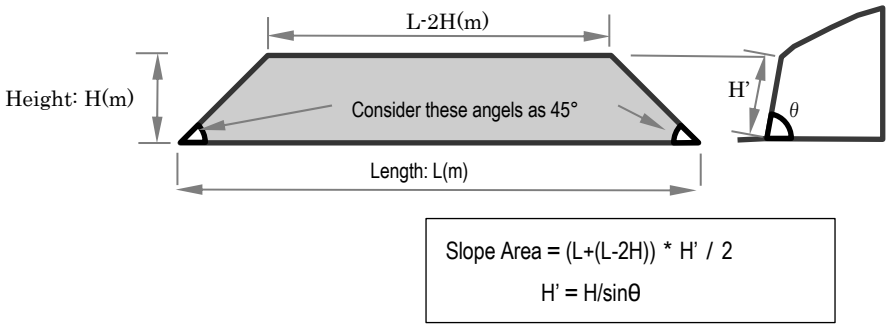
Fc = -18.0+1.27R ---------- (Formula 3)

Slope surface of pyroclastic flow deposit is softened by weathering and R is less than 20 (less than 7,400 kN/m^2). Therefore, it is difficult to evaluate strength. However, 3 tests done at welded tuff average is 43 (35~53) and strength is calculated to 36.61MN/m^2.

Backhoe is suitable for the excavation of weathered part of pyroclastic flow deposit. For the welded tuff need to use Lipper, however, because of surface failure does not occur like a pyroclastic flow deposit, only removal of floating block is enough before slope protection works.

(5) Quantity of Countermeasure for Each Section

The width of the slope calculated based on the handy GPS coordinates of the start and end points. Average height of the slope was measured by hand phone application. Area of slope are calculated by showing in Figure 5.3.6.



Source: JICA Expert Team

Figure 21.7.18 Slope Area Calculation Method

1) Section 1 (0～1.2 ㎞)

Slope ① and ② are located in the Section 1. Total slope area is 1205m^2. Excavation volume (surface weathered soil thickness =40cm) is 482m^3.

2) Section 2 (1.2～1.5 ㎞)

Slope ③ is located in the Section 2. Total slope area is 781m^2 and total excavation volume is 312m^3.

3) Section 3 (1.5～2.4 ㎞)

Slope ④, ⑤ and ⑥ are located in the Section 3. Total slope area is 2676m^2 and total excavation volume is 1,070m^3.

4) Section 4 (2.4～3.5 ㎞)

No target slope in the Section 4.

5) Section 5 (3.5～4.3 ㎞)

Slope ⑦,⑧ and ⑨ are located in the Section 5. Total slope area is 1797m^2 and total excavation volume is 719 m3.

6) Section 6 (4.3～9.9 ㎞)

Slope ⑩ to ㉞ are located in the Section 6. Total slope area is 13040m^2 and total excavation volume is 4616m^3. In addition, slope ⑰ and part of ⑳ are welded tuff, therefore 1500m^3 is neglect from excavation volume.

7) Section 7～10 (9.9～24.2 ㎞)

No target slope in the Section 7 to 10.

List of Target Slope for the protection works are shown in Table 21.7.16.

Table 21.7.16 List of Target Slope for Protection Works

Slope No	Start		End		Slope Condition					Vp (m/s)				SH test		Section
	Latitude	Longitude	Latitude	Longitude	Length	Heght	Angle	Area	Geology	Surface Vp	Surface Thickness(m)	Core Vp	Core Strength kN/m2	R	Strength kN/m2	
1	-4.32827	152.24398	-4.32791	152.2436	61	5	90	280	PFD	388	0.35	483	691			1
2	-4.32616	152.24127	-4.32541	152.2409	98	9	60	925	PFD							1
3	-4.32349	152.24016	-4.3228	152.2395	110	7.5	80	781	PFD							2
4	-4.3219	152.23832	-4.32183	152.238	36	9	80	247	PFD							3
5	-4.32122	152.23662	-4.31999	152.2347	262	8	80	2063	PFD	260	0.32	385	478			3
6	-4.31983	152.23453	-4.31933	152.2342	66	6	80	366	PFD							3
7	-4.31184	152.22681	-4.31152	152.2262	81	11	45	1089	PFD							5
8	-4.31142	152.22601	-4.311	152.2255	77	6	60	492	PFD							5
9	-4.31066	152.22514			36	7	70	216	PFD	240	0.49	357	423			5
10	-4.29569	152.21253	-4.29564	152.212	56	6.5	90	322	PFD							6
11	-4.29577	152.21052	-4.29598	152.2103	35	14.5	60	343	PFD							6
12	-4.29744	152.20847	-4.29754	152.2082	36	17	60	373	PFD							6
13	-4.30037	152.20376	-4.30106	152.2028	128	7	90	847	PFD	233	0.56	370	488	10	7154	6
14	-4.30175	152.20228	-4.30218	152.2019	63	15	60	831	PFD							6
15	-4.30331	152.20043	-4.30389	152.1993	138	8.5	90	1101	PFD	467	NA	556	868	35	25039	6
16	-4.30409	152.19911	-4.30427	152.1989	30	8.5	80	186	PFD							6
17	-4.30508	152.19786	-4.30487	152.1974	51	9	90	378	WT	300	1.02	611	1011	41	29331	6
18	-4.30513	152.19567	-4.30508	152.1951	57	10	90	470	PFD							6
19	-4.30563	152.1942			15	7	80	57	PFD							6
20	-4.30567	152.19405	-4.30632	152.193	136	13	90	1599	PFD/WT	385	NA	400	509	53	37916	6
21	-4.3074	152.19067	-4.3075	152.1903	38	8.5	70	267	PFD					19	13593	6
22	-4.30867	152.18529	-4.30873	152.185	35	7	45	277	PFD							6
23	-4.3088	152.18467			60	10	80	508	PFD							6
24	-4.309	152.184			36	8	80	227	PFD							6
25	-4.30913	152.18359	-4.30922	152.183	71	9	60	644	PFD							6
26	-4.30951	152.18228			44	8	65	318	PFD							6
27	-4.30966	152.18184	-4.30989	152.1816	37	9.5	65	288	PFD							6
28	-4.30995	152.18127	-4.31021	152.1805	94	11	70	972	PFD					11	7869	6
29	-4.30986	152.17867	-4.30942	152.1778	108	8	55	977	PFD							6
30	-4.30849	152.17605	-4.30837	152.1758	32	5.5	45	206	PFD							6
31	-4.3082	152.17556			60	8	60	480	PFD							6
32	-4.30796	152.175	-4.30772	152.1743	72	10	80	630	PFD							6
33	-4.30772	152.17431	-4.30758	152.174	43	10	70	351	PFD							6
34	-4.30744	152.17364	-4.30735	152.1733	42	9	50	388	PFD							6
				Total	2344			19,499		Geology (PFD: Pyroclastic Flow Deposit, WT: Welded Tuf)						

Source: JICA Expert Team

21.8 Preliminary Cost Estimates

The construction cost of the Project Road was estimated based on the following conditions in this Pre-Feasibility Study.

- Construction cost was estimated in accordance with the JICA Design and Cost Estimate Manual.
- Unit costs of labour, materials, equipment, etc. were determined basically based on the quotations obtained in PNG.
- Unit costs which could not be obtained in quotations were determined based on information from past projects in PNG considering price escalation.
- Unit costs of bridge girders were determined in reference to past projects in other countries.
- 1 USD = 143.97 JPY and 1PGK = 41.07 JPY were used as exchange rates.

Construction cost of the Project Road is shown in Table 21.8.1. It shows construction cost of all road sections as well as alternative implementation scheme (selection of road sections to be included in the project).

Table 21.8.1 Construction Cost of the Project Road

Alternative Implementation Scheme	Construction Cost (Million JPY)	Sections									
		1	2	3	4	5	6	7	8	9	10
			Bridge Sediment Pond		Bridge Sediment Pond				Road Height Raising	Bridge Sediment Pond	
All Road Sections (without 10)	7,683 mil JPY (L=20.4 km)										-
Road Sections Including Bridges, Sediment Pond and Road Height Raising (Sections 2, 4, 8, 9)	3,792 mil JPY (L=5.1 km)										-
Road Sections Including Bridges and Sediment Pond (Sections 2, 4, 9)	2,728 mil JPY (L=2.4 km)										-
Road Sections Including Bridges and Sediment Pond for Only Around Beginning Section and In Between (Sections 2, 3, 4)	2,330 mil JPY (L=2.3 km)										-
Road Sections Including Bridges and Sediment Pond for Only Around Beginning Section (Sections 2 and 4)	2,071 mil JPY (L=1.4 km)										-

Source: JICA Expert Team

21.9 Economic Analysis of the Project

21.9.1 Objectives and Preconditions of Economic Analysis

Economic analyses for the project are conducted in this chapter in order to assess the consideration of the project to the national economy. The Economic Internal Rate of Return (EIRR) and Net Present Value (NPV) are adopted as evaluation indicators, and these are calculated from annual benefits and cost of the project with discounted cash flow method.

Table 21.9.1 shows the preconditions for the economic analysis of the project. Items of investment cost such as taxes and price escalation are deleted from financial prices in order to introduce economic cost. The Standard Conversion Factor (SCF), which is used for transformation from financial cost to economic cost, is set at 0.90 as was applied in "the Project for the Study on Lae-Nadzab Urban Development Plan in Papua New Guinea".

Table 21.9.1 Preconditions for Economic Analysis

Items	Conditions	Remarks
Project Life	20 years after opening of road 2029-2048	Starting year of design: 2025 Opening year: 2028
Exchange Rate	1 PGK = 38 Japanese yen	
Social Discount Rate	12%	The Project for the Study on Lae-Nadzab Urban Development Plan in Papua New Guinea (conducted in 2017)
Economic Cost	90% of financial cost	

Source: JICA Expert Team

21.9.2 Economic Benefit

Economic benefit of the Project consists of the savings of vehicle operating cost (VOC), savings of travel time cost (TTC), savings of truck-cargo-hour cost, and the reduction of repair and maintenance cost. The economic benefit of the Project will be listed in the cash flow table from 2025 when the road will be opened to the Public to 2048 which is 20th year of the opening.

(1) Savings of Vehicle Operating Cost

VOC is calculated by type of vehicle in two scenarios: with project and without project. The VOC covers fuel cost, lubricant cost, maintenance costs of vehicles including purchase of tires, driver cost, etc.

This analysis utilises the VOC date of "The Project for the Study on Lae-Nadzab Urban Development Plan in Papua New Guinea" (conducted in 2017) because the data for estimating the VOC is limited in Papua New Guinea. The VOC figures are adjusted to 2022 values by using Papua New Guinea's consumer price index. Table 21.9.2 indicates VOC data by vehicle classification.

Table 21.9.2 VOC by Vehicle Classification (PGK/km/vehicle)

	Car	PMV	Truck	
			Light	Heavy
Without project (30km/h)	3.0	3.6	4.6	7.9
With project (60km/h)	2.4	2.8	3.7	6.3

Source: JICA Expert Team based on "The Project for the Study on Lae-Nadzab Urban Development Plan in Papua New Guinea" (JICA, 2017)

(2) Savings of Travel Time Cost

Savings of travel time cost are based on the assumption that saving time will be used for other productive activities. The unit price (or average hourly output) by the other activities is estimated for a passenger by type of vehicle and for working/non-working hours.

In this analysis, the unit values of TTC are estimated by "The Project for the Study on Lae-Nadzab Urban Development Plan in Papua New Guinea" conducted in 2017. Table 21.9.3 shows travel time costs.

Table 21.9.3 Travel Time Costs

Item	Unit	Car	PMV
Per-capita income of passengers: Average price (a)	PGK /hour/person	1.29	1.01
Average number of passengers *(b)	Person/car	2	15
Travel time cost (c) = (a) X (c)	PGK /hour/car	2.58	15.20

Source: JICA Expert Team based on "The Project for the Study on Lae-Nadzab Urban Development Plan in Papua New Guinea" (JICA, 2017) . JICA Study Team adjusted the TTC figures in 2016 to 2022 value.

(3) Savings of Truck-Cargo-Hour Cost

Cargo value per hour, PGK0.88, is estimated by "The Project for the Study on Lae-Nadzab Urban Development Plan in Papua New Guinea" conducted in 2017. (JICA Study Team adjusted the figure in 2016 to the value in 2022.)

(4) Reduction of Restoration and Rehabilitation Costs Associated with Sediment Disasters

The implementation of the project has the potential to save on emergency disaster response repair costs. The savings (reduction) will be the economic benefit amount. The Kokopo Rabaul Coastal Road has been subject to emergency disaster response to remove sediment washed onto the road due to annual rainy season landslides on slopes along the road and floodways' slopes. Therefore, the implementation of the project is expected to generate economic benefits by eliminating the cost of removing sediment from the road. This reduction in emergency disaster response repair costs (PGK 5 million) was calculated as an economic benefit.

21.9.3 Economic Cost

(1) Development Cost

Development cost consists of construction cost and consulting services cost. These costs are estimated in Section 21.7 for this economic analysis; however, taxes, price escalation, and contingency are eliminated. In addition, the local portion of the development cost is converted from the financial price to the economic price by use of the standard conversion factor in order to correct the distortion between the domestic price (price for non-tradable goods) and the international price (price for tradable goods). Table 21.9.4 indicates the development cost of the project expressed by economic price. The total development cost in economic price amounts to 193 million PGK.

Table 21.9.4 Initial Investment Cost of the Project (Economic Price)

Unit: PGK million

Year	Construction	Consulting Services	Total
2025	1.9		1.9
2026	3.6	45.5	49.1
2027	3.6	91.0	94.6
2028	1.9	45.5	47.4
Total	11.0	182.0	193.0

Source: JICA Expert Team

(2) Maintenance Cost

The operation and maintenance (O&M) and renewal costs are assumed as indicated in Table 21.9.5.

Table 21.9.5 Operation and Maintenance Cost

Item	Cost	Remarks
Routine Maintenance	0.1% of construction cost	Every year
Periodic Maintenance	2.0% of construction cost	Every 10 years

Source: JICA Expert Team

21.9.4 Future Traffic Volume

Future traffic volumes on the project road are estimated as shown in Section 21.3.

21.9.5 Economic Evaluation of the Project

(1) Estimate of Economic Internal Rate of Return

Table 21.9.6 shows the annual cash flow of the Project for four cases. Based on the costs and benefits calculated as explained above, the economic internal rate of return (EIRR) and the net present value (NPV) at a discount rate of 12% are calculated as shown in Table 21.9.7.

The results of all cases of the Project are judged economically inviable as the calculated EIRRs do not exceed 12%, which is considered a threshold to judge project viability in developing countries.

Table 21.9.6 Cash Flow of the Project (PGK Million)

<Case 1>

Year	Costs				Benefits					Net Cash Flow
	Initial Investment Cost	Routine Maintenance Cost	Periodic Maintenance Cost	Total Costs	Value in Operation Cost Savings	Value in Trave Time Savings	Value in Time Savings for Cargo	Reduction Amount of Cost for Emergency Response	Total Economic Benefits	
2025	1.9			1.9						-1.9
2026	49.1			49.1						-49.1
2027	94.6			94.6						-94.6
2028	47.3			47.3	6.5	0.3	0.01		6.8	-40.5
2029		0.2		0.2	13.4	0.6	0.01	5.0	19.0	18.8
2030		0.2		0.2	13.7	0.6	0.01	5.0	19.3	19.1
2031		0.2		0.2	14.0	0.6	0.01	5.0	19.7	19.5
2032		0.2		0.2	14.3	0.7	0.02	5.0	20.0	19.8
2033		0.2		0.2	14.7	0.7	0.02	5.0	20.3	20.2
2034		0.2		0.2	14.9	0.7	0.02	5.0	20.6	20.5
2035		0.2		0.2	15.2	0.7	0.02	5.0	20.9	20.8
2036		0.2		0.2	15.5	0.7	0.02	5.0	21.2	21.1
2037		0.2		0.2	15.8	0.7	0.02	5.0	21.6	21.4
2038		0.2	3.6	3.8	16.1	0.7	0.02	5.0	21.9	18.1
2039		0.2		0.2	16.4	0.7	0.02	5.0	22.2	22.0
2040		0.2		0.2	16.8	0.8	0.02	5.0	22.5	22.4
2041		0.2		0.2	17.1	0.8	0.02	5.0	22.9	22.7
2042		0.2		0.2	17.4	0.8	0.02	5.0	23.2	23.0
2043		0.2		0.2	17.7	0.8	0.02	5.0	23.6	23.4
2044		0.2		0.2	18.0	0.8	0.02	5.0	23.9	23.7
2045		0.2		0.2	18.3	0.8	0.02	5.0	24.2	24.0
2046		0.2		0.2	18.6	0.8	0.02	5.0	24.5	24.3
2047		0.2		0.2	18.9	0.9	0.02	5.0	24.8	24.6
2048		0.2	3.6	3.8	19.2	0.9	0.02	5.0	25.1	21.3
	192.9	3.6	7.3	203.8	332.7	15.1	0.35	100.0	448.2	244.4

<Case 2>

Year	Costs				Benefits					Net Cash Flow
	Initial Investment Cost	Routine Maintenance Cost	Periodic Maintenance Cost	Total Costs	Value in Operation Cost Savings	Value in Trave Time Savings	Value in Time Savings for Cargo	Reduction Amount of Cost for Emergency Response	Total Economic Benefits	
2025	1.9			1.9						-1.9
2026	49.1			49.1						-49.1
2027	94.6			94.6						-94.6
2028	47.3			47.3	6.6	0.3	0.01		6.9	-40.5
2029		0.2		0.2	13.5	0.6	0.01	5.0	19.1	19.0
2030		0.2		0.2	13.9	0.6	0.01	5.0	19.5	19.3
2031		0.2		0.2	14.2	0.6	0.01	5.0	19.9	19.7
2032		0.2		0.2	14.6	0.7	0.02	5.0	20.3	20.1
2033		0.2		0.2	15.0	0.7	0.02	5.0	20.7	20.5
2034		0.2		0.2	15.3	0.7	0.02	5.0	21.0	20.8
2035		0.2		0.2	15.7	0.7	0.02	5.0	21.4	21.2
2036		0.2		0.2	16.1	0.7	0.02	5.0	21.8	21.6
2037		0.2		0.2	16.5	0.7	0.02	5.0	22.2	22.0
2038		0.2	3.6	3.8	16.9	0.8	0.02	5.0	22.6	18.8
2039		0.2		0.2	17.3	0.8	0.02	5.0	23.1	22.9
2040		0.2		0.2	17.7	0.8	0.02	5.0	23.5	23.3
2041		0.2		0.2	18.1	0.8	0.02	5.0	24.0	23.8
2042		0.2		0.2	18.6	0.8	0.02	5.0	24.5	24.3
2043		0.2		0.2	19.1	0.9	0.02	5.0	25.0	24.8

2044		0.2		0.2	19.5	0.9	0.02	5.0	25.4	25.2
2045		0.2		0.2	19.9	0.9	0.02	5.0	25.9	25.7
2046		0.2		0.2	20.4	0.9	0.02	5.0	26.3	26.2
2047		0.2		0.2	20.9	0.9	0.02	5.0	26.8	26.7
2048		0.2	3.6	3.8	21.4	1.0	0.02	5.0	27.3	23.5
	192.9	3.6	7.3	203.8	350.9	16.0	0.37	100.0	467.3	263.5

<Case 3 >

Year	Costs				Benefits					Net Cash Flow
	Initial Investment Cost	Routine Maintenance Cost	Periodic Maintenance Cost	Total Costs	Value in Operation Cost Savings	Value in Trave Time Savings	Value in Time Savings for Cargo	Reduction Amount of Cost for Emergency Response	Total Economic Benefits	
2025	1.9			1.9						-1.9
2026	49.1			49.1						-49.1
2027	94.6			94.6						-94.6
2028	47.3			47.3	7.0	0.3	0.01		7.3	-40.0
2029		0.2		0.2	14.5	0.7	0.02	5.0	20.2	20.0
2030		0.2		0.2	15.2	0.7	0.02	5.0	20.9	20.7
2031		0.2		0.2	15.8	0.7	0.02	5.0	21.6	21.4
2032		0.2		0.2	16.5	0.8	0.02	5.0	22.3	22.1
2033		0.2		0.2	17.2	0.8	0.02	5.0	23.0	22.8
2034		0.2		0.2	17.9	0.8	0.02	5.0	23.8	23.6
2035		0.2		0.2	18.7	0.9	0.02	5.0	24.6	24.4
2036		0.2		0.2	19.5	0.9	0.02	5.0	25.4	25.3
2037		0.2		0.2	20.4	0.9	0.02	5.0	26.3	26.2
2038		0.2	3.6	3.8	21.3	1.0	0.02	5.0	27.3	23.5
2039		0.2		0.2	22.3	1.0	0.02	5.0	28.3	28.2
2040		0.2		0.2	23.3	1.1	0.02	5.0	29.4	29.2
2041		0.2		0.2	24.5	1.1	0.03	5.0	30.6	30.4
2042		0.2		0.2	25.7	1.2	0.03	5.0	31.8	31.7
2043		0.2		0.2	26.9	1.2	0.03	5.0	33.2	33.0
2044		0.2		0.2	28.2	1.3	0.03	5.0	34.5	34.3
2045		0.2		0.2	29.6	1.3	0.03	5.0	36.0	35.8
2046		0.2		0.2	31.1	1.4	0.03	5.0	37.5	37.3
2047		0.2		0.2	32.7	1.5	0.03	5.0	39.2	39.0
2048		0.2	3.6	3.8	34.0	1.5	0.04	5.0	40.5	36.7
	192.9	3.6	7.3	203.8	462.3	21.0	0.49	100.0	583.8	380.0

<Case 4 >

Year	Costs				Benefits					Net Cash Flow
	Initial Investment Cost	Routine Maintenance Cost	Periodic Maintenance Cost	Total Costs	Value in Operation Cost Savings	Value in Trave Time Savings	Value in Time Savings for Cargo	Reduction Amount of Cost for Emergency Response	Total Economic Benefits	
2025	1.9			1.9						-1.9
2026	49.1			49.1						-49.1
2027	94.6			94.6						-94.6
2028	47.3			47.3	7.2	0.3	0.01		7.5	-39.8
2029		0.2		0.2	15.1	0.7	0.02	5.0	20.8	20.6
2030		0.2		0.2	15.8	0.7	0.02	5.0	21.6	21.4
2031		0.2		0.2	16.6	0.8	0.02	5.0	22.4	22.2
2032		0.2		0.2	17.5	0.8	0.02	5.0	23.3	23.1
2033		0.2		0.2	18.4	0.8	0.02	5.0	24.3	24.1
2034		0.2		0.2	19.4	0.9	0.02	5.0	25.3	25.1
2035		0.2		0.2	20.4	0.9	0.02	5.0	26.3	26.2
2036		0.2		0.2	21.5	1.0	0.02	5.0	27.5	27.3
2037		0.2		0.2	22.7	1.0	0.02	5.0	28.8	28.6

2038		0.2	3.6	3.8	24.0	1.1	0.03	5.0	30.1	26.3
2039		0.2		0.2	25.5	1.2	0.03	5.0	31.6	31.5
2040		0.2		0.2	27.0	1.2	0.03	5.0	33.3	33.1
2041		0.2		0.2	28.7	1.3	0.03	5.0	35.0	34.8
2042		0.2		0.2	30.5	1.4	0.03	5.0	37.0	36.8
2043		0.2		0.2	32.5	1.5	0.03	5.0	39.1	38.9
2044		0.2		0.2	34.7	1.6	0.04	5.0	41.3	41.1
2045		0.2		0.2	37.0	1.7	0.04	5.0	43.7	43.5
2046		0.2		0.2	39.5	1.8	0.04	5.0	46.4	46.2
2047		0.2		0.2	42.4	1.9	0.04	5.0	49.3	49.1
2048		0.2	3.6	3.8	44.4	2.0	0.05	5.0	51.5	47.7
	192.9	3.6	7.3	203.8	540.7	24.6	0.57	100.0	665.9	462.1

Source: JICA Expert Team

Table 21.9.7 EIRR and NPV by Case

	EIRR (%)	NPV (PGK million): At discounted rate of 12%
Case 1	8.1	-39
Case 2	8.5	-36
Case 3	10.5	-15
Case 4	11.6	-3

Source: JICA Expert Team

(2) Sensitivity Analysis

Sensitivity analysis is conducted on EIRR by changing conditions with the variation in economic benefits and costs. The results are shown in Table 21.9.8. The results indicate that, in each case, there are some patterns which the EIRR value will exceed 12%.

Table 21.9.8 EIRRs of Sensitivity Analysis

<Case 1R>

		Benefits				
		80%	**90%**	**100%**	**110%**	**120%**
Costs	**120%**	3.7%	4.9%	6.0%	7.1%	8.1%
	110%	4.6%	5.8%	7.0%	8.1%	9.2%
	100%	5.6%	6.9%	8.1%	9.3%	10.4%
	90%	6.8%	8.1%	9.4%	10.7%	11.8%
	80%	8.1%	9.6%	11.0%	12.3%	13.5%

<Case 2R>

		Benefits				
		80%	**90%**	**100%**	**110%**	**120%**
Costs	**120%**	4.0%	5.3%	6.4%	7.5%	8.5%
	110%	4.9%	6.2%	7.4%	8.5%	9.6%
	100%	6.0%	7.3%	8.5%	9.7%	10.8%
	90%	7.1%	8.5%	9.8%	11.0%	12.2%
	80%	8.5%	10.0%	11.3%	12.6%	13.9%

<Case 3R>

		Benefits				
		80%	**90%**	**100%**	**110%**	**120%**
Costs	**120%**	6.0%	7.2%	8.4%	9.5%	10.5%
	110%	6.9%	8.2%	9.4%	10.5%	11.6%
	100%	7.9%	9.3%	10.5%	11.7%	12.9%
	90%	9.1%	10.5%	11.9%	13.1%	14.3%
	80%	10.5%	12.0%	13.4%	14.7%	16.0%

<Case 4R>

		Benefits				
		80%	**90%**	**100%**	**110%**	**120%**
Costs	**120%**	7.1%	8.3%	9.5%	10.6%	11.6%
	110%	8.0%	9.3%	10.5%	11.6%	12.7%
	100%	9.0%	10.4%	11.6%	12.8%	14.0%
	90%	10.2%	11.6%	13.0%	14.2%	15.4%
	80%	11.6%	13.1%	14.5%	15.9%	17.2%

Source: JICA Expert Team

21.10 Environmental and Social Considerations for the Project

21.10.1 Procedures for Environmental and Social Considerations

This section outlines the procedures for environmental impact assessment (EIA) based on the Operation Manual of Environment Act 2000 prepared by the Conservation and Environment Protection Authority (CEPA). In PNG, the only formal process for social and environmental assessment is EIA, and there is no legal document or manual for strategic environmental assessment (SEA) and initial environmental examination (IEE). However, in PNG, an IEE is usually conducted when doing a feasibility study. The Department of Works (DOW) also conducts IEE for restoration projects.

21.10.2 Regulatory Process of Environmental Impact Assessment (EIA) in PNG

The environmental regulatory framework provides a three-tier process for dealing with activities with potential for causing environmental harm. Activities are classified as a Level 1, Level 2 or Level 3 activity. The Level 3 category is essentially for those projects of national importance and have the potential to cause serious environmental harm. These activities are subjected to the environmental impact assessment process. The Minister for Environment and Conservation must issue an Approval in Principle to a Level 3 activity before an Environment Permit for discharge of wastes can be obtained.

The activities in the Level 2 category have the potential to cause environmental harm. Level 2 category is further categorised into Level 2 (Category A) and Level 2 (Category B). Level 2 (Category A) activities are those with low potential for causing environmental harm (e.g., water extraction) and are exempted from the notification and public consultation requirement under the permit assessment process. On the other hand, Level 2 (Category B) activities have high potential for causing environmental harm and are put through the full environment permit assessment process.

Level 1 activities are those not prescribed in the Environment Regulation (Prescribed Activities) 2002 as Level 2 or Level 3 activities. These are activities with very low risk of causing environmental harm. The environmental performance of these activities is guided by environmental guidelines, codes of practices and notices. The Level 1 activities are also obliged to comply with the Act and the regulations or statutory policies developed under the Act.

Although the regulatory processes are clearly set out in the legislation, it is beneficial for a proponent to have an early consultation with CEPA on the proposed activity before formally lodging an application. Early notification is a requirement under the Act for a Level 2 or Level 3 activity. This provision is intended to ensure that all the relevant environmental performance standards relating to the proposed activity are made known to the proponent during the project planning stage. Information Guidelines issued by CEPA during the notification process will enable the proponent to note and include the environmental considerations into the design of the proposed activity. It is also at this stage that the proponent is notified of relevant legal requirements under the environment regulatory process. The guidelines issued by the Department must be understood, otherwise the proponent can seek clarification from CEPA. It is important for the proponent that the application contains sufficient information on the proposed activity, as well as the correct

application fee before the application for an Approval in Principle and/or before an Environment Permit is lodged. Information guidelines or bulletins should be consulted in order to submit the required information. Delay in processing of an application due to insufficient information will be avoided if quality data and relevant information are provided in the first instance. During processing of an application, additional information may be requested from the proponent in order to complete the assessment. In those situations, the proponent should respond promptly and, where verbal advice is given, must receive confirmation in writing. With this proactive participation of the proponent, the submission and assessment of an application under the environmental regulatory process will be conducted efficiently.

21.10.3 Scoping of the Pre-Feasibility Study

Based on JICA's "Guidelines for Environmental and Social Considerations" and PNG DoWH's "Guidelines for Environmental Assessment of Road and Bridge Infrastructure Projects", the potential environmental and social impacts of the Pre-Feasibility Study were identified and summarised in the table below.

Table 21.10.1 Scoping Results for the Pre-Feasibility Study

No	Impact Items	Evaluation			Reason for Evaluation
		Pre-construction	During construction	Operation/ Maintenance	
1	Air Pollution		✓	✓	[During construction] Air quality degradation is expected due to base camp operations, construction activities, and emissions from construction-related vehicles. [Operation and Maintenance] Negative impacts on air quality from vehicle emissions are expected but are not significant. The impact of dust is mitigated by the paving of unpaved roads.
2	Water Pollution		✓		[During construction] Soil erosion from land clearing and excavation can lead to poor water quality in areas such as rivers, beaches, seagrass beds, mangroves, wetlands and swamps. In addition, the water quality of such areas may be affected by turbid water from earthworks and jetties on the onshore road, and by effluent from construction sites and workers' accommodation.
3	Soil Pollution				Soil contamination is expected if the soil of the construction site/construction materials contains contaminants due to some factors (natural conditions, industrial waste). However, the impact of soil contamination from construction equipment and materials is not expected.
4	Waste		✓		[During construction] Excavated soil, concrete lumps, etc. are generated during site preparation and construction work. If these are not properly managed, they may have adverse effects on the surrounding environment. In addition, general waste generation is expected from workers at the base camp.
5	Noises and Vibrations		✓	✓	[During construction] Temporary noise and vibration impacts are expected from construction machinery and vehicles. [Operation and Maintenance] Possible impacts are expected due to increased traffic and higher travel speeds in sensitive areas (e.g., residences, schools, medical facilities) around the road.
6	Ground Subsidence				Land subsidence is not expected.
7	Offensive Odours				Since no chemicals with a strong odour will be used, no impact is expected.
8	Topography and Geology		✓	✓	[During construction] Sedimentation and erosion associated with the construction are expected. Civil engineering works such as cuttings and embankments are expected to occur, affecting the topography. [Operation and Maintenance] The implementation of effective drainage systems can prevent submergence and flooding on land around roads and in low-lying areas. In addition, soil erosion control works can increase the stability of landforms and reduce the risk of landslides and slope failures.

No	Impact Items	Evaluation			Reason for Evaluation
		Pre-construction	During construction	Operation/ Maintenance	
9	Bottom Sediment		✓		[During construction] If the construction overburden generated during construction is not disposed properly, sediment may be deposited on the riverbed or beaches, affecting the characteristics of the river and the marine and aquatic life.
10	Biodiversity and Ecosystems		✓	✓	[During construction] The construction activities associated with the project are expected to affect various natural ecosystems, including terrestrial forests, mangroves, tidal flats, coastal reefs, and marine ecosystems. As there may be important species, habitats and ecosystems in the areas affected by the project, a literature review of previous studies, interviews with ecologically knowledgeable local people and field surveys may also be required. [Operation and Maintenance] The operation of the roads can introduce various forms of pollution into ecosystems, including noise, light, and chemical pollution.
11	Hydrological Phenomena		✓		[During construction] Possible changes in the river due to river crossing structures are expected. Also, construction activities can change natural drainage systems, potentially leading to increased runoff into the ocean and river. This can affect the hydrological balance and may lead to changes in river flow regimes. In addition, if there are seasonal patterns of sand movement in the area, the project activities may restrict that movement, which may cause coastal erosion.
12	Accidents		✓	✓	[During construction] There is possibility of accidents, injuries, and illnesses occurring at construction sites. Also, there may be an increase in accidents due to changes in usual traffic patterns, presence of construction equipment, and possible road closures or detours [Operation and Maintenance] Restoring and upgrading road pavement can reduce the likelihood of accidents by providing smoother and more stable driving surfaces, reducing vehicle skidding and control loss. Meanwhile, enhanced road conditions may lead to a higher likelihood of accidents due to the increased number of vehicles interacting on the road.
13	Climate Change				No large-scale greenhouse gas emissions are expected from the project activity.
14	Involuntary Resettlement	✓			[Pre-construction] Even if physical relocation is not required, the project can still impact livelihoods (for example, affecting businesses or farms adjacent to the road), leading to economic displacement.
15	Local Economy, such as Employment and Livelihood		✓	✓	[During construction] The construction phase of the project can create direct employment opportunities in construction, engineering, and economic activities associated with workers' base camp. [Operation and Maintenance] Improved roads enhance accessibility to markets, services, and other economic opportunities, thereby facilitating trade and commerce. Also, as the area has tourism potential, improved roads can make tourist spots more accessible, thereby boosting the local tourism industry.
16	Land Use and Utilisation of Local Resource			✓	[Operation and Maintenance] The upgrading of roads (implementation of sediment pond) may require additional land. Meanwhile, the upgraded road infrastructure is expected to markedly improve transport efficiency as it is the most direct route linking the region's primary port with its provincial capital and core commercial zone. Local communities will have improved access to broader markets, both for procuring inputs and selling their products, thereby enhancing the utilisation of local resources.
17	Social Institutions such as Social Infrastructure and Local Decision-Making Institutions			✓	[Operation and Maintenance] Improved roads can enhance access to essential services such as healthcare, education, and emergency services.

No	Impact Items	Evaluation			Reason for Evaluation
		Pre-construction	During construction	Operation/ Maintenance	
					In addition, enhanced road infrastructure can strengthen connectivity between communities, which may lead to more robust social networks and increased social interaction.
18	Existing Social Infrastructure and Services		✓	✓	[During construction] The construction phase might temporarily disrupt access to existing services, causing inconvenience to local communities. This can include road closures, traffic delays, and increased noise and air pollution. [Operation and Maintenance] Enhanced road connectivity can significantly improve access to essential services like healthcare, education, emergency services, and government facilities.
19	Socially Vulnerable People (Indigenous People, Ethnic Minorities)				The project is not expected to have a direct impact on indigenous people and ethnic minorities.
20	Socially Vulnerable People (People in Poverty, Persons with Disabilities, Refugees, Internally Displaced persons and minorities)	✓			[Pre-construction] Road expansion may require land acquisition, which can lead to displacement of communities, particularly affecting vulnerable groups. Meanwhile, improved transport links can facilitate better access to markets and job opportunities, which can be particularly beneficial for people in poverty or marginalized communities.
21	Misdistribution of Benefits and Damages			✓	[Operation and Maintenance] If land acquisition for the project disproportionately affects a particular community or demographic group, this can lead to social and economic displacements. In addition, while the improved road might boost economic activities in certain areas or for certain groups, others might not experience these benefits equally.
22	Local Conflicts of Interest	✓			[Pre-construction] The project may benefit certain groups (like business owners) more than others (like low-income communities), leading to conflicts over the perceived unequal distribution of benefits.
23	Gender				The project is not expected to have a direct impact on gender equality.
24	Children's Rights				The project is not expected to have a direct impact on child labour.
25	Cultural Heritage	✓			[During construction] Construction activities might damage historical or cultural sites including the war relics from the Second World War along the Kokopo-Rabaul Coastal Road.
26	Infectious Diseases such as HIV/AIDS		✓		[During construction] Large infrastructure projects can lead to an influx of workers from different areas, potentially increasing the spread of infectious diseases like HIV/AIDS.

Source: JICA Expert Team

21.10.4 Mitigation Measures to be Considered against Environmental and Social Impacts

This section describes measures to mitigate the environmental and social impacts identified in the scoping process discussed previously. These are specific measures to avoid, minimise or offset adverse impacts during the pre-construction, construction and operation and maintenance phases of the Project. The mitigation measures for each impact are shown in the table below.

Table 21.10.2 Mitigation Measures for Impacts caused by Upgrade of Kokopo-Rabaul Coastal Road

No.	Impact Items	Mitigation Measures	
		Pre-/Under Construction	Operation/Maintenance
1	Air Pollution	− When using construction machinery, make the effort to perform necessary maintenance such as periodic and daily inspections to prevent deterioration in the properties of exhaust gas. − Provide education and training on periodic inspections to on-site workers. − Diesel generators will be used only for emergency power backup and will	-

No.	Impact Items	Mitigation Measures	
		Pre-/Under Construction	Operation/Maintenance
		be procured meeting environmental standards. – During strong winds, water should be sprayed as necessary on earthwork sites, construction machinery operating areas, and temporary roads for vehicles transporting materials. – If necessary, cover the earthwork area with a sheet to prevent the dispersion of dust from the bare ground.	
2	Water Pollution	– Construction works in the sections that require river crossings will be carried out during the dry season when the river flow rate is low. If muddy water is generated during construction, a sediment reservoir will be installed in the waterway to prevent the muddy water from flowing downstream. – Portable toilets will be constructed at the base camps and sludge will be removed regularly. In addition, a wastewater treatment plant with an anaerobic-aerobic bio filter system will be installed at each base camp. Alternatively, slogans encouraging regular cleaning and hygienic use of toilets will be prepared and displayed.	-
3	Soil Pollution	– All storage containers of fuel, oil, and lubricants are properly sealed and labelled. – Contractors should have contingency plans in place in the event of a spill or release of hazardous materials. – Transport vehicles and equipment undergo regular maintenance to prevent oil leakage. – Workers are trained to prevent spills and leaks of diesel, oil, and used oil	-
4	Waste	– Verify that waste disposal contractors handle construction materials and waste in accordance with proper procedures. – Excavated soil, asphalt debris and logged trees are stored in designated areas and reused as fill, repair material for surrounding roads and firewood. – Temporary storage areas must be agreed upon in consultation with the community. – The workers will be informed of the waste management methods and will dispose of the waste at the designated waste disposal site.	-
5	Noises and Vibrations	– Minimise work involving vibration near the boundary with structures and buildings. – Set normal working hours from 6:00 a.m. to 6:00 p.m.	– When setting speed limits through densely populated areas. The location of residential areas and facilities requiring quietness (e.g., schools, hospitals, religious buildings) should be taken into account.
8	Topography and Geology	– Excavation work should be done during the dry season. Excess topsoil should be used for grading to prevent it from flowing into drains, streams, and roads. – Balancing cut-and-fill operations during construction to minimise the amount of earth that needs to be moved. – Implementing measures to prevent soil erosion, especially in areas with steep slopes or loose soil. This can include the use of retaining walls, terracing, vegetation cover, erosion control blankets, and silt fences.	-
9	Bottom Sediment	– Do not leave construction debris or scrap near river basins or shorelines, and dispose of them properly. – The quarries and earth dumping sites are basically used only when a permit has been obtained in accordance with the national law.	-
10	Biodiversity and Ecosystems	– Identify natural areas, particularly environmentally sensitive or fragile areas, and locate optional construction sites away from them. – If the project must encroach onto, or pass close to these areas, construct temporary fences or permanent bunds or trenches to confine machines and activities. – For roads approaching or encroaching on mangrove areas or other wetland areas, ensure that adequate care is taken during construction to minimise sedimentation. This includes proper spoil disposal and careful	– Appropriate road signs with speed limits should be placed along roads, and awareness exercise should be carried out in the communities along the roadside.

No.	Impact Items	Mitigation Measures	
		Pre-/Under Construction	Operation/Maintenance
		construction of drainage structures. – During site clearance, pay attention to the habitats of birds and other wild animals. – Provide sufficient curing to prevent wild animals from getting caught in the openings.	
11	Hydrological Phenomena	– Implement erosion control measures such as silt fences, sediment traps, and erosion control blankets. Stabilise construction areas with vegetation or other materials to prevent soil erosion. – Establish and maintain buffer zones along water bodies to protect them from construction activities. These buffers, consisting of natural vegetation, can filter runoff and reduce pollution.	-
12	Accidents	– Provide training on environmental safety and health to all workers to raise awareness, including the use of Personal Protective Equipment (PPE), HIV prevention, and maintenance. – Install signs at all construction sites to enforce/remind about the use of PPE and safety practices. – During and after construction, appropriate signage, warnings, and speed limits should be clearly visible to inform and guide drivers. – Informing the public about ongoing construction and changes in road conditions can help in reducing accidents.	– Implementing effective traffic management system to handle the increased volume, such as signal optimisation, turn lanes, and appropriate signage.
14	Involuntary Resettlement	– Conduct a thorough assessment to understand the extent of physical and economic displacements that the project might cause. – Engage with potentially affected communities to inform, consult, and involve them in the planning process. – Develop a comprehensive resettlement plan that offers fair compensation and, if necessary, assistance on relocation, housing, and livelihood restoration. – Adhere to national and international laws and policies related to involuntary resettlement. These include respecting the rights of those affected and ensuring that they are adequately compensated and supported.	–
16	Land Use and Utilization of Local Resource	– Incorporating sustainable land use planning in the project to minimise negative impacts on agricultural land. – Engaging with local communities to understand their needs and concerns regarding land use changes and resource utilisation	–
18	Existing Social Infrastructure and Services	– Detailed construction plans will be developed and coordinated to minimise service disruptions and the impact on public services. – Residents will be notified in advance of any planned disruptions to basic services such as water supply and electricity.	–
20	Socially Vulnerable People (People in Poverty, Persons with Disabilities, Refugees, Internally Displaced Persons and Minorities)	– Conduct a socio-economic survey to monitor and evaluate the impacts of the project on vulnerable groups and implement a livelihood restoration plan as necessary.	–
21	Misdistribution of Benefits and Damages	– Actively involve diverse community groups in the planning process to understand and address their concerns and needs. – Provide fair compensation and support to those adversely affected by the project, including assistance with relocation and livelihood restoration.	–
22	Local Conflicts of Interest	– Ensure that the planning and decision-making processes are transparent and inclusive, allowing for diverse viewpoints to be heard and considered. – Provide fair and adequate compensation for land acquisition and ensure that resettlement is conducted with sensitivity to the needs of displaced people. – Establish mechanisms for addressing and resolving conflicts, including mediation and community forums.	–
24	Children's Rights	– The project management must adhere strictly to national and international labour laws, which prohibit child labour.	–

No.	Impact Items	Mitigation Measures	
		Pre-/Under Construction	Operation/Maintenance
		− Regular audits and inspections should be conducted to ensure compliance.	
25	Cultural Heritage	− Conduct a site assessment to identify and understand the potential impacts on cultural heritage. − Local communities need to be engaged to ensure that cultural values are respected and preserved at the project site.	–
26	Infectious Diseases such as HIV/AIDS	− Implement comprehensive health education programmes for workers and local communities, focusing on HIV/AIDS awareness, prevention, and treatment. − Regularly monitor the health impacts of the project, particularly concerning HIV/AIDS, and respond promptly to any increases in infection rates.	–

Source: JICA Expert Team

21.11 Conclusions and Recommendations from Pre-FS

21.11.1 Conclusions from Pre-FS

Project implementation for all sections of Kokopo-Rabaul Coastal Road requires approximately PGK 187 million. This may be not economically feasible because of the low traffic volume of the Project Road (1,695 vehicles/day in 2024), relatively small population of the region (277 thousand people in 2022), low amount of export from Rabaul Port (64 billion JPY in 2021), among others.

Therefore, it is proposed that only critical sections should be strengthened under the JICA grant-aid scheme. Technical transfer regarding design and construction of sediment ponds and bridges based on the hydrologic analysis, etc. will be covered in JICA grant-aid project. Implementation of other sections should be made by PNG government with its own fund or from other donor agencies utilising the knowledge to be transferred in the JICA grant-aid project.

The target sections should be finally determined in a prospective full-scale feasibility study. However, it can be considered that the project providing enough benefit to the region can be implemented within the budget of JICA grant-aid aid.

21.11.2 Recommendations from Pre-FS

Road Sections 2 and 4 or Road Section 2, 3 and 4 have been selected as priority target sections initially in this pre-feasibility study, without the conduct of any natural condition surveys.

It is recommended that priority target sections and intervention menus for the JICA grant-aid project should be selected based on natural condition surveys, such as topographic survey, geological survey and hydrological survey, as well as basic design, construction plan, detailed cost estimates, and maintenance plan in a full-scale feasibility study.

PART X
PILOT PROJECTS

Chapter 22 Pilot Projects

22.1 Introduction

22.1.1 Expected Outcome and Overall Goal

Pilot projects in the NEGID-Plan were implemented as initiatives that contribute to improving the attractiveness of the region by involving local businesses and landowners, as well as local governments.

With the support of the JICA Expert Team, the Project Implementation Unit (PIU) for NEGID-Plan had discussed and determined the overall goal for the implementation of the pilot projects which is as follows:

> "To provide a lively space and vibrant atmosphere which can be enjoyed by both residents and tourists."

This overall goal is to guide the local governments, local business owners and other stakeholders for selecting the pilot projects to be implemented.

The pilot projects were designed to make immediate and short-term impacts to the improvement of local physical and business environments. At the same time, they were intended to initiate local activities by creating opportunities to establish private-public partner relationships for seeking the above overall goal in the long run.

22.1.2 Methods Considered for Pilot Projects

Business Improvement District (BID), or Community Improvement District (CID), is a common method of local government and business partnership to encourage economic growth or provide better services in the local area. To do so, the business owners and landowners pay an additional tax (or levy) in order to fund certain projects applied in the district. The projects are to supplement and enhance the existing public services. This kind of method is applied in many parts of the world including Germany, the UK, Canada, Sweden, Singapore, South Korea, Australia, New Zealand, South Africa, Ireland, and the Netherlands.

As an example, some of the roles of BIDs proposed in Australia are as follows:

- Security and crime prevention
- Cleaning and greening
- Advertising
- Branding and marketing
- Placemaking and public realm upgrades
- Advocacy and policy contributions
- Social purpose, inclusivity and well-being

There is also a similar initiative in Japan called Area Management which is a proactive initiative where the private sector (residents, business owners, landowners, etc.) takes the lead to maintain and improve the good environment and local values in the community.

Such initiatives shall be considered for the implementation of pilot projects in the NEGID-Plan. The target areas for the pilot projects will be within the Urban LLGs of Rabaul and Kokopo.

(1) Business Improvement District (BID) in Canada and US

The BID method is used to provide funds for projects which some businesses perceive as being inadequately performed by the government with its existing tax revenues, such as cleaning streets, ensuring public security, maintaining infrastructure, construction of pedestrian pavements and enhancing streetscape, and marketing the area.

1) Examples of BIDs - Toronto

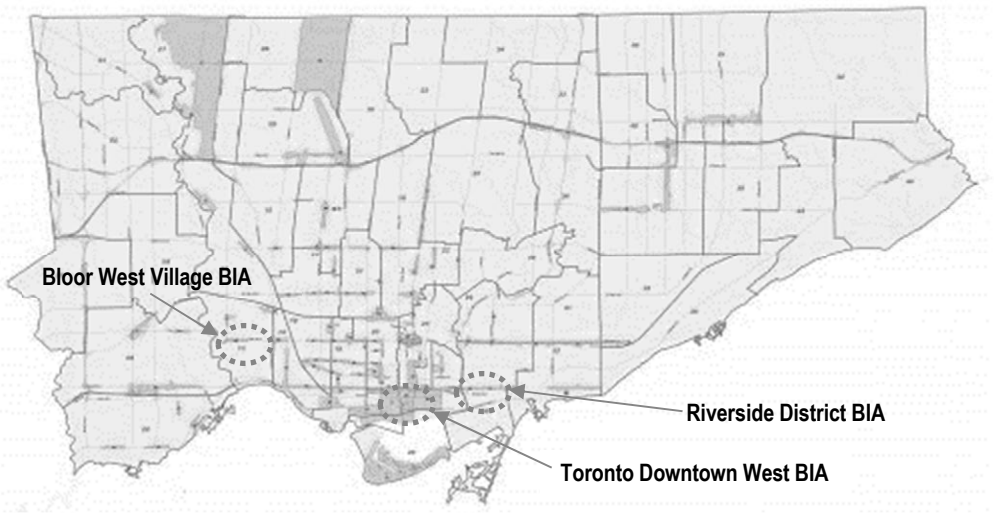
The first BID established was the Bloor West Village Business Improvement Area (BIA) in Toronto in 1970. This BID was initiated by local business owners. Since then, the number of BIDs in Toronto has increased to 83. These areas are shown in Figure 22.1.1. In Toronto, the City Government facilitates the establishment of BIAs and also provides guidance to their operations.

The process for starting a BIA in Toronto is as follows:

- Step 1: Establish a Steering Committee comprised of five or more people which include commercial and/or industrial property owners and business tenants that represent various types of businesses and geographic sections within the area.
- Step 2: Determine community interest within the proposed area.
- Step 3: The City organises and hosts public meeting(s) to determine if there is sufficient interest in creating a BIA. With more than 50% of the participants supporting the BIA, the Steering Committee makes a formal request.
- Step 4: Organise polling and forward a copy of the poll to the property owners and tenants in the BIA area. The City Council will approve a BIA if at least 30% of the ballots (or a minimum of 100, whichever is lower) are returned to the city, and more than 50% of the ballots are in favour of the BIA.

Some of the BIDs in Toronto are as follows:

- Bloor West Village BIA: The BIA presents two major city events of Toronto, which are the Children's Festival and Ukrainian Festival.
- Toronto Downtown West BIA: The BIA was established in 2008. Its mandate is to promote, improve and reserve its area. The BIA has many public art collections and suggests routes as Art Walks. The BIA also organises events to be held in the area.
- Riverside District BIA: The BIA was established in 1980. One of the activities in the BIA is the illumination at night.



Note: Areas in darker colours are the Business Improvement Areas
Source: Toronto City

Figure 22.1.1 Business Improvement Areas in Toronto City

2) Examples of BIDs – UK[1]

The first BID in the UK was Kingston First in London in 2005. There are currently 290 BIDs in the UK.

In the UK, a BID can also be set up by the local government in partnership with local businesses. There is also a loan fund to help communities who wish to create a BID to overcome the initial costs.

The process of starting a BID in the UK is as follows:

- Step 1: Prepare a proposal for BID, which includes the services to be provided, the size and scope of the BID, payer of the levy, the amount of the levy and how it is calculated along with business plan to the local government.
- Step 2: The proposer should notify the local government and the Secretary of State of their intention to a BID proposal to ballot. The ballot will be managed by the local government.
- Step 3: Businesses that are subject to the levy, as set out in the proposals are to take vote in the ballot. The vote is successful if more than 50% voter turnout and more than 50% of the ballots are in favour of the BIA.
- Step 4: Establish the BID company.

In the UK, once the BID is in operation, the levy is charged on all businesses within the BID area regardless of whether or how that business voted in the ballot.

In the UK, tourism BID designed specifically to support the development of tourism at a specific destination also exists as a scheme. The tourism BIDs can be different to the conventional BIDs in the following points:

- The way levy is determined (for example, levy is determined based on the number of customers or sales)
- The way levy payers are defined (for example, only businesses providing certain services or involved in tourism are liable)
- The BID area is likely to be much wider than a conventional BID

(2) Area Management in Japan

1) Purposes and Possible Outcomes of Area Management

The four key purposes considered for conducting Area Management projects are as follows:

- Not Only Develop, but Also Nurture: It is necessary to conduct Area Management that considers not only how to develop (making something) but also how to maintain and operate (management) the community afterwards.
- Initiative by Private Sector: As local problems and solutions to them become more diverse, it is more important for residents, business owners and other community leaders to take the initiative in promoting the project rather than the government.
- Involvement of Various Stakeholders: Area Management should be proceeded by the community as a whole. For this purpose, various ways of involvement by various stakeholders are required. It is also important to involve various related people such as the experts and the government, as necessary.
- Targeting Area: The basic principle of Area Management is to target a certain area. The area is set according to the goals and contents of the activity, the stage of activity, and the level of maturity.

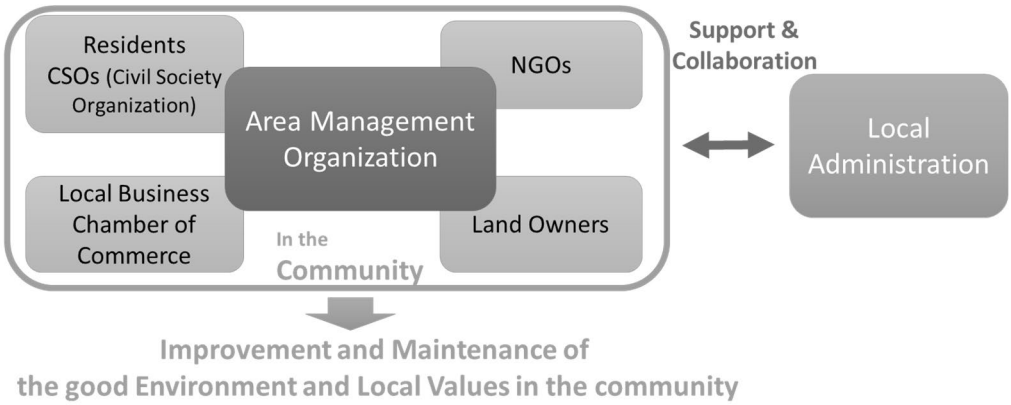
[1] https://www.gov.uk/guidance/business-improvement-districts#how-is-a-business-improvement-district-established

The four possible outcomes of Area Management are as follows:

- Creating a Comfortable Local Environment and Ensuring Its Sustainability: Comfortable and high-quality environment not only for the community people but also for visitors will be created and maintained.
- Enhancement and Maintenance of Local Vitality: For example, increase of visitors to the community, revitalisation of economic activities, decrease in the crime rate, and increase in civic activities.
- Increase and Maintenance of Asset Value: Increase in the asset value of land and buildings in the community by creating beautiful cityscapes and a safe and comfortable environment.
- Increase Attachment to the Community and Community Satisfaction: Community people's increased attachment to the community will raise their awareness of participation in Area Management and enhance their activities, as well as promote settling down and business continuity.

2) Process of Area Management

Area Management usually starts as private initiative led by local stakeholders such as property owners, business operators or local residents to improve specific areas where they own, do businesses or live in. It develops into various activities that area management organisations undertake in partnership with government agencies.



Source: JICA Study Team, based on Ministry of Land, Infrastructure, Transport and Tourism, 2010, Recommendations for Area Management

Figure 22.1.2 Concept of Area Management in Japan

The general process of Area Management project is as follows:

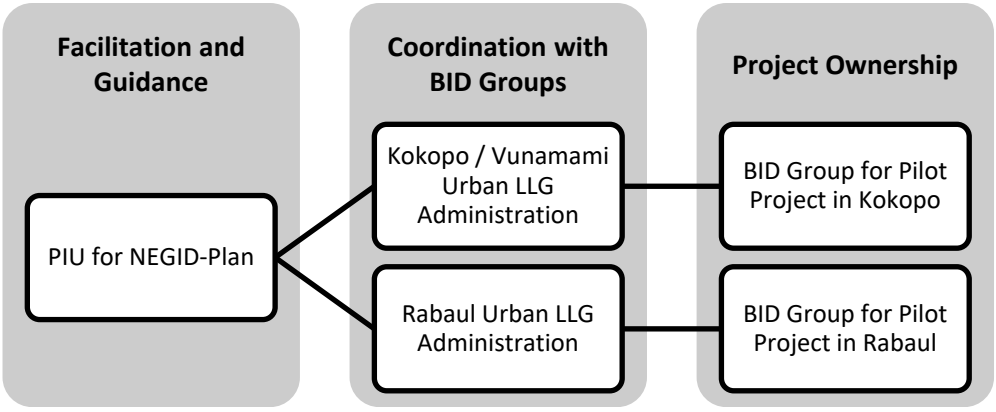
- 1. Finding Issues, Challenges and Needs in the Community: Community people raise the issues and needs in the community that they are used to feel, such as deterioration of living environment, decrease in community safety (increase in crime), necessity for community cleanup (increase in garbage), vulnerability to disasters, and importance to protect natural resources around the community.
- 2. Sharing Issues with Community People and Setting Common Objective of the Project: Meetings are held to share and discuss issues among the community and the objective and direction of the project are considered, and then the objective of the project is shared, and consensus is made.
- 3. Developing Rules, Organisations, and Activities: Specific contents of the project activities are considered. Necessary condition and tools for the implementation of the activities are considered.
- 4. Maturing the Project: Measures to make the project sustainable are considered.

22.1.3 Organisational Structure for Pilot Project Implementation in NEGID-Plan

Based on discussions among PIU members of the NEGID-Plan, it was decided that in representing the provincial administration, the PIU should function to facilitate the implementation of pilot projects in Kokopo City and Rabaul Town. The actual project implementation in Rabaul and Kokopo is to be managed by Rabaul Urban LLG and Kokopo/Vunamami Urban LLG, respectively. The LLG Administrations also selected the target areas (potential BIDs or BIAs).

In the NEGID-Plan Project, the BIDs or BIAs are selected and determined for the implementation of pilot projects by LLGs in Kokopo and Rabaul. BID groups are organised and composed of local business owners, landowners and other local organisations within the areas by the LLG Administration. Members in each group are to have initiatives to provide ideas on projects which are implemented in the NEGID-Plan as a pilot project.

The organisational structure for pilot project implementation in the NEGID-Plan is shown in Figure 22.1.3.



Source: JICA Expert Team

Figure 22.1.3 Organisational Structure of Pilot Projects for Kokopo and Rabaul in NEGID-Plan

22.2 Pilot Project for Kokopo/Vunamami Urban LLG

22.2.1 Pilot Project Ideas for Kokopo/Vunamami Urban LLG

(1) Issues

The following are identified as issues preventing citizens/residents and tourists to utilise public open spaces in Kokopo/Vunamami Urban LLG:

- Insufficient public facilities to enable the utilisation of the open spaces, including the beach in Kokopo City
- Lack of public toilets for tourists and citizens
- No public transport and lack of places for night-time activities, making the town centre of Kokopo City a ghost town after 6:00 p.m.

(2) Objectives

In order to achieve the overall goal described in Section 22.1.1, the objectives to implement a pilot project in Kokopo City are as follows:

- To utilise the existing public open space for the vitalisation of Kokopo City as the capital of the Islands Region and East New Britain Province
- To provide necessary public facilities and services for effective use of open space
- To promote and encourage citizens to enjoy the economic activities in the City

- To improve the attractiveness of Kokopo City for tourists and visitors from outside the City

(3) Proposed Projects

The JICA Expert Team held some meetings with private sectors and Kokopo/Vunamami Urban LLG officers in November 2022 to share ideas on the pilot project for Kokopo City, and to discuss who should have the project's ownership.

Pilot project ideas proposed by the government and private stakeholders in these meetings are shown in Table 22.2.1.

Table 22.2.1 List of Pilot Project Ideas Proposed by Stakeholders for Kokopo City

Project	Location	Necessary Interventions	Purpose
Night Market	Kokopo Market and its surrounding areas	Portable Tables and Chairs, Lights, Power Generator, Grill, Security	To utilise public space for local people and tourists to enjoy at night To provide opportunities for more people to sell and buy foods or goods
Beach Promenade	Public land beside the beach	Beach, Concession Stand	To promote activities at the beach To make the public beach more attractive
Town Library	Tammur Centre	Books, Desks, Chairs, Bookshelves, Wi-Fi	To provide place and opportunity to study and read books especially to kids and students
Children's Playground	Omorong	Gym Equipment, Security, Benches	To provide a safe place to play for children
City Beautification	Kokopo City	Benches and Trash Bins Landscape	To keep public spaces clean To improve road-side landscape
Handcraft Market	Omorong	Public toilets, Hand Washing Taps	To provide places and opportunities for young people to sell handcrafted products

Source: JICA Expert Team based on coordination meetings for Pilot Project for Kokopo City held in November 2022

22.2.2 Night Market

(1) Background

ENBP has been known as one of the safest areas in PNG. Therefore, it is one of the areas in PNG where people can enjoy and relax outside. However, in Kokopo City, except for a few restaurants of tourist hotels, most activities and businesses end before 6 p.m., and there are no economic activities for the residents who would like to go out after work in the evening.

Kokopo Market is situated in the centre of Kokopo Town, and there is an open space adjacent to the Kokopo Market. This is a potential space to be used in the evening for the residents to enjoy the time after school and after work with their families and friends. The market has facilities, such as toilets and water taps, so it can become a place where people can gather and enjoy casual dinner (e.g., BBQ) or have drinks and snacks. Vendors can also sell souvenirs and fresh foods from the local farmers. In addition, this kind of place can be enjoyed by both domestic and international visitors in Kokopo.

To implement this project, it was considered necessary to provide lights for the market, tables and chairs for the visitors, security along the main street in Kokopo Town around the market and ensure that the public motor vehicles (PMV) would be running beyond its usual hours. At the same time, it was also considered that public toilets also should be installed. Improvement of public toilet facilities is effective to make local people, visitors and tourists frequent not only the night market but also the town because Kokopo/Vunamami Urban LLG has no other place with public toilets except in Kokopo Market.

It was suggested that participating companies and other organisations pay a registration fee to procure funds and goods to implement the project. For instance, the registration fee could be used to purchase fuel for generators and allocate security guards around the market. Funding such as a

registration fee or donation by private companies, local people and tourists is necessary to implement and continue to sustainably operate such events. The funds and goods for the project should be managed by an organisation which has the project ownership.



Ebenezer Night Markets



Adelaide's Maker Markets

Source: ForMile Events HP (https://formile.com.au/our-work/ accessed on 11th October 2022)

Figure 22.2.1 Examples of Night Markets (Adelaide, Australia)

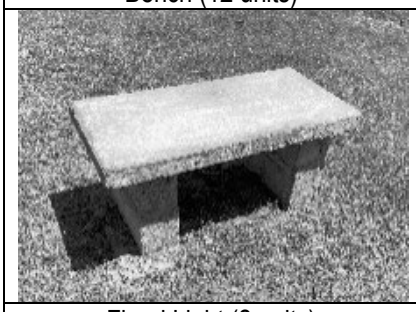
(2) Provision of Facilities for Holding the Night Market

The project site for the Night Market is a public open space next to the Kokopo Market as shown in Figure 22.2.2.



Figure 22.2.2 Site Plan of the Night Market Pilot Project in Kokopo Town

Based on coordination meetings with Kokopo/Vunamami Urban LLG, benches, pedestrian bridges, portable toilets, flood lights and solar lights, as shown in Figure 22.2.3, were installed at the project site as necessary facilities for holding the Night Market with the support of JICA Expert Team for NEGID-Plan. Figure 22.2.2 shows locations of the installed facilities.

Bench (12 units)	Pedestrian Bridge (2 units)	Portable Toilets (2 units)
		
Flood Light (2 units)	**Solar Light (10 units)**	
		

Source: JICA Expert Team

Figure 22.2.3 Installed Facilities for the Pilot Project for Kokopo Town

Installation of these facilities was conducted with the approval of the ENBP Physical Planning Board and ENBP Building Board.

1) Benches

The target site for the Night Market is a place where many people come and go, and where some people sit on the ground to rest. Two public kiosks exist as rest facility at the site, but more rest facilities are needed for people who usually use the open space and eat and drink during the Night Market.

Under this situation, 12 benches were installed as permanent facilities along the pedestrian path of the site. Most of the benches are located under the trees which can give shade.

The installed benches, especially those in the shade in the daytime, have been used daily.

2) Pedestrian Bridges

There is a deep drainage at the site, and it divides the open space. A pedestrian bridge exists over the drainage, but other bridges were required to be constructed to improve the accessibility and utilisation of the open space widely.

Two pedestrian bridges with handrails were constructed as permanent facilities and have been used as convenient and safer path by a lot of residents daily.

3) Portable Toilets

There are only two public toilets in Kokopo City, one at Kokopo Market and the other one at Kokopo Beach Front. Under the situation, to improve public health in Kokopo City, two portable toilets for men and women were installed during the Night Market.

The portable toilets have respective waste tanks and can be used approximately 500 times before the waste needs to be removed. For the Night Market, supplying fresh water and disposing of wastewater were conducted by Kokopo/Vunamami Urban LLG.

Portable toilets can be moved anywhere, so it is expected that they will be utilised for next night market or various events in Kokopo in the future.

4) Lighting

Two types of lights, namely, flood light and solar light, were installed at the site.

Two flood lights were installed on each roof of the existing public kiosks at the site. Electric power for these flood lights has been managed by ENBP Market Authority.

For solar lights, five poles were installed along the drainage and road, and each pole has two solar lights which illuminate different directions.

The flood lights and solar lights are automatically turned on and off depending on the darkness every day. Even though some lights have existed around the site, the illuminated area was partial and there were some risks for residents if they walk there at night. It is expected that the risks will be reduced by the installed lights covering a wider area.

(3) Holding the Night Market

The Night Market was held from 5 p.m. to 9 p.m. on Friday, the 22nd December 2023.

Six groups of vendors set up their stalls with tents, and they sold foods, drinks, clothing, garden plants, handmade products, etc.

For ensuring safety, 10 security guards patrolled around the site during the Night Market.

Besides the Night Market, two other events were held at the site on that day. The one was a market which was organised by ENBP Governor's Office in the daytime. The other was a church event with gospel crusade and musical performance held at the same time with the Night Market.



The Night Market



Stall of the Night Market

Source: JICA Expert Team

Figure 22.2.4 Photos of the Night Market on 22nd December 2023

A questionnaire survey for visitors was conducted during the event to verify the impact of the Night Market. The result of the survey is described in Section 22.2.4.

22.2.3 Organisations for the Pilot Project in Kokopo/Vunamami Urban LLG

(1) Organisation in Charge of Implementation and Operation

Kokopo / Vunamami Urban LLG had taken the lead of the pilot project initially. However, ENBP Governor's Office have took the lead from half way through the preparation of the Night Market because it was difficult for Kokopo / Vunamami Urban LLG to continue manage it due to change of Town Manager.

On the other hand, involvement of the private sector is important as the Night Market is an Area Management project. Chamber of Commerce is the only organisation composed of the business sector in Kokopo, but it works for the whole ENBP. Some members of the Chamber of Commerce with foreign background tend to stay in Kokopo for a few years and leave. Therefore, there was a concern that it would be difficult for such a body to continuously be responsible for maintenance and operation. Under the circumstances, the Night Market Committee was organised as a partnership between government agencies and private sector to manage the Night Market and future events.

(2) Night Market Committee

A Night Market Committee was organised and a meeting was held on the 21st December 2023. The participants of the committee meeting held were Kokopo/Vunamami Urban LLG, ENBP Governor's Office and local vendors.

The following points were discussed and determined in the committee meeting:

- Attendance fee for the Night Market should be free to encourage many vendors to participate.
- Attendance fee will be applied for the next night market.
- Kokopo/Vunamami Urban LLG is to arrange police security in addition to security guards to be arranged by JICA Expert Team
- Local radio can be utilised for advertisement of the Night Market.
- Kokopo/Vunamami Urban LLG is to ask the Market Authority to make announcement of the Night Market.
- Kokopo/Vunamami Urban LLG is to post information on the Night Market on their Facebook.
- This committee should continuously exist to carry out the activities after the Pilot Project for improving night market activities in Kokopo/Vunamami Urban LLG.

22.2.4 Evaluation of the Pilot Project for Kokopo/Vunamami Urban LLG

(1) Objectives

The objectives to evaluate the pilot project for Kokopo are as follows:

- To analyse the sustainability of the Night Market by verifying outcomes and issues of the initiative for making new lively space in manner of the Area Management method and partnership between public and private sectors.
- To propose ideas to make the initiatives effective for Kokopo City

(2) Method

Following questionnaire surveys were conducted for the evaluation.

1) Questionnaire on the Night Market in Kokopo

This questionnaire was administered during the Night Market, from 6 to 9 p.m. on 22nd December 2023. The survey respondents were visitors that included residents and tourists. The purpose of this survey was to verify how the Night Market had impacted the night life of residents and tourists.

The questions are listed in Table 22.2.2.

Table 22.2.2 Content of Questionnaire on the Night Market in Kokopo

No.	Questions
1	Age
2	Sex
3	Place of Residence
4	Who did you come to the Night Market with?
5	How did you come? (Means of Transportation)
6	What is the main purpose of visiting the Night Market?
7	How long will you stay here?
8	Are you enjoying the Night Market?
9	Do you want to come to the Night Market again if there will be any in the future?
10	Do you wish that Night Market would be organised regularly in Kokopo?
11	Do you think Night Market could improve the nightlife of citizens and tourists in Kokopo?
12	Do you think that the Night Market could improve the nightlife all over ENBP in the future?

Source: JICA Expert Team

2) Questionnaire for Vendors at the Night Market

This questionnaire was aimed at vendors at the Night Market. The purpose of this survey was to verify how the Night Market had effects on local business sectors.

The questions are listed in Table 22.2.3.

Table 22.2.3 Content of Questionnaire for Vendors at the Night Market

No.	Questions
1	Age
2	Sex
3	Place of Residence
4	Where do you usually do your business?
5	How often do you open your shop?
6	How did you know the Night Market?
7	What was the main purpose of joining the Night Market?
8	What did you sell at the Night Market?
9	How much was your revenue in the Night Market? (If possible, please answer)
10	Do you want to join the Night Market again if any in the future?
11	What do you think are advantages and disadvantages of Night Market for vendors?
12	Do you wish that Night Market would be organised regularly in Kokopo?
13	Do you think Night Market could improve economies of vendors?
14	What facilities or services do you think are necessary to improve the Night Market?

Source: JICA Expert Team

3) Questionnaire for the Improvement of Open Space in Kokopo Town

This questionnaire was administered on 29th December 2023. The survey respondents were people staying in the project site or those using the constructed facilities. The purpose of this survey was to verify how the constructed facilities contribute to improvement of open space and urban environment in Kokopo.

The questions are listed in Table 22.2.4.

Table 22.2.4 Content of Questionnaire on Improvement of Open Space in Kokopo Town

No.	Questions
1	Age
2	Sex
3	Place of Residence
4	Who did you come to Kokopo Town with?
5	How did you come? (Means of Transportation)
6	What is the main purpose of visiting Kokopo Town?
7	How long will you stay here? / How long have you stayed here?
8	What is the purpose of being here?
9	What kind of public facilities do you think are lacking in Kokopo Town?
10	Which facilities have you found useful?
11	What facilities or activities do you think are necessary in Kokopo Town to improve its urban environment?

Source: JICA Expert Team

4) Questionnaire for the Organisations in Charge of the Project

This questionnaire was aimed at ENBP Governor's office and Kokopo/Vunamami Urban LLG which are organisations in charge of implementation and operation of the Pilot Project. The purpose of this survey was to clarify issues of the organisational structure and take measures for the future.

The questions are listed in Table 22.2.5

Table 22.2.5 Content of Questionnaire for the Organisations in Charge of Pilot Project for Kokopo

No.	Questions
1	What impacts did the Pilot Project (installation of the public facilities (Benches, Pedestrian Bridges, Lightings and Portable Toilet) and holding the Night Market) have on Kokopo City and its urban environment?
2	Were there any challenges in the installation of the public facilities for the Night Market? What were they?
3	Were there any challenges in holding the Night Market? What were they?
4	What do you think are advantages of the organisation structure based on a partnership between government and private sectors for the Pilot Project.
5	Are there any challenges/concerns with the organisation structure for the Pilot Project for the future? What are they?
6	Are there any expected problems in the maintenance of the installed facilities or implementation of Night Markets in the future?
7	What activities do you want to do to improve the urban environment of Kokopo City in the future?

Source: JICA Expert Team

(3) Results of the Questionnaire Surveys

1) Questionnaire on the Night Market in Kokopo

A total of 19 visitors answered the questionnaire on the Night Market. The types of these respondents are shown in the Table 22.2.6.

Table 22.2.6 Types of Respondents to the Questionnaire on Night Market

Sex/Age Group	Under 19	20~29	30~39	40~49	50~59	Over 60	Total
Male	3	5	3	0	3	0	14
Female	1	1	0	2	1	0	5
Total	4	6	3	2	4	0	19

Source: JICA Expert Team

The respondents were citizens of various ages from under 19 to 50s.

Main results of the questionnaire surveys are as follows:

- 84% of respondents came to the Night Market with their families or relatives.
- 84% of respondents answered that they were enjoying the Night Market. They came because they could buy various handmade products and so that they could be with their family.
- On the other hand, 16% of respondents did not enjoy the Night Market. The main reasons were the number of vendors and variety of products were less than they expected.
- 95% of respondents answered that they wanted to come to the Night Market again if any would be held in the future. Specific reasons were that it was a fun activity and a good way to support local SMEs.
- All of the respondents wished that Night Market would be organised regularly in Kokopo. Specifically, 79% of respondents answered that they would prefer it to be a monthly activity.
- 74% of respondents agreed that Night Market could improve the nightlife of citizens and tourists in Kokopo. Specific reason was that people who were busy during the day could come to the Night Market.
- On the other hand, 26% of respondents did not agree to the holding of Night Market. Three of the respondents were concerned about safety.
- 63% of respondents agreed that the Night Market could improve the nightlife all over the ENBP in the future. Specific reasons were that Night Market could encourage community involvement from all of ENBP and that improvement of economy of vendors would improve

quality of their products.

2) Questionnaire for Vendors at the Night Market

Main results of the questionnaire survey are as follows:

- Some vendors earned more than 300 Kina at the Night Market.
- Some vendors want to join Night Market again not only for business, but also for making new friends.
- Night Market is good opportunity to make extra money.
- Earlier public relations are necessary for vendors to prepare their goods.
- They wish that Night Market would be organised fortnightly or monthly in Kokopo.
- Transport to the venue is a problem for vendors.
- They have concerns about securing law and order.

3) Questionnaire on Improvement of Open Space in Kokopo Town

A total of 20 citizens staying in the open space where the facilities were installed answered the questionnaire on improvement of open space in Kokopo Town. The types of respondents are shown in Table 22.2.7.

Table 22.2.7 Types of the Respondents to the Questionnaire on Improvement of Open Space in Kokopo Town

Sex/Age Group	Under 19	20~29	30~39	40~49	50~59	Over 60	Total
Male	0	7	4	3	2	1	17
Female	0	0	0	1	2	0	3
Total	0	7	4	4	4	1	20

Source: JICA Expert Team

Main results of the questionnaire survey are as follows:

- Major purposes of being at the open space were to rest (35% of respondents), to meet someone (20%) and to wait for PMV (10%).
- As the lacking public facilities in Kokopo Town, benches (70%), public toilets (55%), garbage bins (50%), streetlights (50%) and foot paths (45%) were mainly selected for the Night Market.
- Among the installed facilities in the Pilot Project, 70% of the respondent rated the benches, 70% rated the streetlights, and also 70% rated the pedestrian bridges as useful facilities.
- To improve urban environment in Kokopo Town, rest facilities (70%), garbage bins (55%), car parking (55%), public toilets (50%) and footpaths (45%) were mainly required.

4) Questionnaire for the Organisational Structure of the Project

Main results of the questionnaire survey are as follows:

- Public relations were challenge in holding the Night Market.
- Organisational structure based on a public-private partnership worked well for public sector.
- They have concerns that more lighting is needed for future Night Markets.
- They are interested in installation of better facilities for SME as a future project to further improve the urban environment of Kokopo City.

(4) Evaluation Results

- Six groups of vendors joined the Night Market and sold various goods. Most of the visitors enjoyed having dinner and spending time with their families or relatives, whereas some visitors pointed out that more vendors and various foods were necessary for them to sufficiently enjoy the Night Market.

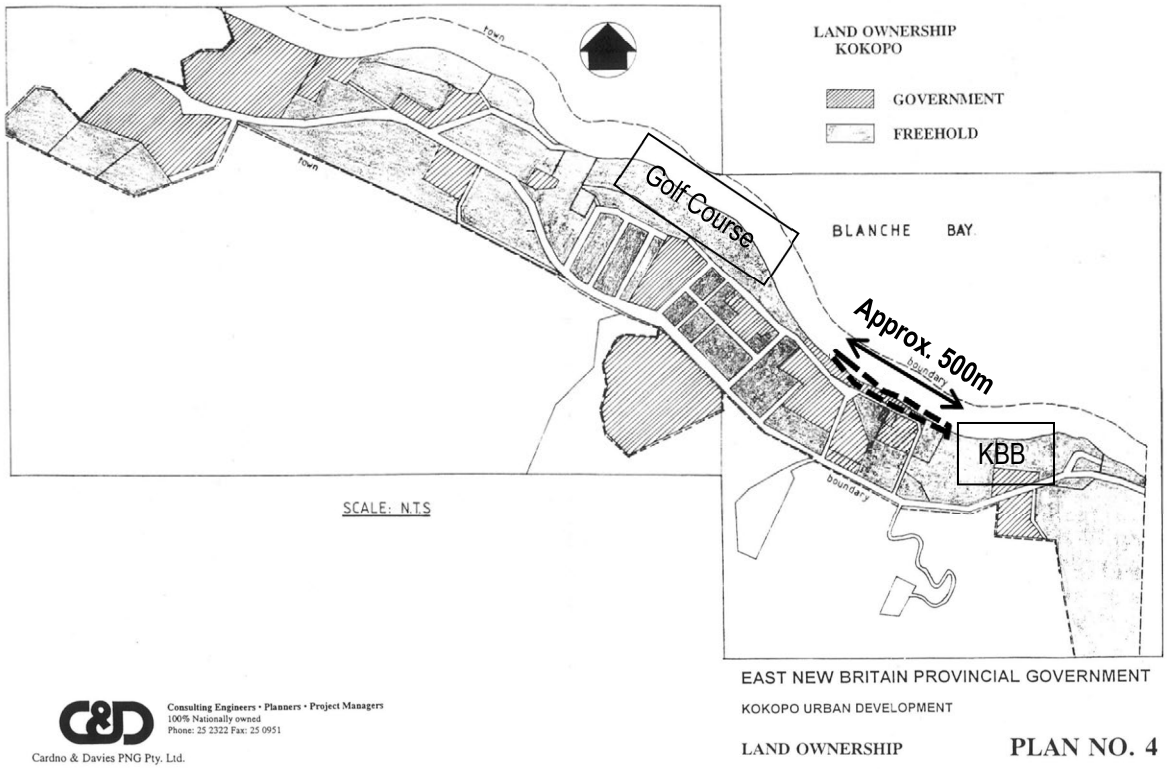
- More vibrant atmosphere was created by holding the Night Market with other events which attracted many citizens. In this regard, the project site can be considered as suitable open space for Night Market since it has enough space to have some events simultaneously.
- The Night Market is useful for citizens who have no time to come to markets to buy daily necessities and enjoy their time.
- Some visitors rated the Night Market as a good initiative for supporting SMEs or encouraging community development.
- There were many positive opinions to have night market regularly in the future. Most of the visitors wished that the Night Market would become a monthly event in Kokopo Town.
- On the other hand, ensuring safety during Night Market is a concern for visitors and vendors.
- Providing transportation at night is a challenge for making Night Market more attractive for visitors and vendors.
- Night Market could be a good initiative to improve urban environment of the town through development of necessary facilities, to promote local economies and to develop local community.
- Benches, lights, and pedestrian bridges installed as permanent facilities contributed to improving convenience and safety not only during the Night Market, but also to the daily life of the citizen and visitors of Kokopo Town.
- Garbage bins, car parking, and public toilets are required to be installed in Kokopo Town to improve its urban environment.

22.2.5 Other Ideas for Pilot Projects in Kokopo/Vunamami Urban LLG

(1) Beach Promenade

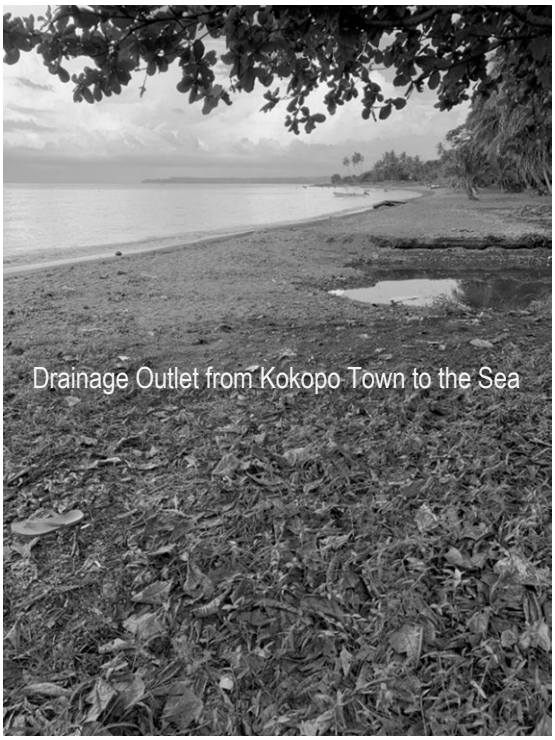
Kokopo Town has a good location that faces the beach. But most of the beachfront is privately owned and the residents are not able to fully enjoy the beachfront areas. However, there is a section located along the beach between Kokopo Beach Bungalow Resort and the golf course owned by the government. The length of this beach section is approximately 500 m. However, in this beach section, there is a drainage outlet to the sea from Kokopo Town. See Figure 22.2.5 and Figure 22.2.6.

Boats plying the islands of Kokopo District use this beach as a boat stop. That means, this beach is also a gateway for the people visiting Kokopo Town or Gazelle Peninsula in East New Britain Province.

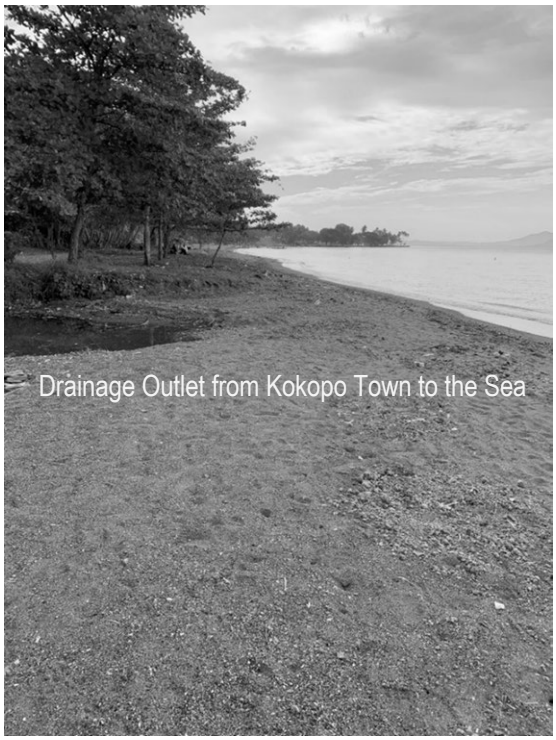


Source: East New Britain Provincial Government, 1995, Kokopo Urban Development Plan Final Report

Figure 22.2.5 Land Ownership of Beachfront Areas in Kokopo City



Direction: Golf Course to Kokopo Beach Bungalow



Direction: Kokopo Beach Bungalow to Golf Course

Source: JICA Expert Team

Figure 22.2.6 Government-Owned Beach at Kokopo City

A beach promenade is a pedestrian path implemented on many famous beaches around the world. It provides a long, open area next to a river or large water body where people can walk. The promenade often has small shops or vendors where people can buy drinks, snacks, etc., and enjoy the view and atmosphere.



Source: Ryde District Mums HP (https://rydedistrictmums.com.au/develop/wp-content/uploads/2021/09/Screen-Shot-2021-09-23-at-3.20.33-pm.png)

Beach Promenade at Parramatta River, Australia



Source: Nagasaki Visitor's Guide HP (https://www.ikikankou.com/storage/tourism_attractions/10101/responsive_images/yhIGCGHdiDlTJ7BT9nWs7hIwmWGrnpGEr2av5YYS__1400_933.jpeg)

Beach at Iki Island, Japan

Figure 22.2.7 Beach Promenades with Stairs

To implement this project, it is necessary to access the beach from the road by stairs. The stairs can be used as benches as well. Frequent cleaning of rubbish flowing into the beach through the drainage should also be conducted.

22.3 Pilot Project for Rabaul Urban LLG

22.3.1 Pilot Project Ideas for Rabaul Urban LLG

(1) Issues

The following are identified as issues preventing citizens/residents and tourists from to utilise public open spaces in Rabaul Urban LLG:

- No public transport connecting the town centre to tourist spots
- Lack of rest places and public toilets for tourists and citizens
- Existence of unused and unavailable spaces after the volcanic eruption in 1994

(2) Objectives

In order to achieve the overall goal described in Section 22.1.1, the objectives to implement a pilot project in Rabaul Town are identified as follows:

- To utilise the existing public open space and unused space for the revitalisation of Rabaul Town
- To provide necessary public facilities and services for effective use of open space in Rabaul Town
- To improve the attractiveness of Rabaul Town for cruise ship tourists from overseas, as well as residents, by improving the urban environment including open space and streets in Rabaul Town

(3) Proposed Projects

The JICA Expert Team held some meetings with private sectors and Rabaul Urban LLG in November 2022 to collect pilot project ideas for Rabaul Town and to discuss who should have the project's ownership.

Pilot project ideas proposed by the local government and private stakeholders in these meetings are shown in Table 22.3.1.

Table 22.3.1 List of Pilot Project Ideas Proposed by Stakeholders for Rabaul Town

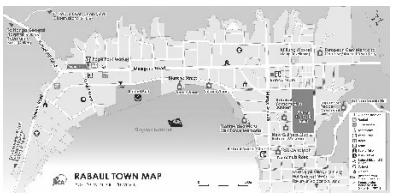
Project	Location	Necessary Interventions	Purpose of the Project
Revitalisation of Queen Elizabeth Park	Queen Elizabeth Park	Gym Equipment, Benches, Shades, Public Toilet	To utilise the open space of Queen Elizabeth Park To provide space for tourists and local people to enjoy and rest
Bicycle Rental	Rabaul Town	Bicycles, Security System, Basic Equipment for Maintenance	To improve mobility of tourists and local people around Rabaul Town
Boat for Cruise Ship Tourists	Rabaul Port - Yacht Club	Boats	To improve access between Rabaul Port and tourism attraction areas
Waterfront Walkway	Waterfront	Footpath	To improve access between Rabaul Port and tourism attraction areas To create new attractive places for Rabaul Town
City Beautification	Rabaul Town	Benches, Trash Bins, Landscape	To keep public space clean To improve road-side landscape
Botanical Garden	Public Open Space	Plants, Gardening Materials	To promote urban greening To provide well-being for local people To vitalise local community
Swimming Pool	Rabaul Yacht Club	Pool	To provide recreational activities
Signboards	Rabaul Town	Signboards	To guide to tourist attraction sites by installing signboards for tourists To improve tourism-related services

Source: JICA Expert Team, basd on coordination meetings for Pilot Projects for Rabaul Town held in November 2022

22.3.2 Provision of Street Furniture

Rabaul Town is a tourist destination but public amenities, such as benches for tourists and citizens, are insufficient. As a result of coordination meetings with Rabaul Urban LLG and Rabaul Community and Business Council, a private organisation based in Rabaul Town, benches, public kiosks (pergolas with seats) and signboard, as shown in Table 22.3.2, were installed at public open spaces and sidewalks to improve public amenities and urban environment in Rabaul Town. Figure 22.3.1 shows locations of the installed facilities.

Table 22.3.2 Installed Facilities for the Pilot Project at Rabaul Town

Benches (9 units)	Public Kiosks (3 units)	Signboard (1 unit)
		



Source: JICA Expert Team

Figure 22.3.1 Locations of the Installed Facilities in Rabaul Town

Installation of these facilities was conducted with the approval of the ENBP Physical Planning Board and ENBP Building Board.

(1) Benches

Nine benches were installed on Malaguna Road and around Rabaul Port where residents and tourists usually take a walk. The benches were put under some trees which can provide shade at daytime.

(2) Public Kiosks

The eastern area of the town is where various tourist attractions are located, such as Tavurvur Volcano and war relics. A lot of tourists walk around to visit these tourist attractions, but the rest facilities in the area are not enough.

Under this situation, three public kiosks which can seat around ten people each were installed at public open spaces on Malaguna Road in the eastern area of the town.

Rabaul Urban LLG plans to revitalise a market at the old market site in the future. Therefore, it is expected that the public kiosks will be utilised much more when this happens.

(3) Signboard

One Signboard showing a town map and tourist information was installed at the Rabaul Market. This is a place where a lot of citizens and most tourists visit, so it was selected as the best installation location of the signboard.

The size of the map is 1,200 mm wide and 600 mm high. It was designed as shown in Figure 22.3.2.



Source：JICA Expert Team

Figure 22.3.2 Map Shown on the Signboard Installed at the Rabaul Market

22.3.3 Organisations for the Pilot Project in Rabaul Urban LLG

(1) Organisations in Charge of Implementation and Operation

Rabaul Urban LLG and Rabaul Community and Business Council have taken the lead for the Pilot Project in Rabaul. They had been responsible for planning and implementing the Pilot Project and maintaining the installed facilities.

It is expected that both organisations will continue to take the lead together to implement more projects for the revitalisation of Rabaul Town.

22.3.4 Evaluation of the Pilot Project for Rabaul Urban LLG

(1) Objectives

The objectives in evaluating the pilot project for Rabaul are as follows:

- To analyse the perspective of tourism promotion in a manner of the Area Management by verifying outcomes and issues of the pilot project
- To propose ideas to make the initiatives effective for Rabaul Town

(2) Method

Following questionnaire surveys are conducted for the evaluation of the pilot project.

1) Questionnaire on the Public Facilities

This questionnaire was conducted on 19th February 2024 when the cruise ship arrived at Rabaul Port. The target of the questionnaire is to both the visitors and the citizens of Rabaul Town. The purpose of this survey was to verify how the constructed facilities contribute to improvement of open space and urban environment in Rabaul Town.

The questions are listed in Table 22.3.3.

Table 22.3.3 Content of Questionnaire on Improvement of Open Space in Rabaul Town

No.	Questions
1	Age
2	Sex
3	Cruise Ship Tourist or Other Visitor or Residents of ENBP?
4	Place of Residence
5	Who did you come to Rabaul Town with?
6	What is the main purpose of visiting Kokopo Town?
7	What do you think are the good points or bad points of Rabaul as a tourist destination?
8	Do you want to come back to visit Rabaul again?
9	Which facilities (street furniture) have you used? What is the purpose for using them?
10	Which facilities (street furniture) are useful for you?
11	What facilities (street furniture) do you think are necessary in Rabaul Town to improve as a tourist destination?

Source: JICA Expert Team

2) Questionnaire on the Organisation Structure of the Project

This questionnaire was aimed at Rabaul Urban LLG and Rabaul Community and Business Council which are organisations in charge of implementation and operation of the Pilot Project. The purpose of this survey was to clarify issues of the organisational structure and take measures for the future.

The questions are listed in Table 22.3.4.

Table 22.3.4 Content of Questionnaire on the Organisational Structure for Rabaul Town

No.	Questions
1	What impacts did the Pilot Project (installation of the street furniture (Benches, Public Kiosks and Signboard)) have on Rabaul Town and its urban environment?
2	Were there any challenges in the installation of street furniture? What were they?
3	What do you think are advantages of the organisation structure based on a partnership between government and private sectors for implementing the Pilot Project.
4	Are there any challenges/concerns with the organisation structure for the Pilot Project for the future? What are they?
5	Are there any expected problems in the maintenance of the installed facilities or implementation of future initiatives?
6	What activities do you want to do to improve the urban environment of Rabaul Town in the future?

Source: JICA Expert Team

(3) Result of the Questionnaire Surveys

1) Questionnaire on the Public Facilities

Unfortunately, there was heavy rain on 19th February 2024, and it was not possible to hear from the cruise ship tourists who used the implemented facilities.

However, it was observed that some tourist guides were utilising the public kiosk to avoid the rain.

2) Questionnaire on the Organisation Structure of the Project

Main findings from the questionnaire survey are as follows:

- There were challenges on communication with contractor for the facilities.
- There is concern that materials of installed facilities could be stolen.

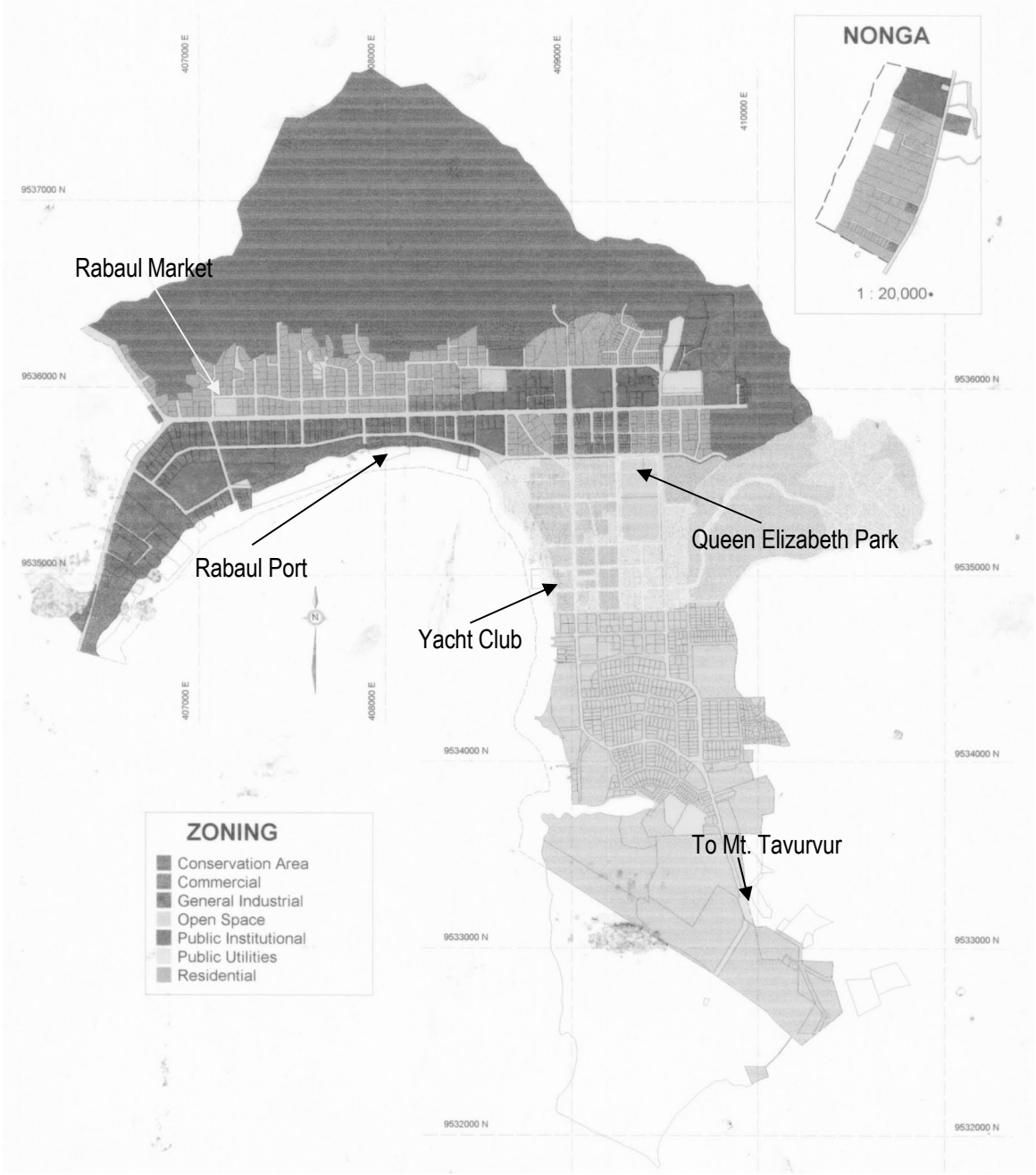
22.3.5 Other Pilot Project Ideas for Rabaul Urban LLG

1) Revitalisation of Queen Elizabeth Park

One of the pilot projects for Rabaul Town is to provide benches, shades, public toilets, free Wi-Fi, etc. at Queen Elizabeth Park for both international tourists and local residents.

Since the eastern part of Rabaul Town (Rabaul downtown) was severely damaged by the 1994 volcanic eruption, it was determined by international development partners not to restore the area. Rabaul Market, which used to be located in the eastern part of Rabaul Town, has shifted its location to the corner of Malaguna Road and Bates Street. The business centre of Rabaul Town has also shifted to the west of the town. As a result, after 28 years after the eruption, the eastern part of Rabaul Town is still quiet. However, the tourism attractions of Rabaul (such as Rabaul Museum, Yamamoto Banker and Japanese Aircraft Wrecks, and Rabaul Hotel) are in the eastern part of the town, approximately 1.5-2.0 km from Rabaul Port. Approximately 2 km to the south is the volcano and the hot spring, which are also popular tourist attractions.

In the last decade until COVID-19 pandemic, Rabaul had received international cruise ships with over 1,000 passengers per cruise ship. (The international cruise ships from Australia recommenced their operation in October 2022.) Cruise ship passengers would stay in Rabaul for about 8 hours (half day) until travelling to the next destination. Around half of the passengers would go sightseeing on tour buses (micro bus), and the rest of the passengers would walk around the town. However, Rabaul Town lacks facilities, such as public toilets, benches, shades, and public transport, for such international visitors. Therefore, some of the cruise ship passengers walk around tourist attractions for approximately 10 km under the sun’s heat.



Source: Rabaul Urban Development Plan Steering Committee, 1996 Rabaul Interim Urban Plan

Figure 22.3.3 Zoning Plan of Rabaul Town and Major Locations

Queen Elizabeth Park is situated between Rabaul Port and Mt. Tavurvur. With Rabaul Hotel and Rabaul Museum, this part of the town is already the centre of tourism on the day cruise ship arrives, but there is no public space for the visitors to enjoy and rest besides Rabaul Hotel. By providing benches, shades, public toilets, free Wi-Fi, etc. at Queen Elizabeth Park, this place will not only be a place for tourists, but also can become a rest place for local residents and trigger the revitalisation of the eastern area of Rabaul Town.



Source: Matsudo City
(https://www.city.matsudo.chiba.jp/shisetsu-guide/kouen_ryokuka/top/shisetuannnai/hikagespot.images/desk1.JPG)



Source: Matsudo City
(https://www.city.matsudo.chiba.jp/shisetsu-guide/kouen_ryokuka/top/shisetuannnai/hikagespot.images/hikage2.JPG)

Figure 22.3.4 Rest Places with Shade and Benches

2) New Mode of Transportation

As explained above, around half of the tourists visiting Rabaul by cruise ship walk around the town during their stay. However, the climate at Rabaul usually has prevailing temperature of over 30°C during daytime all year through, and it is also necessary to walk over 10 km to visit all the tourist attractions within Rabaul Town. Therefore, a new mode of transport can be introduced and operated in Rabaul Town.

One idea is to provide bicycles that can be rented at the Yacht Club or Rabaul Hotel. The second idea is to have a new mode of transportation: a boat connecting Rabaul Port and the Yacht Club. By taking a boat trip directly from Rabaul Port to the Yacht Club, around which Rabaul Museum and Yamamoto Bunker are located, the visitors can directly access the centre of tourism at Rabaul Town

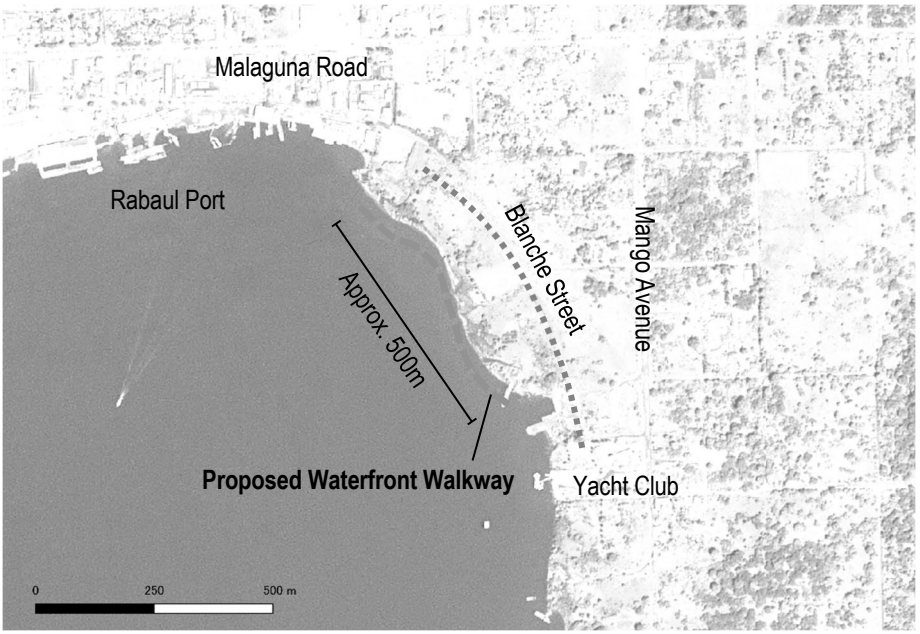
Local residents are not familiar with bicycles in Northeast Gazelle Peninsula. Their introduction can provide business opportunities for local residents and they will become familiar with a new mode of transportation as well.

3) Waterfront Walkway

Before the volcano eruption in 1994, Blanche Street was one of the important roads connecting Rabaul Port with the southeast area of Rabaul where many tourist attractions are located. There was also a waterfront footpath along the seaside. However, both Blanche Street and the waterfront footpath are no longer usable since they were used ash deposit sites during the reconstruction of Rabaul Town.

The implementation of the waterfront walkway is proposed for the section shown in Figure 22.3.5, by constructing a footpath along the seaside for accessing the tourist areas. It is suggested that the waterfront walkway should have enough width for a group of people to walk safely on because cruise ship tourists usually move around in a group of four or five people.

The waterfront walkway is expected to contribute in vitalising activities in Rabaul by providing a convenient access not only for tourists but also for local people.



Source: JICA Expert Team

Figure 22.3.5 Target Site of Proposed Waterfront Walkway



Source: JICA Expert Team

Figure 22.3.6 Seaside Promenade at Nagisa Lava Seaside Promenade, Japan



Source: JICA ExpertTeam

Figure 22.3.7 Waterfront Area in Rabaul

22.4 Recommendations

In both Kokopo and Rabaul, the pilot projects implemented have contributed to the initial step to achieve the overall goal "To provide a lively space and vibrant atmosphere which can be enjoyed by both residents and tourists." Thus, it is necessary in both Kokopo and Rabaul to sustain these initiatives to improve the attractiveness and amenity of their open space and streets through the collaboration of public and private sectors. Furthermore, such initiatives can be implemented in other areas of ENBP with the same overall goal.

Based on the evaluation findings of the pilot projects, the following points are recommended.

(1) Kokopo Pilot Project for Organising a Night Market

Although the night market has been accepted by the vendors and visitors as a good initiative for improving the urban environment, local economies, and communities, there are challenges in continuing it.

For making the night market a regular event, the provision of substantial security and transportation services until the event is finished is important for both vendors and visitors so that participants will have a sense of security. During the pilot project, a private company's security guards were hired with the support of the JICA project. For the LLG to secure financial resources for security, considering that the source of this resource is expected to come from the participation fee of the vendors, the number of vendors participating in the night market is crucial. Also, for the PMVs to operate during nighttime, sufficient number of passengers is also important. Therefore, wider and earlier public relations are required to attract more visitors and vendors.

In the future, Kokopo/Vunamami Urban LLG expects to expand the night market by holding the event at various public open spaces in the LLG regularly. For the sustainable implementation of the night market, further improvement of public facilities, especially streetlights, garbage bins, car parking, and public toilets are important to continue attract visitors and vendors. In order to implement such facilities, it is necessary for Kokopo/Vunamami Urban LLG, Kokopo District and ENBP to discuss and consider how to collect or allocate the budget for such additional facilities.

In addition, increasing the members of the Night Market Committee including the Chamber of Commerce, major business operators in Kokopo and PMV operators is important to continue improving the event. Through the meetings with the committee members, priority projects for improving the event could be identified and, collaboration with the private sector can also be expected.

It is also recommended that various LLG officers (such as those in business development, culture and tourism officer, community officer, and civil works engineer) should establish a team in the LLG to be the main implementation body of the night market and work together for its sustainable operation.

(2) Rabaul Pilot Project for Installing Street Furniture and Open Space Furniture

In Rabaul, benches and public kiosks are highly needed not only for the tourists but also for the residents. At the same time, the local people are eager to revitalise the eastern area of the town which used to be the commercial centre of Rabaul before the volcanic eruption in 1994.

In the discussions for selecting the pilot project for Rabaul, various ideas to improve its urban environment and promote tourism were listed and shared among the local government and private sector. Rabaul Urban LLG and Rabaul Community and Business Council (RCBC) should continue the collaboration for the maintenance of the facilities installed through this pilot project, and further implementation of other facilities. The roles and responsibilities of each organisation should be determined for the future activities based on the experience of the implementation process of the pilot project. In addition, regular meetings should be held between the Rabaul Urban LLG and RCBC.

Regarding the budget for the implementation of facilities for tourists and visitors, revenue collection method should also be considered.

PART XI

CONCLUSION AND RECOMMENDATION

Chapter 23 Conclusions and Recommendations

23.1 Conclusions

(1) Formulation of Infrastructure Development Plan taking into consideration Regional Development Perspectives that are based on characteristics of the region

In the Northeast Gazelle Peninsula, infrastructure development planning revealed the need to reorganise the regional spatial structure over the very long term by clarifying the direction of the region's economic sector development and measures to improve its disaster resilience. Various infrastructure development strategies were identified to support the reorganisation of the regional spatial structure, and a phased development plan was formulated.

In the Northeast Gazelle Peninsula, to work on improving disaster resilience from volcanic eruptions, it was necessary to consider a super-long-term perspective (beyond 25 to 30 years) for the formulation of a 10-year infrastructure development plan.

Given that the population and regional economy in the Northeast Gazelle Peninsula are not very large, the demand for infrastructure is not high enough. For this reason, it is not financially or economically feasible to make the regional spatial structure disaster resilient in the short or medium term. Therefore, the following two-stage development scenario is planned for economic sector development, strengthening disaster resilience, and infrastructure development.

First, in the short and medium terms, measures will be taken to expand the production of existing export-oriented agricultural, forestry, and fishery products. Regarding infrastructure, measures will be taken to rehabilitate and upgrade port and road functions. To improve disaster resilience, measures will be taken to make each infrastructure more disaster resistant.

In the medium term, while continuing the above measures, some industries will also work on diversifying into high-value-added manufacturing and international tourism. For realising such high-value-added economic activities, it is necessary to focus on developing urban infrastructure while establishing the SEZs.

In the long and super-long terms, as the population and regional economy grow, it will be possible to reorganise the regional spatial structure and transfer port and production functions, and develop infrastructure to make the region more disaster resilient.

(2) Formulation of a 10-Year Infrastructure Development Plan

Important projects for each infrastructure sector that correspond to the short and medium-term scenarios above were prepared, and among them the high-priority and priority projects were selected. Eleven high-priority infrastructure projects are to be implemented over the next eight years (by 2032 in line with the target year of PNG's medium-term plan).

(3) Relocation of the functions of Rabaul Port: with comprehensive considerations, not only industrial development and disaster hazards but also environmental perspectives

When considering the location of the new port, which will have an impact on the future spatial structure, a preliminary survey of the marine environment was carried out to investigate the natural environment like flora and fauna that inhabit Kokopo and Ataliklikun Bay. Also, the possibility of changes to the marine environment and the possible impact on the tourism industry due to the

proposed location of the port in Kokopo was also taken into consideration since several resort hotels are currently located in Kokopo.

(4) Budget Planning

ENBPA had formulated long-term plans in the past with large number of projects, but the prioritisation of projects and the steps for implementation are not indicated.

In the NEGID-Plan, 11 high-priority projects were selected to secure budgets for important infrastructure development. The importance of these 11 high-priority projects was explained through the development scenario for the entire region. Coordination was also carried out at an early stage with each central government departments and infrastructure state companies, including the Department of National Planning and Monitoring, to secure funds for feasibility studies and project implementation. These 11 high-priority projects are to be included in the national plans and each sector plan, making it possible to secure certain funding.

(5) Capacity Development

Through TWG meetings, Joint TWG meetings, and SC meetings held at each stage of the plan formulation process, the coordination capacity was strengthened by utilising the forum of the meetings for coordination among stakeholders within the province, and between ENBPA and each sector agency at the central government.

In addition, a PIU was established within the ENBPA, and core members were selected among the PIU members. Through continuing meetings, understanding of each stage of the plan formulation was deepened.

(6) Pre-Feasibility Study

The pre-feasibility study was carried out on the "Kokopo-Rabaul Coastal Road Strengthening Project," with the aim of reducing the risk of landslides and improving transportation functions in line with the short- and medium-term scenarios mentioned above.

23.2 Recommendations

(1) Importance of Formulation of Regional Plans Targeting Part of a Province

The Government of PNG should pay attention on formulating regional development plans and infrastructure development plans targeting "parts of the province" with high development potential, such as the Northeast Gazelle Peninsula, in addition to provincial development plans that cover the entire province. Provincial development plans, tend to be generic as they follow the national government template as medium-term development plans for the need to treat all sectors equally. In contrast, regional development plans targeting specific regions are more likely to be plans that address specific challenges and specific potentials without being bound by given templates.

(2) Characteristics, Logics and Strategies of Provinces and Districts

To achieve sustainable regional development, it is important for national-level planning agencies to listen and understand the regional logic and strategies of the provincial and district-level governments. On the other hand, alongside that, provincial and district-level governments should seek ways to align with national-level policies and priorities while respecting the local characteristics and logics in the province.

(3) Continuing Dialogues Between the National and Local Governments

To promote sustainable development through the implementation of high-priority projects selected through the formulation of this plan, dialogue between the East New Britain Provincial

Administration (ENBPA) and the Department of National Planning and Monitoring (DNPM) should continue. Through this dialogue, it is necessary to aim to achieve the following points:

- To proceed with the process to officially approve the 11 high-priority projects by the National Executive Council (NEC).
- To ensure that the 11 high-priority projects are incorporated in the sector medium-term development plans formulated by the relevant organisations at the national level.
- To obtain the necessary national budget or international development partners' support to conduct full-scale feasibility study or pre-feasibility studies for all high-priority projects.
- To continue efforts to obtain national budget and international development partners' support for implementing the 11 high-priority projects.

APPENDICES

Appendix A Project's Activities

A.1 Progress Made in Phase 1

The Phase 1 period was from the commencement of the Project (December 2020) until the submission of the Progress Report (October 2022). Due to the COVID-19 pandemic, all activities were done remotely until January 2022.

A.1.1 Project Launch

(1) Kick-Off Meeting

The JICA Expert Team held an online kick-off meeting with the Deputy Provincial Administrator (DPA) of ENBP on 15th December 2020 to explain and discuss the overall schedule, steps for start-up of the Project by remote work and the organisational structure of the Project.

The meeting had the following objectives:

- To make a "kick-off" to confirm the start of the Project among the main counterpart organisations, the ENBPA, JICA HQ, JICA PNG Office and the consultant team (JICA Expert Team).
- To inform the ENBPA about the selected consultant team by JICA
- To have discussions and adjustments necessary for the start of the Project

The DPA and JICA Expert Team had agreed upon on the following during the kick-off meeting:

- To organise a Joint Technical Working Group by combining the five TWGs to explain and have discussion on the Inception Report, Progress Report, Interim Report and Draft Final Report
- To add observers from ENBP in the Steering Committee
- To have an online meeting to brief the Provincial Administrator (PA) on the overall project schedule
- The main counterpart members will be appointed by the DPA in order to conduct project activities.
- Tentative dates were set for the holding of the First Steering Committee Meeting and the First Joint TWG Meeting.

(2) The First Steering Committee Meeting

On the 10th February 2021, the First Steering Committee (SC) Meeting was held for the purpose of officially starting the JICA Project together with the Steering Committee organised for the Project. The meeting was held online connecting ENBP, Port Moresby and Tokyo.

In the meeting, the Inception Report was presented and discussed by the members of the SC for the Project.

In the course of discussions held at the First SC Meeting, the focal persons in each organisation at the central level were appointed.

(3) The First Joint Technical Working Group Meeting

The First Joint Technical Working Group (TWG) Meeting was held online on the 17th March 2021 connecting ENBP, Port Moresby and Tokyo.

Some of the major points discussed in the meeting are as follows:

- To take in consideration of the possibility of developing geothermal power in the study
- To take in consideration of not only major industries but also urban and rural based SMEs
- To include National Airports Corporation (NAC) as a member of TWG for Port.
- PNG Ports has recently completed a detailed infrastructure master plan for Rabaul Port. A separate meeting between PNG Ports and JICA Expert Team is to be held to discuss this matter.
- The World Bank (WB) is conducting a programme for the water supply sector in Kerevat.
- There was a transfer of power, done by the Deputy Prime Minister recently, to transfer the power of planning and management of roads from Department of Works (DOW) to the provincial administration and the district administrations.

(4) Establishment of Project Implementation Unit

A Project Implementation Unit (PIU) was established as the project implementation body of ENBPA for this Project. Core members were also selected among the PIU members as the main actors. The list of PIU members as of now are shown in Table A.1.1.

Table A.1.1 PIU Members

No.	Organisation	Position
1	ENBPA	Deputy Provincial Administrator – Socioeconomic Services
2	Division of Policy, Planning and Research, ENBPA	Advisor
3	Division of Policy, Planning and Research, ENBPA	Provincial Planner
4	Division of Policy, Planning and Research, ENBPA	Programme Officer (Infrastructure)
5	Division of Lands and Physical Planning, ENBPA	Advisor
6	Division of Lands and Physical Planning, ENBPA	Physical Planner
7	Division of Lands and Physical Planning, ENBPA	Technical Officer
8	Division of Infrastructure Development, ENBPA	Advisor
9	Division of Infrastructure Development, ENBPA	Civil Engineer
10	Natural Resources Management and Development Unit, ENBPA	Coordinator
11	Division of Community Development , ENBPA	Advisor
12	Division of Disaster and Emergency Services, ENBPA	Director
13	Kokopo District Administration	District Administrator
14	Kokopo District Administration	Civil Engineer
15	Rabaul District Administration	District Administrator
16	Rabaul District Administration	Civil Engineer
17	Gazelle District Administrator	District Administrator
18	Gazelle District Administrator	Civil Engineer
19	Kokopo City	Civil Works Engineer
20	Department of Works ENBP Office	Works Manager
21	Department of Lands and Physical Planning (Island Region)	Development Planner

Source: JICA Expert Team

PIU Meetings and Core Member Meetings were held regularly to discuss various topics as shown in Table A.1.2. The meetings held in 2021 were done online, while the meetings held in 2022 were face-to-face meetings.

Table A.1.2 PIU Meetings and Core Member Meetings

Date	Meeting	Main Topics
12th May 2021	Core Member Meeting	Self-introduction To discuss administrative matters To discuss how to conduct capacity assessment To discuss the Project's nickname
26th May 2021	1st PIU Meeting	To explain roles of Core Group and PIU members To determine the Project's planning area To determine the method of conducting capacity assessment To determine the Project's nickname
9th June 2021	Core Member Meeting	To discuss how to conduct online Task 2 Review of Existing Data, Documents and Information. To discuss the target organisations and personnel to be involved in the capacity assessment
16th June 2021	2nd PIU Meeting	To discuss the interview schedules to conduct Task 2 To discuss ideas for pilot projects
30th June 2021	Core Member Meeting	To discuss the responsibility of Core Group members To confirm the schedule of interviews for Task 2 To explain the process of capacity assessment
21st July 2021	3rd PIU Meeting	To discuss the chairperson for each TWG To review the situation of projects proposed in ENBP-SDP To discuss how to collect ideas for pilot projects
11th August 2021	Core Member Meeting	To discuss how to conduct the Strategic Environmental Assessment (SEA) for the Infrastructure Development Plan
11th August 2021	4th PIU Meeting	To confirm the members of TWG for Roads, TWG for Urban Planning and TWG for Port To confirm the establishment of TWG for Social and Environmental Consideration.
25th August 2021	Core Member Meeting	To discuss the dates for TWG meetings To discuss the current situation of the preparation of ENBP Mid-Term Development Plan
9th September 2021	5th PIU Meeting	To discuss the TWG for Social and Environmental Consideration To explain the progress of the interviews for considering ideas for pilot project(s)
22nd September 2021	Core Member Meeting	To confirm the chairperson for each TWG To discuss the schedules of the TWG meetings to be conducted in 2021
29th September 2021	6th PIU Meeting	To confirm the chairperson for each TWG To confirm the TWGs to be established in the Project To explain the process of the interviews conducted for considering the approach for the implementation of pilot project(s)
20th October 2021	Core Member Meeting	To discuss the dates for TWG Meetings To discuss how to collect the questionnaires for capacity assessment from the district officers
17th November 2021	7th PIU Meeting	To confirm the members and tasks of the TWG for Social and Environmental Consideration To explain the interviews conducted for considering the approach for the implementation of pilot project(s)
15th December 2021	Core Member Meeting	To explain the schedule for 2022
26th January 2022	Core Member Meeting	To kick-off the Project through a face-to-face meeting
3rd February 2022	8th PIU Meeting	To introduce members who are first time in ENBP To discuss the activities to be conducted in February 2022
9th February 2022	9th PIU Meeting (1st Pilot Project Board Meeting)	To discuss what kind of pilot project(s) are appropriate for Kokopo and Rabaul To confirm the main actors in ENBPA for the implementation of the pilot project(s)
28th March 2022	10th PIU Meeting	To introduce members who are first time in ENBP To discuss the activities to be conducted in March – April 2022
31st March 2022	Core Member Meeting	To discuss on the preparation of the First Stakeholders' Meeting
12th May 2022	Core Member Meeting	To introduce members who are first time in ENBP To discuss the activities to be conducted in May 2022
17th May 2022	Core Member Meeting	To discuss future schedule

Source: JICA Expert Team

Based on the discussion with the PIU members, it was decided that the PIU members themselves will function as the board members who will decide on the direction and budget allocations for the pilot project to be implemented in the Project. Therefore, the ninth PIU Meeting was conducted as the First Pilot Project Board Meeting.

A.1.2 Technical Working Group Meetings (TWG Meetings)

(1) Establishment of Technical Working Groups (TWGs)

Based on the discussion with the PIU members, the following TWGs were established:

- TWG for Roads
- TWG for Urban Planning
- TWG for Port
- TWG for Airport
- TWG for Water Supply
- TWG for Power
- TWG for Social and Environmental Consideration

(2) Technical Working Group Meetings (TWG Meetings)

Three TWG meetings were conducted in Phase 1.

1) TWG Meeting for Roads and Urban Planning

The First TWG Meeting for Roads and Urban Planning was held on 1st December 2021 as a combined meeting for members of the two TWGs. The meeting was held online connecting ENBP, Port Moresby and Tokyo.

The following were explained and discussed:

- How to prepare an updated road inventory
- Problems on trunk roads in Northeast Gazelle Peninsula
- Preliminary ideas on future urban areas in Kokopo District and Rabaul District
- Problems on existing land use plans

2) TWG Meeting for Port

The First TWG Meeting for Port was held on 8th December 2021. The meeting was held online connecting ENBP, Port Moresby and Tokyo.

The following were explained and discussed:

- Existing condition of Rabaul Port
- Review of the Detailed Master Plan for Rabaul Port prepared by PNG Ports
- Functions of Rabaul Port
- Port location and regional spatial structure

3) TWG Meeting for Social and Environmental Consideration

The First TWG Meeting for Social and Environmental Consideration was held on 15th December 2021.The meeting was held online connecting ENBP and Tokyo.

The following were explained and discussed:

- SEA study for Infrastructure Development Plan for Northeast Gazelle Peninsula
- Process of SEA study

A.1.3 Stakeholders Meeting

In this Project, stakeholders meetings will be held by involving not only government officers, but also private sectors, academic institutions, civil society organisations and NGOs, for the purpose of stakeholder coordination in both the planning process and strategic environmental assessment (SEA) process. In the stakeholder meetings, various problems, concerns and development directions, as well as SEA related matters, will be discussed in the course of the Project.

The First Stakeholder Meeting was held at Gunan Na Niuvia (GNN) Isolation Centre Conference Room.

1) Objectives

- To kick off a series of stakeholder meetings by involving government officers, private sectors, civil society organisations, universities and researchers in Northeast Gazelle Peninsula
- To listen to views and opinions on the present situation of development in Northeast Gazelle Peninsula
- To start considering the future of Northeast Gazelle Peninsula

2) Date

5th April 2022

3) Participants

Over 50 participants from ENBPA, regional offices of national level governments and agencies, private sectors, university, NGOs, etc.

4) Main Points of Discussion

- Necessity of developing the processing industry and tourism industry, and importance of infrastructure development
- Locational advantage and the risk of volcanic eruption at the existing Rabaul Port
- Condition of roads in Northeast Gazelle Peninsula which is damaging vehicles
- Insufficient and unstable infrastructure were stressed by the participants of the private sectors
- Possibility of geothermal and solar energy for power generation

A.1.4 Data Collection Survey

(1) Data Collection Conducted Online

In 2021, several online meetings were conducted for purposes of data collection. These meetings are listed in Table A.1.3.

Table A.1.3 Online Meetings Conducted for Data Collection

Date	Organisation	Main Topics
26th July 2021	Natural Resource Management and Development Unit, ENBPA	Review and data collection on social and environmental consideration in ENBP
28th July 2021	Rabaul Port	Discussion on alternative scenarios for Rabaul Port Request for necessary data Information on Rabaul Master Plan and 30-Year Port Infrastructure Master Plan
30th July 2021	PNG Ports	Information on Detailed Infrastructure Master Plan for Rabaul Points of considering alternative scenarios for Rabaul Port development Plan formulation and approval process of the Rabaul Port Master Plan Present situation of considering new port development at Kokopo
17th August 2021	Division of Lands and Physical Planning, ENBPA	Existing plans for ENBP Ideas on regional spatial structure
30th August 2021	PNG Ports	Data request from JICA Expert Team Future development of Rabaul Port and its funding

Source: JICA Expert Team

(2) Data Collection Conducted on the Ground

Between the period January and May 2022, a total of 12 members of JICA Expert Team visited Port Moresby and Northeast Gazelle Peninsula to do interviews and site survey.

A.2 Progress Made in Phase 2

The Phase 2 period was from the submission of the Progress Report (October 2022) until the submission of the Interim Report (April 2023).

A.2.1 PIU Meetings and Core Member Meetings

PIU Meetings and Core Member Meetings were held regularly to discuss various topics as shown in Table A.2.1. The meetings held in Phase 2 were conducted face-to-face or online.

Table A.2.1 PIU Meetings and Core Member Meetings in Phase 2

Date	Meeting	Main Topics
23rd November 2022	Core Member Meeting	To discuss the preparation of the Second Stakeholder Meeting To discuss how to conduct scoping for Strategic Environmental Assessment
14th December 2022	11th PIU Meeting	To explain the activities conducted in November 2022 To discuss the future urban area in Northeast Gazelle Peninsula To discuss the proposed priority projects of each sector To explain findings of disaster risk study
10th February 2023	12th PIU Meeting	To explain the activities of the Study Tour in Japan To discuss disaster risk assessment To discuss which proposed priority projects should be top priority To discuss how to organise and implement pilot projects for Kokopo and Rabaul To confirm future schedule of the project

Source: JICA Expert Team

A.2.2 Joint TWG Meeting and Steering Committee Meeting

(1) The Second Joint TWG Meeting

The Second Joint TWG Meeting was held on the 2nd November 2022 at the conference room of Rapopo Plantation Resort while participants from ENBP, Port Moresby and Tokyo were connected online.

Some of the major points discussed in the meeting are as follows:

- Risk of volcanic ashes that can block the movement of cargo out from Rabaul wharf
- Importance of having a plan that covers Pomio District as province
- Existing water supply infrastructure needs to be improved first before any new water supply system is installed.
- Water borehole in Rabaul and Kokopo needs to be increased due to the expansion of the urban area.
- Upgrading Tavilo Airport and the escape route road along the North Coast Roads should be taken into consideration.
- Main problem of power supply is the transmission of power.

(2) The Second Steering Committee Meeting

The Second Steering Committee Meeting was held on the 11th November 2022 at JICA PNG Office while participants from ENBP, Port Moresby, and Tokyo were connected online.

In the meeting, the Progress Report was explained and discussed by the members of the SC for the Project.

Some of the major points discussed in the meeting are as follows:

- Solutions and suggestions regarding the impact of volcanic ash in case the volcano erupts again
- Importance of providing infrastructure such as sufficient internet network and properly

developed jetties for tourism development in Rabaul

- Importance of the national government to work with the provincial government by utilizing regional offices of the national government in ENBP
- Climate change, which can affect people living on Matupit Island, should be considered in the Project
- Transportation connecting road, maritime, and air will make not only ENBP but also other surrounding islands attractive for tourism
- Necessity of an inventory study of resources to consider alternative power generation instead of hydroelectric power.
- Importance of analysing sedimentation of volcanic ash every time it rains
- Drilling some boreholes for groundwater source that will provide water to industrial area in Ulaveo is necessary.
- Tanks made of glass or concrete may help address the corrosion problem of the existing water supply system.
- ENBP has potential to become a model province in PNG.

A.2.3 TWG Meetings

(1) The Second TWG Meeting for Port

The Second TWG Meeting for Port was held on the 3rd November 2022 at Rabaul Urban LLG Office.

The following were explained and discussed:

- Port development and regional spatial structure
- Timeframe for rehabilitation of Rabaul Port and relocation of port functions from Rabaul Port to a new port
- Port demand and capacity of Rabaul Port
- Present condition of Ataliklikun Bay as alternative port location

(2) The First TWG Meeting for Power and Water Supply

The First TWG Meeting for Power and Water Supply was held on the 9th November 2022 as a combined meeting for members of the two TWGs. The meeting was held at the conference room of Kokopo Beach Bungalow Resort.

The following were explained and discussed:

- Problems on power and water supply in Northeast Gazelle Peninsula
- Preliminary consideration of development directions for the power and water supply sector
- Important projects and priority projects of power and water supply sectors

(3) The Second TWG Meeting for Roads and Urban Planning

The Second TWG Meeting for Roads and Urban Planning was held on the 17th November 2022 as a combined meeting for members of the two TWGs. The meeting was held at Kokopo Urban LLG Office.

The following were explained and discussed:

- Existing major road network referring to road inventory and its issue
- Future regional spatial structure and future road network plan
- Priority project for trunk road development
- Town bypass and CBD ring road strategy for urban road in Kokopo

- Port access road and roads in Sector 2 in Rabaul
- Future urban areas in Northeast Gazelle Peninsula

A.2.4 Stakeholders Meeting

The Second Stakeholders Meeting was held at the conference room of Rapopo Plantation Resort.

The presentation of the current situation of Northeast Gazelle Peninsula was conducted by an officer of ENBPA, and the presentation of the preliminary vision and spatial development options for Northeast Gazelle Peninsula and the Strategic Environmental Assessment was conducted by JICA Expert Team.

After the presentation, the participants were divided into two groups to discuss the three alternative scenarios as part of the SEA activities and to share opinions raised in each group.

1) Objectives

- To explain the preliminary future and spatial development options for Northeast Gazelle Peninsula
- To understand possible issues and potential opportunities in Northeast Gazelle Peninsula through the implementation of the proposed spatial development options in terms of environmental, social and economic impact for pre-scoping

2) Date

28th November 2022

3) Participants

38 participants from ENBPA, regional offices of national level governments and agencies, private sectors, university, etc.

4) Main Points of Discussion

- Impacts on marine life and marine biodiversity
- Importance of infrastructure to be built to be disaster resilient against volcanic eruption, earthquake, flooding, landslide, etc.
- Creation of job opportunities and investment opportunities with construction and establishment of the SEZ
- Land acquisition issues for infrastructure development and port relocation to Ataliklikun Bay
- Increase in demand for social services in newly developed areas with more populating settlement
- Impacts on cultures and traditions of the influx of people from outside moving into the area
- Impacts on sacred sites, religious sites, and cemeteries

A.3 Progress Made in Phase 3

The Phase 3 period was from the submission of the Interim Report (April 2023) until the submission of the Draft Final Report (January 2024).

A.3.1 PIU Meetings and Core Member Meetings

PIU Meetings and Core Member Meetings were held regularly to discuss various topics as shown in Table A.3.1. The meetings held in Phase 3 were conducted face-to-face or online.

Table A.3.1 PIU Meetings and Core Member Meetings in Phase 3

Date	Meeting	Main Topics
22nd May 2023	Core Member Meeting	To explain process of Strategic Environmental Assessment for NEGID-Plan To confirm the upcoming schedule of SEA
22nd June 2023	Core Member Meeting	To explain the proposed high-priority projects and priority projects for the Northeast Gazelle Peninsula To explain a phased development plan of high-priority projects and priority projects To discuss which proposed projects should be of the top priority
21st July 2023	13th PIU Meeting	To discuss the future spatial structure To review what was discussed in the meeting with the Provincial Executive Council To confirm the upcoming schedule of the Project for NEGID-Plan
30th August 2023	14th PIU Meeting	To discuss alternative names for the former nickname "KRID-Plan" To explain contents of the pilot projects and how to evaluate the impacts To discuss tasks and responsibilities of organisations concerned To explain purpose and method of the traffic survey To confirm the schedule of the Project for NEGID-Plan
1st November 2023	15th PIU Meeting	To explain the progress of the traffic survey To explain the latest implementation schedule of the pilot projects To discuss the vision for Northeast Gazelle Peninsula To explain the second GIS training conducted in October 2023
23rd November 2023	Core Member Meeting	To discuss the vision for Northeast Gazelle Peninsula To discuss alternative names for the former nickname "KRID-Plan" To explain the traffic survey planned to be conducted in October and November 2023 To explain the latest implementation schedule of the pilot projects in Kokopo and Rabaul

Source: JICA Expert Team

A.3.2 Joint TWG Meeting and Steering Committee Meeting

(1) The Third Joint TWG Meeting

The Third Joint TWG Meeting was held on the 12th May 2023 at the conference room of Kokopo Beach Bungalow Resort, while participants from ENBP and Tokyo were connected online.

Some of the major points discussed in the meeting are as follows:

- High priority projects for Northeast Gazelle Peninsula to be selected in the Plan
- It is vital to retain certain functions of the port, and relocate other functions to the new port at Ataliklikun Bay in a span of 10 to 20 years.
- Kokopo bypass road (Southern Part of Kokopo Town Ring Road) should be included in the high priority projects.
- East New Britain Provincial Government should include in its development budget the conduct of feasibility studies to be undertaken and implemented for the high priority projects.
- As for disaster mitigation, soil protection vegetation along the floodway is necessary.
- It is important to improve drainage system in Rabaul Town together with the improvement of port access road condition for solving the siltation problems of Rabaul Port, as well as for improving the poor pavement condition of the port access road.
- Strengthening of Kokopo-Rabaul Coastal Road should be implemented as the highest priority project.

(2) The Third Steering Committee Meeting

The Third Steering Committee Meeting was held on 16th May 2023 at JICA PNG Office while some participants from ENBP, Port Moresby, and Tokyo were connected online.

In the meeting, the Interim Report was explained and discussed by the members of the SC for the Project for NEGID-Plan.

Some of the major points discussed in the meeting are as follows:

- Social inclusiveness is important since the plan covers customary lands and existing land use areas.
- It is valuable to construct major highways with access roads connecting to other major highways where the people are actually residing.
- It is important for the national government and the provincial governments to work together.
- In the town area, access roads or bypass roads are needed to reduce congestions and for future urban expansion.
- Kokopo City and Rabaul Town should be tourism hubs, and Kerevat should be a main industrial hub.
- To stop the mudflow by structural measures is difficult, considering large costs. However, it is necessary to consider other soft measures.
- This Infrastructure Development Plan needs to be included in the East New Britain Provincial Medium Term Development Plan so that investors know where they can make investments.
- Presentation to the ENBP Assembly should be conducted so that politicians and administration arms of ENBP have a good understanding of the Project for NEGID-Plan.

A.3.3 TWG Meetings

(1) The Third TWG Meeting for Roads

The Third TWG Meeting for Roads was held on the 4th August 2023 at the conference room of ENBPA's Division of Finance.

The following were explained and discussed:

- Strengthening of Kokopo-Rabaul Coastal Road as the project selected for Pre-Feasibility Study
- Major tasks in the Pre-Feasibility Study
- 10 sections of the Kokopo-Rabaul Coastal Road and road improvement plans for each section
- Sections 2, 4 and 8 are critical areas to be implemented.
- ENBP requests JICA Expert Team to design for improvement of all sections of the road.
- Key points for drainage design and slope protection design
- Economic analysis to be conducted in the Pre-Feasibility Study

A.4 Progress Made in Phase 4

The Phase 4 period was from the submission of the Draft Final Report (March 2024) until the submission of the Final Report (July 2024).

A.4.1 PIU Core Member Meeting

PIU Core Group Member Meeting was held on 21st March 2024 to discuss on the way forward of the project and for the preparation of the national seminar.

A.4.2 Joint TWG Meeting and Steering Committee Meeting

(1) The Fourth Joint TWG Meeting

The Fourth Joint TWG Meeting was held on the 19th March 2024 at the conference room of Rapopo Plantation Resort.

In the meeting, the Draft Final Report was explained and discussed by the members of the Joint TWG for the Project for NEGID-Plan. The members of the Joint TWG generally accepted the contents of the Draft Final Report.

Some of the major points discussed in the meeting are as follows:

- Result of the pre-FS for the Strengthening of the Kokopo-Rabaul Coastal Road
- Result of the pilot projects
- Importance of considering alternative source of power supply including solar power and geothermal power.
- Approval process of the NEGID-Plan and the 11 high priority projects

(2) The Fourth Steering Committee Meeting

The Fourth Steering Committee Meeting was held on 25th March 2024 at JICA PNG Office.

In the meeting, the Draft Final Report was explained and discussed by the members of the SC for the Project for NEGID-Plan. The members of the SC generally accepted the contents of the Draft Final Report.

Some of the major points discussed in the meeting are as follows:

- The importance of the awareness to the people for the implementation of the plan
- The importance of the implementation of the approval of the 11 high priority projects by the NEC for implementation of the plan
- The importance to have the essence of NEGID-Plan included in the MTDP IV

A.4.3 ENBP Political Leaders Meeting

The meeting with the political leaders of ENBP was held on 20th March 2024 to explain the major contents of NEGID-Plan. The meeting was chaired by the provincial governor and the members of Provincial Executive Council and the political leaders representing each district were invited.

The participants generally accepted on the contents of the NEGID-Plan.

A.4.4 National Seminar

The national seminar for NEGID-Plan was held with the collaboration of Department of National Planning and Monitoring, ENBPA and JICA, The meeting was held on 26th March 2024 at Stanley Hotel and Suites in Port Moresby.

There were total of 54 participants from the PNG side including various departments and agencies at the national level, Minister for National Planning, political leaders of ENBP and officers from ENBPA.

The main objectives of the meeting were as follows:

- To share the contents of the NEGID-Plan including the selected 11 high priority projects to wider stakeholders
- To submit the result of the NEGID-Plan to the Minister for National Planning
- To share the findings and recommendations from the Project including the possible contribution to PNG by implementing NEGID-Plan

A.5 Technology Transfer

A.5.1 Capacity Assessment Survey

A questionnaire was distributed to the members of TWGs to understand their current capacity for development planning and consider activities for technology transfer. The survey was conducted in the latter half of 2021.

A.5.2 Capacity Development for Regional Development Planning

Capacity development for regional development planning has been conducted through the following Core Group meetings, PIU meetings and TWG meetings.

Core Group Meeting

- Discussion on review of existing data, documents and information (9th June 2021)

PIU Meeting

- Discussion on future vision for Northeast Gazelle Peninsula (1st and 23rd November 2023)
- Explanation of method of traffic survey (30th August and 1st November 2023)

TWG Meeting for Urban Planning

- Explanation of procedure of regional planning and existing spatial structure (1st December 2021)

TWG Meeting for Roads

- Explanation of procedure of road planning and existing major road network in the Region (1st December 2021)
- Discussions for selection of Priority Projects (4th August 2023)
- Explanation of procedure of pre-feasibility study (4th August 2023)

TWG Meeting for SEA

- Explanation of outline of the Strategic Environmental Assessment (15th December 2021)

A.5.3 Study Tour in Japan

(1) Period

For 12days from 30th January to 10th February 2023.

(2) Objective

The objective of the study tour in Japan is to get to know the infrastructure development planning and maintenance in Japan, especially port development, volcanic eruption disaster countermeasures, heavy rain disaster countermeasures, transport planning, tourism (including cruise ship tourism), and infrastructure that contributes to industrial development such as agriculture and fisheries. These infrastructures are related to the infrastructure development plan to be formulated for the Northeast Gazelle Peninsula. Also, the method of area management in Japan is to be introduced as samples for pilot project to be implemented during the project period.

(3) Participants

Eleven officers from the national level and provincial level participated in the study tour, as shown in Table A.5.1

Table A.5.1 List of Participants of the Study Tour

No.	Position	Organisation
1	First Assistant Secretary	Policy and Budgets / Macro Planning, Department of National Planning and Monitoring
2	Economist	Macro Planning Division, Department of National Planning and Monitoring
3	Aid Coordinator – Japan Desk	Development Cooperation Management Division, Department of National Planning and Monitoring
4	District Administrator	Kokopo District Administration, ENBPA
5	Town Manager	Rabaul District Administration, ENBPA
6	Provincial Planner	Division of Policies Planning and Research, ENBPA
7	Advisor	Division of Lands and Physical Planning, ENBPA
8	Provincial Physical Planner	Division of Lands and Physical Planning, ENBPA
9	GIS Officer	Division of Lands and Physical Planning, ENBPA
10	Advisor	Division of Infrastructure Development, ENBPA
11	Acting Provincial Civil Engineer	Division of Infrastructure Development, ENBPA

Source: JICA Expert Team

(4) Cities to Visit

In the study tour, participants visited seven cities and took 26 units of lectures by both administrative and private organisations, and site visiting.

Cities which the participants visited are listed as follow:

- Kitakyushu City, Fukuoka Prefecture
- Naha City, Okinawa Prefecture
- Ishigaki City, Okinawa Prefecture
- Taketomi Town, Okinawa Prefecture
- Kagoshima City, Kagoshima Prefecture
- Shibushi City, Kagoshima Prefecture
- Shinjuku Ward, Tokyo

These visiting sites were selected in terms of its population, geographical characteristics, industries, etc. relevant to those of ENBP.

(5) Discussions

During the tour, participants had a variety of discussions with lecturers in each lecture and site visiting.

On the final day of the tour, participants made presentations on reviews of the tour and future action plans individually and by organisations.

A.5.4 GIS Seminar and Training Workshops

(1) GIS Seminar

On 4th February 2022, GIS Seminar was held to explain the preparation process of the base map done by the JICA Expert Team, and discuss how to finalise such map and necessary capacity development for the officers of ENBPA for utilising GIS. Based on the discussion in this seminar, it was decided that GIS Workshop will be held first for the officers who are not familiar with the GIS software.

The actual preparation process of the base map is explained in Section 2.3.

(2) The First GIS Training Workshops

On the 8th February and the 9th February 2022, the first GIS Training Workshops were held. The main contents were as follows:

- To explain basic information on GIS data and QGIS software
- To share some basic GIS data of Northeast Gazelle Peninsula
- To install QGIS in the laptops of the officers and use QGIS utilising the GIS data of Northeast Gazelle Peninsula

On both days, the contents of the workshop were the same.

Seven officers attended the workshop on the 8th February and one officer attended on 9th February.

(3) The Second GIS Training Workshops

The Second GIS Training Workshops were held from the 25th to the 27th October 2023. The main contents were as follows:

[Day 1]

- To explain basic information on GIS data and QGIS software
- To share some basic GIS data of Northeast Gazelle Peninsula
- To install QGIS in the laptops of the officers and use QGIS utilising the GIS data of Northeast Gazelle Peninsula

[Day 2]

- Introduction of functions of QGIS
- To practice displaying data, handling color palette and editing attribute tables

[Day 3]

- To explain basic information on Google Earth Pro
- To practice importing shapefiles, creating point, line and polygon data to Google Earth Pro, and exporting created data in Google Earth Pro

Lecture and demonstration during the workshop were recorded with a video camera.

Eight officers attended the workshop on the 25th October 2023, six officers attended on the 26th October and seven officers attended on 27th October.

A.5.5 Traffic Survey Workshop

A traffic survey workshop was held on 22nd December 2023. This workshop aimed to explain how to conduct traffic survey with video cameras and practice setting up the video camera. Seven officers from relevant divisions of ENBPA including the Division of Infrastructure Development attended the workshop. Guideline showing preparation of the traffic survey, process of video recording and way to count the traffic volume are distributed to the attendants. In this workshop, attendants practiced setting up video camera and recording under the instruction of JICA Expert Team. It is expected that ENBPA will take the lead to conduct traffic video count survey in the future since video cameras used in the Project were handed over to ENBPA.

A.6 Preparation of Base Map

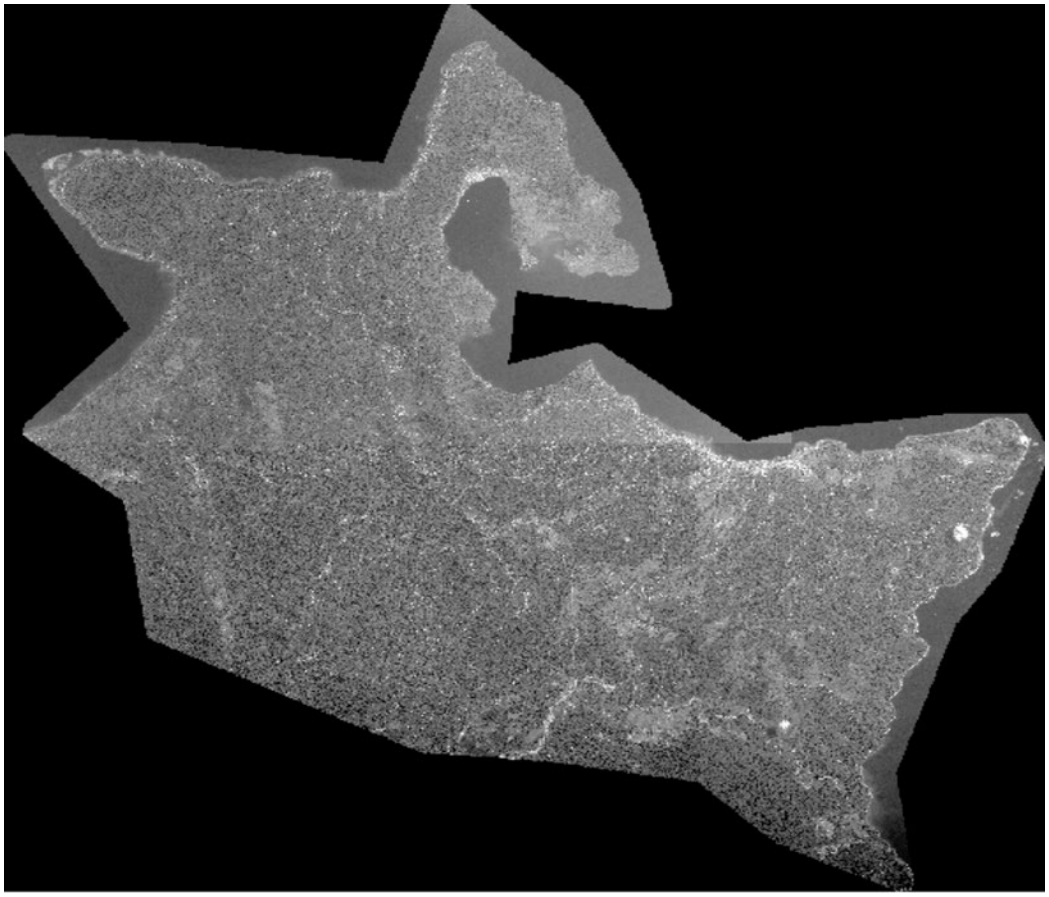
A.6.1 Data Collection for Preparing the Base Map

(1) Purchased Data

For the project, a high-resolution satellite image data and digital elevation model (DEM) data were purchased for producing accurate base maps at the scale of 1:10,000 and 1:25,000. The resolution for the satellite image data is 1.5m and DEM is 2.5m.

1) Satellite Imagery Data

SPOT 6/7 satellite imagery data were taken in 2019 and 2020, and the supplementary data for covering the cloud area were taken in 2017. After purchasing these data, all data had colour tone correction and then mosaiced.

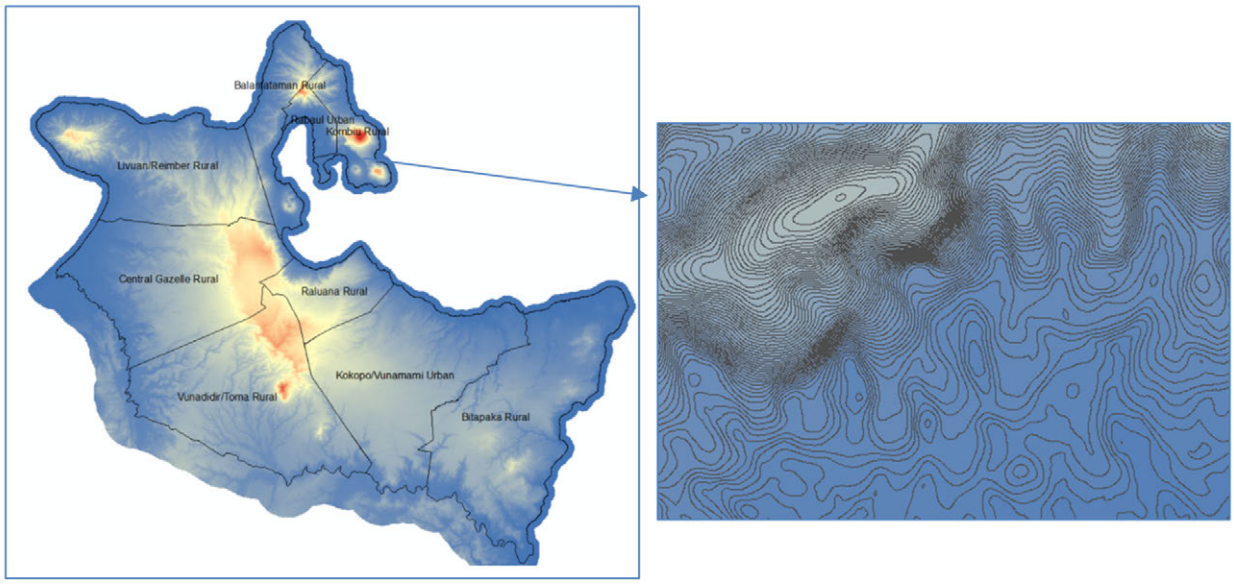


Source: AIRBUS Defence & Space

Figure A.6.1 Purchased Satellite Image Data (SPOT6/7)

2) Digital Elevation Model (DEM)

The DEM (AW3D) data were prepared for creating high accurate contour lines of the base maps. According to the DEM, the highest altitude in the study area is 642.6m. The purchased DEM and the contour lines with 2.5m interval, which were derived from DEM, are shown in Figure A.6.2.



Source: JAXA ALOS　　Source: JICA Expert Team

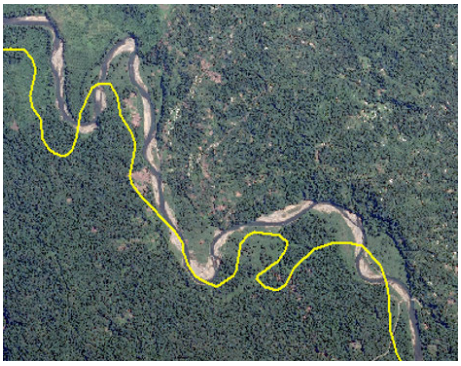
Figure A.6.2　Purchased DEM Data (Left) and Generated Contour Lines (Right)

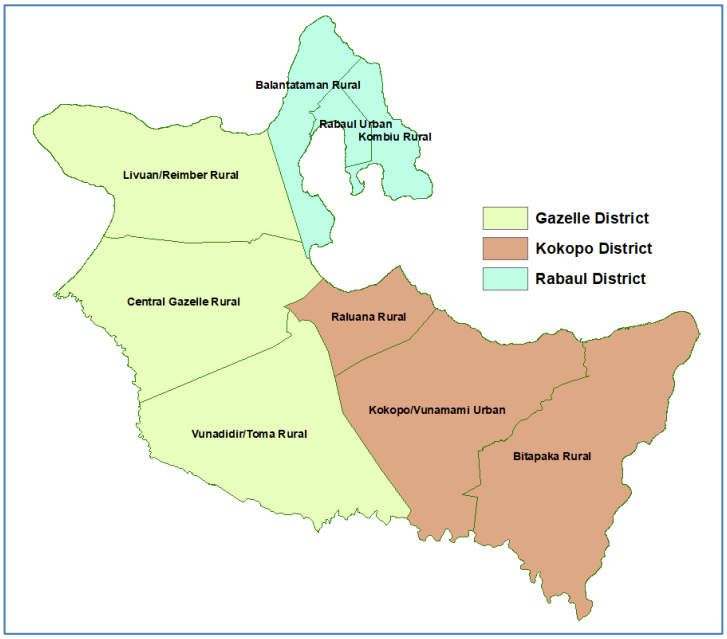
(2) Existing GIS Data

The base map needs the topographical features, such as administrative boundaries, infrastructures, facilities and so on. Therefore, collected GIS data were utilised to create the features efficiently for the base map and some features were also newly generated.

1) Administrative Boundaries

Regarding the administrative boundaries, the existing GIS data collected during the study of detailed plan were utilised. However, some parts, in particular the boundaries along the rivers, did not match the satellite image data. Therefore, the existing administrative boundary data were modified based on the result of discussion with the PIU members.





Source: JICA Expert Team

Figure A.6.3　Modified Administrative Boundaries within Northeast Gazelle Peninsula

2) Road Network

The existing road network data collected during the study of detailed plan were used. However, the road data did not match the satellite image data. Therefore, the road network data were modified using satellite image data.



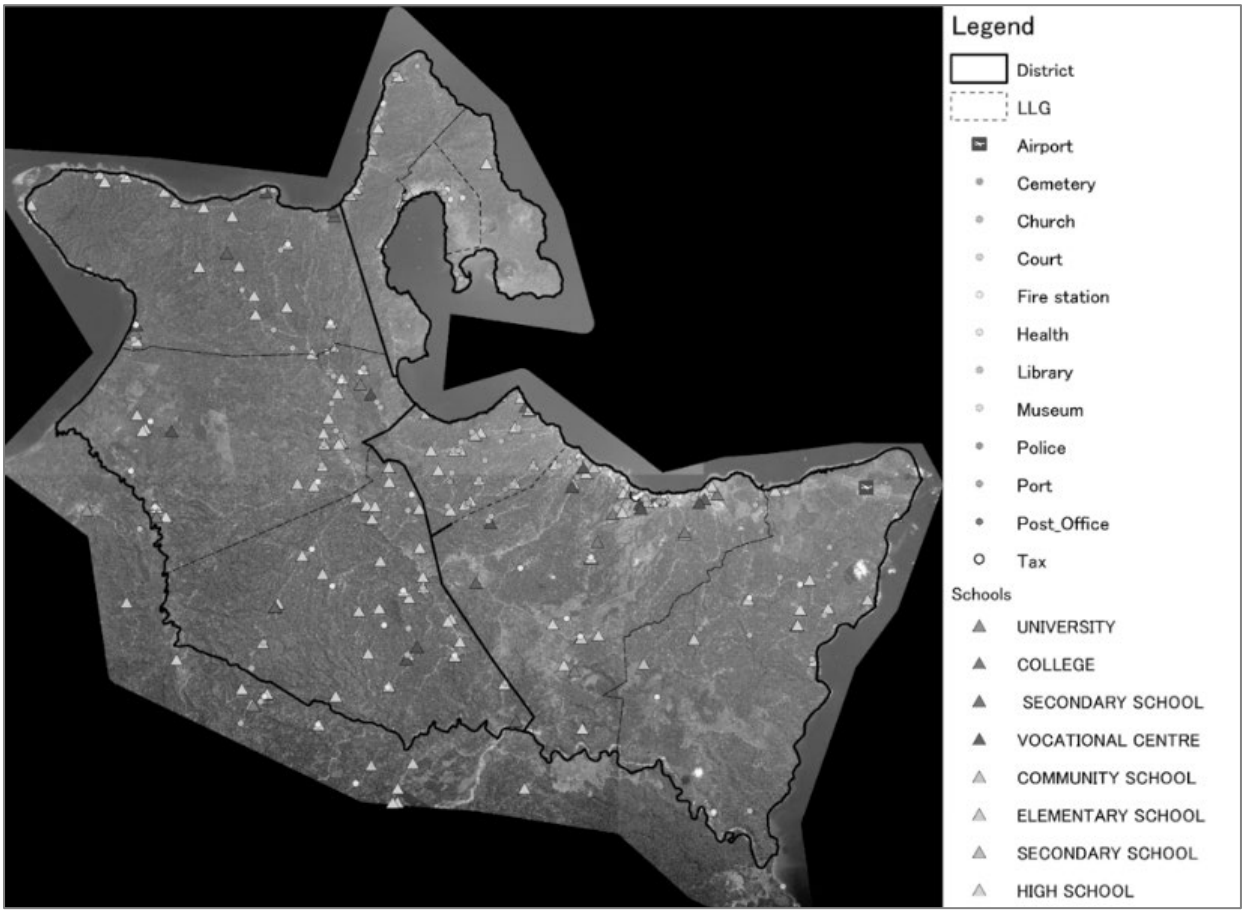
Source: JICA Expert Team

Figure A.6.4 Modified Road Network Data of Northeast Gazelle Peninsula

3) Facilities, Rivers, and Other Infrastructure

The following facilities and infrastructure were included in the base map using existing GIS data and Google Map:

- Education facilities
- Health facilities
- Airport (existing)
- Port
- Police stations
- Fire stations
- Courts
- Post offices
- Churches
- Cemeteries
- Museums
- Village names
- Rivers



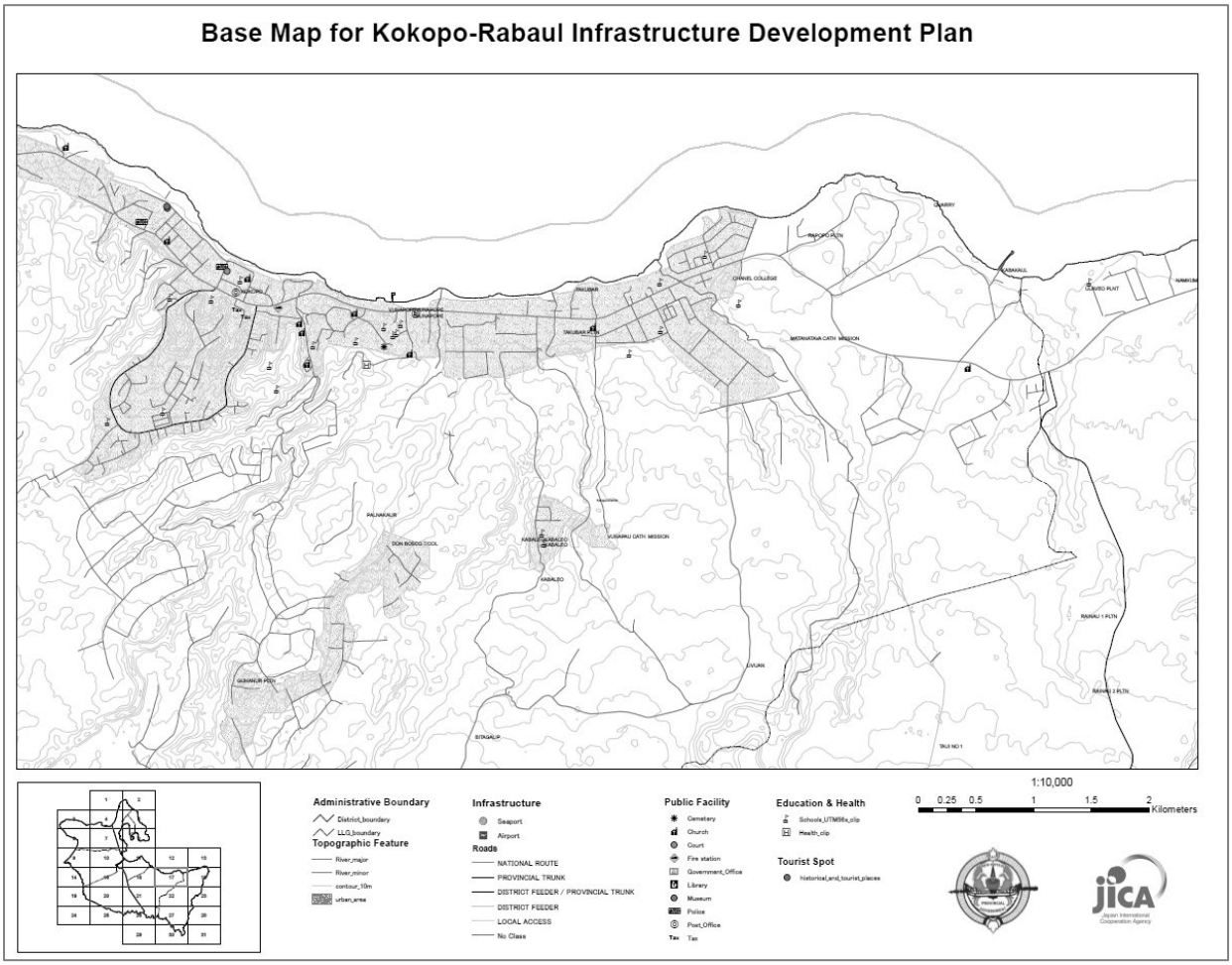
Source: JICA Expert Team

Figure A.6.5 Draft Map of Facilities and Social Infrastructure of Northeast Gazelle Peninsula

Some locations of schools and clinics were confirmed by implementing a ground truth survey. Finally, all data mentioned above were modified based on the satellite image, Google Map and field survey.

A.6.2 Finalisation of the Base Map

The base maps were produced using modified data and newly created data, such as administrative boundary, contour line, road network, river, facility and infrastructure data. However, the maps are not finalised yet. After discussing with concerned organisation, final base maps at the scale of 1:10,000 and 1:25,000 will be prepared. The sample base map around Kokopo area at the scale of 1:10,000, A0 size prepared by the JICA Expert Team is shown below.



Source: JICA Expert Team

Figure A.6.6 Draft Base Map (Kokopo Area)

A.7 Traffic Survey

In the Project, to understand the present traffic demand and future demand in the Northeast Gazelle Peninsula, the following traffic surveys were conducted.

(1) Traffic Volume Survey

This survey aimed to count the number of vehicles at each target site. Outline of the survey is as below.

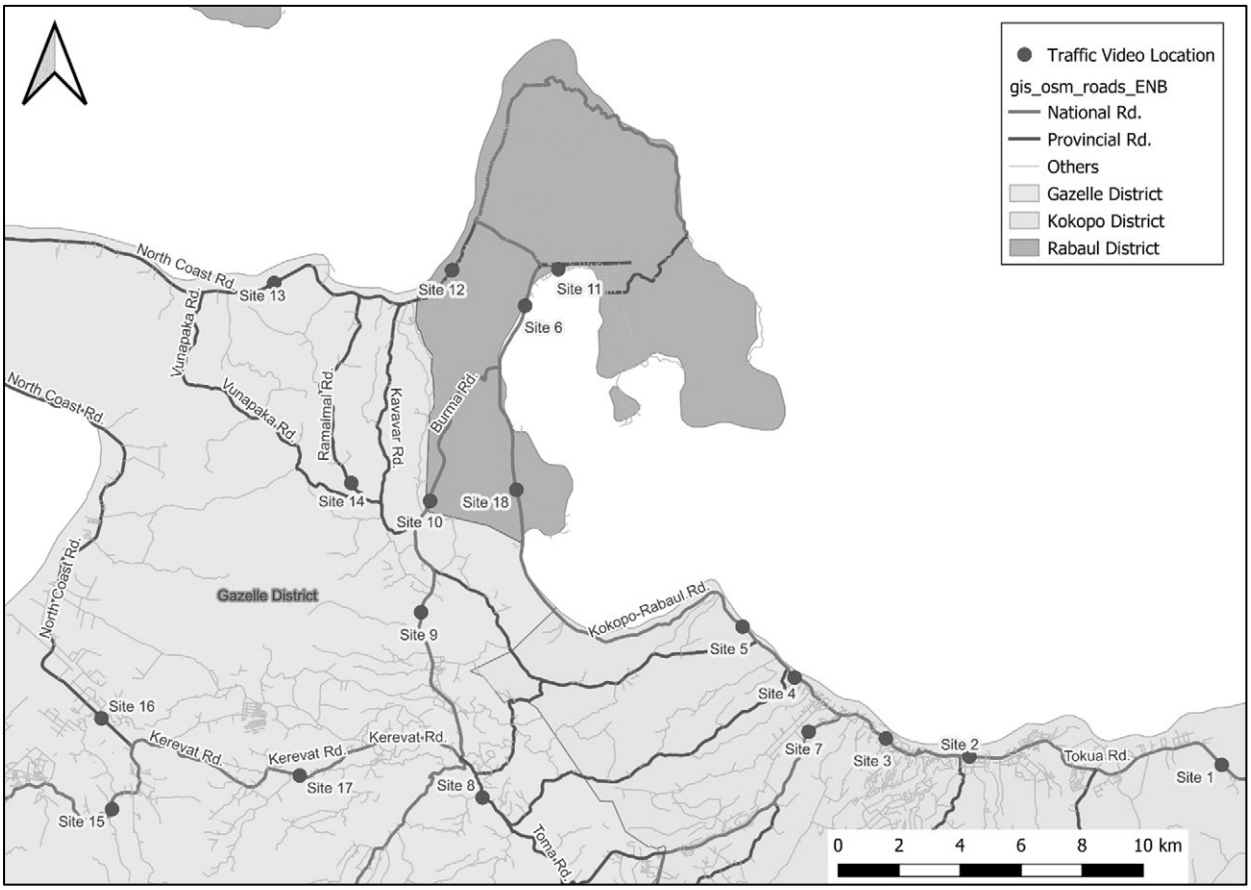
- Survey Period: 11th October to 8th November 2023 (Table A.7.1 shows the survey schedule)
- Time: For 12 hours for each site, from 6AM until 6PM
- Survey Site: Totally 18 sites on main trunk roads in the Northeast Gazelle Peninsula, as shown in Figure A.7.1.

This survey was conducted by using video camera on each site. The number of traffic volume by type of motor vehicle was counted with the video recording data. In this survey, type of motor vehicle was classified into eight categories.

Table A.7.1 Schedule of the Traffic Volume Survey

Day	Date	Survey Site
Day 1	11th October 2023, Wednesday	Site 9
Day 2	12th October 2023, Thursday	Site 1 and 5
Day 3	19th October 2023, Thursday	Site 6, 11, and 18
Day 4	24th October 2023, Tuesday	Site 1, 4, and 5
Day 5	25th October 2023, Wednesday	Site 12, 13, and 14
Day 6	26th October 2023, Thursday	Site 7, 8, and 17
Day 7	31st October 2023, Tuesday	Site 6, 11, and 18
Day 8	1st November 2023, Wednesday	Site 10, 15, and 16
Day 9	2nd November 2023, Thursday	Site 4
Day 10	7th November 2023, Tuesday	Site 7, 8, and 17
Day 11	8th November 2023, Wednesday	Site 2, and 3

Source: JICA Expert Team



Source: JICA Expert Team

Figure A.7.1 Traffic Survey Sites

(2) Passenger Volume Survey

This survey aimed to count the number of passengers of each vehicle.

- Date: 2nd November and 6th November 2023
- Time: 7AM to 9AM and 3PM to 5PM

Regarding PMV, surveyors counted the number of passengers of each PMV at bus stop. For other types of vehicles, the number of passengers in the same timeframe were counted by using the video recording data.

(3) Cargo Volume Survey

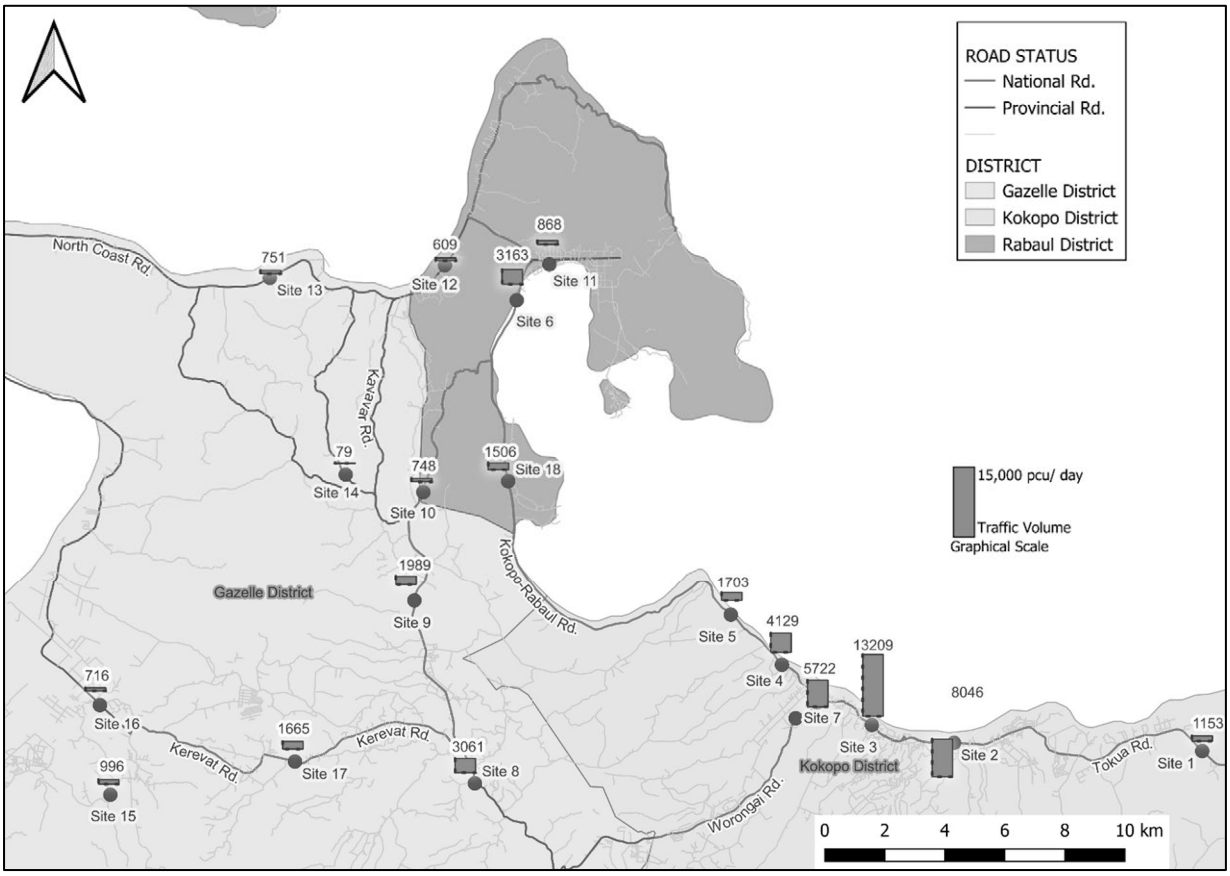
This survey aimed to examine the cargo volume carried by trucks.

- Date: 8th November 2023
- Time: 9AM to 5PM

Surveyors interviewed with some drivers of trucks to ask the cargo volume.

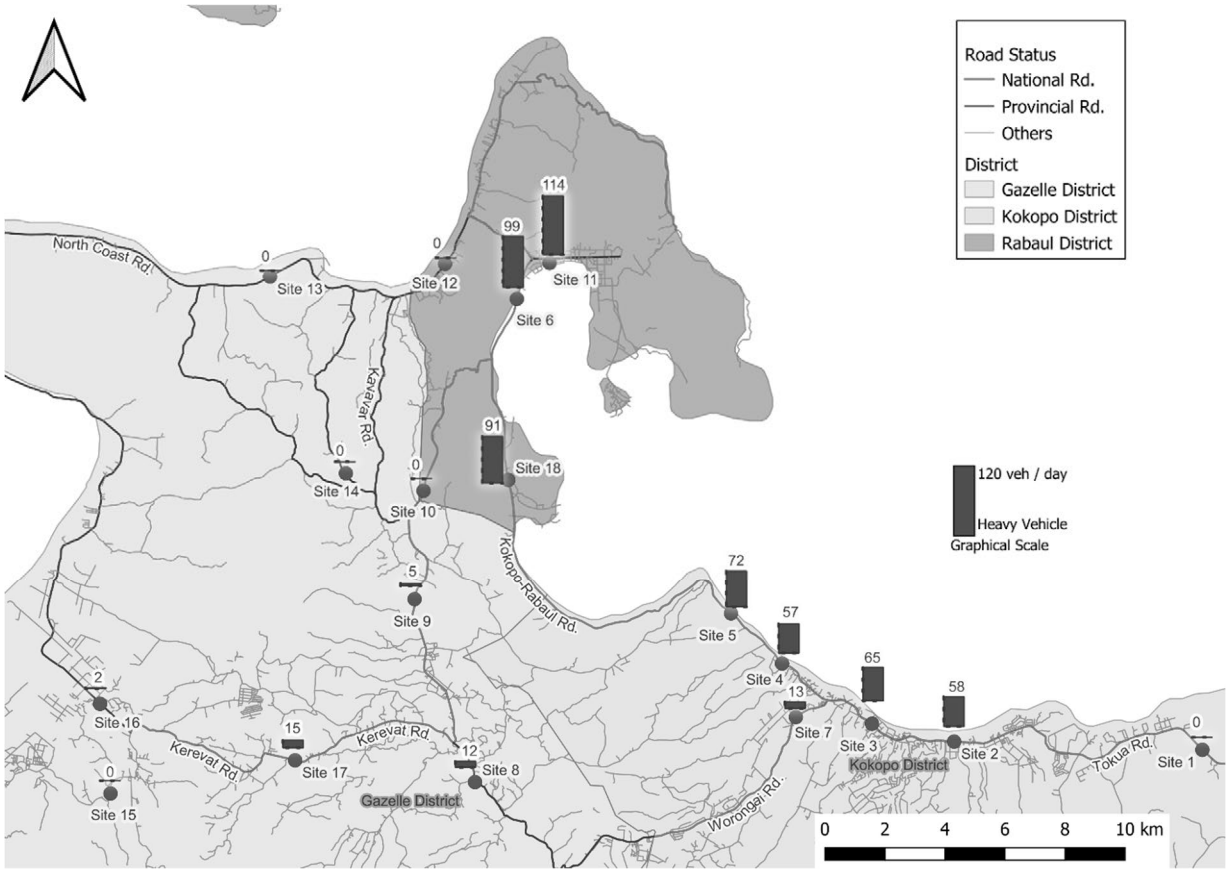
(4) Result of the Survey

The result of the traffic survey is shown in Figure A.7.2. Figure A.7.3, Figure A.7.4 and Figure A.7.5 show the traffic volume by vehicle size. All heavy and medium vehicles use the Kokopo-Rabaul Coastal Road from Rabaul to go to Kokopo and Kerevat.



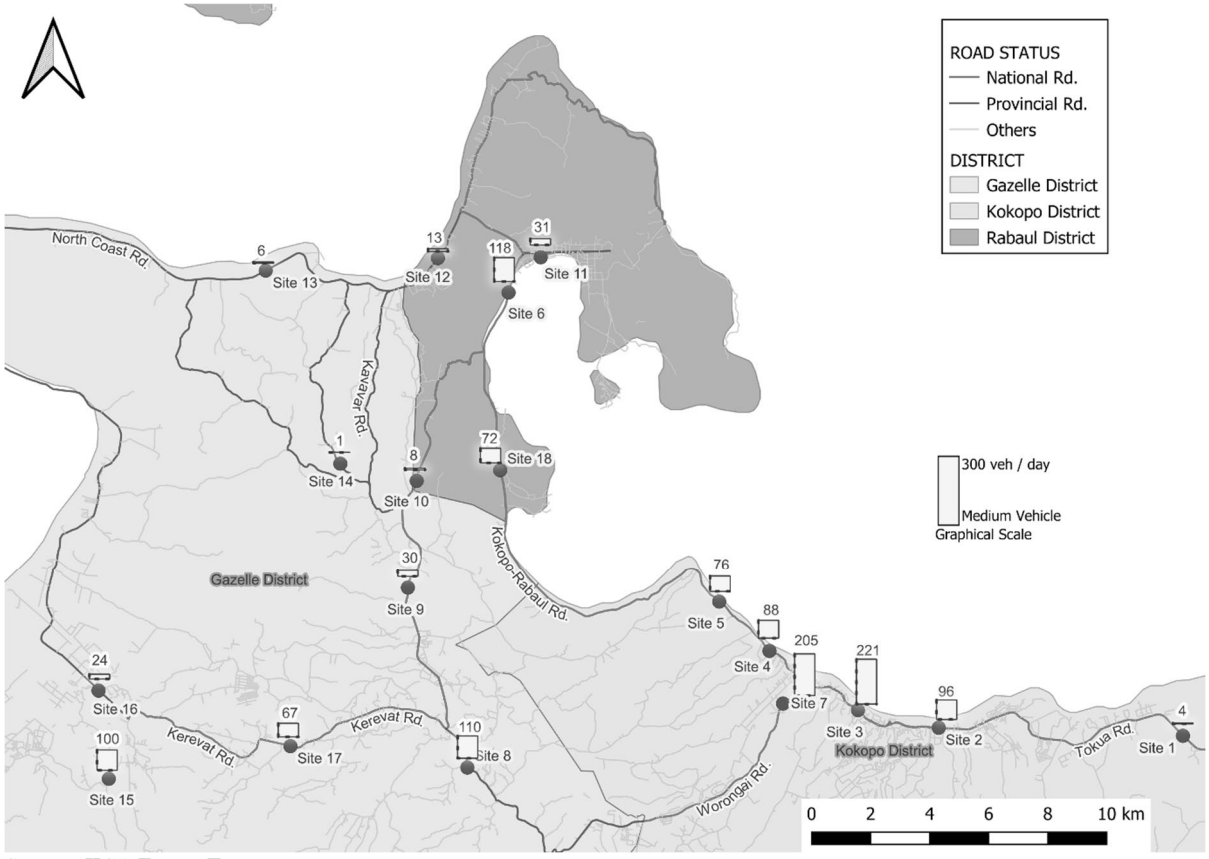
Source: JICA Expert Team

Figure A.7.2 Traffic Volume by Survey Location



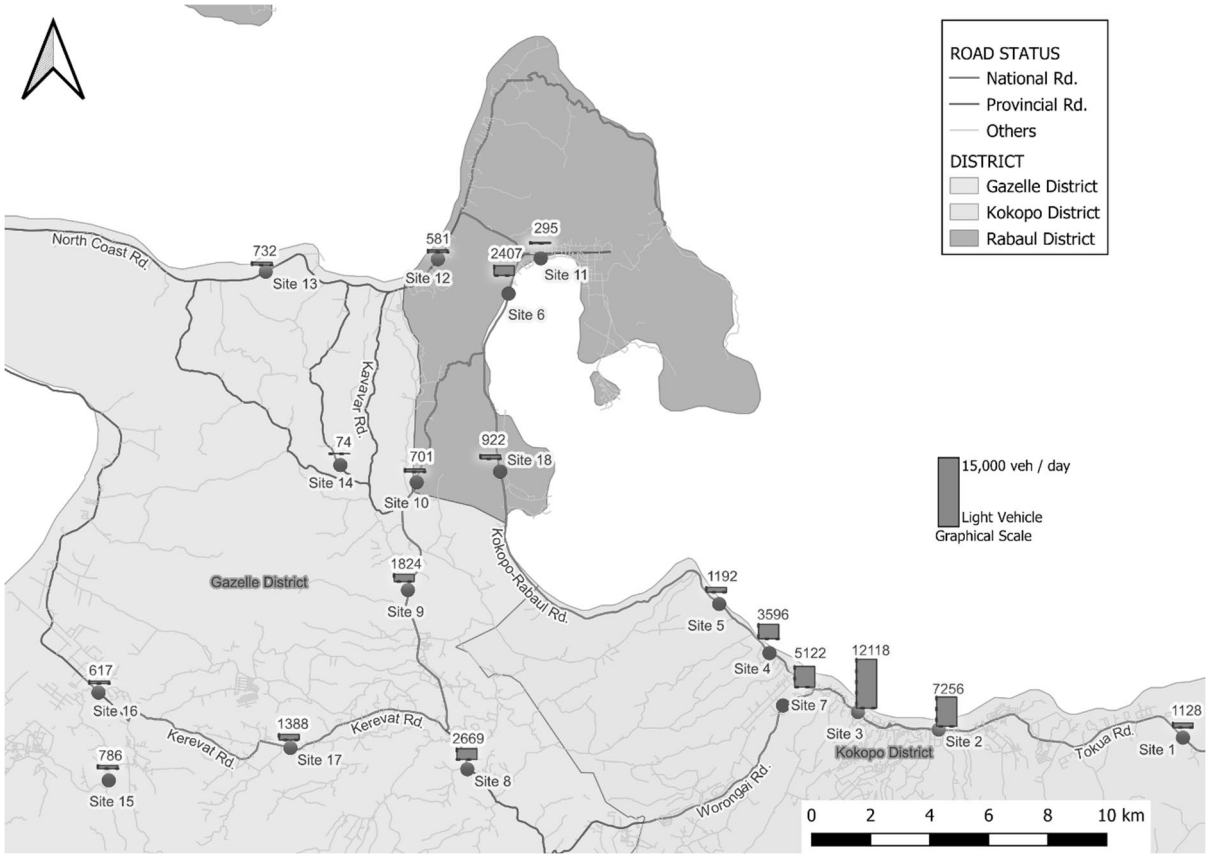
Source: JICA Expert Team

Figure A.7.3 Traffic Volume of Heavy Vehicle by Survey Location



Source: JICA Expert Team

Figure A.7.4 Traffic Volume of Medium Vehicle by Survey Location



Source: JICA Expert Team

Figure A.7.5 Traffic Volume of Light Vehicle by Survey Location

Appendix B National Development Planning System and Sector Development Policies for Papua New Guinea

B.1 National Development Planning System for Papua New Guinea

B.1.1 History of Development Planning in Papua New Guinea[1]

(1) The Foot Mission in 1962 and WB Assisted Five-Year Development Plan in 1964

The discussion on national development planning in the then Territory of Papua and New Guinea dates back to the recommendations of the Foot Mission which was dispatched by the United Nations in 1962. The Foot Mission identified the deficiency in the well-being and development of the indigenous people, and made a recommendation for the formulation and implementation of a development plan.

In response to this recommendation, the World Bank assisted the Australian colonial administration in the formulation of a five-year development plan in 1964. The development plan focused on key economic growth sectors, including plantation agriculture, forestry and livestock development.

(2) Eight Aims (The Eight Point Plan) in 1973

Before the independence of PNG in 1973, the preparation of "Development Strategies for Papua New Guinea" was commissioned by the government. This became known as the Eight Aims, prepared and intended to achieve the equitable distribution of benefits and power in order to reduce potential political disruption. This was based on the understanding that the indigenous people were increasingly being marginalised in terms of political and inclusive economic participation in the pre-independent PNG.

The Eight Aims later became popularly known as the Eight Point Plan, a statement of intent to build a peaceful and harmonious society, as well as to prosper and empower the people of PNG. The overall objectives of the Eight Point Plan are as follows:

- Increased indigenous participation in the economy;
- Equality amongst ethnic groups, gender, and areas;
- Greater attention to rural and village development; and
- Self-reliance.

(3) National Goals and Directive Principles (NGDPs) in the Preamble of the Papua New Guinean National Constitution in 1975

A Constitution was enacted for the Independent State of Papua New Guinea in 1975.

The above mentioned "Report on Development Strategies for Papua New Guinea" (usually referred as Faber Report), from which the following key points of the National Goals and Directive Principles in the preamble of the Constitution were distilled:

- Integral human development;
- Equality and participation;

[1] This section had referred to National Research Institute (NRI), 2014, The Provincial Development in Papua New Guinea: An Appraisal.

- National sovereignty and self-reliance;
- Natural resources and environment; and
- Papua New Guinean ways

(4) National Development Strategy in 1976 and National Public Expenditure Plan (NEPEP) 1978-1986

A newly established Central Planning Office embarked on the preparation of the National Development Strategy in order to operationalise the Eight Point Plan. The National Development Strategy was launched on 27 October 1976.

This was followed by the National Public Expenditure Plan (NPEP), which was designed for the period 1978-1986. The NPEP was implemented by formulating a series of five-year medium term development strategies.

(5) Development Plans Since 1986

Since 1986, the following development plans have been formulated and implemented:

- National Development Plan, 1986-1990, with a Medium-Term Development Program
- Development Plan, 1989-1997, with the 1989-1997 Public Investment Program
- Medium-Term Development Strategy (MTDS), 1997-2002, which incorporates the Medium-Term Resources Framework (MTRF)
- MTDS, 2003-2007, with MTRF, which was abandoned; and
- MTDS, 2005-2010, with 2005-2007 MTRF, which was meant to be a three-year rolling plan

For over 40 years, changes frequently have occurred to names of development plans, as well as to planning authorities. Similarly, those plan formulations, implementation and timeframes have changed.

B.1.2 National Development Framework Delineated by Papua New Guinea Planning and Monitoring Responsibility Act 2016

The current national development planning framework for PNG has been established by the enactment of the Papua New Guinea Planning Monitoring Responsibility Act 2016.

The Act stipulates the following three matters:

(1) Elements of the National Planning Framework

The national planning framework consists of the following elements:

(a) The Constitution which provides the underlying directive principles;
(b) The National Strategy for Responsible Sustainable Development (NSRSD) which prescribes the consequent development paradigm;
(c) Vision 2050 Human Development Index Objective and Its subsequent reviews;
(d) Medium-Term Development Plans (MTDPs);
(e) Sector plans;
(f) Annual budgets relating to the implementation of the MTDPs; and
(g) Any other documents made for such purposes.

(2) Cascading Manner Among Different Levels of Plans

The elements of the national planning framework shall operate in a cascading manner from above mentioned (a) to (g) in that order.

(3) Period Covered by Medium-Term Development Plans (MTDPs)

The MTDPs shall coincide with the term of each Parliament.

B.1.3 Development Plans under the National Development Framework of Papua New Guinea

(1) Vision 2050 and Development Strategic Plan (DSP) 2010-2030

In accordance with the Papua New Guinea Planning Monitoring Responsibility Act 2016, under the current Constitution and other directive principles, the following vision and development plans are to be formulated:

National Level

- Vision 2050
- PNG Development Strategic Plan (DSP) 2010 - 2030
- Medium-Term Development Plan III (MTDP III) 2018-2022
- Sector Development Plans (Medium-Term Sector Development Plans 2018-2022)

Provincial and Lower Levels

- Provincial Development Plans
- Medium-Term Provincial Development Plans
- Provincial Sector Development Plans
- District Level, LLG Level, and Ward Level Development Plans



Source: Department of National Planning and Monitoring, 2019, presented by Mr. Jeremiah Paua, Senior Economic Policy Officer, Department of National Planning & Monitoring, Papua New Guinea at Asia-Pacific Workshop on Mainstreaming the Sustainable Development Goals into Planning, Budgetary, Financing and Investment Processes, 5th-7thNovember, 2019, Bangkok, Thailand

Figure B.1.1 National Development Planning Framework for PNG, 2019

B.2 Transport Sector Policies, Strategies and Plans

B.2.1 National Transport Strategy (NTS) 2014-2030

(1) Vision set by the National Transport Strategy 2014-2030

In 2013, the PNG national government launched its National Transport Strategy 2014–2030 (NTS 2014-2030).

The National Transport Strategy (NTS) is PNG national government's 20-year framework for policy principles and priorities to guide the formulation of policies, institutional/legislative and infrastructure investment programs for the transport sector of PNG.

The following vision was set by this strategy:

> "A well-integrated, competitive, safe, affordable, financially and environmentally sustainable transport system that efficiently serves the economy and society of Papua New Guinea"

(2) Key Goals

The NTS 2014-2030 emphasizes PNG's the following key goals to seek the above-mentioned vision.

- To restore the national transport network
- To fully fund maintenance as far as possible from user charges
- To deliver a safe and secure transport system for users and the public
- To mitigate or avoid adverse social, health and environmental effects of transport
- To develop new infrastructure to serve national and provincial priorities where economically viable and within financial and capacity constraints
- To provide better Government institutional structures to deliver transport infrastructure and services
- To strengthen human resource capacity of the Government transport agencies
- To develop capacity and capability of PNG national enterprises in the transport sector
- To bring 95% of the population within easy reach of all-weather transport access
- To provide transport access to 95% or more of developable agricultural land
- To provide well planned regulated and operated traffic networks and urban public transport systems in the major cities

(3) Policies set by NTS

For the purpose of achieving the key goals set by the NTS, the following set of aspects and policies are covered by the NTS:

- Transport Demand and Outlook for Growth
- Overall Sector Policy
  - Public and Private Sector Roles
  - National, Provincial and Local Level Government Roles
  - Market Entry and Competition Regulation
  - Cost Recovery and User Charges
  - Priorities for Call on Available Funds
  - Community Assistance, Subsidies and CSOs
  - Transport Corridor Protection and Land Acquisition
  - Service Quality Standards and Monitoring
  - Transport Safety

  - Transport Security
  - Transport Integration
- Policy for Cross-Cutting Issues
  - Good Governance and Policies against Corruption
  - Environmental Protection and Enhancement
  - Climate Change
  - Poverty Alleviation
  - Gender Equality and Women's Development
  - Communicable Disease Control, HIV/AIDS
- Policy on Institutional Reform
  - The Need for Reform
  - Principles for Institutional Reform
  - Delegation and Outsourcing of Functions
  - Roles and Functions of the Government Transport Agencies
  - Role of Oversight and Regulatory Institutions
  - Role of Special Purpose Infrastructure Development Agencies
  - Public-Private Sector Coordination
  - The National Budget Process
- Policy for Land Transport
- Policy for Maritime Transport
- Policy for Air Transport
- Policy for Modal Integration
- Policy on Sector Capacity Building
- Supporting Legislative Programme
- Transport Infrastructure Investment

(4) NTS 2014-2030 and Medium Term Transport Plans

The National Transport Strategy (NTS) documents are composed of the following three volumes:

- Volume 1 – National Transport Strategy Summary
- Volume 2 – The Medium Term Transport Plan, 2014-2018
- Volume 3 – Detailed National Transport Strategy

The NTS is to be supported by succeeding 5-year Medium Term Transport Plans (MTTP) for achieving the vision. In actuality, MMT for 2014-2018 and MTTP2 for 2019-2022 period are aligned with the NTS.

B.2.2 Medium Term Transport Plan 2 (MTTP 2) 2019-2022

(1) Introduction

For achieving the outcomes set by MTDP III, the MTTP 2 is designed to set national transport investment priorities.

MTTP2 is composed of the following two volumes:

- Volume 1 – Strategic Framework
- Volume 2 – Implementation Plan for Transport Sector Agencies

The implementation plan is equipped with the goal of achieving national-level outcomes in line with development priorities.

(2) Funding Capacity Considerations: Funding Ceilings

The transport sector over the recent years had received funding below the value amount of the total projects submitted for funding each year through the budget process. This has resulted in a widening gap between the MTDP requirements and project funding, particularly since the introduction of the funding ceilings. The funding of transport sector projects is increasingly dependent on development partners' loans and grants.

(3) Funding Requirements

The transport sector has a large and long list of priority projects, which the government of PNG does not have any sufficient funding capacity to deliver. This situation poses difficulties to implement transport sector plans to achieve the development goals by necessary investment in transport infrastructure. There has been a significant shrinking in the allocated budget for the transport sector in both capital and operational funding, particularly in 2015 and beyond.

Priority projects identified by sector agencies will be submitted to DOT's transport sector team for prioritization and submission to the central agencies. They prioritize again and allocate funding if it is in line with the sector requirement.

In the transport sector, 132 priority projects in total for achieving the outcomes of MTDP III were submitted by the transport sector agencies to DOT for seeking inclusion in MTTP 2. In comparison of the 2019 appropriation capital against the estimated total capital to complete the priority projects over the next five years, there will be a large funding shortage.

B.3 PNG WaSH Sector Policies, Strategies and Plans

B.3.1 PNG Water, Sanitation and Hygiene (WaSH) Policy 2015

(1) Goal of the National WaSH Policy

The goal of the National WaSH policy is to contribute to the improvement of the quality of life, more specifically to the following three aspects:

- Reduction in morbidity and mortality caused by water-related diseases.
- Improved livelihood opportunities and economic growth through improved health and reduced economic and financial losses.
- Increased equity of services between rural, peri-urban and urban areas, and to disadvantaged groups.

(2) Objectives of the National WaSH Policy

The objectives of the WaSH policy are as follows:

- To provide equitable access to safe, convenient and sustainable water supply and sanitation and
- To promote improved hygiene practices and long-term hygiene behaviour change at the personal, household, community and institutional level,
    - Particularly to rural and urban settlement areas that are currently under-served.

(3) Targets of the National WaSH Policy

For achieving the objectives above mentioned, the policy will be implemented by taking actions against the following targets to be achieved by 2030:

<u>Targets for Water Supply by 2030</u>

- In rural areas, 70% of the population has access to a safe, convenient and sustainable water

supply.

- In urban areas, 95% of the population has access to a safe, convenient and sustainable water supply.
- 100% of educational institutions and medical centres6 across the country have access to a safe, convenient and sustainable water supply.

Targets for Sanitation by 2030

- In rural areas, 70% of the population has access to safe, convenient and sustainable sanitation facilities.
- In urban areas, 85% of the population has access to safe, convenient and sustainable sanitation facilities.
- 100% of educational institutions and medical centres have access to safe, convenient and sustainable sanitation facilities.

Targets for Hygiene by 2030

- 100% of educational institutions and medical centres have hand washing facilities with running water and soap.
- 100% of the households that have access to an improved water supply practice total sanitation.

(4) Seven Strategies of the National WaSH Policy

This policy document of National WaSH Policy aims to accelerate the services delivery, particularly to rural, peri-urban and settlement areas to achieve the policy targets. It will achieve this by implementing the following seven strategies:

- Strategy One: Improved Sector Coordination and Leadership
- Strategy Two: Increased WaSH Sector Funding
- Strategy Three: Develop and Implement an Effective Management Information System for the WaSH Sector
- Strategy Four: Improved and Consistent Approaches to WaSH Service Delivery
- Strategy Five: Appropriate Technology Promotion
- Strategy Six: Enhanced Private Sector Participation and Partnerships
- Strategy Seven: Increase Sector Capacity Building and Training

B.4 National Energy Policy 2017 - 2027 (NEP 2017-2027)

(1) Overview of the Energy Sector of PNG: The Importance of Renewable Energy Sector

The energy sector is supported by two energy sources. The one is fossil fuels, such as petroleum, natural gas and coal. The other is renewal energy (including hydro, geothermal, solar, wind, tidal wave, ocean current, and biofuel).

The energy sector accounts for about 14% of the GDP of PNG through the development and exporting of LNG. The renewable energy sector is expected to contribute to increase in GDP, enhance energy security, mitigate climate change, generate income, create employment, and generate foreign exchange savings under the National Energy Authority of Papua New Guinea (NEA) which the Government intend to establish as agency for development of renewable energy resources.

The National Energy Policy is designed to find “a balance between making PNG an attractive investment destination for exporting energy (in the form of LNG) to energy hungry world and at the same time promoting PNG’s economic development based on low energy cost.

(2) Overall Objectives of the National Energy Policy

The overall objective of the National Energy Policy is "to ensure an affordable, competitive, sustainable, and reliable supply of energy to meet national and provincial development needs at the least cost while protecting and conserving the environment." For this aim, the "National Energy Policy 2017-2027" was established in 2017 as a basis for developing the energy sector.

(3) Principles of the National Energy Policy

The policy principles are strategically set from a viewpoint of society, economics, environment, and energy security, as shown in Table B.4.1.

Table B.4.1 Principles of NEP 2017-2027

No.	Principle	Viewpoint
1	Strengthen institutional capacity and recruit appropriate human resources to manage the energy sector	Society
2	Develop an integrated planning process for sustainable energy supply and utilization	Society
3	All energy resources will be developed by the State for the betterment of all citizens	Society
4	Promote a conducive environment for long-term sustainable economic solutions in the supply of all energy sources	Economics
5	Encourage involvement of the private sector in the development and provision of energy infrastructure and services	Economics
6	Ensure energy resources are developed and delivered in an environmentally sustainable manner	Environment
7	Promote efficient systems and safety in energy supply in all sectors (transport, residential, commercial, industrial, and agriculture)	Environment
8	Diversify the cost-effective development and utilization of energy resources for the nation's well-being and economic prosperity	Energy Security
9	Promote energy efficiency and conservation measures and wise use of energy	Energy Security

Source: NEP 2017-2027

(4) Issues on Energy Sector

The Government recognises the following items as issues on energy sector and plans to enhance the development, operation and maintenance of energy infrastructure and delivery systems by supporting Public Private Partnerships.

- Energy infrastructure development.
- Energy sector environmental disaster mitigation, response and recovery.
- Hydro risk mitigation.
- Energy efficiency and conservation programmes and
- Promotion of renewable energy initiatives

(5) Electricity Supply

In terms of electricity supply, only 13 percent of the households are connected to electricity. On the other hand, electricity demand has increased since 2011 due to accelerated economic growth, especially in Lae, Port Moresby and Gazelle area where energy intensive activities such as mining, infrastructure developments, new LNG facilities, commercial and residential building constructions are increasing in the short to medium term. Several key generation projects exist to meet this increasing demand in PNG, which include a geothermal energy project in Rabaul.

(6) Three Major Transmission Networks: Port Moresby, Lae and Gazelle

The PNG's existing transmission network depends on the three major systems in Port Moresby, Lae and Gazelle (in ENBP) and is expected to be extended to improve network coverage based on the National Electricity Rollout Plan (NEROP). PNG Power is conducting transmission projects for developing a robust grid system.

(7) Economic Corridors and Energy Development Planning

Energy development planning is based on the ten economic corridors as per the PNG-DSP 2010-2030, which includes South Coast Corridor targeting East New Britain and West New Britain.

It is pointed out that transmission infrastructure is weak, inadequate and poorly integrated as one of challenges of power supply in PNG. The Government intends to invest the development of the national transmission system to enhance affordability and enhance transmission infrastructure.

(8) Poor Redundancy and Aging Infrastructure of PNG's Distribution Networks

It is also problems of PNG's power supply system that distribution network with restricted redundancy and aging installations causes frequent and prolonged supply interruptions. To reduce power supply interruptions and improve the quality of supply service, the Government has a strategy to eliminate overhead distribution systems gradually.

Appendix C Review of Existing Provincial Development Plans

C.1 Introduction

C.1.1 Objectives of Reviewing and Evaluating Existing Provincial Development Plans

In this chapter, past and existing provincial development plans are reviewed and evaluated for identifying problems to be solved in methodologies of provincial-level development planning, and for understanding points to be revised in strategies embedded in the provincial development plans.

By getting some lessons learnt from this exercise, it is expected that the JICA Expert Team together with the PNG counterpart team will be able to formulate a ten-year infrastructure development plan more implementable for the Northeast Gazelle Peninsula.

C.1.2 Existing Provincial Development Plans to Be Reviewed

In this chapter, the following three provincial-level development plans are reviewed and evaluated:

- Economic Development Plan for East New Britain Province (ENBP-EDP 2003-2030)
- Strategic Development Plan for East New Britain Province (ENBP-SDP 2011-2021)
- Infrastructure Sector Development Plan for East New Britain Province (ENDP-ISDP 2014-2018)

These development plans were formulated by ENBPA, with support from some foreign advisors, for seeking prosperous and sustainable development beyond the restoration phase after the 1994 volcanic eruptions.

C.2 Provincial Development Planning in Papua New Guinea: An Appraisal

(1) Background of the Appraisal of Provincial Development Planning in PNG

"Provincial Development Planning in Papua New Guinea: An Appraisal" is Discussion Paper No. 128, written by Agogo Mawuli and Osborne Ogis Sanida and published by the National Research Institute (NRI) in 2014.

The NRI is an independent government research authority, established in 1998, on social, political, economic, educational, legal, environmental, and cultural issues and problems of Papua New Guinea.

(2) Study Objectives

The study had the following three objectives:

- [The First Objective] To determine the extent of planning for the different types of provincial development plans;
- [The Second Objective] To analyse the contents of the provincial development plans in order to determine the soundness of planning; and
- [The Third Objective] To examine the constraints that have impeded the planning, implementation and monitoring of the provincial development plans.

(3) History of Provincial-Level Development Planning in PNG

PNG's practice of provincial-level development planning dates back to the early 1980s. However, when the *Organic Law on Provincial Governments and Local-Level Governments* (OLPG&LLG) was enacted in 1995, preparation of provincial-level development plans became a legal/constitutional requirement for the provincial governments.

However, many provincial governments had not complied with this constitutional requirement satisfactorily more than a decade after its enactment in 1995.

(4) Findings: Results of the Study, Analysis and Conclusions with Respect to the Three Objectives

1) Findings and Conclusion for the First Objective

[The First Objective of this Appraisal] To determine the extent of planning for the different types of provincial development plans

With respect to the first study objective, the conclusion was that there was a low level of actual planning in the provinces which prepared all the six types of plans: provincial long-term plans (PLTPs), provincial development plans (PDPs), provincial sector plans (PSPs), cross-cutting plans (CCPs), corporate plans (CPs) and annual activity plans (AAPs).

2) Findings and Conclusion for the Second Objective

[The Second Objective of this Appraisal] To analyse the contents of the provincial development plans in order to determine the soundness of planning

In relation to the second study objective, the following comments and evaluations were done after analysing the contents of two types of plans, namely, Provincial Development Plans (PDPs, five-year, rolling) and Provincial Sector Plans (PSPs):

- Poor documentation of the planning process;
- Inadequate documentation of the provincial and sector profiles;
- Inadequate specification of the mission, vision and values;
- Inadequate specification of the plan objectives;
- Poor formulation of the implementation plans; and
- Poor specification of the monitoring, evaluation and feedback protocols.

3) Findings and Conclusion for the Third Objective

[The Third Objective of this Appraisal] To examine the constraints that have impeded the planning, implementation and monitoring of the provincial development plans

With respect to the third objective, the major constraints which were expressed by key informants in this appraisal were as follows:

- Lack of a formal planning process;
- Lack of data collection and weak information management;
- Lack of resources;
- Poor monitoring and evaluation;
- Poor intra-plan linkages;
- Poor inter-plan linkages;
- Lack of synergy in the plan life cycle;
- Lack of networking and coordination; and
- Lack of political and administrative support.

C.3 Perspectives in Reviewing and Evaluating Existing Provincial Development Plans

The JICA Expert Team examined the three provincial-level development plans from the following perspectives:

- If alternative overall regional development strategies/scenarios have been formulated or not in those plans
- If alternative regional spatial structures (spatial patterns) have been considered or not in those plans
- If prioritisation of projects proposed by those plans have been conducted or not
- If phased development is proposed by those plans or not
- If appropriate scale of costs is estimated for the proposed projects in those plans
- If the formulated development plans, strategies and projects have been explained or proposed to national-level sector departments or sector state-owned enterprises for implementation or not

C.4 Review of Economic Development Plan for East New Britain Province (ENBP-EDP 2003-2030)

C.4.1 Background

(1) 1986 ENBP Integrated Development Plan

Having obtained a provincial status in 1978, ENBPA tried a shift from sectoral planning to provincial development planning at the provincial level. However, at that time, there was a lack of clarity in provincial development planning because most divisions of provincial governments were still aligned with mother (national) departments.

In 1986, ENBP formulated and adopted a "Provincial Integrated Development Plan" to reflect needs of ENBP in the long-term and to ensure coordination in development planning. This Plan only provided the framework for sectoral planning (or divisional planning) that divisions were to undertake in the midterm (5-10 years). The Plan contained 7 major strategic objectives with respective implementation (specific) strategies as follows:

- Making Optimal Use of Available Resources
- Promoting Economic Development Through Primary and Secondary Processing
- Encouraging Community Participation and Promoting Family Life
- Making Rural Life More Attractive
- Lessening Disparities
- Improving Effectiveness of Community Governments
- Minimising Problems on Law and Order

In 1986, ENBP formulated an Integrated Development Plan for promoting the development of regional economies which were strongly oriented to downstream processing and manufacturing industries. However, it was evaluated that little progress was made as of 2003.

(2) Formulation of East New Britain Provincial Economic Development Plan 2003-2033 (ENBP-EDP 2003-20033)

East New Britain Provincial Economic Development Plan 2003-2033 (ENBP-EDP 2003-2033) was formulated to indicate a roadmap beyond the reconstruction stage after the last volcanic eruption in 1994. Its formulation and approval took 27 months from 2001 until 2003.

The document of the NEBP-EDP described a future vision, principles and development objectives to be pursued and strategies and projects/activities to be implemented by the provincial government in collaboration with private sectors, in the next 30 years.

The document comprised of five volumes and 24 chapters.

C.4.2 Visions of ENBP-EDP 2003-2030

Based on the evaluation result of the above-mentioned 1986 Integrated Development Plan, the previous "future vision for ENBP" was revised and a new vision statement was adopted for ENBP Provincial Economic Development Plan 2003-2033.

In order to have an open progressive society and a strong robust economy, in which people could live safe and fulfilling lives by utilising potentiality of people and resources in East New Britain Province, the following future vision was set for ENBP-EDP 2003-2030:

> *To create diversified economies including manufacturing and service industries (including tourism) based on strong agriculture and other primary industries.*

C.4.3 Development Objectives of ENBP-EDP 2003-2030

(1) Coverage of Sectors and Aspects in ENBP-EDP

Development objectives cover the following sectors and aspects in four districts of ENBP:

- 14 Economic Sectors
  - Agriculture-Livestock
  - Fisheries
  - Forestry
  - Commerce
  - Manufacturing
  - Tourism
  - Mining
  - Electricity/Gas/Energy
  - Construction
  - Wholesale/Retail
  - Communications
  - Property/Business
  - Culture/Entertainment
  - Human Resources/Other Services
- Infrastructure Sectors
  - Roads and Bridges
  - Maritime Transport
  - Air Transport
- Other Aspects
  - Social and Culture
  - Land
  - Natural Resources and Environment
  - Organisations

(2) Development Objectives of ENBP-EDP

The ENBP-EDP 2003-2033 identified the following 13 points of development objectives concerning the overall economy of ENBP:

- To create a favorable and business-friendly environment in East New Britain that will enable the private sector to expand and further strengthen
- To develop a comprehensive economic path that will provide guide to resource allocation and distribution for the benefit and welfare of the people of East New Britain
- To diversify the agriculture base of the East New Britain economy and promote manufacturing and service industries
- To enhance effective dialogue among various stakeholders in East New Britain to create environment for partnership between the public and private sectors for future economic investment
- To reduce the expenditure on consumption goods and encourage people to invest on capital goods
- To promote cooperation among all stakeholders in East New Britain to contribute to the sustainable management of natural resources on the part of basic users
- To give emphasis mainly to road infrastructure covering both maintenance and the opening-up of remote regions for greater involvement of the people of East New Britain to sustain existing level of development and venture in advanced commercial areas
- To develop an environment that is conducive to business entities including the formal and informal sectors
- To develop and coordinate institutional capacity building for all employees working in both public and private sectors
- To improve trade position and unleash trade imbalances so that the region can abate internal constraints, and face and overcome external challenges
- To create an enabling environment that encourages microenterprises as they also contribute to the economic growth of the region
- To encourage and promote greater local participation in tourism industry in the New Guinea Islands region
- To have a reliable and efficient transport system withstanding all-weather type conditions for delivery of goods and services

C.4.4 Projects and Implementation Situation for ENBP-EDP 2003-2030

In this development plan, over 150 projects were identified for the economic sectors, infrastructure sectors, as well as for different districts.

Some of the projects identified by the ENBP-EDP 2003-2033 are also positioned as important projects in the ENBP-SDP 2011-2021. By doing so, the development policies and strategies proposed by the ENDP-EDP are linked to the ENBP-SDP.

C.5 Review of Strategic Development Plan for East New Britain Province (ENBP-SDP) 2011-2021

C.5.1 Background

(1) ENBP Strategic Development Plan (ENBP-SDP) 2011-2021

The ENBP Strategic Development Plan (ENBP-SDP) was a major policy framework to guide its sectoral plans and programmes. This Provincial Development Strategic Plan focused on the ten-year period 2011-2021.

The 1994 volcanic disaster changed the long-term plan and directed the provincial and national governments' efforts at restoration from the volcanic disaster. The restoration programme was supported by international development partners, as well as by the national government.

The programme was managed by the Gazelle Restoration Authority (GRA). As part of this programme, the following studies and development plans were formulated:

- ENBP Disaster Risk Report 2001, which identifies all forms of risks that are likely to cause natural disasters and identified the likely locations.
- ENDP Economic Development Plan 2003-2033, which outlines the strategy to build the provincial economy in order, to ensure long-term sustainability of all development brought about by the MTRP and through normal government programmes.
- Urban Regional Development Plan 2006, which outlines a strategy for urban development in the Kokopo/Tokua Corridor, and the Growth Centre Hierarchy Strategy. This Growth Centre Strategy identified growth centres to be developed (in order to spread the risks of future disasters) and to establish service centres closer to the rural majority.

The ENBP-SDP 2011-2021 was formulated by ENBPA based on the above study and development plans.

(2) Rationales and Needs for Formulating the ENBP Strategic Development Plan 2011-2021

The ENBP-SDP 2011-2021 was formulated in response to the following rationales and needs for this Strategic Development Plan:

- The need to adequately streamline all policy changes being undertaken both at the national and provincial levels into a coordinated set of strategies to impact on the way the province allocate its limited resource for the purpose of delivering services.
- The need to map out in the medium term, a strategic direction as guiding principles for provincial annual planning that will ensure sustainability in the long term.
- The need to integrate the 4x District and 18x LLG plans into a single set of organised annual plans and programmes that can be the basis for decision-making and budgeting.
- The need to strategically engage with the private sector as part of the Private-Public Partnership Policy. This is based on the need to grow a local economy driven by the local business community which should ensure economic efficiency.

(3) Vision Set by the ENBP Strategic Development Plan 2011-2021

In the ENBP-SDP 2011-2021, the vision for ENBP is as follows:

> "*ENB to have an educated, healthy and wealthy people living in a socially peaceful and wise community*"

This vision is set for the following reasons:

- For the socioeconomic prosperity of the people of ENBP
- The plan (ENBP-EDP) recognises the important role of economic sectors in the development of ENBP.
- The plan will build upon that strength so that the sector is better placed to support an industrial sector and service sector.
- The agriculture sector should be prepared and its activities are re-oriented from primary production to secondary sectors (processing sectors).
- The Northeast Gazelle Peninsula will be the centre to provide services to support industrialisation (development of processing industries).

- By implementing the ENBP-SDP, the vision is sought "to firstly sustain and improve the level of development brought about by the restoration programme" after the 1994 volcanic eruptions and, secondly, to improve poor indicators of delivering all services including health and education, as well as life expectancy and academic performance.

C.5.2 The Long-Term Strategic Objectives (Seven Pillars)

The ENBP-SDP covers 16 sectors and integrates all plans and policies at the national, state, district and LLG levels, by articulating strategic objectives and strategic policies to be implemented over the 10-year period 2011-2021. In the ENBP-SDP, the following seven strategic objectives (seven pillars) are selected and set for long-term development beyond the 10-year planning period for the ENBP-SDP:

- Making Optimal Use of Available Resources
- Promoting Economic Development Through Primary and Secondary Processing
- Encouraging Community Participation and Promoting Family Life
- Making Rural Life More Attractive
- Lessening Disparities
- Improving the Effectiveness of Local-Level Governments
- Minimising Problems on Law and Order

The first two pillars are closely related to the economic development strategies and spatial development strategies in the region (Northeast Gazelle Peninsula).

Key features of the seven strategic objectives (seven pillars) are summarised as follows:

1) Making Optimal Use of Available Resources

To make sure that all resources (including finance, human, land, marine, etc.) are better managed, so that there is efficiency in their usage

2) Promoting Economic Development Through Primary and Secondary Processing

To continue to develop and improve primary production for the purpose of promoting downstream processing and industrialisation in the areas

3) Encouraging Community Participation and Promoting Family Life

To empower the people to be active participants in the development of the province, and to build upon very strong family units which are prepared to live independently within stable communities

4) Making Rural Life More Attractive

To focus on rural development targeting the majority of rural dwellers

5) Lessening Disparities

To ensure that there is equitable distribution of development benefits to all regions of ENBP – Pomio, Qaqet and the Gazelle Peninsula

6) Improving the Effectiveness of Local-Level Governments

To enable ENBP to improve capacity of the LLGs and other institutions as focal points for service delivery

7) Minimising Problems on Law and Order

To streamline the programmes of all sectors to integrate law and order, although law enforcing agencies are required to maintain their functional responsibilities

C.5.3 The 24 Points of Strategic Direction

In ENBP-SDP, 24 points of strategic direction are set for guiding and implementing programmes and projects, as shown in Table C.5.1. These points have been determined in policy and planning discussions at different government levels. They provide directions in policies and strategies by which to guide programmes and projects for implementation.

Table C.5.1 The 24 Points of Strategic Direction in Various Sectors in ENBP-SDP 2011-2021

No.	Sectors	Points of Strategic Direction
1	Primary Sectors and Secondary Sectors	Re-orient and further develop the primary sectors to support an industrial, manufacturing and service sectors.
2	Furniture, Fisheries, and Business Industries	Establish furniture, fisheries and business industries using resource that are abundant in this province.
3	Balsa, Coffee, and Spices	Develop balsa, coffee and spice industries in the periphery of the North East Gazelle to support industrialisation.
4	Downstream Processing Industries	Carry out feasibility studies on crops that can be downstream processed in ENB.
5	Cocoa Processing	Facilitate the establishment of a cocoa processing facility in Kokopo.
6	Oil Palm and Mills	Facilitate the development of the three (3) oil palm projects and mills in the province (Illi/Wawas, Memalo and Mukus/Melkoi)
7	Fisheries Storage Facilities	Facilitate fisheries storage facilities to assist in fisheries trans-shipment at Toboi.
8	Fish Fillet	Facilitate the Kabakaul Integrated Project to commence fish filleting.
9	Parks and Botanical Gardens	Develop a Provincial Park and 4x District Botanical Gardens.
10	Port Location	Carry out survey and investigation for possible international seaport sites (including Putput, Vudal, Vunapalading Bay and Kurakakaul as alternate international seaports).
11	Training and Credits	Support to establish business training and credit facilities for our people, using the Personal Viability (PV) concept.
12	Tourism	Aggressively pursue tourism development through a comprehensive Tourism Development Model.
13	Credits	Build a self-reliant population by creating a policy environment for credit facilities to be granted to people who are members of respective cooperative societies and/or community associations.
14	Human Resources	Convert our human resource base to be economically viable.
15	Public Service Manpower	Reduce the public service manpower by 40% and outsource those functions that the private sector can undertake in a cost-effective manner.
16	Arable Land	Convert excess arable land to be an economic factor of production rather than inheritance.
17	Health Sector	Design an insurance cover policy in order to improve health, and change the health sector from being a service sector to that of an industry.
18	School Education	Design a strategy to immediately improve academic performance of grade 8, 10 and 12.
19	Conservation Areas	Facilitate the immediate gazettal of Kavakuna and Muruk Conservation Areas and the Nanuk and Talele Islands Management Areas.
20	Government	To have a functional autonomous government by 2021
21	Import Replacement of Products	Import replacement of products that can be economically produced locally.
22	VCT	To make VCT (Voluntary Counselling and Testing) accessible to ENB population
23	New Britain Highway	Facilitate the progress of the New Britain Highway.
24	Geothermal Energy	Facilitate geothermal energy development in the province.

Source: ENBPA, 2011, ENBP Strategic Development Plan (ENBP-SDP) 2011-2022

C.5.4 Review of Situation of Implementation of Identified/Proposed Projects in ENBP-SDP 2011-2021

A review of the status and progress of implementation of the projects proposed in the ENBP Strategic Development Plan 2011-2021 was done in the formulation study for detailed plan for NEGID-Plan in 2017.

In August 2022, this review was updated by PIU members of ENBP. The result of the updated review is shown in Table C.5.2.

Table C.5.2 Updated Review of the Projects Proposed in the ENBP Strategic Development Plan 2011-2021

	Sector	Name of Project	Location	Situation of Project Implementation
1	Airport	Vunakanau Emergency Airport Project	Vunakanau Airport	The target area of this project was changed to Tavilo. Due to concerns about volcanic eruption, candidate sites other than Tokua Airport have been discussed, but no concrete action has been taken.
2	Health	Nonga (Specialist Referral) Hospital Relocation to Putput Project	Nonga	The project is planned as a Regional Hospital in Wairiki. The location of the project is not Putput.
3	Community Development	ENB Multi-sport Facilities Project		This project was completed.
4	Road	ENB Dirt and Sealed Road Prorgramme		The progress of this programme is unknown.
5	Administration	Civic Centre Project	Kokopo	This project is under implementation. The selection process of a contractor is underway.
6	Industry	ENB Provincial Fisheries Construction Project-Kabakaul	Kabakaul sea	The pier used by fishing boats and the Kabakaul fish processing plant is no longer in use. Instead, a feasibility study was conducted for a project on a new fishery processing plant in Rabaul. The Government of PNG approved the Rabaul Tuna Processing Economic Zone planned next to Rabaul Port as one of the pilot projects for free-trade zone.
7	Education	ENB Library Support Programme	Kokopo	This project will be included in the Civic Centre under construction.
8	Social	ENB Cultural Centre Project	Not identified	Land is available between Kokopo and Tokua. However, the project has not been implemented.
9	Electricity	Rural Electricity Programme	Rural area	This project is on-going. Data integration with PNG Power is required to get a complete picture of the project.
10	Water supply	Rural Water Supply Bores Programme	Rural area	No special activity has been done. Kokopo District and Rabaul District suffer water shortages during the dry season.
11	Road	New Britain Highway Expansion	New Britain Highway (from Gaulim to northwest)	The road from Billo needs improvement as it is an earth road.
12	Administration	Land Acquisition Programme – ENBPG Plantations		This project is under implementation.
13	Bridge	ENB Provincial Bridges Programme	Whole ENB, especially Northeast Gazelle	At present, the inventory of roads and bridges is under implementation.
14	Airport	International Airport Development	Tokua Airport	A feasibility study for upgrading the existing Tokua Airport was conducted. However, the financial assistance for the implementation of the project has not been decided.
15	Administration	Relocation of Kokopo Police Barack	Kenabot	This project has not been implemented.
16	Regional Development	Illi-Wawas IRD Programme	Mevelo	The implementation situation of this project is unknown.
17	Regional Development	Illi Stand Alone IRD Programme	Not identified	The implementation situation of this project is unknown.
18	Regional Development	Toriu Headwaters IRD Programme	Toriu	The programme has been implemented, and cacao farms are operational.

	Sector	Name of Project	Location	Situation of Project Implementation
19	Regional Development	Sigite- Mukus IRD Programme	Not identified	The implementation situation of this project is unknown. Many palm oil plantations have already been developed.
20	Regional Development	Mukus-Melkoi IRD Programme	Not identified (Melkoi)	The implementation situation of this project is unknown.
21	Industry	Ulaveo Industrial Centre Project	Ulaveo	Ulaveo and Takubara IDCs were completed. However, infrastructure development has not been sufficient.
22	Corridor	Kokopo/Tokua Corridor Development Project	Kokopo area	A sewage treatment plant was constructed as part of the Kokopo-Tokua Corridor. Other interventions have not been implemented.
23	Tourism	Tourism Development Programme	Kokopo-Tokua	Hotel development is underway near Tokua.
24	Urban Development	Kurakakaul Urban Development Programme	Kurakakaul	Land is being subdivided in Kurakakaul Area.
25	Education	Vunamami ENB Technical College Project	Vunamami	An upgrade from a vocational school to a technical college was considered. However, it has not been realised.
26	Social	Resettlement Programme		The project implementation situation is unknown.
27	Physical Plan	Growth Centre Development Programme	ENBP as a whole	Physical development plans will be formulated for Open Bay Area and Keravat Area, which have been designated as growth centres.
28	Economic Sector	Cacao and Coconut Rehabilitation	ENBP as a whole	This project is under implementation.
29	Economic Sector	Cocoa Processing Plant Feasibility Study		This project has not been implemented.
30	Economic Sector	Livestock Development Project	Kokopo District, Rabaul District	Although there is a demand, the project has not yet been implemented. Poultry farming should be emphasised in the project.
31	Community Development	Juvenile Centre		This project has not been implemented.
32	Community Development	Palmalmal Rural Lock Up	Palmalmal	This project was completed.
33	Administration	Rabaul Police Barrack	Kurakakaul	This project has not been implemented.
34	Community Development	Kerevat CS Major Fencing Upgrading	Kerevat	This project has not been implemented.
35	Port	International Seaport Development	Rabaul Port or other sites (Kabakaul, Kabaira, Open Bay)	The new port location has not been determined. In case of a new port in Kabakaul, land acquisition will be required.
36	Electricity	Power Generation	Urban area	The rehabilitation of Warangoi Hydro Power Plant was completed. It is necessary to consider geothermal power generation for increasing the capacity of power generation.
37	Power	Palmalmal Mini Hydro	Pomio District	This project has not been implemented.
38	Electricity	Pondo Power Station	Pondo area	No special activity is observed.
39	Community Development	Major ENB Manpower Development Programme	ENB Province	This project is under implementation.
40	Environment	New Britain Biodiversity Conservation Project	ENB Province and WNB Province	This project has not been implemented.
41	Environment	Provincial Recreation and Park Development	Unidentified	This project has not been implemented.
42	Education	Kokopo Polytechnical Collage	Kokopo	This project has not been implemented.

Source: JICA Expert Team, based on Information from PIU Officers of ENBPA, 2022

C.6 Review of Infrastructure Sector Development Plan for East New Britain Province (ENBP-ISDP) 2014-2018

C.6.1 Background

The document "ENBP Infrastructure Sector Development Plan 2014-2018" is a development framework reflecting identified needs and aspirations of the people of ENBP and the infrastructure sector. It is an implementation guide for annual planning and resource allocation in the infrastructure sector for the five-year period 2014-2018.

The ENBP Infrastructure Strategic Development Plan (ENBP-ISDP) describes the results of the top-down and bottom-up planning in reference to East New Britain Provincial Strategic Development Plan (ENBP-SDP) 2011-2021, ENB Corporate Plan 2011-2013 and Districts and Local Level Government Plans 2014-2018.

C.6.2 Vision, Mission, and Goals

Vision, mission and goals of the provincial infrastructure sector development plan are as follows:

(1) Vision

"ENB to have a Safe, Sound, and Consistent Infrastructure Service that will improve the livelihood of the people"

(2) Mission

"To organise all resources, mobilise all implementing agencies and monitor the implementation of the sector plan to elevate economic growth"

(3) Goals

"People of East New Britain must access infrastructure services promptly."

Infrastructure development are necessary for the following goals:

- A Higher Quality of Life for our People
- Full Access to all Essential Services by our People
- Enhanced ENB Multi-ethnic Way of Life
- Healthy and Health Conscious Population
- Literate, Educated, Skilled, Innovative and Self-reliant Population
- Just, Safe and Sound Environment
- Entrepreneurial and Economically Self-Sufficient (Sweat Equity)
- Socially, Spiritually and Mentally Sound Population
- Effective, Accountable, Transparent and Responsive Government
- Partnership Through Strategic Alliances
- Fair and Equitable Distribution of Resources and Shared Responsibilities

(4) Policy Resolutions to Provide a Conducive Environment for Economic Growth Through Infrastructure Development

On June 2014 during its planning workshop, the ENB Technical Services Division agreed to implement the following policy resolutions to provide a conducive environment for economic growth through infrastructure development:

- That there is a need to establish a realistic structure for the Technical Services Division-staffing consistent with the public sector reform strategy;
- That there is a need to improve relationship with the Gazelle Restoration Authority (GRA)

with a possibility to changing GRA's scope and focus to integrate ENBPA Technical Services Division;

- That there needs to be an understanding on cost sharing arrangement with Department of Works or the Gazelle Restoration Authority through a Memorandum of Understanding (MoU) and eventually a Memorandum of Agreement (MoA);
- That ENBPA Technical Services Division collaborates with the Provincial Service Improvement Programme (PSIP) Secretariat within the Finance and Administration Division on improvements of accountability on the implementation of this plan;
- That there needs to be an inventory of contractors in ENB thus open up tendering processes;
- That there needs for the Technical Services Division to produce Service Level Agreements (SLA) for all contractors;
- That there is a need for the Technical Services Division to produce an operational manual that integrates all relevant infrastructure development policies;
- That there is a need for the enforcement of contractual obligation for completion of projects;
- That there is a need to review the inventory of provincial infrastructure to make them updated and current.

C.6.3 Infrastructure Strategic Objectives

The following key objectives are to guide the ENBPA 5-year Infrastructure Sector Plan (2014 – 2018):

- To strengthen tendering and procurement processes;
- To maintain specifications and standards, and elevate infrastructure coordination and implementation to a higher level;
- To outsource infrastructure services to service providers through the Public-Private Partnership (PPP) concept;
- To work in partnership with all levels of implementing agencies in the name of Economic Growth, and these are PHQ, District, LLGs, DOW, GRA and other related organisations;
- To re-identify and strengthen the Monitoring & Evaluation concept;
- To conduct major awareness programmes on the Infrastructure Protection Act 2010;
- To identify new ways to improve current programmes and implementing techniques;
- To implement the Road Act 2010 in a big scope;
- To revitalise communication access to remote parts of ENBP;
- To implement and strengthen the Small Craft Act;
- To pursue legal actions against infrastructure vandalism offenders;
- To re-examine and assess human resource capacity by re-adjusting structures for a convenient implementation at all levels;
- To boost revenue collection by penalising infrastructure offenders through the Infrastructure Act of 2010;
- To identify resealing schedule for all sealing (pavement) works in ENBP;
- To continue to look for new ways to upstage infrastructure to the next level;
- To promote capacity development of resourced and upskilled current workforce.

C.6.4 Key Strategic Areas on Infrastructure in ENBP

Key strategic areas on infrastructure intervention in ENBP are summarised in Table C.6.1.

Table C.6.1 Key Strategic Areas on Infrastructure in ENBP

Key Indicators	Baseline Information	Issues	2021 Target/Objective
• Road network in ENB (km)	• 3,600 km • 21.88% good condition • 78.12% need improvement • (DOW/ENBPA)	• All roads are gradually deteriorating in recent years • Consideration should be based on a joint work partnership • Provincial programme to target key road networks • Joint Implementation programme ENBPA/DOW	• 100%
• Priority Roads National (km)	• 600 km • 71.43% good condition • 28.5% require improvement	• Much of the responsibilities are minimal compared to ENBPA. DOW should share some responsibilities if funding is available.	• ENBPA - 70% • DOW - 30%
• Priority roads Provincial (km)	• 3,000 km • 12% good condition • 88% require improvement	• District Roads Supervisors not responsible for major road works in their districts that are to be scoped, documented and tendered	• 4x major road works/ year/ district • 40xmajor road works by 2021
• Usable Bridges • Unused Bridges	• 35 within Gazelle area • 2 in Pomio (Matale and Unung)	• There needs to be maintenance on priority bridges that link economic routes. The 2 unused bridges in Pomio require urgent maintenance.	• All bridges be refurbished 100%
• Usable Airstrips • Unused Airstrips	• 83.34% • 16.66%	• All located in Pomio, the district should reopen a couple more airstrips because of the difficulties faced in getting to the nearest airfield	• 100%
• Usable Jetties • Unused Jetties	• 85.34% • 14.28%	• Some usable jetties are in need of major upgrading whilst the unused should be considered special projects.	• 100%
• Building and Public Utilities	• 60% of all buildings in bad condition • ENB Radio Network down by 80% • Enforcement of sea transport policies down by 90%	• Lack of funds for maintenance • Lack of communication to outstations within sectors • Increasing number of sea unworthy small crafts	• Maintain 100% by 2021 • Improve by 100% • Improve by 100%

Source: ENBPA, 2011, ENBP Infrastructure Sector Development Plan (ENBP-ISDP) 2014-2018

C.6.5 Priority Programmes and Projects for ENBP

The 29 priority programmes and projects identified in the ENBP Infrastructure Sector Plan are listed with brief project description in Table C.6.2.

Table C.6.2 Priority Programmes and Projects for ENBP

No.	Project	Sector	Funding Source	Cost (K)	Brief Description/ Status
1	Vunakanau Emergency Airport Project	•Infrastructure-Transport •Lands	•GoPNG •ENBPA	15 million	At the start of 2009, the continuous ash fall from Tavurvur Volcano went on for more than two days that normally experienced in the last 15 years. It continued for nearly a month. This prompted the ENB Provincial Executive Council to approve Vunakanau as an alternative emergency airport, for short term and for emergency use when Tokua Airport is closed because of continuous ash fall. It can be developed to take Dash 8 or Twin Otter aircraft.

No.	Project	Sector	Funding Source	Cost (K)	Brief Description/ Status
2.	Nonga Base Hospital Relocation to Kuraiba Project	•Infrastructure •Health	•GoPNG •ENBPA	150 million	The Provincial Government has made a decision to relocate Nonga Base Hospital to a safer area in the Gazelle District. Land has been identified and the Provincial Government and the National Department of Health are working together to move this project forward. Nonga Base Hospital is a regional Referral Hospital which serves not only ENB Province but New Guinea Islands as well.
3	ENB Multi-sport Facilities Project	•Infrastructure •Community Development •Lands	•GoPNG •ENBPA	250 million	The ultimate goal of the project is to restore back the sporting facilities that were destroyed during the twin volcanic eruptions and to have a modern provincial sporting complex that can cater for national and international games. Land has been secured (200 hectares of mission land).
4	ENB Dirt and Sealed Road Programme	•Infrastructure	•GoPNG •ENBPA	357.53 million	The ultimate goal of the project is to improve the accessibility of the existing Provincial Seal and Dirt Roads through Rehabilitation, Reconstruction, Renovation and Improvement of existing seal pavement condition, and construct drainages and upgrade and seal existing dirt roads.
5	Civic Centre Project	•Infrastructure •Administration	•ENBPA	45 million	The ultimate goal of the project is to improve the efficiency and effectiveness of the Provincial Government and its Administration's machinery through the building of Government Office Complex at Kokopo, the Provincial Capital of ENB Province. The building will be the icon and restore the seat of the government of the province.
6	ENB Provincial Fisheries Construction Project - Kabakaul	•Infrastructure •Economic sector (fisheries)	•GoPNG •ENBPA	5 million*	The ENB Provincial Fisheries Project aims to improve the overall economy of the province by facilitating the construction of facility that will be built in the Province. This is to improve and have a reliable cool storage facility that will attract local and overseas markets through the construction of a Provincial Cool Room storage facility and construction of Raft Boat Building Yard and wharf infrastructure.
7	ENB Library Support Programme	•Infrastructure •Education	•GoPNG •ENBPA	10 million	The Province had a Public Library in Rabaul Town that was destroyed by the 1994 volcanic eruptions. The current primary schools in ENB are very much lacking in library support in terms of book supply and library buildings.
8	ENB Cultural Centre Project	•Infrastructure •Economic sector (tourism)	•GoPNG •ENBPA	10.4 million	The ENB Cultural Centre's overall objective is to promote and preserve the culture of the different ethnic and cultural groups of East New Britain and, at the same time, promote economic development and prosperity of the province. The project will involve the construction of 800m fenced facility as well as construction of earth mould, cultural villages, public toilets, stalls and lightings.
9	Rural Electricity Programme	•Infrastructure	•GoPNG •ENBPA	8 million	The ultimate goal of the project is to improve the living standard of rural people through the provision of electricity to the rural communities and government-approved Growth Centres. The Rural Electrification Programme is having a positive impact on the provincial economy. It is enabling the people in the rural areas to set up small businesses like petrol stations, tyres services, sawmilling, small garages for repair of vehicles, just to name a few.

No.	Project	Sector	Funding Source	Cost (K)	Brief Description/ Status
10	Rural Water Supply Bores Programme	•Infrastructure	•GoPNG •ENBPA	8 million	There has been a number of deep water supply bores that GRA has constructed in the province made possible under the Community Development Programme in the GRA Restoration Programme funded by World Bank. It is planned that this will continue to be done in the Rural Local Level Government so that it will eventually linked with each other to form a major water supply system/ network for the whole province.
11	New Britain Highway Project	•Infrastructure •Economic sector (forestry IRDP)	•GoPNG •ENBPA •IRDP Developer	120 million	The New Britain Highway has been re-routed from Gaulim-Open Bay to Malasaet -Open Bay. This has been made possible by the Toriu Headwaters Integrated Rural Development Project. The project has constructed the road from Toriu linking the existing Malasaet Road.
12	Land Acquisition Programme - ENBPG Plantations	•Lands	•ENBPA	10 million	The objective of the project is to focus on effective revenue generation, proper land use and equitable land allocation; and secure sufficient funds annually to sustain goods and service delivery in all the districts with the assistance of the private sector.
13	ENB Provincial Bridges Programme	•Infrastructure	•GoPNG •ENBPA	10 million	The status of bridges in the province, especially in North East Gazelle, is very badly deteriorated due to two main factors: (a) continuous rainfall over the years, and (b) continuous lack of proper maintenance because of insufficient maintenance funding. These two factors have resulted in the worsening condition of a number of bridges in certain roads, making it extremely difficult for people to access markets and receive essential services.
14	Tokua Airport Improvement Project	•Infrastructure	•GoPNG •ENBPA	5 million	The ENBPA and Civil Aviation are working together to develop Tokua Airport to an international status. This is the main objective of the Provincial Government so that it can open up direct international flights to Australia via Cairns and Honiara (Solomon), Asia and the United States via Guam. This will enhance tourism potential and thus the general economy of the province through direct international market access for value-added produce including fish and other marine produce targeting the Japanese and Asian markets.
15	Relocation of Kokopo Police Barracks Project	•Infrastructure •Community Development (Police)	•GoPNG •ENBPA	5.1 million	The current police barracks is situated in the commercial centre zone. It is to be relocated to Kenabot where police staff houses will be built to accommodate the families of the Kokopo Police Station staff.
16	Illi-Wawas IRD Programme	•DPI- Forestry Infrastructure •Lands	•GoPNG •ENBPA •IRDP Developer		The project involves road-line logging, as well as road construction and agricultural development which is for oil palm within the Mevelo Valley. This is currently in operation since 2009.
17	Illi Stand Alone IRD Programme	•DPI- Forestry •Infrastructure •Lands	•GoPNG •ENBPA •IRDP Developer		The project involves salvage logging, sawmilling of reject and undersized logs and export of premium species and merchandise round logs. It also involves development of agricultural activities (cocoa rehabilitation) as part of the land use plan, and infrastructure upgrading and support to social services such as education and health. This is in current operation which started end of 2008.

No.	Project	Sector	Funding Source	Cost (K)	Brief Description/ Status
18	Toriu Headwaters IRD Programme	•DPI- Forestry •Infrastructure •Lands	•GoPNG •ENBPA •IRDP Developer		The project involves logging, roads and bridges upgrading and construction as well as agriculture development in terms of cocoa and reforestation. The construction of the New Britain Highway is inbuilt within the project development scale. The landowners have ventured into lease lease-back arrangements with the developer in terms of land mobilisation.
19	Sigite- Mukus IRD Programme	•DPI- Forestry •Infrastructure •Lands	•GoPNG •ENBPA •IRDP Developer		The project is a large-scale integrated land-use project involving two types of enterprises-oil palm plantation and forest plantation. The forest plantation is a combination of two plantation schemes: Tree Plantation, and Tree Plantation by Assisted Natural Regeneration (ANR). The integration of forest plantation to the project is aimed to maximise utilisation of land to generate income. Areas not suitable for oil palm which will be planted with fast-growing trees with high commercial value and harvestable at shorter rotations. About 21,000 hectares of the project area will be developed into oil palm plantation on the 1st to 4th year and about 10,000 hectares into forest plantations on the 3rd to 4th year period. The project will have 2 palm oil mills constructed within the project area to process fresh palm fruits to produce crude palm oil mainly for export. The forest plantation will be planted with *Eucalyptus Deglupta* (Kamarere) and *Acacia mangium* (Mangium), both are endemic and fast-growing species, for sawn timber and pulpwood production respectively. The landowners have ventured into lease lease-back arrangements with the developer in terms of land mobilisation.
20	Mukus-Tolo IRD Programme	•DPI- Forestry •Infrastructure •Lands	•GoPNG •ENBPA •IRDP Developer		The project will involve logging activities and agricultural development.
21	Ulaveo Industrial Centre Project	•Infrastructure •Lands •Commerce and Industry	•GoPNG		The project has currently been established where several industries, such as PNG Balsa, have set up within their blocks and residential houses have been built. The project aims to improve manufacturing industries and upgrade/ improve standard as well as strengthen the province's economy.
22	Kokopo/ Tokua Corridor Development Project	•Lands •Infrastructure •Commerce •Tourism and Industry	•GoPNG •ENBPA		This is developmental concept which is currently in progress. There have been hotels, residences, educational institutions and light industries along from Kokopo to Takubar and to Rapopo. The area is being cleared for subdivision. The Ulaveo Industrial Centre, as well as the Kabakaul Fisheries Project and the CPL Ulaveo are currently located farther up towards Tokua.
23	Hotel Development Programme	•Infrastructure •Economic	•GoPNG •ENBPA		The development involves a whole range of hotels being developed along the Kokopo-Tokua Corridor at the beach front.
24	Kurakakaul Urban Development Programme	•Infrastructure •Lands	•GoPNG •ENBPA		The project is currently on going with the establishment of the Rabaul District Office. Kurakakaul is a Level 2 Growth Centre. It is to provide district administrative functions with provision of social, communication and public utilities. The Growth Centre even will encourage and promote communication, industrial and tourism activities.

No.	Project	Sector	Funding Source	Cost (K)	Brief Description/ Status
25	Vunamami Polytechnical School Project	•Infrastructure •Education	•GoPNG •ENBPA		The project will involve upgrading of the educational institution into a polytechnic centre where more researches are carried out on the fresh food crop supply. This is currently under construction by the US Military.
26	Resettlement Programme (K20 million Disaster)	•Lands	•GoPNG •ENBPA		The disaster has made way for more development into purchasing land for resettlement. The land purchased is to be realigned and subdivided for development or resettlement.
27	Tol Growth Centre Development Programme	•Lands •Infrastructure	•GoPNG •ENBPA		Tol is a Level 3 Growth Centre. This will include LLG Administration and all corresponding essential services. There will be also a wharf and other business spin-off activities.
28	Pondo Growth Centre Development Programme	•Lands •Infrastructure	•GoPNG •ENBPA		Pondo is a Level 4 Growth Centre where the following will be created: retail shop, market, electricity, bore well, fuel station, fishing, sawmilling, accommodation and tourism products and activities.
29	South Coast Corridor Development Programme	•DPI- (Forestry , Agriculture) •Infrastructure •Lands •Commerce and Industry	•GoPNG •ENBPA		The South Coast Corridor is an economic corridor which is from Ralubang –Tol-Pomio-Gasmata-Kandrian - Gloucester that is a region in which the government provides a well-planned zoning system, a comprehensive and effective network of transport and utilities, and education and health services. Within this region, businesses are able to operate at low cost and under well-designed incentives, thereby encouraging foreign and domestic private sector investments.

Source: ENBPA, 2011, ENBP Infrastructure Sector Development Plan (ENBP-ISDP) 2014-2018

C.7 Summary of Review and Evaluation of the Existing Three Provincial Development Plans

(1) Findings from the Perspectives Set for Review and Evaluation of the Existing Three Provincial Development Plans

Based on literature review, hearings from ENBP officers and stakeholder meeting, the following characteristics were observed in the existing three provincial development plans:

- Alternative overall regional development strategies/scenarios have not been formulated.
- Alternative regional spatial structures (spatial patterns) have not been considered.
- Prioritisation of projects proposed in the ENBP-EDP and ENBP-SDP has not been conducted. As a result, a large "wish list" of projects, in which a number of desired projects are prepared and compiled in the ENBP Economic Development Plan.
- No phased development is planned.
- There seems to be a tendency to formulate much larger-scale projects in comparison with the size of population and the scale of economies of the region.
- ENBPA has not had a series of coordination meetings to explain important or high-priority projects proposed by ENBP EDP and ENBP SDP to concerned national-level departments and state companies, such as PNG Ports, Water PNG and PNG Power.

(2) Conclusion of Evaluation of the Existing Three Provincial Development Plans

Despite the above results of evaluation, the existing three development plans have the following good features:

- The ENBP Economic Development Plan (EDP) 2003-2033 is a 30-year development plan

which has an ambitious vision and goals for development. It has a good set of overall strategies and sectoral development strategies. This plan proposes many projects covering many sectors in order to implement those strategies. However, no prioritisation of those proposed projects was done. Moreover, no phased development is considered. Therefore, it is difficult to select and prioritise some important projects for implementation.

- On the other hand, the ENBP Strategic Development Plan (SDP) 2011-2021 is a 10-year development plan, which has a decent vision and goals for development. However, beyond the 10-year period, long-term objectives (pillars) for over 10 years are not forgotten. Those long-term objectives are embedded in the above ENBP Economic Development Plan 2003-2033.
- The ENBP Infrastructure Sector Development Plan (ISDP) 2014-2018 is a 5-year infrastructure development plan. This plan has a similar set of projects in some strategic areas. This plan selected 29 priority projects for various sectors of infrastructure.
- As described in the above three points, these existing three development strategies, projects and plans were well prepared. However, prioritisation and phased development planning have not been conducted. As a result, it is difficult to attract financial and technical support from international development partners.
- In order to do prioritisation, it is useful to have a spatial pattern (spatial structure) for the present and for the future for the purpose of considering priority projects.

C.8 Review of East New Britain Province Strategic Development Plan 2023-2032（ENBP-SDP 2023-2032）

C.8.1 Background

ENBPA formulated ENBP-SDP 2023-2032 as a plan to follow ENBP-SDP 2011-2021. ENBPA submitted this 10 years plan to DNPM as an alternative plan for MTDP 2023-2027.

C.8.2 Vision

The vision in ENBP-SDP 2023-2032 is as follows:

"Our people of East New Britain to be Wise, Smart, Educated, Healthy, Prosperous and Resilient, living in Peaceful, Safe and Secured Communities."

C.8.3 Strategic Objectives as Seven Pillars in ENBP-SDP 2023-2032

ENBP-SDP 2023-2032 has seven strategic objectives which is the seven pillars in the strategeic development plan. The seven strategic objectives are as follows:

- Making optimal use of available resources
- Promoting economic development through primary and secondary processing
- Encouraging community participation and promoting family life
- Making rural life more attractive
- Lessening disparities
- Improving the effectiveness of Local-level Governments
- Minimizing Law & Order Problems

C.8.4 Priority Projects

ENBP-SDP 2023-2032 has 41 priority projects. Among them, the following projects are included which are related to NEGID-Plan:

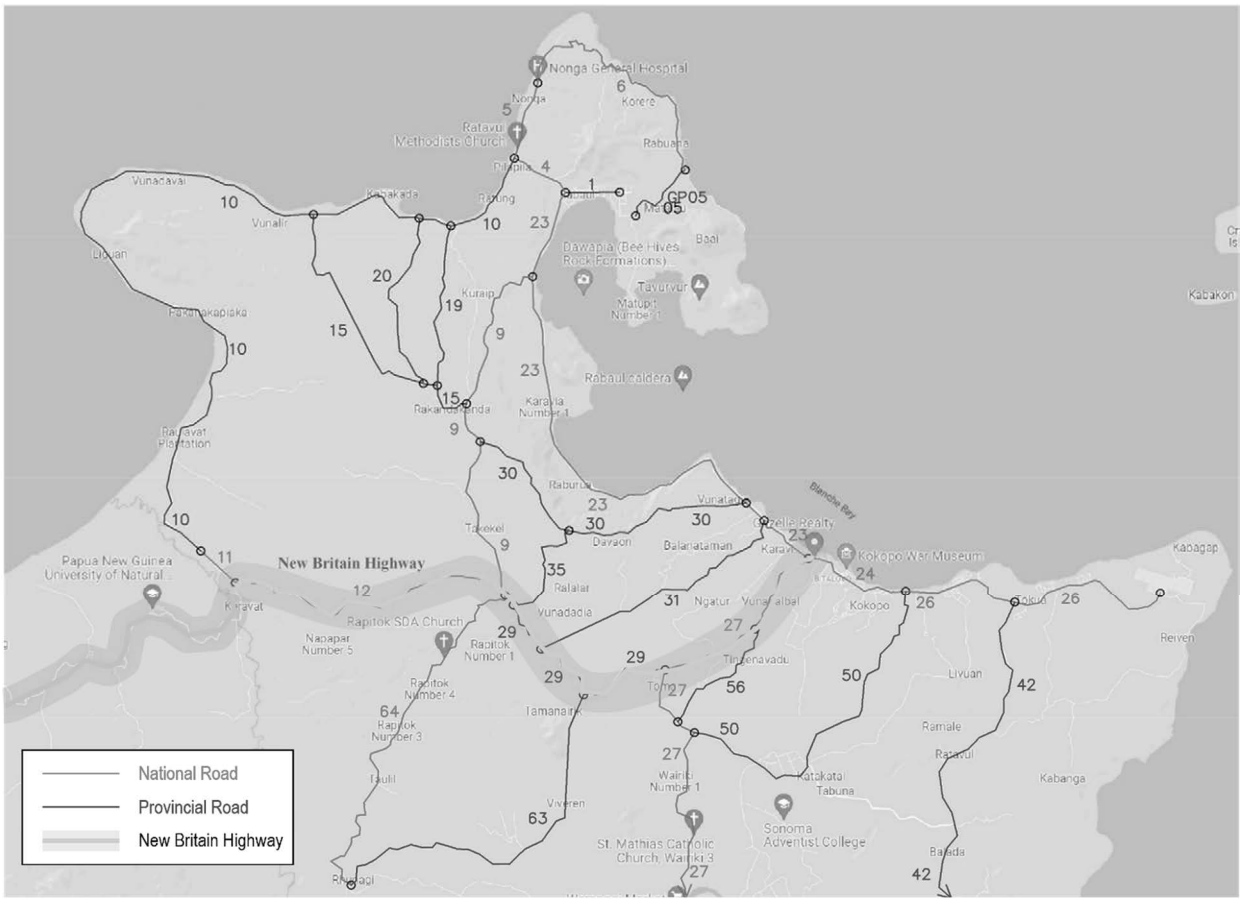
- Tavilo Alternative Airport

- ENB Dirt & Sealed Road Program
- ENB Provincial Fisheries Hub Construction Project
- New Britain Highway Project
- Tokua Airport Upgrading Project
- Free Trade Zone
- South Coastal Economic Corridor
- Ulaveo Industrial Project
- Kokopo/Tokua Corridor Development Project
- Growth Centre Development Program
- Cocoa & Coconut Rehabilitation Project
- Coca Processing Plant Facility Study
- Livestock Development Project
- Alternate Seaport Feasibility Studies
- Power Generation

Appendix D Points of Maintenance and Rehabilitation of Trunk Roads in Northeast Gazelle Peninsula

D.1 Trunk Roads in Northeast Gazelle Peninsula

In Northeast Gazelle Peninsula, the 25 roads shown in Figure D.1.1 and Table D.1.1 are categorised as trunk roads.



Source: JICA Expert Team in Consultation with Technical Working Group for Roads of NEGID-Plan

Figure D.1.1 Proposed Trunk Roads in Northeast Gazelle Peninsula

Table D.1.1 Trunk Roads Proposed by JICA Expert Team in Consultation with Technical Working Group of NEGID-Plan for Northeast Gazelle Peninsula, 2022

NO. in Inventory 2003	NO. in Inventory 1990	ROAD NAME	ROAD		ROAD LENGTH		LENGTH (KM)	LLG AREA	ROAD CONDITION	CLASSIFICATION
			TYPE	STATUS	START	END				
1	GP01	MALAGUNA	TRUNK	SEALED	TUNNEL HILL	OLD MARKET	5.9	RABAUL ULLG	GOOD	PROVINCIAL TRUNK
4	GP02	TUNNEL HILL	TRUNK	SEALED	TUNNEL HILL	TOLEAP	2.7	RABAUL/BALA	GOOD	NATIONAL ROUTE
5	GP03	NONGA	TRUNK	SEALED	TOLEAP	NONGA HOSP.	3.4	BALANATAMAN	GOOD	NATIONAL DISTRICT RD
6	-	KORERE	FEEDER	SEALED	NONGA HOSP.	MATALAU	10.5	BALA/KOMBIU	POOR	NATIONAL DISTRICT RD
9	GP11	BURMAH	TRUNK	SEALED	BURMAH JUNC.	TOKARONGON	14.2	BALA/CENTRAL	GOOD	NATIONAL ROUTE
10	GP12	NORTH COAST	TRUNK	SEALED	TOLEAP	LAES	39.7	BALA/LIVUAN/CENT	GOOD	PROVINCIAL TRUNK
11	GP12	LAES	TRUNK	SEALED	LAES	KEREVAT	2.1	CENTRAL	GOOD	INSTITUTIONAL ROAD
12	GP13	KEREVAT	TRUNK	SEALED	TOKARONGON	KEREVAT	14	CENTRAL	GOOD	NATIONAL DISTRICT RD
15	-	VUNAPAKA	FEEDER	SEALED/DIRT	RAKUNAI	VUNALIR	13.6	REIMBER/LIVUAN	FAIR	PROVINCIAL TRUNK
19	-	KAVAVAR	FEEDER	SEALED	KAVAVAR	KURAKAKAUL	7.05	REIMBER/LIVUAN	FAIR	PROVINCIAL TRUNK
20	-	RAMALMAL	FEEDER	SEALED	RAMALE	VUNAVUTUNG	7.08	REIMBER/LIVUAN	FAIR	PROVINCIAL TRUNK
23	GP10, GP22	KOKOPO	TRUNK	SEALED/DIRT	TUNNEL HILL	KOKOPO H/SCH	25.9	BALA/RAL/KPO/VM	GOOD	NATIONAL MAIN ROAD
24	-	WILLIAMS RD	4 LANE	SEALED	KOKOPO H/SCH	VUNAPOPOE	3	KPO ULLG	GOOD	NATIONAL MAIN ROAD
26	-	TOKUA	TRUNK	SEALED	VUNAPOPOE	TOKUA	9	KPO/VM/BITAPAKA	GOOD	NATIONAL MAIN ROAD
27	GP23, GP40	WARONGOI	TRUNK	SEALED	KOKOPO H/SCH	WARONGOI D	28.9	KPO/VM/TOMA/SINIVIT	GOOD	NATIONAL MAIN ROAD
29	GP23	TOMA	TRUNK	SEALED	BALIORA	TOKARONGON	10.1	TOMA/VUNADIDIR	GOOD	PROVINCIAL TRUNK
30	-	KURADUI	FEEDER	SEALED	KURADUI	NAVUNARAM	13.1	RALUANA/CENTRAL	GOOD	PROVINCIAL TRUNK
31	-	MALAPAU	FEEDER	SEALED	MALAPAU	TOMAVATUR	12.3	RAL/VDR/TOMA	GOOD	PROVINCIAL TRUNK
35	-	VUNADIDIR	FEEDER	DIRT	VUNADIDIR	NANGANANGA	8.1	VDR/RALUANA	FAIR	PROVINCIAL TRUNK
42	GP34, GP35	GANAI	TRUNK	SEALED/DIRT	KABAKAUL	SIGUTE	25.5	BITAPAKA	FAIR	PROVINCIAL TRUNK
50	GP43	BAILU	TRUNK	SEALED	BAILU	VUNAPOPE	15	VUNAMAMI	POOR	PROVINCIAL TRUNK
56	-	BITAVAVAR	ACCESS	SEALED/GRAVEL	BITAVAVAR	MALAKUNA 4	5.6	VUNAMAMI	FAIR	PROVINCIAL TRUNK
63	-	RATUNUR	FEEDER	SEALED/GRAVEL	TOMA JUNCTION	GAULIM	17	TOMA/INLAND BAIN	POOR	PROVINCIAL TRUNK
64	GP50	GAULIM	TRUNK	SEALED/GRAVEL	TOKARONGON	GAULIM	16.7	TOMA/INLAND BAIN	FAIR	NATIONAL ROUTE
-	GP05	MATALAU	TRUNK	SEALED/DIRT	MATALAU	NAMANULA	4.5	KOMBIU	POOR	PROVINCIAL TRUNK

Source: JICA Expert Team in Consultation with Technical Working Group for Road of NEGID-Plan

D.2 Points of Maintenance and Rehabilitation of Trunk Roads in Northeast Gazelle Peninsula

As a development plan for trunk roads in Northeast Gazelle Peninsula, it is proposed that all trunk roads in the region are improved. Proposed improvement for each trunk road is shown in Table D.2.1 to Table D.2.25.

Table D.2.1 Road Condition and Proposed Improvement (Malaguna Road)

Road Name: **Malaguna Road**		Road No. in Updated Road Inventory 2003: **1**
Start to End: **Tunnel Hill to Old Market**	Type: **Trunk**	Classification: **Provincial Road**
Number of Lanes: **4 lanes**		Road Length: **6 km**

Road Condition:

- ✓ **Road capacity is enough at present.**
- ✓ **Heavy vehicles use this road.**
- ✓ **Pavement condition is fair at most sections, but there are some potholes and cracks.**
- ✓ **Roadside drainage is installed at some sections.**

Functions of the Road:

- ✓ **This is the main town road in Rabaul.**
- ✓ **This is a disaster evacuation road.**

Photos:



4-lane carriageway divided with median



Cracks on pavement



Pothole on pavement



Container depot

Proposed Improvement:

- ✓ **To upgrade the pavement with sufficient cross fall to discharge surface water properly**
- ✓ **To install roadside drainage facility and cross drainage culvert at all sections**

Source: JICA Expert Team

Table D.2.2 Road Condition and Proposed Improvement (Tunnel Hill Road)

Road Name: **Tunnel Hill Road**		Road No. in Updated Road Inventory 2003: **4**
Start to End: **Tunnel Hill to Toleap**	Type: **Trunk**	Classification: **National Road**
Number of Lanes: **2 lanes**		Road Length: **3 km**

Road Condition:

- ✓ **Road capacity is enough at present.**
- ✓ **Heavy vehicles use this road.**
- ✓ **Pavement condition is good at most sections, but there are some potholes.**
- ✓ **Roadside drainage is installed at some sections.**
- ✓ **Road gradient is steep at some sections.**

Functions of the Road:

- ✓ **This is an access road connecting Rabaul and villages in the North Coast area and Nonga Hospital.**
- ✓ **This is a part of main access between Rabaul and Kerevat where the capital town of Gazelle District is located.**
- ✓ **This is a disaster evacuation road.**

Photos:



Good condition of pavement



Pothole on pavement



Section with roadside drainage



Section with steep gradient

Proposed Improvement:

- ✓ **To upgrade the pavement with sufficient cross fall to discharge surface water properly**
- ✓ **To install roadside drainage facility and cross drainage culvert at all sections**

Source: JICA Expert Team

Table D.2.3 Road Condition and Proposed Improvement (Nonga Road)

Road Name: **Nonga Road**		Road No. in Updated Road Inventory 2003: **5**
Start to End: **Toleap to Nonga Hospital**	Type: **Trunk**	Classification: **National Road**
Number of Lanes: **2 lanes**		Road Length: **3 km**

Road Condition:

- ✓ **Road capacity is enough at present.**
- ✓ **Pavement condition is good at most sections.**
- ✓ **Roadside drainage is installed at some sections.**
- ✓ **Cross drainage culvert is installed at some points.**

Functions of the Road:

- ✓ **This is an access road to Nonga General Hospital.**
- ✓ **This is a disaster evacuation road.**

Photos:



Good condition of pavement



Repaired pothole



Cross drainage culvert



Road side drainage (Curve)



Road side drainage (Open ditch)



Nonga General Hospital

Proposed Improvement:

- ✓ **To upgrade the pavement with sufficient cross fall to discharge surface water properly**
- ✓ **To install roadside drainage facility and cross drainage culvert at all sections**

Source: JICA Expert Team

Table D.2.4 Road Condition and Proposed Improvement (Korere Road)

Road Name: **Korere Road**		Road No. in Updated Road Inventory 2003: **6**
Start to End: **Nonga Hospital to Matalau**	Type: **Feeder**	Classification: **National Road**
Number of Lanes: **1 lane**		Road Length: **11 km**

Road Condition:

- ✓ **Road capacity is enough at present.**
- ✓ **Pavement condition is fair at most sections, but severely damaged at some sections.**
- ✓ **Roadside drainage is not installed at most sections, but installed at cut section.**
- ✓ **Road gradient is steep at some sections.**
- ✓ **Road width is narrow at some sections.**

Functions of the Road:

- ✓ **This is an access road to provincial secondary school and villages.**
- ✓ **This is a disaster evacuation road.**

Photos:



Roadside drainage at cut section



Severe damage of pavement



Narrow section of road



Box culvert under construction

Proposed Improvement:

- ✓ **To upgrade the pavement with sufficient cross fall to discharge surface water properly**
- ✓ **To install roadside drainage facility and cross drainage culvert at all sections**
- ✓ **To widen the road at narrow sections**
- ✓ **To provide countermeasures for soil erosion**

Source: JICA Expert Team

Table D.2.5 Road Condition and Proposed Improvement (Burmah Road)

Road Name: **Burmah Road**		Road No. in Updated Road Inventory 2003: **9**
Start to End: **Burmah Junction to Tokarongon**	Type: **Trunk**	Classification: **National Road**
Number of Lanes: **2 lanes**		Road Length: **14 km**

Road Condition:

- ✓ **Road capacity is enough at present.**
- ✓ **Heavy vehicles use this road.**
- ✓ **Pavement condition is good at most sections, but severely damaged at some sections.**
- ✓ **Roadside drainage is installed at some sections.**
- ✓ **Cross drainage culvert is installed at some points.**
- ✓ **Road gradient is very steep near Burmah Junction. Container trucks cannot pass onto this road.**
- ✓ **Curved radius is small near Burmah Junction. Container trucks cannot turn through this curve.**

Functions of the Road:

- ✓ **This is an alternative route of Kokopo-Rabaul Road.**
- ✓ **This is a disaster evacuation road.**
- ✓ **This is the main access to villages in hilly area.**

Photos:



Steep gradient section



Small curve radius section



Good condition of pavement



Roadside drainage at some sections



Severe damage of pavement



Balsa factory

Proposed Improvement:

- ✓ **To upgrade the pavement with sufficient cross fall to discharge surface water properly**
- ✓ **To install roadside drainage facility and cross drainage culvert at all sections**
- ✓ **To widen the road at narrow sections**
- ✓ **To improve vertical alignment (avoiding steep gradient)**
- ✓ **To improve horizontal alignment (providing larger curved radius)**
- ✓ **To provide countermeasures for soil erosion**

Source: JICA Expert Team

Table D.2.6 Road Condition and Proposed Improvement (North Coast Road)

Road Name: **North Coast Road**		Road No. in Updated Road Inventory 2003: **10**
Start to End: **Toleap to LAES**	Type: **Trunk**	Classification: **Provincial Road**
Number of Lanes: **2 lanes**		Road Length: **40 km**

Road Condition:

- ✓ **Road capacity is enough at present.**
- ✓ **Heavy vehicles use this road.**
- ✓ **Pavement condition is good at already rehabilitated sections.**
- ✓ **Some sections are not sealed.**
- ✓ **Roadside drainage is installed at some sections.**
- ✓ **Cross drainage culvert is installed at some points.**
- ✓ **Sidewalk is provided near the school.**
- ✓ **There is a long steep gradient section.**

Functions of the Road:

- ✓ **This is main access between Rabaul and Kerevat where the capital town of Gazelle district is located.**
- ✓ **This is a disaster evacuation road.**

Photos:



Not sealed pavement



Sidewalk near the school



Roadside drainage at some sections



Long steep gradient section

Proposed Improvement:

- ✓ **To upgrade the pavement with sufficient cross fall to discharge surface water properly**
- ✓ **To install roadside drainage facility and cross drainage culvert at all sections**
- ✓ **To provide countermeasures for soil erosion**

Source: JICA Expert Team

Table D.2.7 Road Condition and Proposed Improvement (LAES Road)

Road Name: **LAES Road**		Road No. in Updated Road Inventory 2003: **11**
Start to End: **LAES to Kerevat**	Type: **Trunk**	Classification: **National Road**
Number of Lanes: **2 lanes**		Road Length: **2 km**

Road Condition:

- ✓ **Road capacity is enough at present.**
- ✓ **Pavement condition is good at most sections, but severely damaged at some sections.**
- ✓ **Roadside drainage is installed at some sections.**
- ✓ **There is a bridge on the road.**

Functions of the Road:

- ✓ **This is an access road to Kerevat.**
- ✓ **This is a disaster evacuation road.**

Photos:



Good condition of pavement



Severe damage of pavement



Bridge (Steel girder and concrete deck)



Roadside drainage at some sections

Proposed Improvement:

- ✓ **To upgrade the pavement with sufficient cross fall to discharge surface water properly**
- ✓ **To install roadside drainage facility and cross drainage culvert at all sections**
- ✓ **To provide countermeasures for soil erosion**

Source: JICA Expert Team

Table D.2.8 Road Condition and Proposed Improvement (Kerevat Road)

Road Name: **Kerevat Road**		Road No. in Updated Road Inventory 2003: **12**
Start to End: **Tokarongon to Kerevat**	Type: **Trunk**	Classification: **National Road**
Number of Lanes: **2 lanes**		Road Length: **14 km**

Road Condition:

- ✓ **Road capacity is enough at present.**
- ✓ **Heavy vehicles use this road.**
- ✓ **Pavement condition is good at most sections.**
- ✓ **Pavement is severely damaged near Kerevat.**
- ✓ **Roadside drainage is installed at some sections.**
- ✓ **Cross drainage culvert is installed at some points.**

Functions of the Road:

- ✓ **This is a major trunk road of the region as part of New Britain Highway.**
- ✓ **This is an access road to Kerevat.**
- ✓ **This is a disaster evacuation road.**

Photos:



Good condition of pavement



Roadside drainage (Curve)



Roadside drainage (Open ditch)



Severe damage of pavement



Gazelle District's administration office



Kerevat's town centre

Proposed Improvement:

- ✓ **To upgrade the pavement with sufficient cross fall to discharge surface water properly**
- ✓ **To install roadside drainage facility and cross drainage culvert at all sections**
- ✓ **To provide countermeasures for soil erosion**

Source: JICA Expert Team

Table D.2.9 Road Condition and Proposed Improvement (Vunapaka Road)

Road Name: **Vunapaka Road**		Road No. in Updated Road Inventory 2003: **15**
Start to End: **Rakunai to Vunalir**	Type: **Feeder**	Classification: **Provincial Road**
Number of Lanes: **2 lanes**		Road Length: **14 km**

Road Condition:

- ✓ **Road capacity is enough at present.**
- ✓ **Pavement is severely damaged at most sections, but was rehabilitated at some sections.**
- ✓ **Roadside drainage is not installed at most sections, but was installed at pavement's rehabilitated section.**
- ✓ **Road gradient is steep at some sections.**

Functions of the Road:

- ✓ **This is an access road to Vunapaka where there are many villages, health centre and primary school.**
- ✓ **This is a disaster evacuation road.**

Photos:



Severe damage of pavement



Pavement's rehabilitated section



2-cell box culvert



Grasses growing on outlet of culvert



Roadside drainage at rehabilitated section

Proposed Improvement:

- ✓ **To upgrade the pavement with sufficient cross fall to discharge surface water properly**
- ✓ **To install roadside drainage facility and cross drainage culvert at all sections**
- ✓ **To provide countermeasures for soil erosion**

Source: JICA Expert Team

Table D.2.10 Road Condition and Proposed Improvement (Kavavar Road)

Road Name: **Kavavar Road**		Road No. in Updated Road Inventory 2003: **19**
Start to End: **Kavavar to Kurakakaul**	Type: **Feeder**	Classification: **Provincial Road**
Number of Lanes: **1 lane**		Road Length: **7 km**

Road Condition:

- ✓ **Road capacity is enough at present.**
- ✓ **Pavement is severely damaged at most sections.**
- ✓ **Roadside drainage is not installed at most sections.**
- ✓ **Road gradient is steep at some sections.**
- ✓ **Road width is narrow at some sections.**

Functions of the Road:

- ✓ **This is an access road to Kurakakaul.**
- ✓ **This is a disaster evacuation road.**

Photos:



Steep gradient section



Severe damage of pavement



Narrow section of road



Pothole on pavement

Proposed Improvement:

- ✓ **To upgrade the pavement with sufficient cross fall to discharge surface water properly**
- ✓ **To install roadside drainage facility and cross drainage culvert at all sections**
- ✓ **To widen the road at narrow sections**
- ✓ **To provide countermeasures for soil erosion**

Source: JICA Expert Team

Table D.2.11 Road Condition and Proposed Improvement (Ramalmal Road)

Road Name: **Ramalmal Road**		Road No. in Updated Road Inventory 2003: **20**
Start to End: **Ramale to Vunavutung**	Type: **Feeder**	Classification: **Provincial Road**
Number of Lanes: **2 lanes**		Road Length: **7 km**

Road Condition:

- ✓ **Road capacity is enough at present.**
- ✓ **Pavement is severely damaged at most sections.**
- ✓ **Roadside drainage is not installed at most sections.**
- ✓ **Cross drainage culvert is installed at some points, but it is not working properly due to lack of maintenance.**
- ✓ **Road width is narrow at some sections.**
- ✓ **Road gradient is steep at some sections.**

Functions of the Road:

- ✓ **This is an access road to Kurakakaul.**
- ✓ **This is a disaster evacuation road.**

Photos:



Narrow section of road



Severe damage of pavement



Trees growing on outlet of culvert



Steep gradient section



Primary school along the road

Proposed Improvement:

- ✓ **To upgrade the pavement with sufficient cross fall to discharge surface water properly**
- ✓ **To install roadside drainage facility and cross drainage culvert at all sections**
- ✓ **To widen the road at narrow sections**
- ✓ **To provide countermeasures for soil erosion**

Source: JICA Expert Team

Table D.2.12 Road Condition and Proposed Improvement (Williams Road)

Road Name: **Williams Road**		Road No. in Updated Road Inventory 2003: **24**
Start to End: **Kokopo High School to Vunapopoe**	Type: **Trunk**	Classification: **National Road**
Number of Lanes: **4 lanes**		Road Length: **3 km**

Road Condition:

- ✓ **Road capacity is enough at present.**
- ✓ **Heavy vehicles use this road.**
- ✓ **Pavement condition is good at most sections.**
- ✓ **There are some potholes and cracks.**
- ✓ **Roadside drainage is installed at most sections, and cross drainage culvert is installed at some points.**
- ✓ **Sidewalk and median are provided.**

Functions of the Road:

- ✓ **This road is part of the access connecting Kokopo and Tokua.**
- ✓ **This is the main town road in Kokopo.**

Photos:



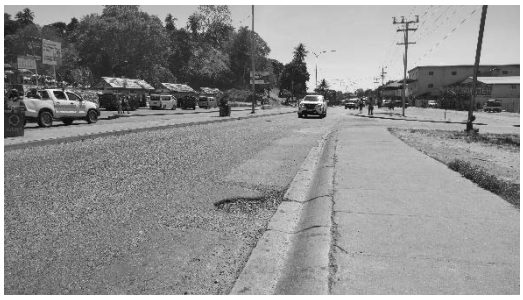
4-lane carriageway divided with median



Pothole repair



Roundabout at end of the road



Pothole on pavement



Inlet of drainage facility

Proposed Improvement:

- ✓ **To upgrade the pavement with sufficient cross fall to discharge surface water properly**

Source: JICA Expert Team

Table D.2.13 Road Condition and Proposed Improvement (Tokua Road)

Road Name: **Tokua Road**		Road No. in Updated Road Inventory 2003: **26**
Start to End: **Vunapope to Tokua**	Type: **Trunk**	Classification: **National Road**
Number of Lanes: **2 lanes**		Road Length: **9 km**

Road Condition:

- ✓ **Road capacity is enough at present.**
- ✓ **Heavy vehicles use this road.**
- ✓ **Pavement condition is fair at most sections. However, pavement is severely damaged near the intersection with Bailu Road (No. 50), as much rainwater is accumulated in this intersection from Bailu Road.**
- ✓ **There are some potholes and cracks.**
- ✓ **Roadside drainage is installed at some sections.**

Functions of the Road:

- ✓ **This road is the only access to Tokua Airport.**
- ✓ **Container trucks use this road, as there is a container depot in ICDC along the road.**

Photos:



Severe damage of pavement



Roadside drainage at some sections



Fair condition of pavement



Repaired pothole



Container depot

Proposed Improvement:

- ✓ **To upgrade the pavement with sufficient cross fall to discharge surface water properly**
- ✓ **To install roadside drainage facility and cross drainage culvert at all sections**

Source: JICA Expert Team

Table D.2.14 Road Condition and Proposed Improvement (Warongoi Road)

Road Name: **Warongoi Road**		Road No. in Updated Road Inventory 2003: **27**
Start to End: **Kokopo High School to Warongoi D**	Type: **Trunk**	Classification: **National Road**
Number of Lanes: **2 lanes**		Road Length: **29 km**

Road Condition:

- ✓ **Road capacity is enough at present.**
- ✓ **Heavy vehicles use this road.**
- ✓ **Pavement condition is good at most sections.**
- ✓ **Roadside drainage is not installed at some sections.**
- ✓ **Sidewalk is provided only near the school. Students walk on the shoulder of the road which has much traffic volume of heavy vehicles.**

Functions of the Road:

- ✓ **This is a major trunk road of the region as part of New Britain Highway.**
- ✓ **This is the main access to villages in hilly area.**
- ✓ **This is a disaster evacuation road.**

Photos:



Good condition of pavement



Roadside drainage and sidewalk



Primary school along the road



Students walking on the shoulder



No roadside drainage section

Proposed Improvement:

- ✓ **To upgrade the pavement with sufficient cross fall to discharge surface water properly**
- ✓ **To install roadside drainage facility and cross drainage culvert at all sections**
- ✓ **To provide sidewalk on the section between school and villages**

Source: JICA Expert Team

Table D.2.15 Road Condition and Proposed Improvement (Toma Road)

Road Name: **Toma Road**		Road No. in Updated Road Inventory 2003: **29**
Start to End: **Baliora to Tokarongon**	Type: **Trunk**	Classification: **Provincial Road**
Number of Lanes: **2 lanes**		Road Length: **10 km**

Road Condition:

- ✓ **Road capacity is enough at present.**
- ✓ **Heavy vehicles use this road.**
- ✓ **Pavement condition is good at most sections.**
- ✓ **Roadside drainage is installed at most sections.**
- ✓ **Cross drainage culvert is installed at some points.**

Functions of the Road:

- ✓ **This is a major trunk road of the region as part of New Britain Highway.**
- ✓ **This is a disaster evacuation road.**

Photos:



Good condition of pavement



Roadside drainage (Curved)



Roadside drainage (Open ditch)

Proposed Improvement:

- ✓ **To upgrade the pavement with sufficient cross fall to discharge surface water properly**
- ✓ **To install roadside drainage facility and cross drainage culvert at all sections**
- ✓ **To provide countermeasures for soil erosion**

Source: JICA Expert Team

Table D.2.16 Road Condition and Proposed Improvement (Kuradui Road)

Road Name: **Kuradui Road**		Road No. in Updated Road Inventory 2003: **30**
Start to End: **Kuradui to Navunaram**	Type: **Feeder**	Classification: **Provincial Road**
Number of Lanes: **2 lanes**		Road Length: **13 km**

Road Condition:

- ✓ **Road capacity is enough at present.**
- ✓ **Pavement condition is fair at most sections, but severely damaged at some sections**
- ✓ **Roadside drainage is installed at some sections, but not properly maintained.**
- ✓ **Cross drainage culvert is installed at some points, but not properly maintained.**
- ✓ **Road width is narrow at some sections.**
- ✓ **Sidewalk is provided near the village.**

Functions of the Road:

- ✓ **This is an alternative route of Kokopo-Rabaul Road.**
- ✓ **This is a disaster evacuation road.**

Photos:



Roadside drainage (Open ditch)



Narrow section of the road



Not properly maintained drainage facility



Severe damage of pavement



Roadside drainage (Curved), Sidewalk near the village



Culvert with gabion and plantation

Proposed Improvement:

- ✓ **To upgrade the pavement with sufficient cross fall to discharge surface water properly**
- ✓ **To install roadside drainage facility and cross drainage culvert at all sections**
- ✓ **To widen the road at narrow sections**
- ✓ **To provide countermeasures for soil erosion**

Source: JICA Expert Team

Table D.2.17 Road Condition and Proposed Improvement (Malapau Road)

Road Name: **Malapau Road**		Road No. in Updated Road Inventory 2003: **31**
Start to End: **Malapau to Tomavatur**	Type: **Feeder**	Classification: **Provincial Road**
Number of Lanes: **2 lanes**		Road Length: **12 km**

Road Conditions:

- ✓ **Road capacity is enough at present.**
- ✓ **Pavement condition is fair at most sections.**
- ✓ **Roadside drainage is not installed at some sections.**

Functions of the Road:

- ✓ **This is an access road to schools, health centre and villages.**
- ✓ **This is a disaster evacuation road.**

Photos:



Fair condition of pavement



Pavement under rehabilitation



Storage space for base course material



Roadside drainage at some sections

Proposed Improvement:

- ✓ **To upgrade the pavement with sufficient cross fall to discharge surface water properly**
- ✓ **To install roadside drainage facility and cross drainage culvert at all sections**
- ✓ **To provide countermeasures for soil erosion**

Source: JICA Expert Team

Table D.2.18 Road Condition and Proposed Improvement (Vunadidir Road)

Road Name: **Vunadidir Road**		Road No. in Updated Road Inventory 2003: **35**
Start to End: **Vunadidir to NangaNanga**	Type: **Feeder**	Classification: **Provincial Road**
Number of Lane: **1 lane**		Road Length: **8 km**

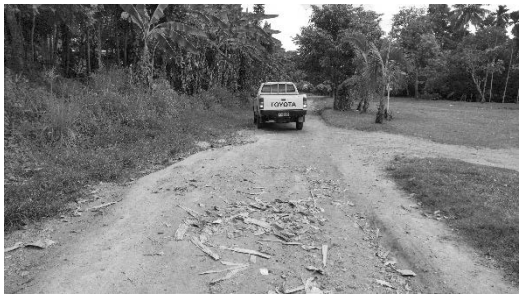
Road Condition:

- ✓ **Road capacity is enough at present.**
- ✓ **Pavement is severely damaged at most sections.**
- ✓ **Roadside drainage is not installed at most sections.**
- ✓ **Road gradient is steep at some sections.**
- ✓ **Road width is narrow at some sections.**

Functions of the Road:

- ✓ **This is an access road connecting Toma Road (No. 29) and Karadui Road (No. 30).**
- ✓ **This is a disaster evacuation road.**

Photos:



Severe damage of pavement



Narrow section of the road



Toma / Vunadidir LLG office



Island Regional Training Centre

Proposed Improvement:

- ✓ **To upgrade the pavement with sufficient cross fall to discharge surface water properly**
- ✓ **To install roadside drainage facility and cross drainage culvert at all sections**
- ✓ **To widen the road at narrow sections**
- ✓ **To provide countermeasures for soil erosion**

Source: JICA Expert Team

Table D.2.19 Road Condition and Proposed Improvement (Ganai Road)

Road Name: **Ganai Road**		Road No. in Updated Road Inventory 2003: **42**
Start to End: **Kabakaul to Sigute**	Type: **Trunk**	Classification: **Provincial Road**
Number of Lanes: **2 lanes**		Road Length: **26 km**

Road Condition:

- ✓ **Road capacity is enough at present.**
- ✓ **Pavement condition is fair at most sections.**
- ✓ **Rehabilitation of pavement is ongoing at some sections.**
- ✓ **There are some potholes and cracks.**
- ✓ **Roadside drainage is not installed at most sections.**
- ✓ **Road width is narrow at some sections.**

Function of the Road:

- ✓ **This road is the shortest access connecting Kokopo and Pomio Districts. However, this road is not used much due to its bad condition.**

Photos:



Pavement under rehabilitation



Pavement under rehabilitation



Narrow section with base course material being prepared for road repair.



Repair of pavement damage

Proposed Improvement:

- ✓ **To upgrade the pavement with sufficient cross fall to discharge surface water properly**
- ✓ **To install roadside drainage facility and cross drainage culvert at all sections**
- ✓ **To widen the road at narrow sections**
- ✓ **To provide countermeasures for soil erosion**

Source: JICA Expert Team

Table D.2.20 Road Condition and Proposed Improvement (Bailu Road)

Road Name: **Bailu Road**		Road No. in Updated Road Inventory 2003: **50**
Start to End: **Bailu to Vunapope**	Type: **Trunk**	Classification: **Provincial Road**
Number of Lanes: **2 lanes**		Road Length: **15 km**

Road Condition:

- ✓ **Road capacity is enough at present.**
- ✓ **Heavy vehicles use this road.**
- ✓ **Pavement is severely damaged at most sections.**
- ✓ **Roadside drainage is not installed at most sections, but installed at some cut sections.**
- ✓ **Roadside drainage is under construction near the intersection with Tokua Road (No. 26).**

Functions of the Road:

- ✓ **This is an access to the resettlement area (Gelegele and Clifton/Asing) from Rabaul District.**
- ✓ **Container trucks use this road, as there is a balsa factory along the road.**

Photos:



Severe damage of pavement



Roadside drainage at cut sections



Roadside drainage under construction



Kombiu LLG office



Balsa factory



Pothole on pavement

Proposed Improvement:

- ✓ **To upgrade the pavement with sufficient cross fall to discharge surface water properly**
- ✓ **To install roadside drainage facility and cross drainage culvert at all sections**
- ✓ **To provide countermeasures for soil erosion**

Source: JICA Expert Team

Table D.2.21 Road Condition and Proposed Improvement (Bitavavar Road)

Road Name: **Bitavavar Road**		Road No. in Updated Road Inventory 2003: **56**
Start to End: **Vitavavar to Malakuna 4**	Type: **Access**	Classification: **Provincial Road**
Number of Lanes: **1 lane**		Road Length: **6 km**

Road Condition:

- ✓ **Road capacity is enough at present.**
- ✓ **Pavement is severely damaged at most sections.**
- ✓ **Roadside drainage is not installed at most sections.**
- ✓ **Road width is narrow at some sections.**

Function of the Road:

- ✓ **This is an access road to school, church and villages.**

Photos:



Severe damage of pavement



Villages along the road



Primary school along the road



Narrow section of the road



Balsa plantation

Proposed Improvement:

- ✓ **To upgrade the pavement with sufficient cross fall to discharge surface water properly**
- ✓ **To install roadside drainage facility and cross drainage culvert at all sections**
- ✓ **To widen the road at narrow sections**
- ✓ **To provide countermeasures for soil erosion**

Source: JICA Expert Team

Table D.2.22 Road Condition and Proposed Improvement (Ratunur Road)

Road Name: **Ratunur Road**		Road No. in Updated Road Inventory 2003: **63**
Start to End: **Toma Junction to Gaulim**	Type: **Feeder**	Classification: **Provincial Road**
Number of Lane: **1 lane**		Road Length: **17 km**

Road Condition:

- ✓ **Road capacity is enough at present.**
- ✓ **Pavement condition is good on the beginning half section from Toma Junction.**
- ✓ **Pavement is severely damaged on the remaining section.**
- ✓ **Cross drainage culvert is installed at some points, but not working properly due to lack of maintenance.**
- ✓ **Road gradient is steep at some sections.**
- ✓ **Road width is narrow at some sections.**
- ✓ **There are 2 bridges on the road. The wooden deck is replaced approximately every year.**

Function of the Road:

- ✓ **This is an access road to Gaulim where there are many villages, teacher training college, primary school and health centre.**

Photos:



Good condition of pavement



Gabion wall covered with concrete



Plantation as countermeasure to soil erosion



Outlet of cross drainage culvert



Severe damage of pavement



Bridge (Steel girder and wooden deck)

Proposed Improvement:

- ✓ **To upgrade the pavement with sufficient cross fall to discharge surface water properly**
- ✓ **To install roadside drainage facility and cross drainage culvert at all sections**
- ✓ **To widen the road at narrow sections**
- ✓ **To provide countermeasures for soil erosion**
- ✓ **To construct a concrete bridge**

Source: JICA Expert Team

Table D.2.23 Road Condition and Proposed Improvement (Gaulim Road)

Road Name: **Gaulim Road**		Road No. in Updated Road Inventory 2003: **64**
Start to End: **Tokarongon to Gaulim**	Type: **Trunk**	Classification: **National Road**
Number of Lanes: **2 lanes**		Road Length: **17 km**

Road Condition:

- ✓ **Road capacity is enough at present.**
- ✓ **Pavement condition is good at most sections.**
- ✓ **Roadside drainage is installed at some sections.**
- ✓ **Cross drainage culvert is installed at some points.**

Function of the Road:

- ✓ **This is an access road to Gaulim where there are many villages, teacher training college, primary school and health centre.**

Photos:



Good condition of pavement



Roadside drainage at some sections



Primary and secondary schools along the road



Teacher training college in Gaulim

Proposed Improvement:

- ✓ **To upgrade the pavement with sufficient cross fall to discharge surface water properly**
- ✓ **To install roadside drainage facility and cross drainage culvert at all sections**
- ✓ **To provide countermeasures for soil erosion**

Source: JICA Expert Team

Table D.2.24 Road Condition and Proposed Improvement (Matalau Road)

Road Name: **Matalau Road**		Road No. in Road Inventory 1990: **GP05**
Start to End: **Matalau to Namanula**	Type: **Trunk**	Classification: **Provincial Road**
Number of Lane: **1 lane**		Road Length: **5 km**

Road Condition:

- ✓ **Road capacity is enough at present.**
- ✓ **Pavement is severely damaged at most sections.**
- ✓ **Roadside drainage is not installed at most sections.**
- ✓ **Road gradient is steep at some sections.**
- ✓ **Road width is narrow at some sections.**
- ✓ **Road edge is eroded by rainwater.**

Functions of the Road:

- ✓ **This is an access road to school and villages.**
- ✓ **This is a disaster evacuation road.**

Photos:



Severe damage of pavement



Steep gradient section



Eroded road edge

Proposed Improvement:

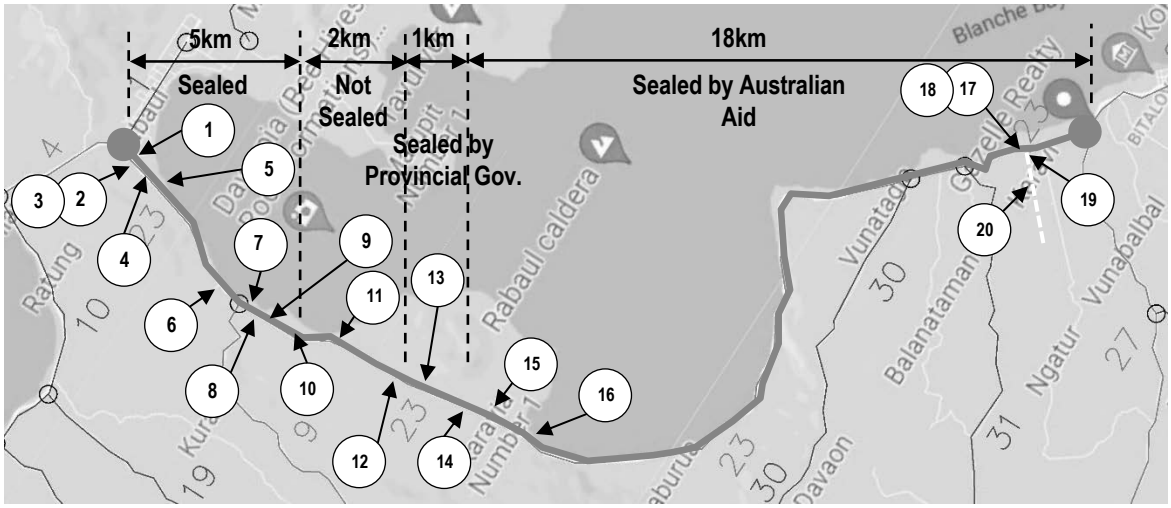
- ✓ **To upgrade the pavement with sufficient cross fall to discharge surface water properly**
- ✓ **To install roadside drainage facility and cross drainage culvert at all sections**
- ✓ **To widen the road at narrow sections**
- ✓ **To provide countermeasures for soil erosion**

Source: JICA Expert Team

Table D.2.25 Road Condition and Proposed Improvement (Kokopo Road)

Road Name: **Kokopo Road**		Road No. in Updated Road Inventory 2003: **23**
Start to End: **Tunnel Hill to Kokopo High School**	Type: **Trunk**	Classification: **National Road**
Number of Lanes: **2 lanes**		Road Length: **26 km**

Location Map:



Road Condition:

- ✓ **Road capacity is enough at present.**
- ✓ **Pavement condition is good at beginning section.** (Photo 1)
- ✓ **Concrete barrier is installed along the road around the beginning section to avoid flowing silt into the road during rain. Much silt is present on mountain surface after the volcanic eruption in 1994.** (Photos 2 and 3)
- ✓ **Pavement condition is good around beginning section, but there are some potholes.** (Photos 4 and 5)
- ✓ **Cross drainage culvert has been functioning due to good maintenance.** (Photo 6)
- ✓ **Pavement is severely damaged near the intersection with Burmah Road (No. 9). Large vehicles cannot drive here in flood condition.** (Photo 7)
- ✓ **Road condition is fair at most sections. But the pavement is severely damaged at lower section due to accumulation of water during rain.** (Photos 8 and 9)
- ✓ **Seal (pavement surface) is provided from the beginning point to this point. The road is not sealed from this point. Donors such as World Bank and Australian Aid decided not to repair the damaged road in this section after the 1994 volcanic eruption, as this section may be affected by eruption again.** (Photo 10)
- ✓ **Many trailer trucks have been using this road, as this is the main trunk road connecting Rabaul Port and Kokopo.** (Photo 11)
- ✓ **Seal (pavement surface) is provided from this point again. The provincial government constructed the sealing in 2016 to avoid blowing dusty sand caused by vehicles, as there are villages around this section.** (Photo 12)
- ✓ **Roadside drainage is installed in this section. This part is properly maintained and functioning.** (Photo 13)
- ✓ **The road was upgraded by Australian Aid from this point to end in 2003.** (Photo 14)
- ✓ **The road is severely damaged at some sections.** (Photo 15).
- ✓ **Cross drainage culvert is not functioning due to lack of maintenance.** (Photo 16)
- ✓ **Four-cell box culvert originally had 3 m height, but it has been completely filled by soil, grasses and trees at present.** (Photo 17)
- ✓ **Much soil filled the box culvert, so it is not functioning.** (Photo 18)
- ✓ **Much water runs on this crossing road and accumulates at the not functioning box culvert during heavy rain.** (Photo 19)
- ✓ **This crossing road has been eroded by rainwater to approximately 1.5 m height.** (Photo 20)

Functions of the Road:

- ✓ **This is a major trunk road connecting Rabaul and Kokopo.**
- ✓ **Many container trucks and large-size vehicles from/to Rabaul Port use this road.**

Photos:



1. Good condition of pavement



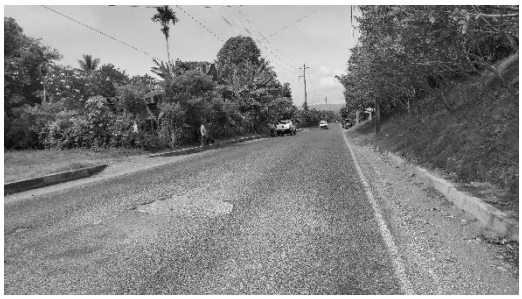
2. Concrete barrier along the road



3. Open ditch behind concrete barrier



4. Good condition of pavement



5. Pothole on the pavement



6. Cross drainage culvert



7. Severe damage of pavement



8. Severe damage of pavement



9. Fair condition of pavement



10. End of sealed section



11. Trailer truck using the road



12. Start of sealed section



13. Good condition of roadside drainage



14. Road upgraded by Australian Aid



15. Severe damage of pavement



16. Not functioning cross drainage culvert



17. 4-cell box culvert (Downstream side)



18. 4-cell box culvert (Upstream side)



19. Crossing road next to box culvert



20. Crossing road to Kokopo Road

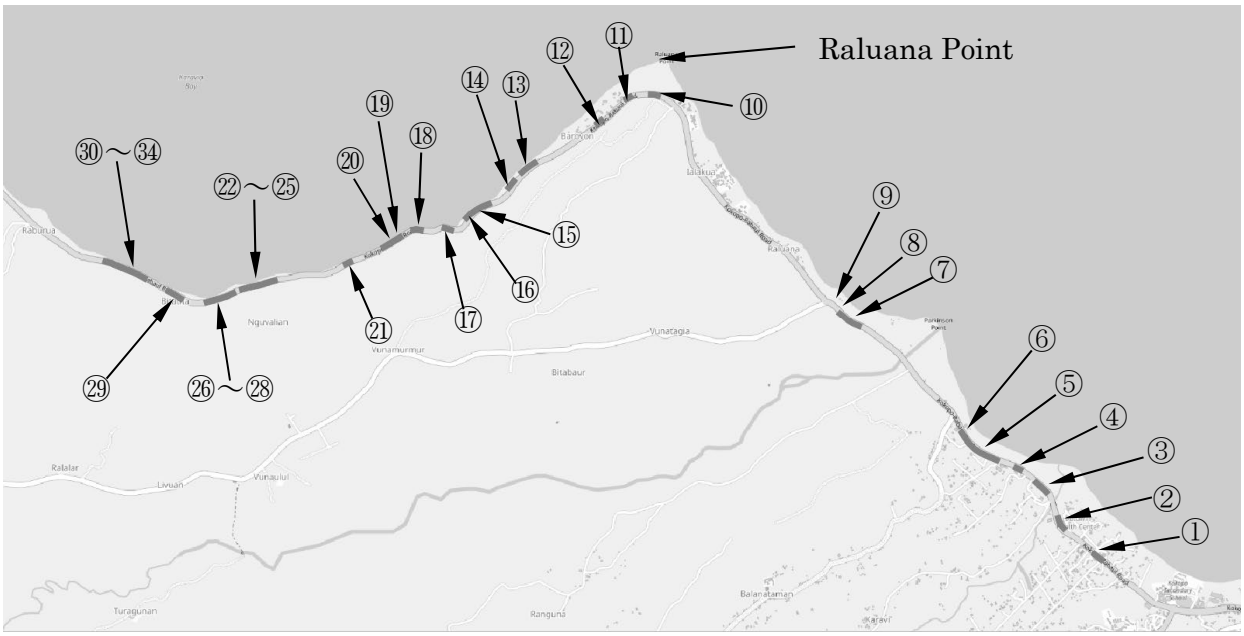
Proposed Improvement:

- ✓ **To upgrade the road with asphalt concrete pavement, with sufficient cross fall to discharge surface water properly**
- ✓ **To replace existing 4-cell box culvert considering proper rainfall intensity, catchment area, frequency, etc.**
- ✓ **To raise the road height at existing low sections**
- ✓ **To install roadside drainage facility and cross drainage culvert at all sections**
- ✓ **To provide countermeasures for soil erosion**

Appendix E Condition of Slopes along Kokopo-Rabaul Coastal Road

E.1 Detail of Slop Conditions

Summary of each slope shown in Figure E.1.1is given in Table E.1.1. Elastic wave velocity measurements and Schmidt Hammer tests were conducted to determine the strength of the ground mass in a simplified method. Vp indicates longitudinal wave travel velocity (m/s), D indicates depth of surface softening (m), and R indicates Schmidt hammer rebound described in the geologic conditions.



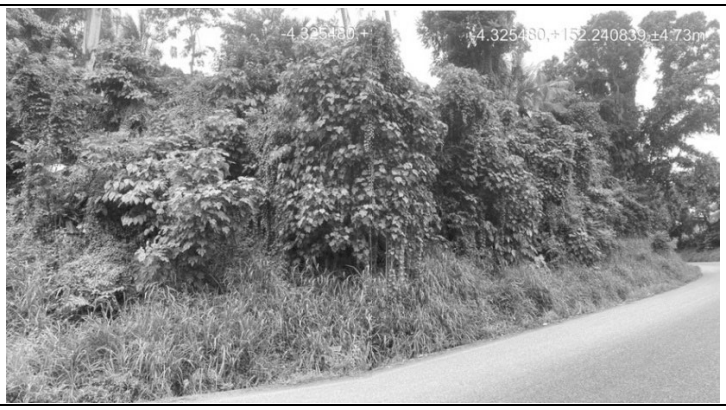
Source: JICA Expert Team

Figure E.1.1 Location Map of Slope to be Protected along Kokopo-Rabaul Coastal Road

Table E.1.1 Detail of Slopes along Kokopo-Rabaul Coastal Road

①	4.32827 S, 152.24398 E	
Ave. Height	5m	
Length	61m	
Slope Angle	90°	
Area of Slope	280m^2	
Geological Condition	Pyroclastic flow deposits D=0.35m Vp=483m/s	

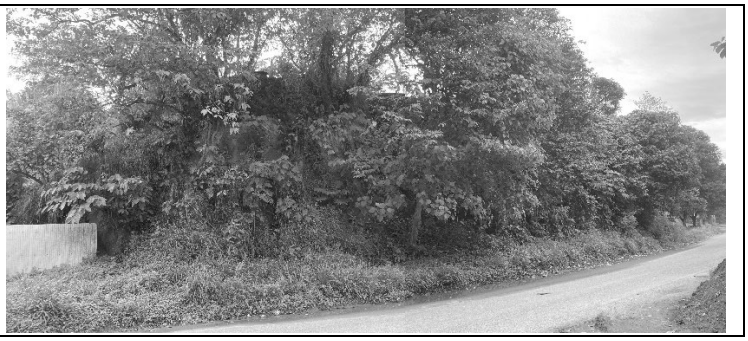
②	4.32616 S, 152.24127 E
Ave. Height	9m
Length	98m
Slope Angle	60°
Area of Slope	925m^2
Geological Condition	Pyroclastic flow deposits



③	4.32349 S, 152.24016 E
Ave. Height	7.5m
Length	110m
Slope Angle	80°
Area of Slope	781m^2
Geological Condition	Pyroclastic flow deposits



④	4.32190 S, 152.23832 E
Ave. Height	9m
Length	36m
Slope Angle	80°
Area of Slope	247m^2
Geological Condition	Pyroclastic flow deposits



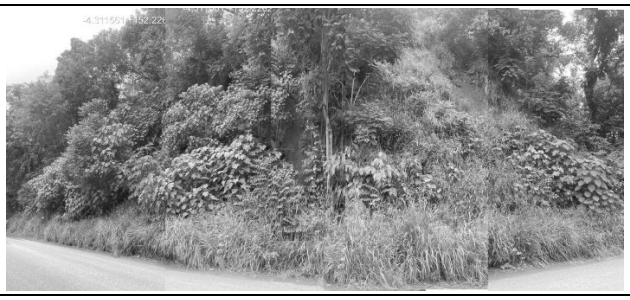
⑤	4.32122 S, 152.23662 E
Ave. Height	8m
Length	262m
Slope Angle	80°
Area of Slope	2063m^2
Geological Condition	Pyroclastic flow deposits D=0.32m Vp=385m/s



⑥	4.31983 S, 152.23453 E
Ave. Height	6m
Length	66m
Slope Angle	80°
Area of Slope	366m^2
Geological Condition	Pyroclastic flow deposits



⑦	4.31184 S, 152.22681E
Ave. Height	11m
Length	81m
Slope Angle	45°
Area of Slope	1089m^2
Geological Condition	Pyroclastic flow deposits



⑧	4.31142 S, 152.22601 E
Ave. Height	6m
Length	77m
Slope Angle	60°
Area of Slope	492m^2
Geological Condition	Pyroclastic flow deposits D=0.49m Vp=357m/s



⑨	4.31066 S, 152.22514 E
Ave. Height	7m
Length	36m
Slope Angle	70°
Area of Slope	216m^2
Geological Condition	Pyroclastic flow deposits



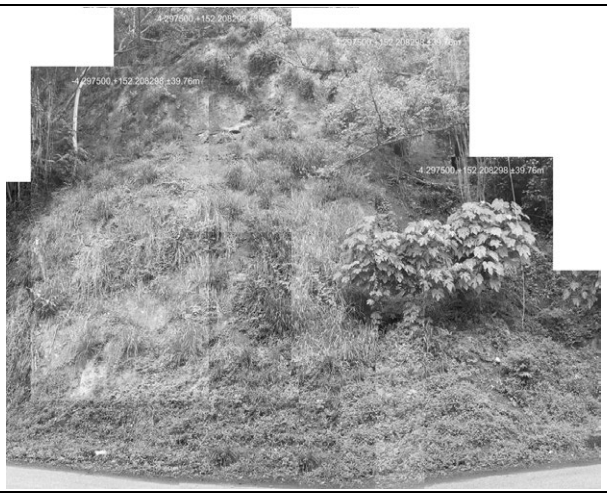
⑩	4.29569 S, 152.21253 E
Ave. Height	6.5m
Length	56m
Slope Angle	90°
Area of Slope	322m^2
Geological Condition	Pyroclastic flow deposits



⑪	4.29577 S, 152.21052 E
Ave. Height	14.5m
Length	35m
Slope Angle	60°
Area of Slope	343m2
Geological Condition	Pyroclastic flow deposits



⑫	4.29744 S, 152.20847 E
Ave. Height	17m
Length	36m
Slope Angle	60°
Area of Slope	373m2
Geological Condition	Pyroclastic flow deposits



⑬	4.30037 S, 152.20376 E
Ave. Height	7m
Length	128m
Slope Angle	90°
Area of Slope	847m^2
Geological Condition	Pyroclastic flow deposits D=0.56m Vp=370m/s R = 10



⑭	4.30175 S, 152.20228 E
Ave. Height	15m
Length	63m
Slope Angle	60°
Area of Slope	831m^2
Geological Condition	Pyroclastic flow deposits



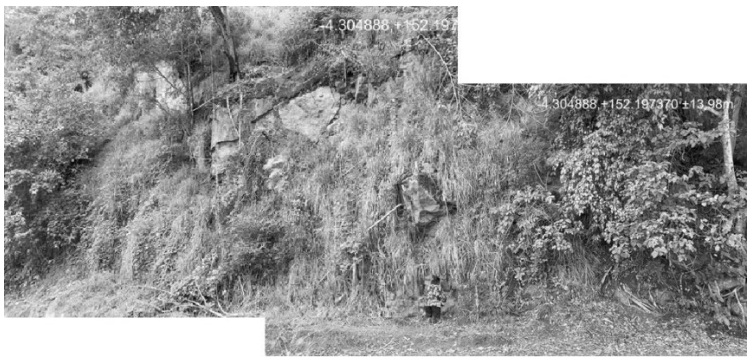
⑮	4.30331 S, 152.20043 E
Ave. Height	8.5m
Length	138m
Slope Angle	90°
Area of Slope	1101m^2
Geological Condition	Pyroclastic flow deposits / Welded Tuff Vp=556m/s R = 35



⑯	4.30409 S, 152.19911 E
Ave. Height	8.5m
Length	30m
Slope Angle	80°
Area of Slope	186m^2
Geological Condition	Pyroclastic flow deposits / Welded Tuff



⑰	4.30508 S, 152.19786E
Ave. Height	9m
Length	51m
Slope Angle	90°
Area of Slope	378m^2
Geological Condition	Pyroclastic flow deposits / Welded Tuff D=1.02m Vp = 611m/s R = 41



⑱	4.30513 S, 152.19567 E
Ave. Height	10m
Length	57m
Slope Angle	90°
Area of Slope	470m^2
Geological Condition	Pyroclastic flow deposits



⑲	4.30563 S, 152.19420 E
Ave. Height	7m
Length	15m
Slope Angle	80°
Area of Slope	57m^2
Geological Condition	Pyroclastic flow deposits



⑳	4.30567 S, 152.19405 E
Ave. Height	13m
Length	136m
Slope Angle	90°
Area of Slope	1599m^2
Geological Condition	Pyroclastic flow deposits Vp=400m/s Welded tuff in the Right bottom R=53



㉑	4.30740 S, 152.19067 E
Ave. Height	8.5m
Length	38m
Slope Angle	70°
Area of Slope	267m^2
Geological Condition	Pyroclastic flow deposits R = 19



㉒	4.30867 S, 152.18529 E
Ave. Height	7m
Length	35m
Slope Angle	45°
Area of Slope	277m^2
Geological Condition	Pyroclastic flow deposits



㉓	4.30880 S, 152.18467 E
Ave. Height	10m
Length	60m
Slope Angle	80°
Area of Slope	508m^2
Geological Condition	Pyroclastic flow deposits



㉔	4.30900 S, 152.18400 E
Ave. Height	8m
Length	36m
Slope Angle	80°
Area of Slope	227m^2
Geological Condition	Pyroclastic flow deposits

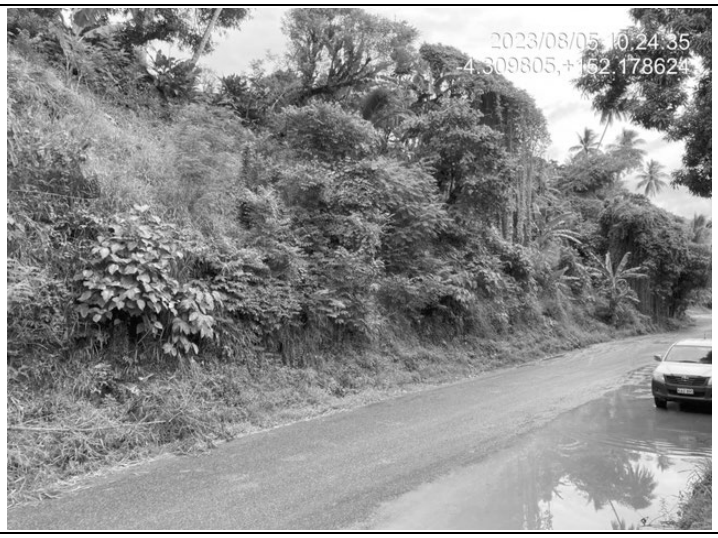


㉕	4.30913 S, 152.18359 E	
Ave. Height	9m	
Length	71m	
Slope Angle	60°	
Area of Slope	644m^2	
Geological Condition	Pyroclastic flow deposits	
㉖	4.30951 S, 152.18228 E	
Ave. Height	8m	
Length	44m	
Slope Angle	65°	
Area of Slope	318m^2	
Geological Condition	Pyroclastic flow deposits	

㉗	4.30966 S, 152.18184 E	
Ave. Height	9.5m	
Length	37m	
Slope Angle	65°	
Area of Slope	288m^2	
Geological Condition	Pyroclastic flow deposits	

㉘	4.30995 S, 152.18127 E	
Ave. Height	11m	
Length	94m	
Slope Angle	70°	
Area of Slope	972m^2	
Geological Condition	Pyroclastic flow deposits R = 11	

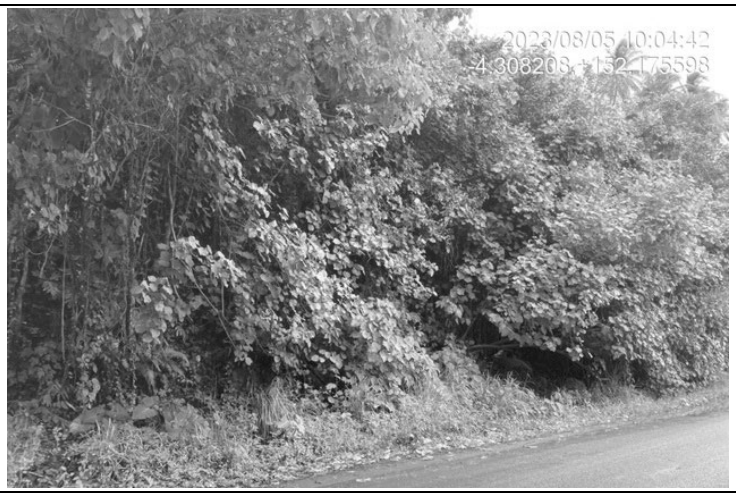
㉙	4.30986 S, 152.17867 E
Ave. Height	8m
Length	108m
Slope Angle	55°
Area of Slope	977m^2
Geological Condition	Pyroclastic flow deposits



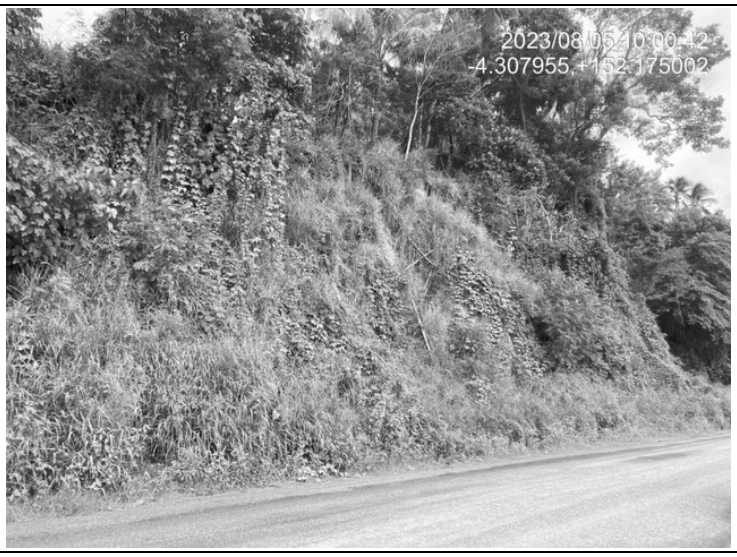
㉚	4.30849 S, 152.17605 E
Ave. Height	5.5m
Length	32m
Slope Angle	45°
Area of Slope	206m^2
Geological Condition	Pyroclastic flow deposits



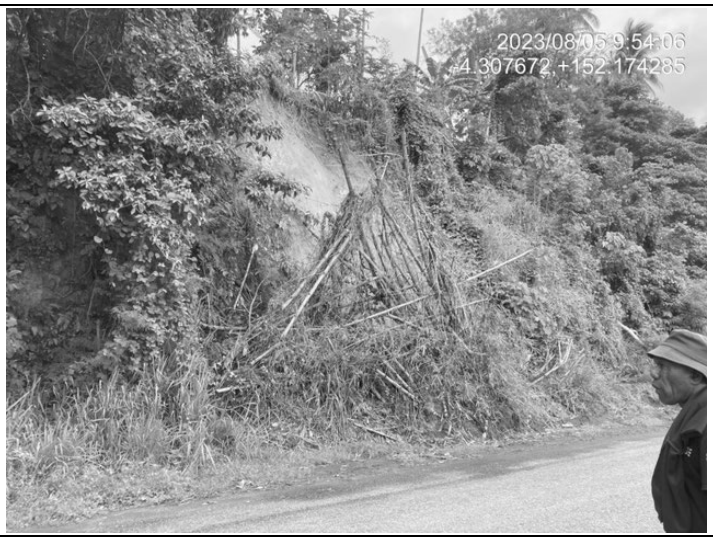
㉛	4.30820 S, 152.17556 E
Ave. Height	8m
Length	60m
Slope Angle	60°
Area of Slope	480m^2
Geological Condition	Pyroclastic flow deposits



㉜	4.30796 S, 152.17500
Ave. Height	10m
Length	72m
Slope Angle	80°
Area of Slope	630m^2
Geological Condition	Pyroclastic flow deposits



㉝	4.30772 S, 152.17431 E
Ave. Height	10m
Length	43m
Slope Angle	70°
Area of Slope	351m^2
Geological Condition	Pyroclastic flow deposits



㉞	4.30744S, 152.17364
Ave. Height	9m
Length	42m
Slope Angle	50°
Area of Slope	388m^2
Geological Condition	Pyroclastic flow deposits



Source: JICA Expert Team