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Project Description

Rio Tuba Nickel Mining Corporation

1

This Environmental Impact Statement (EIS) was prepared in compliance with the requirements of the Environmental Management Bureau (EMB) for the Environmental Compliance Certificate (ECC) application of Rio Tuba Nickel Mining Corporation (RTNMC) for its Rio Tuba Nickel Mining Project (AMA-IVB-144A). Discussed in this chapter are the details of the proposed project including the location, components, process/technology, size, development plan, manpower requirements, and project costs as indicated in the EMB Technical Scoping Checklist.

1.1 PROJECT BACKGROUND

1.1.1 Historical Background of the ECC Application

The following matrix (**Table 1.1.1**) summarizes the history of the ECC application for the Rio Tuba Nickel Mining Project (AMA-IVB-144A) of RTNMC in Mt. Bulanjao, Municipality of Bataraza, Province of Palawan.

Table 1.1.1. Summary of the history of the ECC application for the Rio Tuba Nickel Mining Project (AMA-IVB-144A)

Date	Activities/Remarks
September 13, 2004	1st Level Scoping with the EMB Central Office (CO)
October 16, 2004	On-site scoping
2005	First EIA Report evaluation by the EMB CO
2005 to 2009	The proposed project was delayed for approximately five (5) years due to the proponent's initiative to settle issues on land use reclassification with the municipal government.
July 7, 2009	Another Technical Scoping Meeting with the EMB was conducted to clarify the scope of the EIA document.
August 3, 2010	Draft copy of the EIS was submitted to the EMB; Conduct of Public Consultation Meeting.
August 2010	Draft ECC was presented by the EMB.
2010 to 2014	The DENR requested RTNMC to secure a Strategic Environmental Plan (SEP) Clearance from the Palawan Council for Sustainable Development (PCSD). The proposed project was again put on-hold due to the unavailability of a SEP Clearance.
December 14, 2014	PCSD granted RTNMC with an SEP Clearance (No. MPSA-121114-001)
May 7, 2015	A request letter for Technical Scoping Meeting was sent to the EMB-EIA Division for the re-application of the ECC. Evaluation of the proposed re-application by the EMB proceeded.
July 24, 2015	Technical Scoping Meeting was conducted at the EMB Conference Room
June 17, 2016	The EIS document was submitted for the First Technical Screening. The result was released on June 27, 2016.
August 25, 2016	The responses to the result of the 1st screening was forwarded to EMB
August 2016	The EIA Report was held in abeyance to DMO 2016-01
Current	Re-submission of the EIA Report for EMB Substantive review process

During the technical scoping meeting on July 24, 2015, the EMB Central Office and the Review Committee required the submission of an Environmental Impact Statement (EIS), since the proposed mining area is not within the current 990-ha Mineral Product Sharing Agreement (MPSA 114-98-IV) of RTNMC. However, due to the existing operation of RTNMC proximate to the project site and the utilization of the existing mining ancillary facilities for the proposed project, it was agreed during the meeting that the combined impacts of the existing operation and proposed mining project should be considered in the EIS.

1.1.2 The RTNMC Mining Operations

The mining operation of RTNMC in the municipality started in 1967 with the exploration and subsequent discovery of nickel silicate ore at Barangay Rio Tuba, Bataraza, Palawan. The first Mining Lease Contract (MLC) of the company was approved in September of 1970 covering 110 mining claims with a total area of 990 ha (**Table 1.1.2**). A feasibility study was completed in July 1973 and in September of 1975, land acquisition and mine development started. The first shipment of beneficiated nickel silicate ore to Japan was made in April of 1977.

The second set of MLCs was approved in June of 1978 covering 214 mining claims with about 1,926 ha as seen in **Table 1.1.2**. In the following year, the third and fourth sets of MLCs covering 255 mining claims were approved. These three sets of MLCs have an aggregate area of 5,211 ha. Details of the MLCs of RTNMC are presented in **Table 1.1.2** and illustrated in **Figure 1.1.1**.

Table 1.1.2. Mining lease contracts of RTNMC

Mining Lease Contract No.	Mineral Claims Covered	Total Area (ha.)	Within the AMA-IV-144A (ha.)	Date Approved
MPSA-114-98-IV:				
V-882	14	126	-	18 September 1970
V-883	64	576	-	
V-884	32	288	-	
Total	***110***	***990***	-	*Current operation*
MRD-36	10	90.00	90.00	29 June 1978
MRD-37	6	54.00	54.00	
MRD-38	82	738.00	738.00	
MRD-39	98	882	696.30	
MRD-40	10	90	90.00	
MRD-41	4	36	-	
MRD-42	4	36	36.00	
Total	***214***	***1,926***	**1,704.30**	
MRD-172	24	216	216.00	25 June 1979
MRD-173	14	126	126.00	
MRD-175	12	108	-	
MRD-178	6	54	54.00	
MRD-179	6	54	54.00	
Total	***62***	***558***	**450.00**	
MRD-174	121	1,089	870.10	17 August 1979
MRD-176	60	540	421.00	
MRD-177	12	108	108.00	
Total	***193***	***1,737***	**1,399.10**	
Grand Total	**579**	**5,211**	**3,553.40**	

Renewal of the MLC/conversion to MPSA for the first 110 mining claims was applied in 1996. In 1997, the ECC for the applied area was granted, and in the following year (1998) the MPSA was approved. In 2013, RTNMC applied for an amendment of the ECC for the proposed Nickel Silicate Ore Expansion (Production/Extraction Output) Project within the 990-ha MPSA and was approved in March 9, 2015 denoted as ECC-CO-1312-0043.

Only 990 hectares out of the total 5,211 ha covered in the mining claims of RTNMC were converted to MPSA and the remaining 4,221 ha are for renewal/conversion to MPSA. Out of the 4,221 ha, only 3,553.40 ha is the subject of this ECC application. Note that the proposed project coverage is limited to areas **within** the Municipality of Bataraza, Palawan and

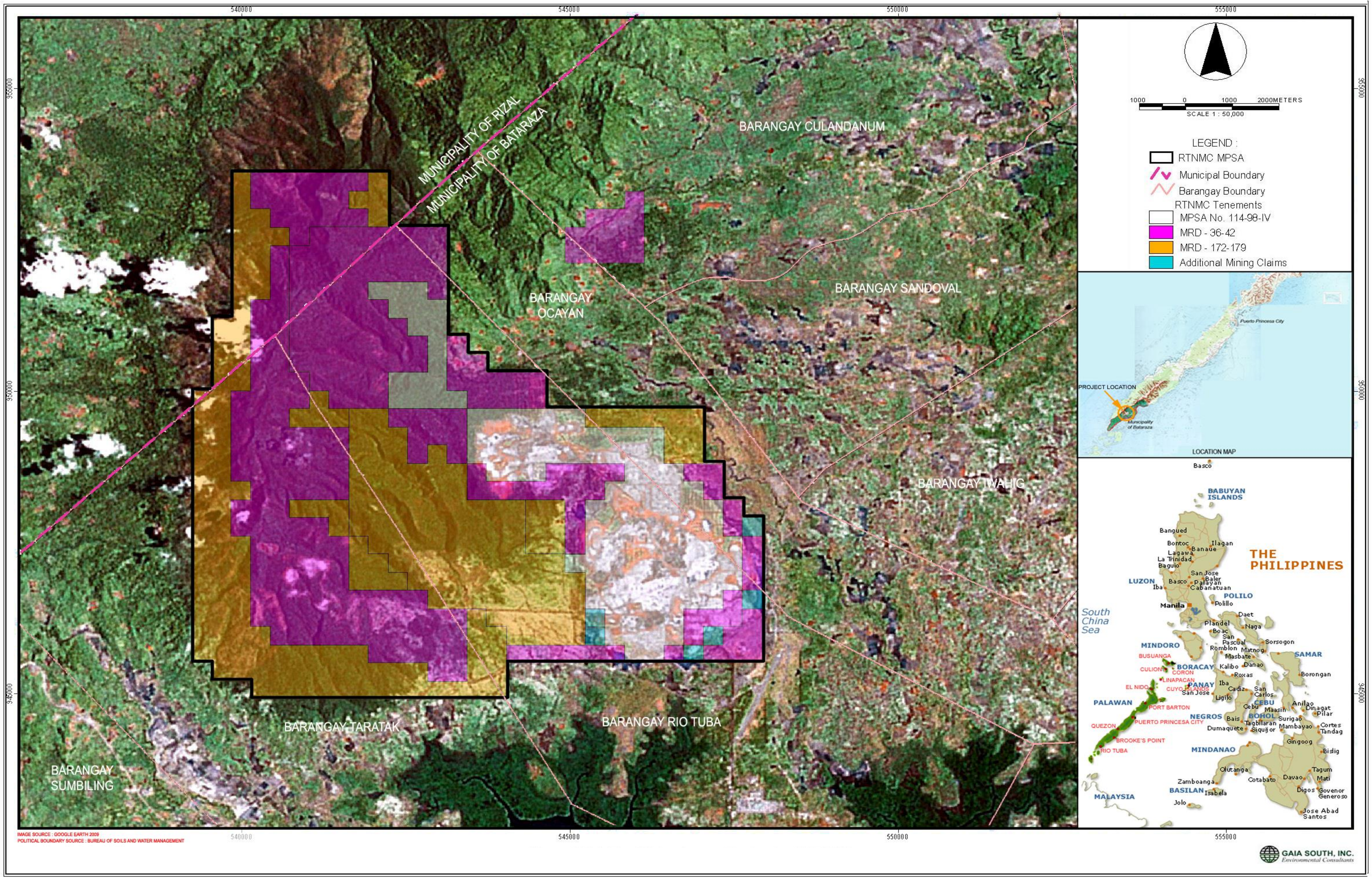


Figure 1.1.1. The MLCs of RTNMC

is contained in the Application for Mineral Agreement No. AMA-IVB-144A. Excluded in this application are the remaining 667.6 ha area located in the Municipality of Rizal under AMA-IVB-144B.

As approved by the PCSD under Resolution No. 14-517 "*A Resolution Granting a Strategic Environmental Plan Clearance To Rio Tuba Nickel Mining Corporation on its Nickel Mining Project Denominated as Application for Mineral Agreement (AMA) No. AMA-IVB-144A*", which was released last December 11, 2014 (**Annex 1.1.1**), the area above 1,000 masl should not be part of the mining operation.

It should be noted again that the Environmental Impact Assessment (EIA) for the proposed mining operations in AMA-IVB-144A was started in 2004. Considering the major requirement of the DENR for the Proponent to attach the SEP Clearance (**Annex 1.1.2**), RTNMC waited for the release of such document until 2014. Consequently, an updated EIA Report based on EMB Memorandum Circular No. 2014-005 was submitted to the EMB Central Office for the re-application of the proposed project's ECC.

1.2 PROJECT LOCATION AND AREA

1.2.1 Location, Vicinity and Access

The current mining operation and existing facilities of RTNMC are located in the Municipality of Bataraza, Province of Palawan. Palawan is a long and narrow island located in the southwestern part of the Philippines. It is approximately 850 km southwest from Manila.

The 3,553.4 ha land covered by AMA-IVB-144A is bounded by the coordinates presented in **Table 1.2.1**. It is within the political boundaries of three (3) barangays in the Municipality of Bataraza namely: Barangays Rio Tuba, Ocayan, and Taratak. **Figure 1.2.1** shows the vicinity map of the proposed project.

As seen in the map, current facilities of RTNMC are within AMA-IVB-144A. Summary of the current land allocation within the 3,553.4-ha land is discussed in the *Section 1.5.2*. Aside from the existing mining area and facilities of RTNMC, other industries located near the proposed mining area are the Hydrometallurgical Processing Plant (HPP) of Coral Bay Nickel Corporation (CBNC) and the Lime Milk Plant of the Unichamp Minerals Philippines (UMPI).

Table 1.2.1. AMA-IVB-144A boundary coordinates

Point	Latitude	Longitude	Point	Latitude	Longitude
Parcel 2					
1	8° 33' 10.43"	117° 25' 4.98"	36	8° 36' 6.20"	117° 23' 36.68"
2	8° 33' 10.43"	117° 24' 6.13"	37	8° 35' 6.20"	117° 23' 46.50"
3	8° 32' 50.90"	117° 24' 6.13"	38	8° 35' 56.43"	117° 23' 46.50"
4	8° 32' 50.90"	117° 21' 58.61"	39	8° 35' 56.43"	117° 23' 56.31"
5	8° 33' 0.66"	117° 21' 58.61"	40	8° 35' 46.67"	117° 24' 56.31"
6	8° 33' 0.66"	117° 21' 38.98"	41	8° 35' 46.67"	117° 24' 25.73"
7	8° 33' 10.43"	117° 21' 38.98"	42	8° 35' 27.14"	117° 24' 25.73"
8	8° 33' 10.43"	117° 21' 29.17"	43	8° 35' 27.14"	117° 24' 15.93"
9	8° 35' 27.14"	117° 21' 29.17"	44	8° 35' 27.14"	117° 24' 1.21"
10	8° 37' 4.33"	117° 23' 12.15"	45	8° 35' 27.14"	117° 23' 46.5"
11	8° 37' 4.33"	117° 23' 36.38"	46	8° 35' 12.49"	117° 23' 46.5"
12	8° 36' 25.73"	117° 23' 36.38"	47	8° 34' 57.84"	117° 23' 46.5"
13	8° 36' 25.73"	117° 23' 26.87"	48	8° 34' 57.84"	117° 23' 56.31"
14	8° 36' 35.31"	117° 23' 26.87"	49	8° 34' 48.08"	117° 23' 56.31"
15	8° 36' 35.31"	117° 23' 12.15"	50	8° 34' 48.08"	117° 24' 11.03"

Point	Latitude	Longitude	Point	Latitude	Longitude
16	8° 36‘ 35.31"	117° 22’ 57.43”	51	8° 34‘ 48.08”	117° 24’ 25.75”
17	8° 36‘ 25.73"	117° 22’ 57.43”	52	8° 34‘ 57.84”	117° 24’ 25.75”
18	8° 36‘ 25.73"	117° 23‘ 7.24”	53	8° 34‘ 57.84”	117° 24’ 38.83”
19	8° 36‘ 15.96"	117° 23’ 7.24”	54	8° 34‘ 57.85”	117° 24’ 51.9”
20	8° 36‘ 15.96"	117° 23’ 17.06”	55	8° 34‘ 57.85”	117° 25’ 4.98”
21	8° 36‘ 6.20"	117° 23’ 17.06”	56	8° 34‘ 48.08”	117° 25’ 4.98”
22	8° 36‘ 6.20"	117° 23’ 26.87”	57	8° 34‘ 48.08”	117° 24’ 55.17”
23	8° 35‘ 56.43"	117° 23’ 26.87”	58	8° 34‘ 38.32”	117° 24’ 55.17”
24	8° 35‘ 46.67"	117° 23’ 26.87”	59	8° 34‘ 38.32”	117° 24’ 45.36”
25	8° 35‘ 46.67"	117° 23’ 17.06”	60	8° 34‘ 23.67”	117° 24’ 45.36”
26	8° 35‘ 46.67"	117° 23’ 7.24”	61	8° 34‘ 9.02”	117° 24’ 45.36”
27	8° 35‘ 36.90"	117° 23’ 7.25”	62	8° 34‘ 9.02”	117° 24’ 35.56”
28	8° 35‘ 27.14"	117° 23’ 7.25”	63	8° 33‘ 59.25”	117° 24’ 35.56”
29	8° 35‘ 27.14"	117° 23’ 10.8”	64	8° 33‘ 59.26”	117° 24’ 45.36”
30	8° 35‘ 27.14"	117° 23’ 19.72”	65	8° 33‘ 49.49”	117° 24’ 45.36”
31	8° 35‘ 27.14"	117° 23’ 46.5”	66	8° 33‘ 39.73”	117° 24’ 45.37”
32	8° 35‘ 36.90"	117° 23’ 46.5”	67	8° 33‘ 20.20”	117° 24’ 45.37”
33	8° 35‘ 36.90"	117° 23’ 36.68”	68	8° 33‘ 20.20”	117° 24’ 55.17”
34	8° 35‘ 49.11”	117° 23’ 36.68”	69	8° 33‘ 20.20”	117° 25’ 4.98”
35	8° 36‘ 1.32”	117° 23’ 36.68”			
Parcel 3					
1	8° 35‘ 27.14"	117° 25‘ 44.24”	24	8° 33‘ 20.20"	117° 25‘ 34.43”
2	8° 34‘ 57.85"	117° 25‘ 44.24”	25	8° 33‘ 29.96"	117° 25‘ 34.43”
3	8° 34‘ 57.85"	117° 25‘ 54.05”	26	8° 33‘ 39.73"	117° 25‘ 34.43”
4	8° 34‘ 38.82"	117° 25‘ 54.05”	27	8° 33‘ 39.73"	117° 25‘ 44.24”
5	8° 34‘ 38.32"	117° 26‘ 3.87”	28	8° 33‘ 39.73"	117° 25‘ 54.06”
6	8° 34‘ 28.55"	117° 26‘ 3.87”	29	8° 33‘ 49.49"	117° 25‘ 54.06”
7	8° 34‘ 18.79"	117° 26‘ 3.87”	30	8° 33‘ 49.49"	117° 26‘ 3.87”
8	8° 34‘ 18.79"	117° 26‘ 13.68”	31	8° 34‘ 4.14"	117° 26‘ 3.87”
9	8° 33‘ 49.49"	117° 26‘ 13.68”	32	8° 34‘ 18.79"	117° 26‘ 3.87”
10	8° 33‘ 49.49"	117° 26‘ 3.87”	33	8° 34‘ 18.79"	117° 25‘ 54.06”
11	8° 33‘ 39.73"	117° 26‘ 3.87”	34	8° 34‘ 28.55"	117° 25‘ 54.05”
12	8° 33‘ 39.73"	117° 26‘ 13.68”	35	8° 34‘ 38.32"	117° 25‘ 54.05”
13	8° 33‘ 10.43"	117° 26‘ 13.68”	36	8° 34‘ 48.08"	117° 25‘ 44.24”
14	8° 33‘ 10.43"	117° 25‘ 44.24”	37	8° 34‘ 48.08"	117° 25‘ 44.24”
15	8° 33‘ 20.20"	117° 25‘ 44.24”	38	8° 34‘ 57.85"	117° 25‘ 34.43”
16	8° 33‘ 20.20"	117° 25‘ 54.06”	39	8° 34‘ 57.85"	117° 25‘ 34.43”
17	8° 33‘ 29.96"	117° 25‘ 54.06”	40	8° 34‘ 7.61"	117° 25‘ 24.62”
18	8° 33‘ 29.96"	117° 25‘ 44.24”	41	8° 35‘ 17.38"	117° 25‘ 24.61”
19	8° 33‘ 20.20"	117° 25’ 44.24”	42	8° 35‘ 17.38"	117° 25’ 24.61”
20	8° 33‘ 20.20"	117° 25’ 34.43”	43	8° 35‘ 17.37"	117° 25’ 11.53”
21	8° 33‘ 10.43"	117° 25’ 34.43”	44	8° 35‘ 17.37"	117° 24’ 58.45”
22	8° 33‘ 10.43"	117° 25’ 24.62”	45	8° 35‘ 27.14"	117° 24’ 45.36”
23	8° 33‘ 20.20"	117° 25’ 24.62”	46	8° 35‘ 56.43"	117° 24’ 45.36”

The project site is accessible from Manila via a direct flight to the site by private plane or through Puerto Princesa City, the capital of Palawan. Puerto Princesa City may be reached from Manila through a 1-hour flight by commercial airplane or through a 28-hour commercial boat ride.

From Puerto Princesa City, the project site can be accessed by a 5-hour land trip via the south road passing through the Municipalities of Aborlan, Narra, Española, and Brooke's Point. A bus company and commercial utility vans service the route.

1.2.2 Delineation of Impact Areas

The identified pre-EIA direct impact areas (DIA) covered by the proposed MPSA are Brgys. Rio Tuba, Taratak, and Ocayan (**Figure 1.2.2**). On the other hand, indirect impact areas (IIA) include Brgys. Sandoval, Sumbiling, Culandanum, Igang-igang, Iwahig, Sarong, and

Tarusan. Taking into account the establishment of additional mine facilities, these barangays are likely to be indirectly affected by the project operation. All these barangays are benefitting from the Social Development and Management Plan (SDMP) of RTNMC and CBNC.

Based on the environmental assessment presented in *Chapter 2,* the following were identified as direct impact areas:

- Barangay Rio Tuba, Barangay Taratak and Barangay Ocayan which are host barangays of the mining areas and mining ancillary facilities;
- Rio Tuba and Ocayan River which are downstream rivers of the proposed mining areas; and
- Areas along Coral Bay determined thru sediment transport modeling as the affected areas in case of failure of structures containing silt/sediment including 500 m buffer zone.

As for the indirect impact areas, the following are considered:

- Barangays Sandoval, Sumbiling, Culandanum, Igang-igang, Iwahig, Sarong, and Tarusan which are located near m the vicinity of the proposed mining areas and recipient of the benefits from SDMP; and
- Areas along Coral Bay within 500 m from the primary impact area.

Figure 1.2.3 shows the impact map of the proposed project based on the environmental assessment.

The Municipality of Bataraza and its vicinities constitute the regional impact area (RIA) of the project where the impacts of the operation can still be felt. The entire province of Palawan may be indirectly affected by the project in the medium- and long-term based on the perspective of socio-economic development.

1.3 PROJECT RATIONALE

Executive Order No. 270 recognizes the important role of the mining industry to the national economy. To optimize the industry's socio-economic benefits, the Order outlines the National Policy Agenda that will promote the rational exploration, development, utilization and conservation of mineral resources in a sustainable and responsible mining operation.

To support Executive Order No. 270, RTNMC will continue with the MPSA application (AMA-IVB-144A) that is located within the Municipality of Bataraza, Province of Palawan.

According to the World Nickel Statistics published by the International Nickel Study Group[1], the world nickel consumption had exhibited a growth rate of 28% for a period of six (6) years, from 1,286,100 tonnes in 2008 to 1,781,000 tonnes in 2011 (**Table 1.3.1**). The increasing trend in total annual consumption started in 2009. Asia, in particular, is the only region that showed an increasing trend since 2009. The statistics also show that Asia has consistently been the highest market for nickel for that same 6-year period. In 2013, 69% of world nickel consumption was attributed to Asia.

[1] http://www.insg.org/stats.aspx

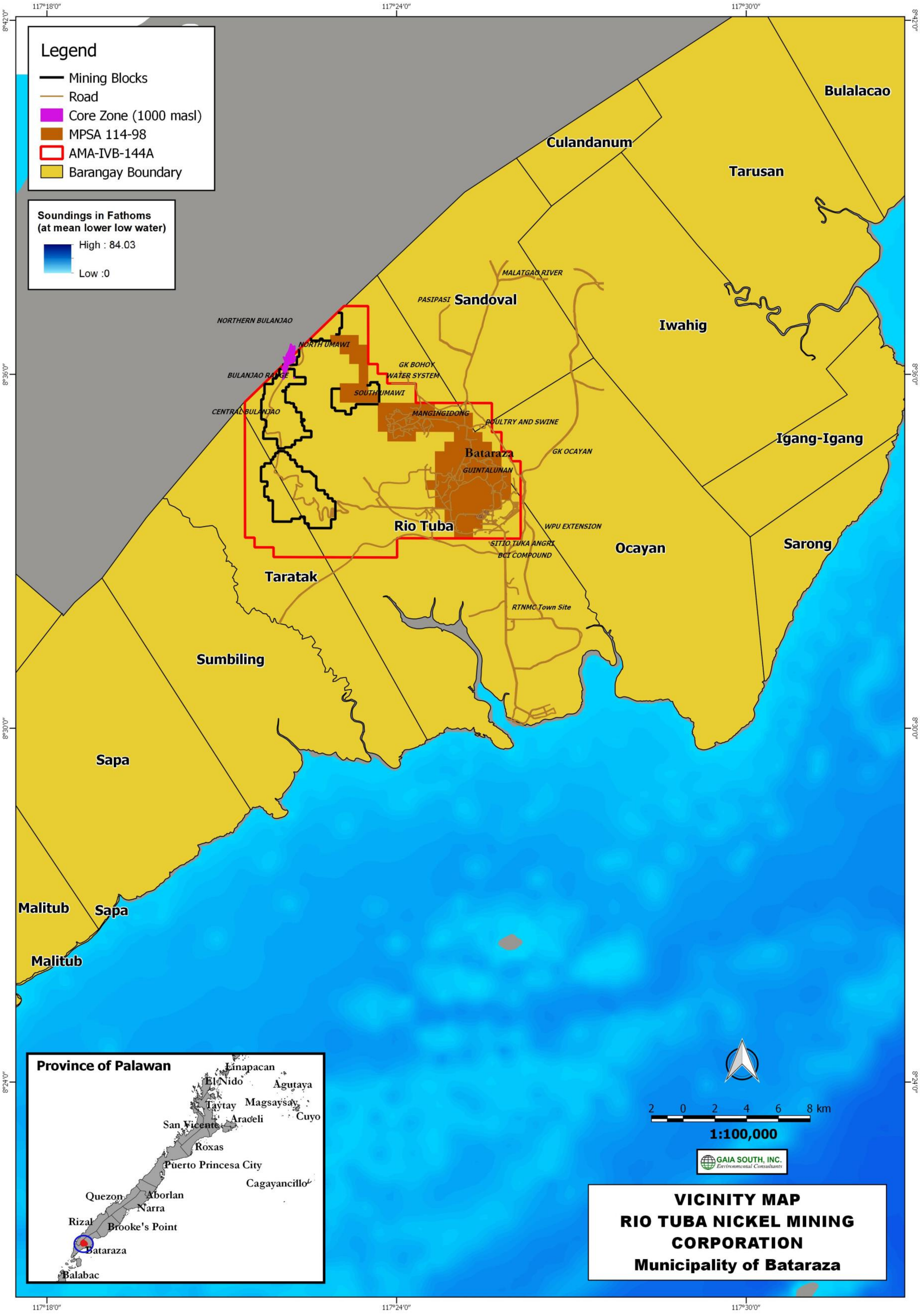


Figure 1.2.1. Vicinity map of the proposed Rio Tuba Nickel Mining Project

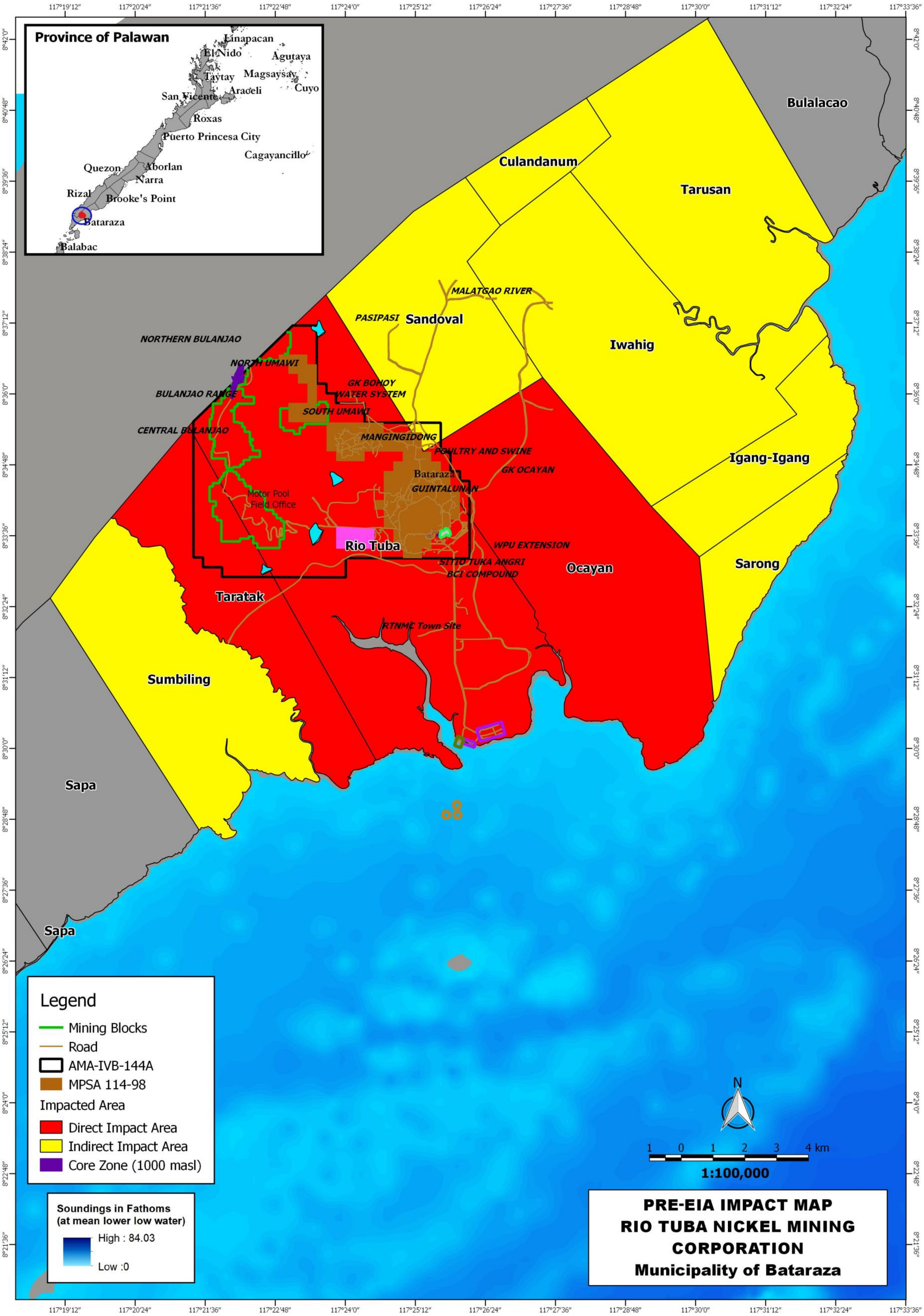


Figure 1.2.2. Pre-EIA impact map of the proposed Rio Tuba Nickel Mining Project

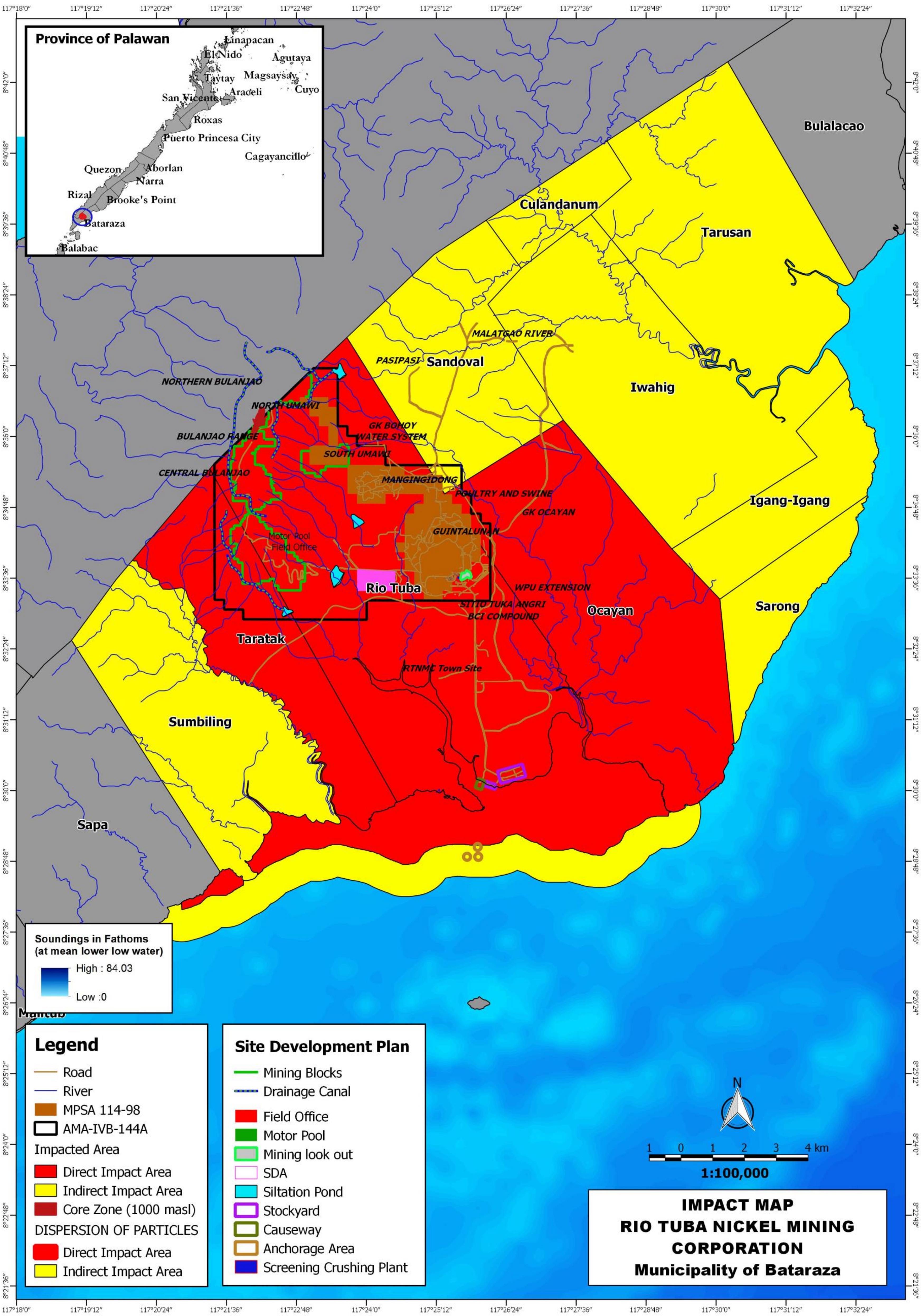


Figure 1.2.3. Impact map of the proposed Rio Tuba Nickel Mining Project

Table 1.3.1. World Nickel Usage (2008-2013)

Region	Nickel Usage ('000 tonnes)					
	2008	2009	2010	2011	2012	2013
Africa	27.0	31.7	24.0	23.9	24.6	22.9
America	160.5	121.8	153.2	165.0	166.4	174.8
Asia	688.3	760.4	929.4	1,050.6	1,102.0	1,233.6
Europe	407.5	317.7	355.9	364.5	359.9	347.0
EU27	365.1	279.9	317.4	325.5	322.0	307.7
Oceania	2.9	2.7	2.7	2.7	2.7	2.7
World	**1,286.1**	**1,234.3**	**1,465.2**	**1,606.7**	**1,655.6**	**1,781.0**

Source: *World Nickel Statistics, http://www.insg.org/stats.aspx*

The MPSA application will extend the life of the mine and enable the company to achieve the following:

- <u>Sustain the employment of more than 5,000</u>[2] employees (including 690 RTNMC regular employees, 1,910 RTNMC contractor employees, 600 CBNC employees, 1,550 CBNC contractor employees);
- <u>Support the local economy of the municipality of Bataraza</u>. The jobs creation enabled by RTNMC and CBNC stimulates local economy with increased consumption of goods and services;
- <u>Continued support to host and neighboring communities including the indigenous communities through Social and Development Programs (Php 200 Million per annum) and CSR Projects (Php 250 Million per annum)[3].</u>
- <u>Generate revenue to the National and Local Governments (Php 1.03 Billion per annum[4]).</u>
- <u>Combined export value of USD 80,000,000.</u> The granting of the MPSA will enable the continued export of nickel ore to Chinese and Japanese partners.

1.4 PROJECT ALTERNATIVES

The project alternatives for this proposed Rio Tuba Nickel Mining Project (AMA-IVB-144A) are presented in **Table 1.4.1**.

Table 1.4.1. RTNMC project alternatives

Aspect	Standard Criteria	Options Considered	Assessment
Siting of Mining area/ Location of Mine Ancillary Facilities	• Perception of Affected communities • Ancestral Domain issues • Land classification • Environmental Consideration	• Continue MPSA application (AMA-IVB-144A)	• RTNMC is securing the MPSA application before the EMB. • RTNMC has already secured a compliance certificate from the National Commission on Indigenous Peoples (NCIP) for the said MPSA application denominated as AMA-IVB-144. • The MPSA application has already been endorsed by the local government thru the passing of resolutions presented as **Annex 1.4** and was granted with SEP clearance by the PCSD. This is under the condition that all mining activities shall be confined within the 3,600.4 ha approved mining area. • By working towards the MPSA application and expanding the mining operations, RTNMC is likely to continue providing employment opportunities to the communities, tax contributions to the government, and it's SDMP. This will also ensure

2 RTN, CBNC, and third-party employees
3 Including SDMP and CSR contributions of CBNC
4 Based on 2017 data

Aspect	Standard Criteria	Options Considered	Assessment
			the continuous operations of the HPP, which is a high valued private investment, along with the delivery of its associated socio-economic benefits. • The proximity of the proposed project area will enable RTNMC to use the existing facilities, which are already under an environmental management plan. Less area shall be opened for the support facilities and impact areas shall be confined within the existing impact areas of the current operation. Furthermore, the 4.1-ha area above the 1,000 masl (core zone) shall be excluded from the mining plan.
		• Discontinue MPSA application (AMA-IVB-144A)	• By doing nothing, the existing physical assets of RTNMC proximate to the proposed new mining area, which can be used for the development and operation of the proposed project, will be wasted if operation is discontinued. • If RTNMC will not continue the MPSA application (AMA-IVB-144A), it loses the chance to develop and extract the nickel and cobalt within the 3,553.4 ha. However, this may and probably will also result to other entities filing an MPSA application over the same area. Depending on the capabilities of these entities and their successful compliance with the government's requirements, the mineral property may thus be developed and the nickel and cobalt similarly extracted. This way, the host and surrounding communities may benefit from the new mining ventures. If the government rejects the new entities' MPSA application, mining in the area will cease. The HPP will eventually run out of ore feed and be forced to shut down as well. There will be an adverse economic impact to the host and surrounding communities as jobs, tax revenues, and company-sponsored social services and community programs will cease. The resulting backlash would be an acutely reduced economic activity in the municipality as money in circulation (particularly originating from salaries and wages from both RTNMC and its sister company CBNC, which sources its raw materials directly from RTNMC) will be significantly reduced. Once these employees leave, the demand for resources will be lowered and the suppliers of these will lose their sources of income. It can be assumed that many families and individuals will most probably have no option but to leave the area and seek employment elsewhere.
Mining method	• Ore geochemistry • Ore location and dimensions • Production cost	• Contour Mining • Underground mining	• RTNMC shall employ the same mining method used in its current mining operation, which is contour mining. The support facilities, equipment and manpower to be utilized are already available within the area. The experience of RTNMC with the contour mining method and the findings of this EIS shall help them anticipate environmental impacts and be able to provide the most appropriate mitigating measures.

Aspect	Standard Criteria	Options Considered	Assessment
Technology selection / Operation processes	• Marketability • Capital cost • Type and volume of ore • Local situation • Condition of the site		• RTNMC currently sell two (2) types of nickel ore: limonitic nickel ore and saprolitic nickel ore to CBNC and to Japanese and Chinese buyers. The current MPSA (AMA-IVB-144A) application of RTNMC shall extend the mining operations in Bataraza. • Since RTNMC started its operation in the municipality of Bataraza in 1970's, the company has acquired or established several physical assets such as production facilities, road networks, its own townsite, its own wharf, and hundreds of heavy equipment. Development of the AMA-IVB-144A shall only require an additional working capital of PhP 984,247,000 to upgrade the current facilities and equipment and procure new equipment.
Resource utilization	• Power and water requirement • Availability of power and water supply	•Existing power and water supply •Development of other source of power and water	• Due to the utilization of the existing facilities, the same power and water supply can be used. • Additional water requirement for the road watering activities should be sourced from the existing settling ponds or from the proposed settling ponds to reduce the water requirement from the Rio Tuba Water Supply.

1.5 PROJECT COMPONENTS

1.5.1 Existing Operation

The construction and subsequent operations of AMA-IVB-144A will be done using the existing facilities of the mining operations under MPSA-114-98-IV.

1.5.1.1 Ore Reserve and Mine Operation within the MPSA-114-98-IV

From 1975 to 2004, RTNMC was engaged in mining saprolite ore for direct shipment to Japan. From 2005 up to the present, RTNMC is engaged in limonite operation, in addition to its saprolite operation and in support of CBNC's HPP Operation.

As of December 31, 2017, the saprolite and limonite ore reserves of RTNMC's MPSA-114-98-IV, both stockpile and in-situ, are shown in the following table:

Table 1.5.1. MPSA-114-98-IV Ore Reserves (as of December 31, 2017)

Ore	KWMT	KDMT	%Ni	%Fe
Saprolite	10,853	7,346	1.44	14.72
Limonite	27,772	19,420	1.03	36.52
Total	**38,625**	**26,766**	**1.14**	**30.54**

Currently, RTNMC is operating on a maximum annual production capacity of 3.0 Million WMT of saprolite with a maximum annual extraction rate of 4.0 Million WMT. This is due to the increased demand for low-grade saprolite ore by Chinese and Japanese markets. On the other hand, to support the current HPP's capacity of 25,000 MT of nickel and 1,875 MT of cobalt per year as mixed sulfide, its annual maximum limonite production capacity is 5.0 Million WMT with a 6.0 Million WMT annual extraction rate.

1.5.1.2 Existing Mining Facilities and Equipment

The current operation maintains various mining facilities. **Table 1.5.2** shows the tabulated mine components, facilities and ancillary buildings of RTNMC while **Table 1.5.3** shows the tabulated mining equipment used in their mining operation. Note that most of these equipment and facilities will still be used by RTNMC upon operation of the mining activity in the Bulanjao range.

Table 1.5.2. RTNMC mine facilities and infrastructures as of 2018

Facility	Floor Area/Capacity	Quantity/ Remarks
Townsite Infrastructure		
ATM Booth/Waiting Shed	30 m^2	1 lot
Bachelor's Quarter	766 m^2	2 units
Badging Office, Gate 1	24 m^2	1 unit
Badminton, 2 courts	391m^2	1 unit
Bath House and Filtration/Pump Room	119 m^2	1 unit
Camp Maintenance Bldg/Storage room/Workshops	653 m^2	1 unit
Church Convent/Parish Hall	955 m^2	1 lot
Clubhouse	370 m^2	1 unit
Fitness Gym	70 m^2	1 unit
Foreman's Duplex	119 m^2/unit	32 units
GSSI Dormitory	196 m^2	2 units
Guest House (Ex. Consultant's Res.)	158 m^2	1 unit
Guestlodge	463 m^2	1 unit
Guestlodge Laundry Shed	30 m^2	1 unit
Gymnasium	854 m^2	1 unit
Hospital Building	1,654 m^2	Level 1
Hospital Garage	110 m^2	1 unit
Hospital Kitchen/Storage Room	223 m^2	1 lot
Hospital Morgue	32 m^2	1 unit
Information Center (CRA) Bldg.	440 m^2	1 unit
Junior Staff House	82 m^2	24 units
Laborer's Dormitory	232 m^2	116 units
Laborer's Row Houses	202 m^2	1 unit
Ladies Dormitory	338 m^2	1 unit
Resident Mine Manager Residence	118 m^2	1 unit
LSVMS School Bldg. (Elementary Dept.)	5,460 m^2	1 lot
LSVMS School Bldg. (High School Dept.)	4,900 m^2	1 lot
Market Building	384 m^2	1 unit
Motorcycle Shed, Gate 2	127 m^2	1 unit
Rice/Cement Warehouse Bldg.	60 m^2	1 unit
Senior Staff House	102 m^2	8 units
Senior Staff Dorm (Ex. JTA Dorm)	422 m^2	1 unit
Shopping Center	420 m^2	1 unit
Swimming Pool	655 m^2	1 area
Oval Sport Facilities: Basketball Court Volleyball Court	495 m^2	1 unit
Tennis Court, 3 units	2,937 m^2	1 area
Nickel Nook Two-storey bldg. and dirty kitchen	566 m^2	1 unit
Water Disinfection Bldg.	12 m^2	1 unit
Water Refilling Station	39 m^2	1 unit
Mine and Plant Site		
Mine Pit	142 hectares	1 unit
Siltation Ponds		6 units
Tagpisa Pond	16.54 hectares; 574,000 cubic meter capacity	203,588 cu.m.
Upper Togpon Pond	11.66 hectares; 433,175 cubic meter capacity	282,175 cu.m
Lower Togpon Pond	9.10 hectares; 126,000 cubic meter capacity	182,753 cu.m 1,160.56 cu.m.
Upper Kinurong Pond	5 hectares; 120,000 cubic meter capacity	99,994 cu.m
Lower Kinurong Pond	12.43 hectares; 88,200 cubic meter capacity	79,678 cu.m.

Facility	Floor Area/Capacity	Quantity/ Remarks
Stockpile and Solar Drying Area	101.42 hectares	-
Hauling/Access Road		48 km
Macadam Road		7.1 km
Mine Office	235 m^2	1 unit
Administration Building	774 m^2	1 unit
Safety Office	334 m^2	1 unit
Mechanical Building	1,358 m^2	1 unit
Mine lookout office	222 m^2	1 unit
Preventive maintenance office and shop	586 m^2	1 unit
Light equipment shop	1,820 m^2	1 unit
Assay Laboratory	424 m^2	1 unit
Power Plant building	469 m^2	1 unit
Screening and crushing plant	576 m^2	1 unit
Warehouse building	1,120 m^2	1 unit
Airport office and hangar	383 m^2	1 unit
Marine barracks	521 m^2	1 unit
Ore shed	580 m^2	1 unit
Drying shed	300 m^2	1 unit
Carpentry shop	60 m^2	1 unit
Tire Washer	44 m^2	1 unit
Pier/Ore Loading Facility	102 m^2	1 unit
Pier Stockyard	61 hectares	1 unit
Canvas sheet stockroom	450 m^2	1 unit
Power Plant Building	168 m^2	1 unit
PSCM Workshop	74.4 m^2	1 unit
Customs Office	63.6 m^2	1 unit
Sampling Stand	22 m^2	1 unit
Pier and sea craft maintenance office	180 m^2	1 unit
Nagoya Beach	2,000 m^2	1 unit
Fuel Storage		
Diesel Depot	1,077,147 liters	1 unit
Diesel Depot	1,711,018 liters	1 unit
RTNMC Domestic Water System		
Water Wells	-	4 units
Plantsite Water Tank	71 m^3	1 unit
Townsite Water Tanks	268 m^3 and 300 m^3	2 units
Water Disinfection Building	12 m^2	1 unit
Umawi Water Source (Intake Area)	2,880 m^2	1 unit

Table 1.5.3 Mining equipment and facilities maintained by RTNMC **(as of January 2019)**

Equipment/Facility	Make/ Model/Floor Area	Quantity / Remarks
Production		
Dump Trucks	ISUZU CYX51K, VOLVO FM-13, VOLVO FM-11	41 units 49 units
Bulldozers	DRESSTATD20M, KOMATSUD85PX-15LGP, CATERPILLARD7R-IILGP, CATERPILLARD7R-II, KOM D85EX-15R, CATERPILLARD7R-LGP	18 units
Track Excavators	KOMPC450-7, KOMPC200LC-8A, VOLVOEC460BPRIME, VOLVOEC210BPRIME, VOLVOEC460BLPRIME, VOLVOEC210BLCPRIME, KOMPC-300-8, CATERPILLAR336D, CAT320D, KOMPC-200 8SLF, KOMPC-200 8SLF, KOMPC200LC-8MO	38 units
Wheel Loaders	KOMWA470-5, DRESSTA534E, VOLVOL150F, VOLVOL150G, CAT966H, CATERPILAR 966L	41 units
Other Equipment		
Fuel Lorry	VOLVOFM64R, ISUZU CYZ51K, ISUZU/FORWARD, UDCWE370	4 units
Truck Crane	KATOSR-700L	1 unit
Water Truck	ISUZUCYZ51K	7 units
Maintenance Trucks	ISUZUNPR, ISUZUNPR22, ISUZUCYZ6MF, ISUZUVYZ51K, ISUZU NPS, ISUZU CYZ51Q,	8 units

Equipment/Facility	Make/ Model/Floor Area	Quantity / Remarks
	ISUZU 4KH1, ISUZU NPR71	
Garbage Trucks	ISUZU NPS	2 units
Fire Trucks	ISUZU NQR 4.6	1 units
Hauling Trucks	ISUZUCYZ51K	1 units
Road Grader	VOLVO G930	4 units
Road Roller	BOMAG/BW212D-40, CATERPILLARCS533E	2 units
Truck trailer	VOLVO FM64R	1 unit
Wheel Excavator	VOLVO EW145BPRIME, CATM313D	8 units
Service Vehicles		
Service Jeeps	SUZUKIJIMNYJLXMT, SUZUKIJIMNYJLXAT	13 units
Service Buses	ISUZU/JALDXZ16MK, ISUZUJALFTR33P, ISUZU6HK1, ISUZU CYZ510	5 units
Service Pick-up	NISSAN FRONTIER, ISUZU D-MAX, NISSAN FRONTIER (NAVARA), MIT. STRADA .5 GL 4X2 MT, ISUZU DMAX 4X4 LS MT, TOYOYA HI-LUX	13 units
Service Trucks	KIA K2700, ISUZU NPR66, ISUZU NPS, MITSUBISHI CANTER, ISUZU NPS75L, ISUZU NPR85L, MAHINDRA ENFORCER	25 units
Wagon	NISSANSUPERSAFARI, NISSANURVANESTATE, MIT. MONTEROSPORT, MIT ADVENTURE, TOYOTA HI-ACE	8 units
Service Equipment		
Welding machine	DENYODLW400ESW, YANMARYDW190AE	4 units
Tug boats	CATD342, CAT3406DI	3 units
Pump boat	MIT. 4DR50A	1 unit
Barge	250-Ton Capacity	11 units
Farm tractor	KUBOTA S2602-D1-A	1 unit
Lifting machine	TCM FD30T32, TCM INOMA FD30T37, KOMATSU FD30T-17	3 units
Screening / Crushing plant		
Jaw Crushers	KURIMOTO, 3020ST, 770MM X 500MM O 80MM closed side setting	1 unit
Cone Crusher	TEREX-JAQUES, JW42 125MM CLOSED SIDE SETTING	1 unit
	TEREX-JAQUES, TC 1000 25 MM closed side setting	1 unit
Roll Crusher	KURIMOTO, 3624 Double Roll Crusher 25 MM closed side setting	1 unit
Vibrating Screen	ALCHAMERS, Single Deck, 1220mm x 274mm Inclined Vibrating Screen 25mm grizzly bar opening	2 units
	1960 Metal industries, Single Deck, 1200mm x 3650mm; Inclined Square Opening	1 unit
	Aggregates Engineering Ltd., Triple Deck, 6’x 16’ Inclined Vibrating Screen 1st Deck: 80mm Square Opening 2nd Deck: 40mm Square Opening 3rd Deck: 25mm Square Opening	1 unit
	Aggregates Engineering Ltd., Double Deck 5’ x 16’ Horizontal Vibrating Screen 1st Deck: 40mm Square Opening 2nd Deck: 3.2mm Square Opening	1 unit
Trommel	Locally Fabricated, 1082 dia x 3575mm length 3.2mm Opening pf Perforated Sheet	1 unit
Desander	Aggregates Engineering Ltd., Double Deck 5’x16’ 3.6m W x 3.3mL x 2.9m H, 60 microns Cut Point	1 unit
Scalping Divergator	Aggregates Engineering Ltd., 1200mm x 600mm 500mm maximum feed size	1 unit
Apron Feeder	Aggregates Engineering Ltd., 1200mm x 6000mm; 500mm maximum in feed size	1 unit
Portable Crushers	Cedar Rapids mobile Primary Jaw Crushers, 30”	1 unit

Equipment/Facility	Make/ Model/Floor Area	Quantity / Remarks
	x 42"120mm Closed Side Setting	
	SANDVIK, QJ241 Tracked Jaw Crusher, 39" x 26"120mm Closed Side Setting	1 unit
	TEREX, Premier track XA400S Mobile Crusher 1100mm x 700mm, 120mm Closed Side Setting	1 unit
Fixed Grizzly	6m x 7m, 50mm opening tapered to 120mm bottom opening, Inclined at 30 deg.	1 unit
Assaying Equipment		
Jaw Crusher	Feedable size: 150mm max Crushing size: -50mm	1 unit
Roll Crusher	Feedable size: -50mm Crushing size: -25mm	1 unit
	Feedable size: -25mm Crushing size: -10mm	1 unit
Drying Oven	Memmert, UF1060	1 set
	Chamber type	2 sets
	"Daihan" Wisen ven, Industrial Forced convection Model: WOF - 1000	1 set
Top Grinder	15 kg/hr crushing cap.	2 sets
Sample Grinder	20 kg/hr crushing cap	2 sets
Sieve Shaker	RX – 86	1 set
V- Type Mixer	1101 -3 V type, 3li cap.	1 unit
Pulverizer, Direct Driven	BICO	2 units
	UA V- Belt Pulverizer, model: 242-53/51	
Platform Balance , Mechanical	OHAUS, 20 kg cap.	1 set
Top Loading Balance	BOECO, BWL60	1 unit
Microwave Oven	GE JEI 2870SP SS	1 unit
Vibratory Disc Mill	RETSCH, RS 200	1 unit
Hot Plate	Brand: Barnstead Model: HPA2240M	1 unit
	Brand: Thermo Scientific Model: HPA2240M	1 unit
Muffle Furnace	Brand: DAIHAN Model: Wisetherm/FM-14	1 unit
Universal Oven	Brand: DAIHAN Model: WON50; 50 Li	1 unit
Weighing Balance, analytical	Brand: Melter Toledo Model; AB204S/FACT & ML 204/02 200g cap	2 units
Spectronic 20A	Milton Roy	1 unit
Spectroquant UV- VIS	Brand: PHARO Model: 300 UV-VIS	1 unit
Atomic Absorption Spectrophometer	Brand: PHARO Model: 300 UV-VIS	1 unit
Water de- ionizer	Matten D.I. system, 100L/hr	1 set
Magnetic Stirrer	Nuova / SP18420Q, Thermolyne	2 units
Auto-Desiccator Cabinet Type	Brand: SECADOR Model: F42073- 1220	1 unit
Electronic Dry Cabinet	Model: All DRY – series	1 unit
Wavelength Dispersive X-Ray Fluorescence Spectrophometer (XRF)	Brand: Shimadzu Sequential Model: XRF- 1800	2 sets
Portable Dehumidifier	Model: DPI- 45E- 03	1 unit
UPS for XRF	Brand: INFORM Model: DSMP1110	1 unit
	Brand: INFINITE GALEON	1 unit
UPS for Chiller	Brand: INFORM Model: DSpU33010	2 units
Press Machine for XRF Sample	Brand: SPECAC Model: T40	1 unit
pH Meter	Brand: Jenway Model: 3510	1 unit
	Brand: HANNA Model: HI 98130	1 unit

Equipment/Facility	Make/ Model/Floor Area	Quantity / Remarks
Auto Desiccator	Model: SECADOR	1 unit
Digital Burette	Brand: Titrette Model: 4760161	2 units
Weather Station Equipment		
Rain Gauge Thermo hydrograph Evaporimeter Barometer		

Plates 1.5.1 to **1.5.11** show the current facilities located within the project area and townsite of RTNMC. Among these are the two (2) stockyards (**Plate 1.5.1**) for shipping grade and beneficiated nickel silicate ore, the Macadam Road (**Plate 1.5.2**) used for hauling and the airstrip (**Plate 1.5.3**).

Regular employees are housed in the RTNMC townsite (**Plate 1.5.4**) where a hospital (**Plate 1.5.5**), a school (**Plate 1.5.6**), a public market **(Plate 1.5.7)** and a Community Relations Office (**Plate 1.5.8**) are also situated.

Plate 1.5.1. Stockyards for shipping graded and beneficiated nickel silicate ore

Plate 1.5.2. Macadam Highway

Plate 1.5.3. RTNMC Airstrip

Plate 1.5.4. RTNMC Townsite

Plate 1.5.5. RTNMC Hospital

Plate 1.5.6. Leonidas S. Virata Memorial School (LSVMS)

Plate 1.5.7. RTNMC Townsite Public Market

Plate 1.5.8. RTNMC/CBNC Community Relations Office

Within the mining complex are heavy equipment depot (**Plate 1.5.9**), crushing plant (**Plate 1.5.10**), administration building (**Plate 1.5.11**), the back-up power plant (**Plate 1.5.12**), and the solar drying areas (**Plate 1.5.13**).

Plate 1.5.9. RTNMC Heavy Equipment Depot

Plate 1.5.10. RTNMC Crushing Plant

Plate 1.5.11. RTNMC Administration Building

Plate 1.5.12. Back-up Power Plant

Fuel Storage and Handling System

Fuel is used for the mining fleet, loading facility, service units and power generation. The 2.7 million liter receiving fuel storage tank is located along the shoreline in Sitio Tagdalongon, Brgy. Rio Tuba. The storage tanks are lined with an impervious bound to contain 110% of the total volume of the tanks.

Plate 1.5.13. Solar Drying Area

Port Loading Facility

The existing pier at Sitio Marabajay, Brgy. Rio Tuba shall also be utilized for this project**.** The pier is capable of accommodating a maximum of nine (9) shipments per month during peak season, and around four (4) per month during the peak of the rainy season; each shipment is approximately 52,000 MT.

1.5.1.3 Pollution Control and Waste Management Facilities

The following are the pollution control measures being employed by RTNMC for its mining operation within MPSA 114-98-IV. These measures shall also be used by RTNMC for its proposed mining project.

Sediment Control Structures

Water flowing from disturbed areas is directed into existing siltation ponds. At present, there is a series of siltation ponds for the existing minesite. The silt control facilities constructed include diversion canals and settling ponds.

There are currently five (5) siltation ponds in the mining complex that catches runoff: Upper and Lower Kinurong, Tagpisa, Lower and Upper Togpon. These basins temporarily impound the run-off water then release it in a more manageable flow toward Togpon Creek and Kinurong Creek then finally to Rio Tuba River. These siltation ponds have a combined capacity of approximately 1 million cubic meters.

Drainage System

Drainage canal and culverts were installed along the peripheries of the mining area to catch and prevent surface runoff from elevated areas within the site and to manage domestic sewerage from mine offices. Along with proper slope engineering, boulder toe dressing and reforestation activities, containment of runoff and stabilization of slope is being practiced by RTNMC.

RTNMC controls and prevents soil erosion and subsequent siltation of river through slope management and soil stabilization techniques. Other soil erosion control measures include the covering of stockpiles with canvass sheets and the provision of a drainage system that allows run-off to be contained first to siltation ponds before it discharges to the receiving water bodies. Regular retrieving of settled silt materials, called desiltation, is performed on a monthly basis and most particularly during the dry season when the water levels are low in the silt ponds.

Leaching Control Measures

Besides the siltation of important waterways, the leaching of potentially harmful heavy metals is also a notable concern that needs to be addressed. In order to mitigate and control the possible leaching of heavy metals, RTNMC employs and researches several Leaching Control Measures:

1.) Installation of charcoal gabions at the discharge point of Lower Togpon and Lower Kinurong Siltation Ponds was done to contain possible percolation of suspected hexavalent chromium in the area.
2.) Certain species of Vetiver Grass are placed at strategic locations where the capacity of the said plants to absorb heavy metals is observed.
3.) A regulated amount of a FerroSulfate $FeSO_4$ compound is doused at the inlets of major siltation ponds during the rainy season. This chemical compound reduces Hexavalent Chromium (Cr^{+6}) to the non-harmful Trivalent Chromium (Cr^{+3}).
4.) The design of the major siltation ponds in itself is a countermeasure to the occurrence of heavy metals: the series of siltation ponds ensure that any volume of

water carrying heavy metals are detained long enough and its velocity decreased in order to ensure heavy metal precipitation .

5.) Regular desilting of the silt ponds to ensure that all heavy metal precipitates are removed from the silt ponds and will not have a chance to re-oxidize into harmful aqueous cations.

Dust Control Measures

The mining operation, stockpiling of soil materials and ores, and hauling of these materials will generate dust. Dust generation is being minimized by watering haul roads regularly. Covering these stockpiles also helps minimize dust generation.

The installation of accordion chutes in the screening and crushing plant has been performed by RTNMC to enclose dust particles that are agitated and dispersed into the air during deposition and stockpiling of the operation. Windbreakers and dust collector boxes are also in place at strategic locations around the crushing plant discharge to prevent any dust from dispersing further.

Domestic Waste Management

RTNMC has designated garbage bins within the buildings and waste disposal areas around the site, which are being cleaned and collected at a regular basis. Designated holding areas for other wastes such as busted lamps, metal craps and other hazardous materials were allocated and handled properly by RTNMC.

Oil Contamination Management

The use of heavy equipment increases the risk of oil and grease contamination of water bodies. This is controlled by providing oil and water separators in the equipment depot and the motorpool.

The annual cost of the Environmental Protection and Enhancement Program's (EPEP) mitigation measures is presented in **Table 1.5.4**.

Table 1.5.3. Cost of Environmental Protection and Enhancement Program

Activities	2015-2019	2020-2024	2025-2029	2030-2032
Tree Planting/ Reforestation Projects	68,640	42,440	29,180	17,508
Mine Rehabilitation	113,387	262,766	278,920	186,584
Silt Control Project	40,825	59,615	58,766	30,204
Dust Emission Control Project	55,920	56,170	56,170	33,702
Heavy Metal Control Projects	3,525	3,525	3,525	2,115
Waste Water Treatment Control Projects	6,408	5,430	5,430	3,258
Solid Waste Disposal Project	12,925	7,9258	7,925	4,755
IEC and Monitoring	12,850	12,850	12,850	7,710
Others	82,018	71,142	60,806	36,582
Total	**396,497**	**521,862**	**513,582**	**322,688**

Note: all values in x1000 Php

1.5.2 Proposed Rio Tuba Nickel Mining Project

1.5.2.1 Proposed Mining Operation

Currently, the nickel mining operation of RTNMC is confined only within the 990 hectare-mining area denominated as MPSA 114-98-IV. With the proposed mining project, RTNMC shall operate mining activities in AMA-IVB-144A consisting of 3,553.4 ha. However, the operation shall exclude the 4.1 ha above 1,000 MPSA per condition stipulated under the SEP Clearance of RTNMC for the proposed project (**Annex 1.1.1**). **Figure 1.5.1** shows the site development plan of the proposed project.

Based on feasibility study conducted for the proposed project (**Annex 1.5.1**), RTNMC shall have an average annual production capacity of 2.20 M WMT for saprolite, 3.78 M WMT for limonite-HPAL/High Fe and 1.80 M WMT limonite-No assay. The proposed long-range mining plan from 2017 to 2026 is provided as **Figure 1.5.2**. Other details of the proposed operation are provided in **Table 1.5.5**.

Table 1.5.4. Proposed operation within AMA-IVB-144A

Component	Details
Average annual production capacity	Saprolite : 2.20 M WMT
	Limonite: 3.78 M WMT (HPAL/High Fe) 1.80 M WMT (No Assay)
Annual shipping capacity	Saprolite : 2.11 M WMT
	Limonite: 0.06 M WMT (High Fe) 3.54 M WMT (HPAL)
No. of stockyards	One (1) 61-hectare Pier stockyard (same stockyard used in the current operations)
Average no. of ore shipment per year	42 shipments per year (assuming 52,000 WMT/shipment)
Stockpile limit	18,000 WMT

As seen in **Figures 1.5.1** and **1.5.2**, the proposed mining activities within AMA-IVB-144A shall be limited in the areas below 1,000 masl.

As mentioned in the previous section, the existing facilities of RTNMC, represented by green color in **Figure 1.5.1**, shall be utilized in the operation of the proposed mining project. Also included in the site development map are the shared facilities, denoted by the yellow color, which includes Macadam road and access/Magam road. These roads are being used by CBNC, UMPI and RTNMC and will be utilized also for the proposed project.

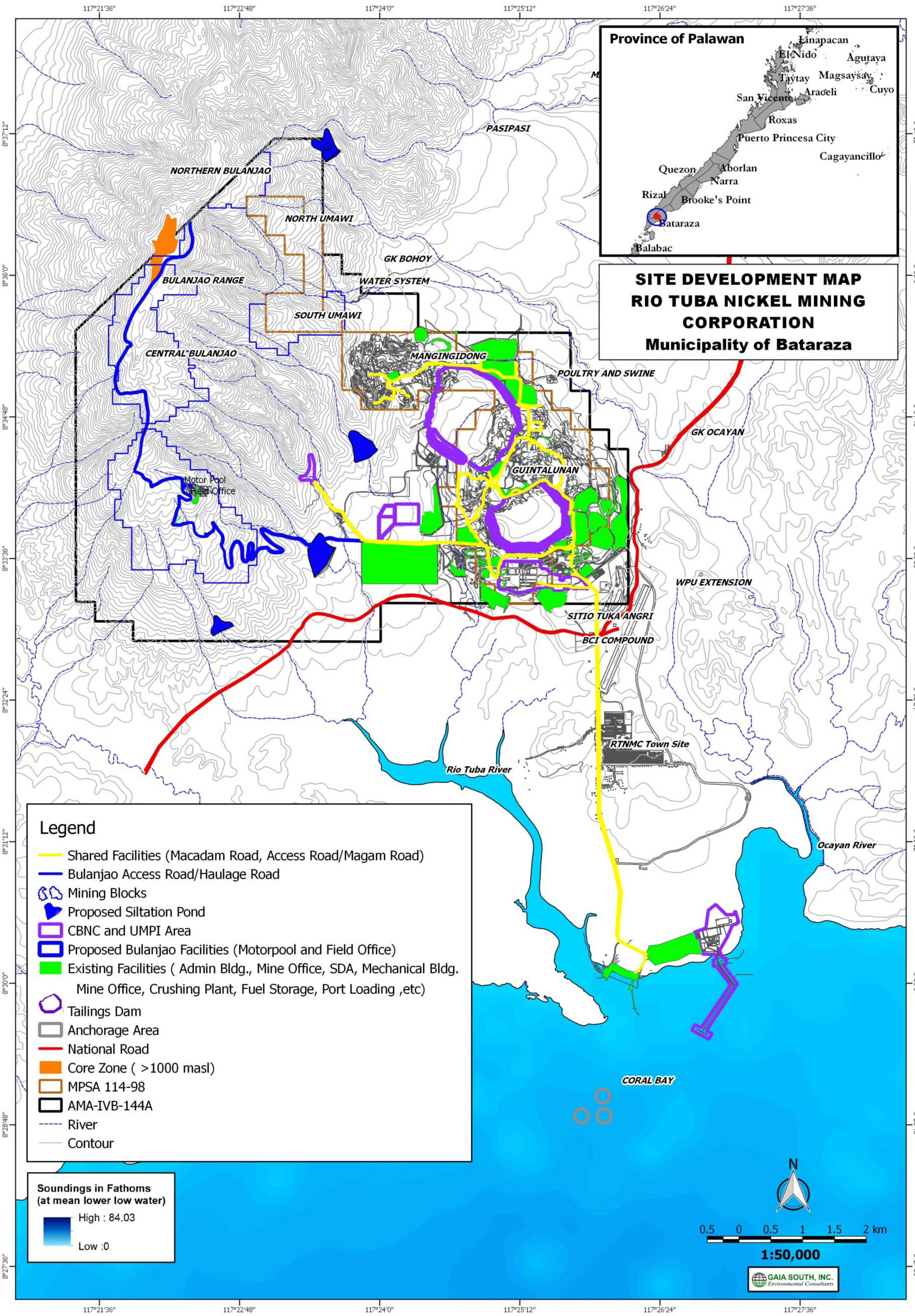


Figure 1.5.1. Site development plan of the proposed Rio Tuba Nickel Mining Project

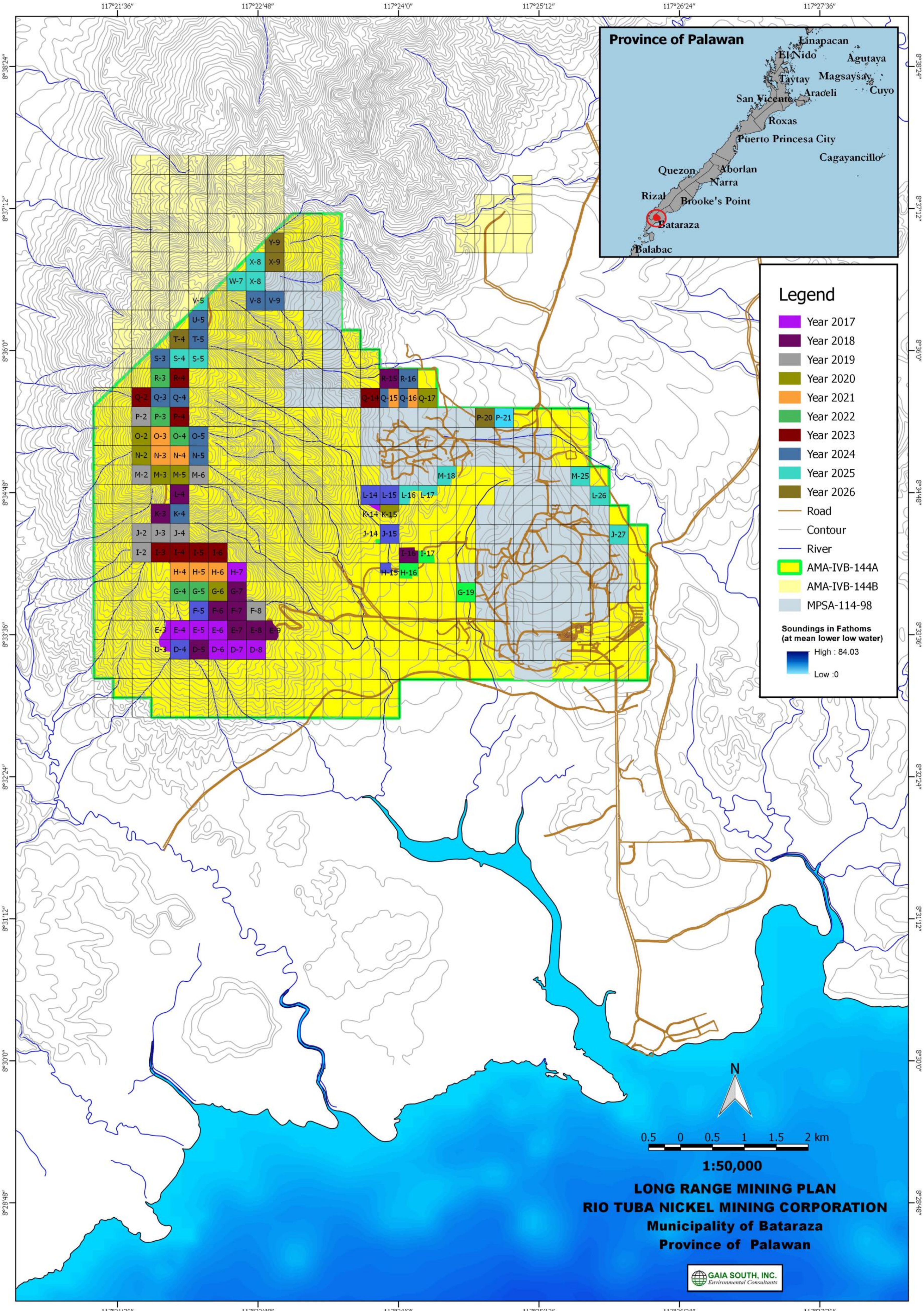


Figure 1.5.2. Long Range Mining Plan of the proposed Rio Tuba Nickel Mining Project

1.5.2.2 Proposed Support Facilities

In addition to the existing facilities of RTNMC, a field office and a motorpool shall be constructed in Bulanjao to support the proposed operation within AMA-IVB-144A. Location of the proposed facilities is provided in **Figure 1.5.1**. In addition, environmental structures such as drainage system, siltation ponds and silt sump shall be installed.

Table 1.5.5. Proposed infrastructure in Bulanjao (assumed area)

Facility	Floor Area
Bulanjao Field Office	150 m^2
Bulanjao Motorpool	192 m^2

Currently, some facilities of RTNMC are situated within AMA-IVB-144A. **Table 1.5.7** shows the existing and proposed project components within the 3.553.4-ha land.

Table 1.5.6. Existing and proposed project components within AMA-IVB-144A

Project Component	Area (ha)
AMA-IVB-144A	**3,553.4***
Existing Facilities	
Crushing plant facilities	2.53
Administration Building	1.50
Mine Office & Mine Look-out	7.30
Mechanical Building	2.80
Access Road	33.00
Siltation Ponds	55.61
Solar Drying Area	13.50
Ore Stockpile Area	16.90
CBNC Used Area	98.29
Tailings Dam No. 2 (CBNC)	76.24
Sub-total	307.67
Proposed Facilities	
Mining area	678
Bulanjao Field Office	0.015
Bulanjao Motor pool	0.019
Siltation ponds	16.32
Drainage canal	2.47
Access road	4.00
Sub-total	700.82
Total	**1,008.49**
Remaining area within the AMA-IVB-144A*	**2,544.91**

*Note: *This includes the 4.1 ha above 1,000 masl.*

1.5.2.3 Power Supply and Requirements

RTNMC owns one (1) 700 kW, and two (2) units of 350 kW diesel generator sets for its power generation needs. The same equipment shall be used upon operation of the mining project in the Bulanjao area. Approximately 4,276,403 kW annual power requirement is expected from the townsite and the mining operations. **Table 1.5.8** provides the breakdown of the power requirement.

Table 1.5.7. Breakdown of the power requirement

Facilities	Working hours per day	Working days per year	Power Requirement (kW/hour)	Annual Power Requirement (kW)
Gizzly/Crusher	16	210	23.064	77,496
Townsite	24	365	256.125	2,243,655
Plantsite	8	350	620.408	1,737,141
Piersite	24	365	24.899	218,111
		Total	**934.495**	**4,276,403**

Diesel supply used for the power generation is loaded to the company's fuel tank located at the pier site. The fuel is conveyed to the storage tank (located in the plant site) using fuel lorries. The fuel is then pumped to the power plant's 6 m^3 settling tank. The supply pipe is equipped with a 10 kW heater, which is operated during fuel movement.

The pier site power plant also maintains one (1) unit of 75 KW Caterpillar generator to provide electricity requirement of the pier facilities for dry-docking maintenance and barge loading operations.

1.5.2.4 Water Requirements

The current operation of RTNMC requires a total of 1,924,200.00 m^3/year of water, which is sourced from Rio Tuba Water Supply System, rivers and groundwater resources. This is distributed for domestic, equipment cleaning, and road watering needs.

Water used for drinking and other domestic needs of RTN Townsite and some *sitios* of Rio Tuba (*e.g.* Sto. Niño and Kinurong) is supplied by the Rio Tuba Water Supply System, which is sourced from Umawi stream at Sitio Bohoy. The water supply system has an actual capacity of 4,400 m^3/day and has the following major components:

- One (1) unit Infiltration gallery with Backwash System;
- One (1) unit Dual Media Filter with Backwash System;
- 50 m^3 capacity Filtered Water Well;
- 10.5 km by 200 millimeters Steel Transmission Pipes;
- Two (2) units – 300 m^3 capacity Elevated Water Tank; and
- Disinfection or Chlorination System.

Majority of the water requirement for road watering is also sourced from Umawi stream but supplemented by water impounded in the mine pit and siltation ponds (Mangingidong Pit 26, Tagpisa Siltation Pond and Lower Togpon siltation pond) during the dry months. On the other hand, water requirement for equipment cleaning are from water wells no. 2 and 3.

In terms of water discharge (rainy season) from the settling ponds established by RTNMC, the average volume flow rate per year of Lower Kinurong and Lower Togpon silt ponds are 83,220 m^3/yr and 611,010 m^3/yr, respectively. The recipient of the discharge is the Rio Tuba River.

The projected water requirement for the proposed RTNMC's mining activities is estimated at 2,030,700 m^3/year, which is only about 7.84% of the available water from various sources. Since the proposed mining project in Bulanjao area will be conducted by phase after the current stockpile is utilized, the current water requirement for the townsite and equipment cleaning shall be the same. On the other hand, additional 106,500 m^3/yr shall be needed for watering of the proposed additional access road in Mt. Bulanjao. Shown in **Table 1.5.9** is the water balance matrix and the breakdown of projected water use of RTNMC.

Table 1.5.8. Water balance matrix of RTNMC

Water Sources	Available Water (m^3/yr)	Proposed water requirement (m^3/yr)		
		Town site	Equipment Cleaning	Road Watering
Rio Tuba Water Supply System*	1,606,000	1,500,000.00	274,200.00	256,500.00
Siltation ponds	897,818			
Groundwater Well No. 2 and 3	385,000.00			
Total	**2,888,818.00**	**2,030,700.00**		

Source: RTNMC, 2013
Note: The townsite domestic water requirement of RTNMC and Brgy. Rio Tuba is sourced from Umawi Creek which is a tributary of Ocayan River. Umawi creek's annual water discharge is 1,600,000.00 m^3.

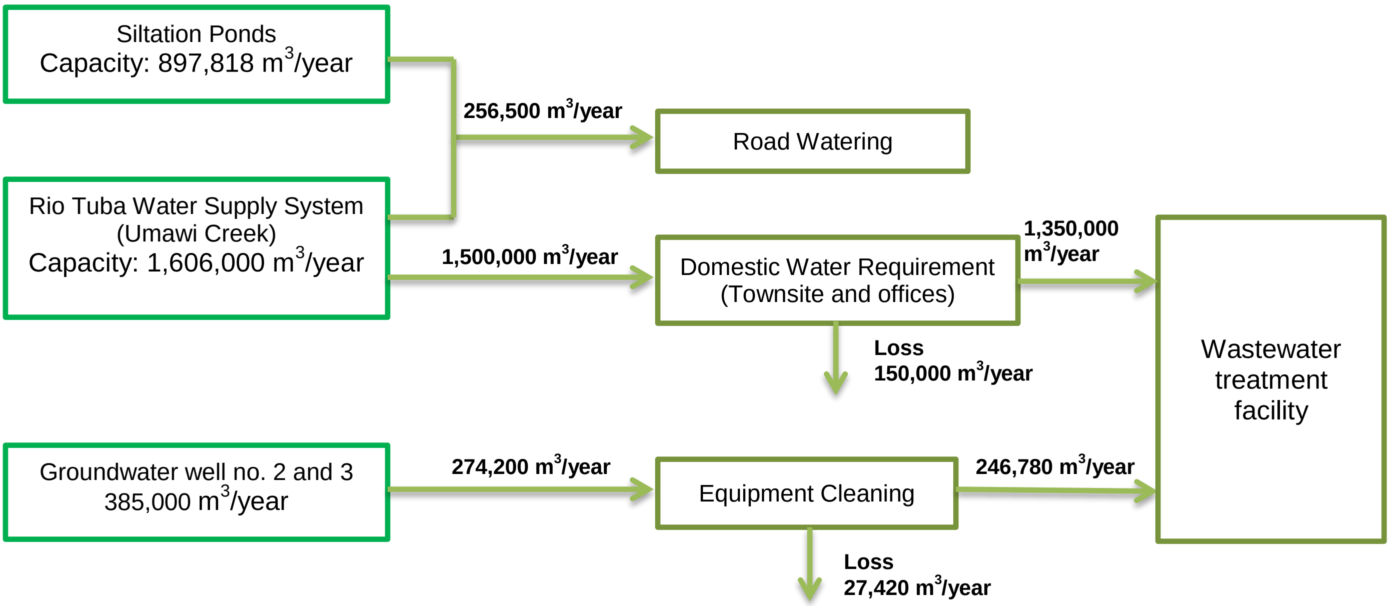


Figure 1.5.3. Water balance diagram

1.5.2.5 Fuel Requirements

The projected fuel requirement of the proposed mining operations is approximately 1,059,168 liters/month (**Table 1.5.10**).

Table 1.5.9. RTNMC fuel requirements

Fuel	Proposed Fuel Requirement (L/mo.)
Diesel	1,033,292
Lube and Grease	17,760
Regular gasoline	7,166
Aviation gas	950
Total	**1,059,168**

1.5.2.6 Waste Generation and Management

The waste generated during the project development and operation phases shall compose of overburden materials. As much as possible, all overburden materials shall be used in the progressive rehabilitation of mined-out areas. Unsalable materials that are not used in the rehabilitation shall either be stockpiled or used in engineering projects such as mine road matting or on the embankment of certain structures.

Mined-out areas after the cessation of mining shall be progressively rehabilitated to bring back the natural vegetation of the site. Through rehabilitation, soil erosion and siltation is diminished. This will also encourage displaced wildlife to colonize the mined-out areas.

1.6 PROCESS/TECHNOLOGY OPTIONS

1.6.1 Ore Extraction

The current mining operation of RTNMC is within MPSA-114-98-IV. The nickel ore is extracted through surface mining called the Contour Mining Method. The same process of operation shall be employed in the proposed mining project in the Bulanjao area. The sequence of operations comprises the following processes:

- Development drilling;
- Clearing and overburden removal;
- Limonite mining and stockpiling;
- Soft saprolite ore mining;
- Hard saprolite ore mining;
- Waste material handling;
- Saprolite ore beneficiation involving solar drying of raw soft ore, reclamation of solar dried ore, screening and crushing, transfer of marginal ore to stockpiles;
- Ore hauling and stockpiling of beneficiated saprolite ore;
- Direct limonite ore hauling to HPAL Plant; and
- Limonite ore stockpile retrieval and delivery to HPAL plant.

Detailed discussion of the process is provided in *Section 1.8.2*.

1.6.2 Pollution Control Measures for the proposed mining project

In this section, proposed additional pollution control measures of RTNMC for its proposed operation in AMA-IVB-144A shall be discussed.

1.6.2.1 Drainage Canal

To prevent storm water run-off from disturbed areas of the proposed project from directly flowing towards the downstream rivers, RTNMC shall construct a drainage canal with an approximate length of 13.4 km. The said canal shall divert the storm water run-off to siltation ponds where sediments shall be allowed to settle before flowing towards the downstream rivers.

1.6.2.2 Sediments control dam

As presented in the previous section, RTNMC shall construct four (4) siltation ponds to help mitigate possible siltation. Details of the proposed siltation ponds are provided in **Table 1.6.1**.

Table 1.6.1. Dimensions of the siltation ponds to be constructed

Dimension	Dike 1	Dike 2	Dike 3	Dike 4
Construction year	2016	2017	2020	2022
Capacity (m^3)	6,545	163,401	37,912	32,987
Area (hectare)	0.35	12.22	0.47	3.28
Dike Elevation				
Top	85	55	120	80
Base	77	50	110	76

Table 1.6.1. Continuation…

Dimension	Dike 1	Dike 2	Dike 3	Dike 4
Width of Dike				
Top	6	6	6	6
Base	42.5	81.5	39	20.5
Height of Dike	8	5	10	4
Length of Dike	79	575	145	230

Source: A Feasibility Study on Mt. Bulanjao Mining Project (AMA-IVB-144A) MPSA Acquisition, 2015

1.6.2.3 Reforestation of Mangroves

Destroyed mangrove areas located at the downstream of the proposed mining area were identified by RTNMC. These areas shall be subjected to reforestation with the technical assistance from the CENRO-Brooke's Point. This reforestation project shall help prevent silt from reaching the sea since mangroves are natural silt filters.

1.7 PROJECT SIZE

1.7.1 Ore Reserves within AMA-IVB-144A

With the inclusion of the proposed mining area (AMA-IVB-144A), the total ore reserves of RTNMC, and consequently its mine life will be increased significantly. **Table 1.5.10** shows the summary of the ore reserves for AMA-IVB-114A.

Table 1.7.1. AMA-IVB-144A Ore Reserves (as of December 31, 2014, Projected)

Mineral Type	Classification	Tonnes (kwmt)	Tonnes (kdmt)	%Ni	%Fe	Contained Ni (kt)
Saprolite	Proved and Probable	9,710	6,456	1.57	12.09	102
Limonite	Proved and Probable	22,805	15,911	1.13	33.85	179

1.7.2 Proposed production rate

Based on the feasibility study conducted, for a period of 10 years, the proposed mining project is expected to move a total material volume of 63,078,352 WMT (**Table 1.7.2**), 46,303,970 WMT of which are for shipment or feed tonnage (**Table 1.7.3**).

An annual extraction rate of 8,245,563 WMT is expected for the first six (6) years. This value will generate **2,280,000 WMT** of saprolite ore, **3,800,000 WMT** of HPAL/High Fe Type limonite, **1,900,000 WMT** of limonite (no assay) and **265,563 WMT** of wastes. **Figure 1.7.1** shows the material balance diagram.

Table 1.7.2. Annual production plan for AMA IV-B-144A

Year	Raw Material Moved (WMT)				
	Saprolite	HPAL/ High Fe	No Assay*	Waste	Total
2017	2,280,000	3,800,000	1,900,000	265,563	8,245,563
2018	2,280,000	3,800,000	1,900,000	265,563	8,245,563
2019	2,280,000	3,750,000	1,950,000	265,563	8,245,563
2020	2,280,000	3,750,000	1,950,000	265,563	8,245,563
2021	2,280,000	4,050,000	1,650,000	265,563	8,245,563
2022	2,280,000	4,050,000	1,650,000	265,563	8,245,563
2023	2,280,000	3,271,094	1,568,856	213,600	7,333,550
2024	2,280,000	-	-	93,400	2,373,400
2025	2,280,000	-	-	93,400	2,373,400
2026	1,479,451	-	-	45,173	1,524,624
TOTAL	**21,999,451**	**26,471,094**	**12,568,856**	**2,038,951**	**63,078,352**

Source: A Feasibility Study on Mt. Bulanjao Mining Project (AMA-IVB-144A) MPSA Acquisition, 2015
Note: A good percentage of the total limonite-No Assay tonnage is expected to turn-out as saleable limonite based on actual experience

Average Annual Extraction Rate:
Saprolite: 2.2 M WMT
Limonite: 3.78 M WMT (HPAL/High Fe)
1.80 M WMT (No Assay)

Average Annual Production Capacity:
Saprolite 2.11 M WMT
Limonite: 0.06 M WMT (High Fe)
3.54 M WMT (HPAL)

Average Annual Waste Material: 0.2 M WMT
Waste material will be temporarily stockpiled prior to use as topsoil in mined-out areas

Figure 1.7.1. Material balance diagram of the proposed Rio Tuba Nickel Mining Project

Table 1.7.3. Annual shipment and feed tonnage

Year	Saprolite	Limonite		Total
		High Fe	HPAL Feed	
2017	2,300,000	100,000	3,600,000	6,000,000
2018	2,300,000	100,000	3,600,000	6,000,000
2019	2,300,000	50,000	3,600,000	5,950,000
2020	2,300,000	50,000	3,600,000	5,950,000
2021	2,300,000	50,000	3,600,000	5,950,000
2022	2,300,000	50,000	3,600,000	5,950,000
2023	2,252,634	44,756	3,173,704	5,471,094
2024	1,900,000	-	-	1,900,000
2025	1,900,000	-	-	1,900,000
2026	1,232,876	-	-	1,232,876
TOTAL	**21,085,510**	**444,756**	**24,773,704**	**46,303,970**

Source: A Feasibility Study on Mt. Bulanjao Mining Project (AMA-IVB-144A) MPSA Acquisition, 2015

A summary of the components of the proposed mining operation during direct shipping is presented in **Table 1.7.4.**

Table 1.7.4. Components of the proposed mining operations

Component	Details of the Proposed Mining Operations
Mine area opening	AMA-IVB-144A (3,553.4 hectares)
Average Annual Production Capacity	**Saprolite**: 2.20 M WMT **Limonite**: 3.78 M WMT (HPAL/High Fe) 1.80 M WMT (No Assay)
Average Shipping Capacity	**Saprolite**: 2.11 M WMT **Limonite**: 0.06 M WMT (High Fe) 3.54 M WMT (HPAL)
Ore reserves *(as of Dec 31, 2015)*	**AMA-IVB-144A** **Saprolite**: 9,947,636 WMT **Limonite**: 19,191,710 WMT Cut-Off Grades used: **Saprolite:** ≥ 0.80% Ni **Limonite High Fe:** < 0.80% Ni, > 44.00% Fe **Limonite HPAL:** ≥ 0.80% Ni, ≥ 20.00% Fe
Method of ore extraction	Contour Mining
No. of stockyards	One (1) 61-hectare Pier Stockyard
Average # of ore shipments/year	42 shipments per year *(assuming 52,000 WMT/shipment)*
Port loading capacity	Maximum of three ships at any given time.
Stockpile limit	18,000 WMT
Power Source	One (1) 700 kW Nigata Power Plant Two (2) 350 kW
Domestic and Industrial Water Source	Domestic source from Rio Tuba Water Supply System (Umawi Creek) established by RTNMC Water Wells 3, 4 & 5 For road watering, water impounded in the siltation ponds as well as from mine pits due for rehab.

Component	Details of the Proposed Mining Operations
Water requirements	Total: 2,031,700 m^3/yr Townsite: 1,500,000 m^3/yr Equipment Cleaning: 274,700 m^3/yr Road watering/dust control: 256,000 m^3/yr
Fuel tank capacity	*Pier Site (2 units)* Diesel (1st Unit): 1,077,147 L Diesel (2nd Unit): 1,711,018 L
Manpower requirements	690 (engineering, maintenance, production)
Project Cost	PhP 4,583 B

Source: RTNMC, 2015

1.8 DESCRIPTION OF PROJECT PHASES

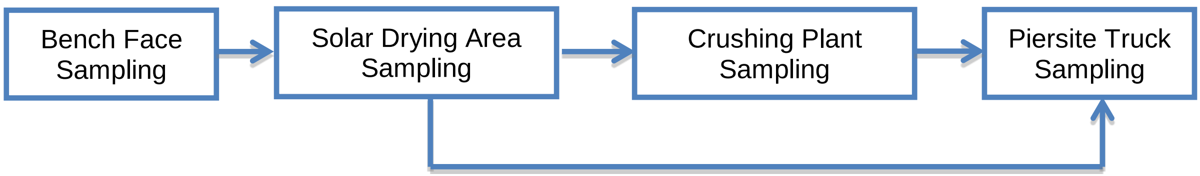
1.8.1 Construction Phase

The opening of the mining area within the 3,553.4 ha AMA-IVB-144A shall include site preparatory activities such as ground clearing and road construction. Mitigating measures shall also be implemented during the construction phase.

1.8.2 Operation Phase

The proposed mining project shall concentrate at the mining blocks located in the Bulanjao area excluding the areas with elevation of 1,000 masl as a conditionality based on the SEP Clearance granted by the PCSD. The nickel ore mining process will use the contour method of surface mining. The sequence of operations shall consist of development drilling, pit planning and survey, clearing and grubbing of scheduled pit area, stripping of overburden, mining, beneficiation, ore stockpiling, ore stockpile retrieval, ore hauling, ore feeding, and ore shipment.

A rigid grade control system is followed starting at the pit right up to ore shipment to ensure that the product shipped complies with the client specifications. The grade control activities are:



The process of ore mining is described in the succeeding sections.

1.8.2.1 Development Drilling

This is needed to delineate the extent of the mineable ore and determine pit limits. The identified extent of laterization in the tenement was already subjected to 300 m x 300 m exploration drilling. Present and future drilling works are needed for the development and planning of the pit.

The drilling equipment consists of one (1) unit of YBM YSO-1, and 10 units of YBM YHP-1 drill. The Yoshida machines yield core samples at an average drilling rate of 2.15 m/hr.

From the 300-m grid drill, development drilling will be conducted at a 100-m grid and then at a 20-m grid. The end-result of the 20 m x 20 m drilling pattern is positive ore delineation for contour mining.

1.8.2.2 Pit Planning and Survey

After determining the volume and grade of the nickel silicate ore, pit plans are generated. Pit plans include removal of overburden and mining limits, haul roads and ramps, drainage system, equipment requirement, and work schedule.

Surveying involves geodetic measurement of alignments, areas and volumes on a daily basis to map the excavated and planned pit outline and conduct routine measurement of pit advance, elevations, and extracted volumes.

1.8.2.3 Clearing and Grubbing

The area scheduled for mining will be first cleared and grubbed of its tropical trees and vegetation using bulldozers. Clearing and grubbing are normally undertaken months ahead of mining in order to expose for a longer time the surface of the area. A long surface exposure reduces moisture content of the ore to be mined.

1.8.2.4 Overburden waste handling

The upper part of the ore zone contains laterite and low-grade soft ores. These materials are heavily weathered and rippable, thus, no blasting is required during mining. Using track excavators and loaders, the overburden will be drawn and loaded to waiting dump trucks. The trucks in turn will haul and dump the overburden to designated stockpiles or used as top soil in mined-out areas. Benches will still be maintained at 3 m.

The overburden waste to ore ratio is negligible as experienced from the mining operation within the Guintalunan and Mangingidong deposits. Overburden removal is conducted during devegetation activities.

1.8.2.5 Limonite Mining

The existing proven limonite nickel ore reserves of RTNMC are both in the form of in-situ (in-the-ground) ore and stockpiled ore (**Figure 1.8.2**). Note however that there are no stockpiled ore sourced from the Bulanjao deposit.

In-situ limonite Ore Mining

In-situ limonite nickel ores are normally mined from May to November using contour mining. Backhoes with 1.8 m^3 bucket sized will be used to draw the limonite ores and loaded onto dump trucks for delivery to HPP or to a designated mine stockpile yard, or to pier stockyard depending on ore classification.

Stockpile limonite ore retrieving

The existing ore stockpiles are piled separately according to ore quality. Using excavators fitted within 1.8 m^3 backhoe and 15 m^3 dump trucks, ores are retrieved from stockpiles. In ore retrieving within soft-ground stockpiles, the retreating method is used. In this method both the excavator/loading unit and dump trucks are positioned on top of the ore block being excavated.

HPP limonite ore feeding

Using a front-end loader, the ores from the HPP stockyard are retrieved, hauled and dumped into the receiving hopper of the HPP's Ore Preparation Area. Within the Ore Preparation

Area, the lateritic ores are washed and screened separating the -1.4 mm fraction from the +1.4 mm size fraction. The +1.4 mm size fraction (oversize materials) is rejected and hauled back by RTNMC onto a designated oversize ore stockyard. Depending on the quality of these oversize materials, it may be shipped to other interested nickel ore buyers. The -1.4 mm size (undersize materials) comprises the final ore products sold to CBNC.

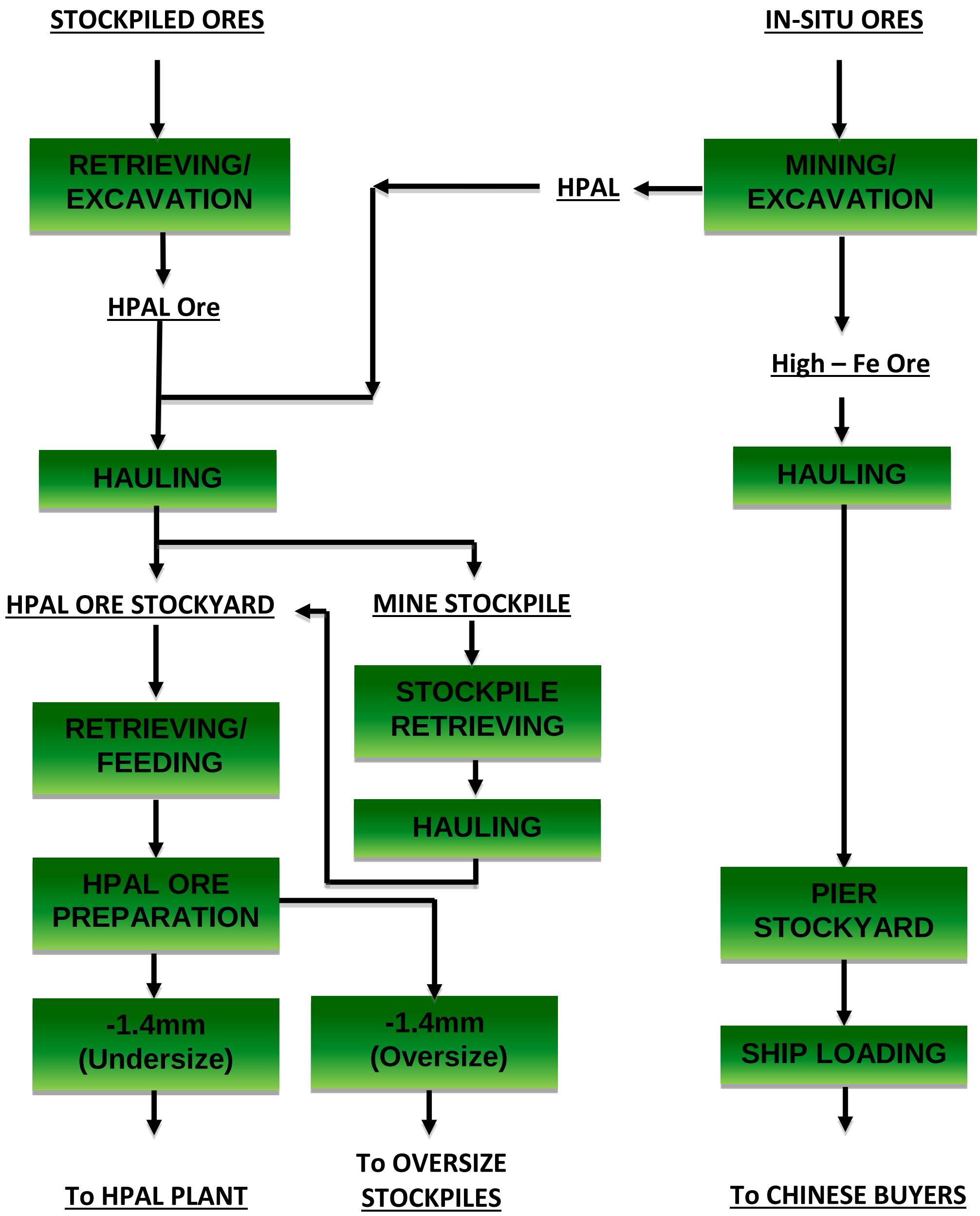


Figure 1.8.1. RTNMC process production for laterite/limonite ore

1.8.2.6 Saprolite Mining

Soft Ore Mining

Soft ore mining is normally carried out from January to March to provide ample time for the solar drying of the mined ore before shipment.

Selective mining and ore segregation are guided by the results of sampling. The 3 m benches are face sampled every 5 m by cutting a continuous channel along it. The ore is then classified into one of the classes described in **Table 1.8.1**.

Table 1.8.1. RTNMC soft ore classification

Ore Class	% Ni Range	% Fe Range
1B Mgl (High Grade Sapro)	2.00 and up	< 20.0
LGSO-LF (Low Grade Sapro)	1.00-1.99	< 20.0
High Fe Ore	2.00 and up	20.0 and up
Limonite-HPAL (Limonite/Laterite)	1.20-1.99	>20.0
Laterite-HPAL (LG Soft Ore)	0.50-1.19	>20.00
Laterite (High Fe)	<0.80	>44.00
Limonite Waste	below 0.5	<44.00
Saprolite Waste	below 1.0	<20.0

Source: RTNMC, 2015.

Backhoes with 1.8 m^3 capacities are used to selectively draw the nickel ore. Materials belonging to any one of the soft ore classes defined in **Table 1.8.1** are loaded, hauled, and dumped separately on designated piling spaces at the solar drying area.

Hard Ore Mining

Hard ore is found on top and within the saprolite zone. Mining of this ore is undertaken throughout the year. Using hydraulic breakers, hard ore is broken in situ to sizes suitable for loading into dump trucks. The boulders are then brought to a breaking field stockyard where they are broken down to about 200 mm diameter using hydraulic breakers. The fragmented hard ore is then sorted according to the classifications described in **Table 1.8.2**.

Table 1.8.2. RTNMC hard ore classification

Ore Class	% Ni Range
High Grade	2.20 and up
Ordinary	2.00 - 2.19
Low Grade	1.20 - 1.99

Reduction of hard ore to 200 mm at the breaking field stockyard prevents the dilution of the soft ore at the pit with low-grade boulder chips. Hard ore mixed with the laterite and low-grade soft ore drawn from the pit are recovered/handpicked in the stockpiles by locals hired by RTNMC. This provides the local residents with an additional source of income.

The hard ore from the breaking field stockyard and those handpicked from the stockpiles are hauled and dumped at the crusher feed stockyard for crushing.

Saprolite Ore Beneficiation

This involves solar drying of the soft ore, reclamation of solar dried ore, screening of soft ore, transferring of marginal ore, and crushing of hard ore. This process is only for saprolite ores exported to Japanese and Chinese markets.

Solar Drying of Soft Ore

This is carried out during the dry season from January to the first week of May. The run-of-mine soft ore is hauled and dumped to the solar drying area. A total of 24 truckloads (equivalent to 264 m^3) form a solar dry pile.

To reduce water content, the piles are scraped using wheel loader. About 20 cm thick of the surface on one side of the pile is scraped and pushed over the top of the pile towards the other side. Scraping is done twice a day and it takes about 30 days or 60 scrapes to bring the moisture content of the mined raw soft ore from 44% to 32% water.

Reclamation of Solar Dried Ore

Once the desired moisture level is reached, wheel loaders reclaim and load the ore into dump trucks for screening. Reclamation is done by batch according to ore classification.

Screening of Soft Ore

RTNMC maintains a fixed grizzly screen with dimensions 5 m x 7 m, bars set at 50 mm, top tapered to 120 mm bottom openings, and inclined at 30 degrees. Solar dried ore is fed to the fixed grizzly line at an average screening rate of 160 tons per hour to scalp the oversize material larger than the required shipment size of less than 200 mm.

The oversize of the fixed grizzly is fed to the portable crusher for further size reduction. The grizzly undersize together with the crushed oversize materials constitutes the beneficiated nickel silicate soft ore.

Transfer of Waste/Unsaleable Materials

After sampling and analysis, some of the ore piled at the solar drying area that are found below quality specifications is immediately reclaimed, hauled, and dumped to the appropriate stockpile where it is stored waiting for the proper market specification and demand.

Crushing of Hard Ore

Hard ore stockpiled at the crusher feed stockyard is fed to a portable jaw crusher. The crusher, with dimensions of 500 mm x 500 mm and discharge opening of 100 mm, has a yield capacity of 200 tons per hour.

Crushing is done 16 hours per day from February to May, during which, screening of solar dried soft ore is also taking place. During the rainy months from June to January, crushing is done 8 hours per day, where 10% of the year’s required beneficiated nickel silicate ore production is generated.

1.8.2.7 Ore Shipment

Ore Hauling

Beneficiated nickel silicate ore (saprolite) and Hi-Fe limonite shall be loaded using wheel loaders/backhoes and hauled by dump trucks 7 km away to the pier ore stockyard. Road graders and rollers maintain the haul road regularly. Water trucks shall be used to suppress the dust.

Ore Stockpiling

The beneficiated saprolite and High-Fe limonite ores are hauled and stockpiled at the 38-hectare pier ore stockyard. The stockpiling of ore is in accordance with the ore classification (based on Ni and Fe content) for grade control purposes during shipment. For easy handling and grade control, each stockpile is limited to about 18,000 WMT. Stockpiles are covered with canvas sheets to maintain moisture content.

Shipment

Due to the shallow water, ore boats anchor almost 3 km offshore. Reclaimed stockpiled ores are unloaded directly to 1,200-1,500 ton ore barges anchored alongside the pier. The loaded barges will be towed by tugboats to the ore boat. A crane fitted at the ore boat loads the ore. With 14 barges and 8 tugboats operating at 24 hours per day, it normally takes 9-10 days to fully load a 52,000 WMT capacity.

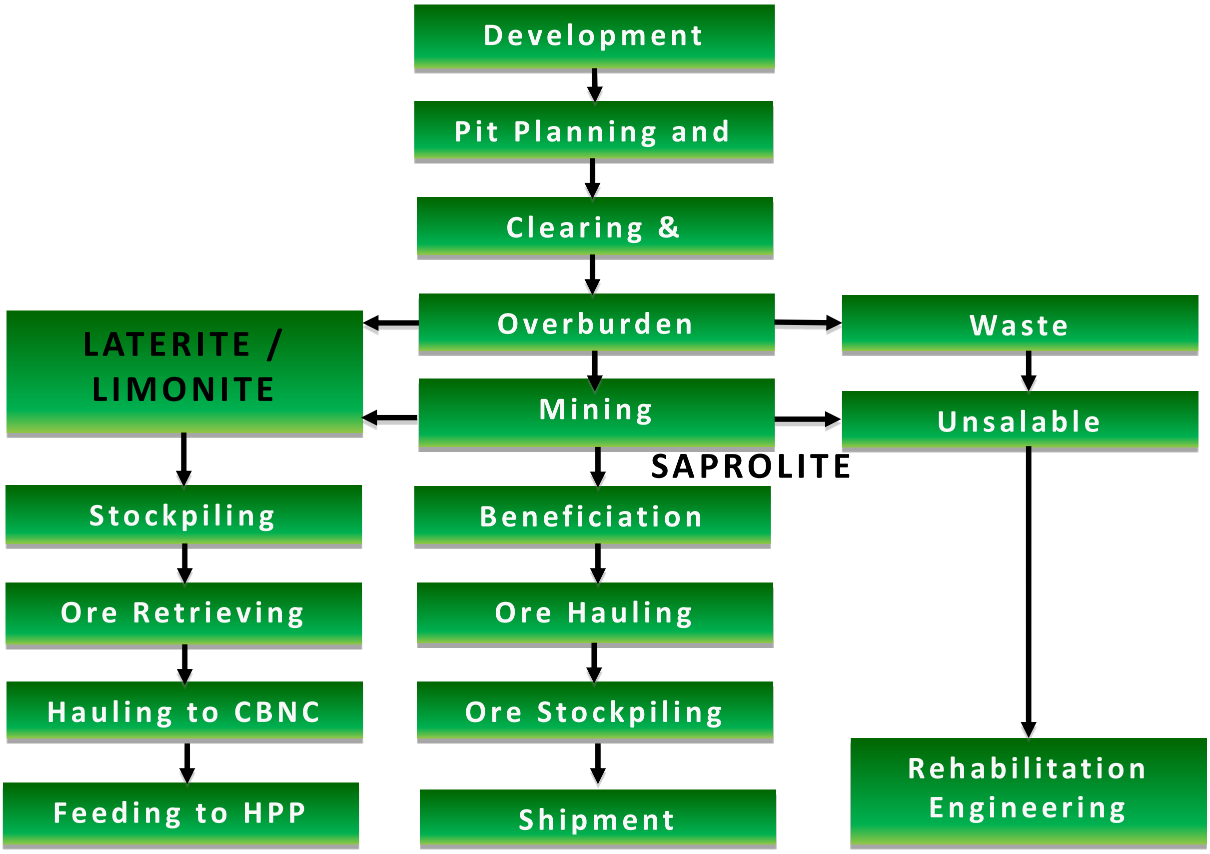


Figure 1.8.2. Process production of beneficiated nickel silicate ore (saprolite)

1.8.3 Abandonment/ Rehabilitation Phase

After all the ores has been exhausted in an area, rehabilitation of the said area will commence. This goes on while the mining operation relocates to another area where ore is still available. This system of rehabilitation is done in phases as the mining progresses. This has been the practice of the company in its past 40 years of operations.

1.8.3.1 Final Landform Design

In addition to the mining areas, other areas affected by the mining operations will also be included in the rehabilitation process. These areas include the sun drying areas, the siltation ponds, the laterite/low grade ore stockpile areas, and other disturbed areas.
Final landform design for mined-out areas will be planned to conform with the original surface configuration but contoured with an elevation relatively lower by some 20 m.

Other lands affected by the mining operations may be converted to forestlands, industrial tree plantation, aquaculture, and pastureland, as may be necessary and as suggested by community residents.

1.8.3.2 Mine Rehabilitation

Surface Preparation

Surface preparation starts by backfilling small, depressed areas or pits with materials sourced nearby. Using bulldozers, waste materials within the same mined-out areas will be pushed into the depressions and then leveled-off to a more favorable land configuration. Laterite materials from the present mining operations can be utilized as backfilling materials.

After backfilling and leveling, a 30-cm topsoil will be spread all over the area and regraded to the same topographic configuration. Adequate drainage system will be provided within the reclaimed land surface.

In 2005, the rehabilitation activity in the Bulanjao Mining areas entails the use of coconut fibers for slope stabilization (**Plate 1.8.1**).

Revegetation

Similar to the current revegetation practice of RTNMC, fast growing and heat tolerant pioneer species will be used. These include *Acacia mangium*, *A. auricoliformes*, *Gmelina arborea*, and *Casuarina nodiflora*. These pioneer species are currently grown and reared in the existing RTNMC nursery (**Plates 1.8.2** and **1.8.3**).

Field planting will be done during the onset of rainy season after surface preparation. Distance between plants shall be maintained at 2-m interval.

Plate 1.8.1. Coconut fiber used for slope stabilization

Introduction of climax species shall start three (3) years after the pioneer/reforestation species have established. It is assumed that by then, the pioneer species have already developed the necessary cover for the growth and survival of shade loving climax species. Initial climax species consist of Apitong (*Dipterocarpus grandiflorus*), Ipil (*Intsia bijuga*), Narra (*Pterocarpus indicus*), Almaciga (*Agathis philippinensis*), and Kamagong (*Diospyros philippinensis*).

Fruit bearing trees shall be planted also within the periphery of the rehabilitated areas to serve as food sources for the wildlife species that may inhabit these areas.

Plate 1.8.2. RTNMC Nursery potting and transplanting area

Plate 1.8.3. RTNMC Nursery seedling hardening area

Maintenance

To insure the survival of pioneer trees, the newly rehabilitated areas will be monitored closely. Maintenance activities such as grass cutting, watering during dry months, reapplication of fertilizer and fencing shall be conducted until the seedlings have grown. Replanting of dead seedlings shall be conducted to guarantee sufficient cover for the climax species.

The rehabilitated areas shall be protected from forest fires. Perimeter firebreak will be constructed to prevent damage by forest fires.

The abandonment/rehabilitation plans will be discussed in detail in the EPEP, which RTNMC will be submitted to the DENR.

1.9 MANPOWER

Table 1.9.1 specifically presents the nature and number of jobs to be offered by RTNMC and the hiring scheme. Five divisions make up the RTNMC organization, namely:

1. **Office of the Manager** – This is composed of the Accounting Department, Safety Department, Assay Section, Warehouse Section, Special Project, Aviation, ComRel Department, and Purchasing Section.
2. **Production Division** – This covers the Mine Operation Group such as the Limonite Operation, Limestone Operation which includes the Gotok Quarry and Crushing, Saprolite Operation which includes Pit Section and Beneficiation Section, and Port Operation.
3. **Administration Division** - This includes the Human Resources Department, Legal & Gov't. Affairs Department, Security Department, General Affairs, Puerto Operations, Transport Section and Guest Lodge.
4. **Engineering Division** – This includes the Mine Engineering Department, Geology Department, Mine Statistics, and Information Technology Section.
5. **Technical Services Division** – This includes the Mechanical Group such as Heavy Equipment Department, Light Equipment Department and Shop Services; Transport Unit, Power/Electrical Department and Pier and Sea Craft Maintenance Section.

Table 1.9.1. RTNMC manpower, nature of work and employment scheme

Skills/Manpower	Proposed Mining Operation No. of Employees		Method of Hiring
	Non-IP	IP	
Office of the Manager			Direct hiring by RTNMC
Regular and probationary employment	104	13	
Temporary employment	61	32	
Production Division			
Regular and probationary employment	300	43	
Temporary employment	278	26	
Administration Division			
Regular and probationary employment	37	6	
Temporary employment	12	0	
Engineering Services Division			
Regular and probationary employment	53	5	
Temporary employment	210	44	
Technical Division			
Regular and probationary employment	131	11	
Temporary employment	2	65	
Sub-total	**1,188**	**245**	
Total	**1,433**		

Source: RTNMC, as of February 2019.

1.10 INDICATIVE PROJECT INVESTMENT COST

The project cost estimates for the expanded capacity is shown in **Table 1.10.1**.

Table 1.10.1. RTNMC project cost estimates

Particulars	(x Php 1,000)
A. Existing Company Assets (as of December 31, 2014)	
Current Assets	
Cash and Cash equivalents	914,511
Trade and other receivables	573,277
Inventories	477,056
Other current assets	27,334
Total Current Assets	**1,992,178**
Non-current Assets	
Property and Equipment	1,306,887
Other Non-current Assets	299,731
Total Non-current Assets	**1,606,618**
B. Additional Capital Expenditures	
Replacement of existing old equipment	347,041
Additional new production equipment	92,129
Other support equipment	40,159
Mine Development and Infrastructure	73,513
Area Clearing	10,227
Advanced stripping/Limonite mining	103,656
Additional Working Capital Expenditures	228,153
Contingency	89,488
Total Additional Capital Expenditures	**984,366**
Total Project Investment Cost	**4,583,162**

Assessment of Environmental Impacts

2

Rio Tuba Nickel Mining Corporation

This chapter describes the current conditions of the project area and vicinities prior to project implementation. The conditions are broken down into the land, water, air and socio-economic environment. This section also serves as basis of determining the most appropriate management and monitoring plans for the proposed project.

2.1 The Land

2.1.1 Land Use and Land Classification

2.1.1.1 Methodology

The study on land use covered the review of existing literature and maps of the project area and the conduct of field verification assessment last August 14-15 and 26-28, 2015.

A discussion of the Strategic Environmental Plan (SEP) of Palawan (RA 7611) is included in this section to provide a background of the law that declared Palawan as a protected area. This law provides for the protection and development control over the whole of Palawan through the Environmentally Critical Areas Network or ECAN.

Existing land uses and vegetation were identified, described and represented on a map. The identification of the different land uses was done with the aid of Google earth imagery interpretation, in consultation with the National Mapping and Resources Information Authority (NAMRIA) Land Cover Map, 2010.

The complete baseline methodology used for this Environmental Impact Statement (EIS) report is provided as **Annex 2.1.1**.

2.1.1.2 ***Baseline*** Conditions

SEP of Palawan Province

The SEP is a comprehensive framework for sustainable development of Palawan attuned with protecting and enhancing the natural resources and environment of the province. It is aimed at guiding the local government of Palawan and the government agencies concerned in the formulation and implementation of plans, programs, and projects affecting the province (Sec. 4, R.A. 7611). The SEP identified the ECAN, which defines the basis for the development programs of the island.

Environmentally Critical Areas Network (ECAN)

The ECAN is a graded system of protection and development control over the whole of Palawan to serve as the main strategy of the SEP.

According to *Section 7* of R.A. 7611, the ECAN shall ensure the following:

1. Forest conservation and protection through the imposition of a total commercial logging ban in maximum protection and restricted use zones;
2. Protection of watersheds;
3. Preservation of biological diversity;

4. Protection of tribal people and preservation of culture;
5. Maintenance of maximum sustainable yield;
6. Protection of rare and endangered species and their habitat;
7. Provision of areas for environmental and ecological research, education and training; and
8. Provision of areas for tourist and recreation.

The three (3) main components of ECAN are (*Section 8*):

1. Terrestrial;
2. Coastal/marine area; and
3. Tribal ancestral land.

The terrestrial component is discussed here in relation to the proposed Mineral Production Sharing Agreement (MPSA) application of RTNMC. The terrestrial component may be subdivided into smaller management components and the management components further subdivided into the different zones (*Section 9*). Subsequent changes in the definition of ECAN based on the Palawan Council for Sustainable Development (PCSD) resolutions are presented in **Table 2.1.1.**

<u>Preparation and Declaration of ECAN Zoning Plan</u>

Chapter V of the PCSD Resolution No. 94-44 lays down the procedures for the preparation and declaration of the ECAN zoning plan. These procedures include:

1. Organization of a planning team in each municipality or city composed of the following:
    - Planning and Development Coordinator;
    - Municipal Environment Officer;
    - Community Environment and Natural Resources Officer (CENRO);
    - District Manager of PCSD; and
    - Representatives from the private community;
2. Preparation by said planning team of the draft ECAN Zoning plan;
3. Presentation of the draft plan for public hearing in the locality;
4. Endorsement by the Sangguniang Bayan/Panglunsod and the Sangguniang Panlalawigan to the Council Staff;
5. Endorsement by the Council Staff to the PCSD; and
6. Final approval of the plan by the PCSD.

The Plan contains the following:

- Description of the Area
- Goals and Objectives
- Zoning Strategy (priorities, methodologies for marking zone boundaries
- Zone Management (activities, regulatory measures, policy directions)
- Administration
- Monitoring and evaluation
- Annexes (maps and references)

Section 23 of PCSD Resolution 94-44 likewise establishes a conflict resolution process in recognition of vested or prior rights. The process covers consultation, negotiations and payoffs, and finally, judicial process.

2006 ECAN Map

An ECAN Map for the Municipality of Bataraza has been prepared by PCSD (**Annex 2.1.2**) and approved in 2006.

Relative to this ECAN Map, approximately 39.64% of RTNMC's (MPSA) application area is within the core zone, 13.06% within restricted use zone, 10.83% within controlled use zone, and 36.47% within multiple-use zone. The Municipal Council of Bataraza adopted an ECAN Map (v. 2005) of Bataraza on 9 January 2006 under Resolution No. 01, Series of 2006 and incorporated in Land Use Map (**Figure 2.1.1**)

2014 ECAN Map

However, the Municipal Council of Bataraza proposed to update the Comprehensive Land-Use Plan (CLUP) of Bataraza in 2009 based on the requirements of the Local Government Code. The proposed CLUP incorporates the changes in the land use classification for the following:

- Agricultural lands
- Mineral Development Zone
- Tribal Traditional use areas
- >1000m elevation

The MCLUP of the Municipality of Bataraza, Palawan covering period 2009-2018 has been approved by the Sangguniang Panlalawigan of Palawan through Resolution No. 8300-10 on January 2010 (**Figure 2.1.2**).

Subsequent to this, the ECAN Map of the Municipality of Bataraza was proposed to be updated to cover the approved MCLUP. **Table 2.1.1** reflects the area changes in the 2014 ECAN Map while **Figure 2.1.3** shows the 2014 ECAN Map.

Table 2.1.1. Area changes for the 2014 ECAN Map

ECAN Zone	Area 2006 (ha)	Area 2014 (ha)	Difference (ha)	Change
Core Zone	16,473	14,779	1,694	decrease
Controlled Use Zone	13,902	15,561	1,659	Increase
Multiple Use Zone	34,501	34,488	13	decrease
Restricted Use Zone	2,689	2,100	589	decrease
Traditional Use Zone	2,770	3,406	636	increase
Total	**70,334**	**70,334**	**4,591**	

The revised ECAN map was approved by the PCSD Executive Committee Meeting on 27 September 2014 and presented at the PCSD meeting on 28 October 2014. Subsequently, the SEP Clearance was granted to RTNMC for the proposed MPSA project on December 11, 2014 (**Annex 1.1.2**). The 3,600.4-ha (AMA-IVB-144A) area of RTNMC excludes the 4.1-ha area above 1,000 masl as approved by the PCSD under PCSD Resolution No. 14-517 "*A Resolution Granting a Strategic Environmental Plan Clearance To Rio Tuba Nickel Mining Corporation on its Nickel Mining Project Denominated as Application for Mineral Agreement (AMA) No. AMA-IVB-144A*" (**Annex 1.1.1**).

Land Use

The project site and vicinities is covered by five (5) Landuse/Vegetation units (**Figure 2.1.16**). These are:

- Forest;
- Shrubland ;
- Grassland;
- Bare area (Mining area/ Kaingin); and
- Built-up area.

Forest are located on Mount Bulanjao in the western half of the project area (**Plates 2.1.1** and **2.1.2**). Shrublands on the other hand, are found in the northeastern part of the project area in Barangay Ocayan and in the southwestern part on the toe and midslope of Mount Bulanjao in Barangay Taratak. Grasslands are found in the mid-southern part of the project area in Barangay Rio Tuba down to Barangay Taratak. Small Grassland is also found on the mid-northern part in Barangay Rio Tuba. Mining areas as bare areas exist adjacent to the of the project area with MPSA-114-98. *Kaingin* as bare areas found on the steep midslopes of Mount Bulanjao in the southwestern part of the project area in Barangay Taratak. Built-up areas in the southeastern part of the project area are the facilities of RTNMC (offices, residential areas, schools, hospital, road network, and etc.).

Plate 2.1.1. Inside the canopy of the forest at the midslope of Mt. Bulanjao

Plate 2.1.2. The forest at the midslope of Mt. Bulanjao with young Agoho tree

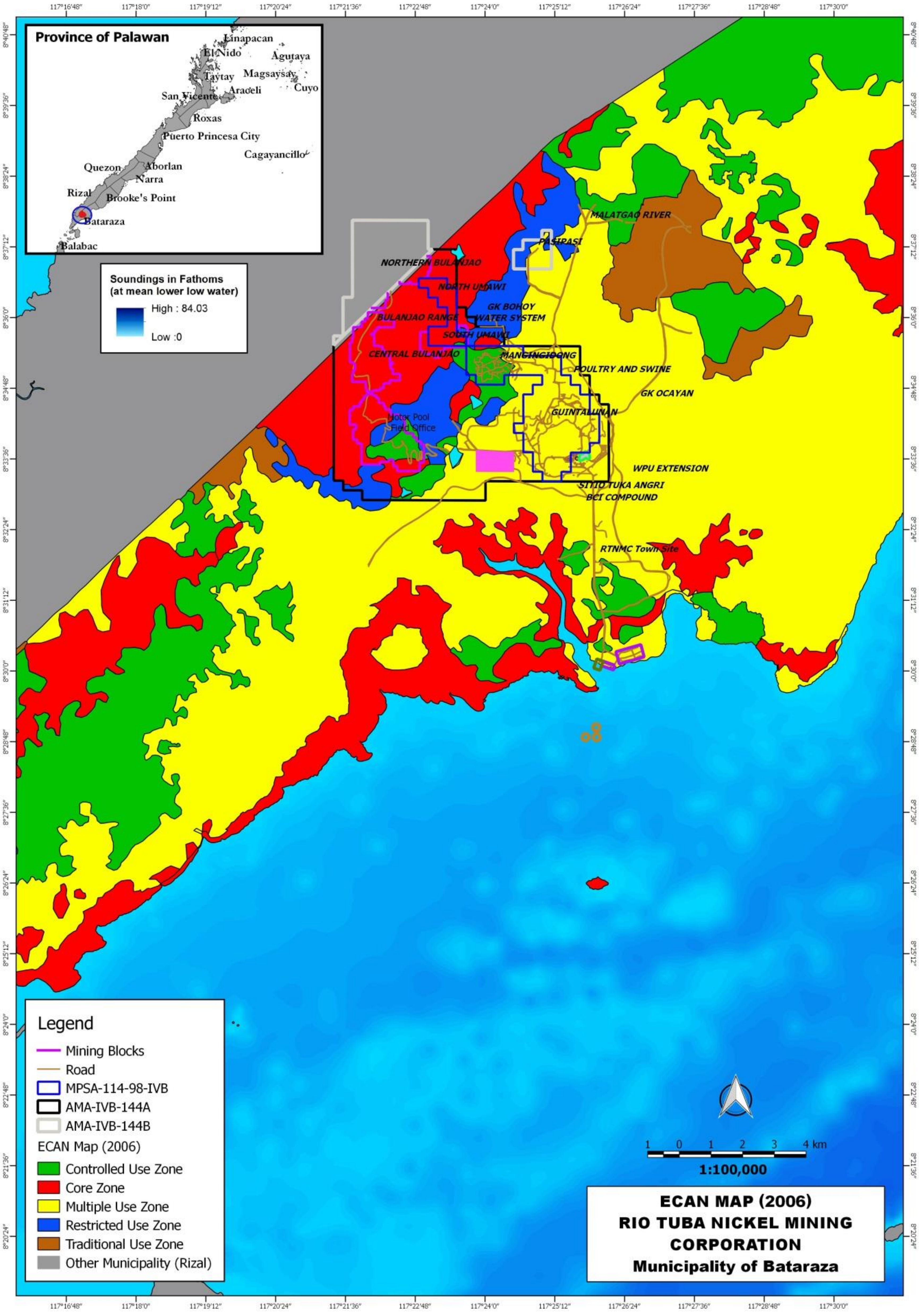


Figure 2.1.1. 2006 ECAN Zone map of Bataraza

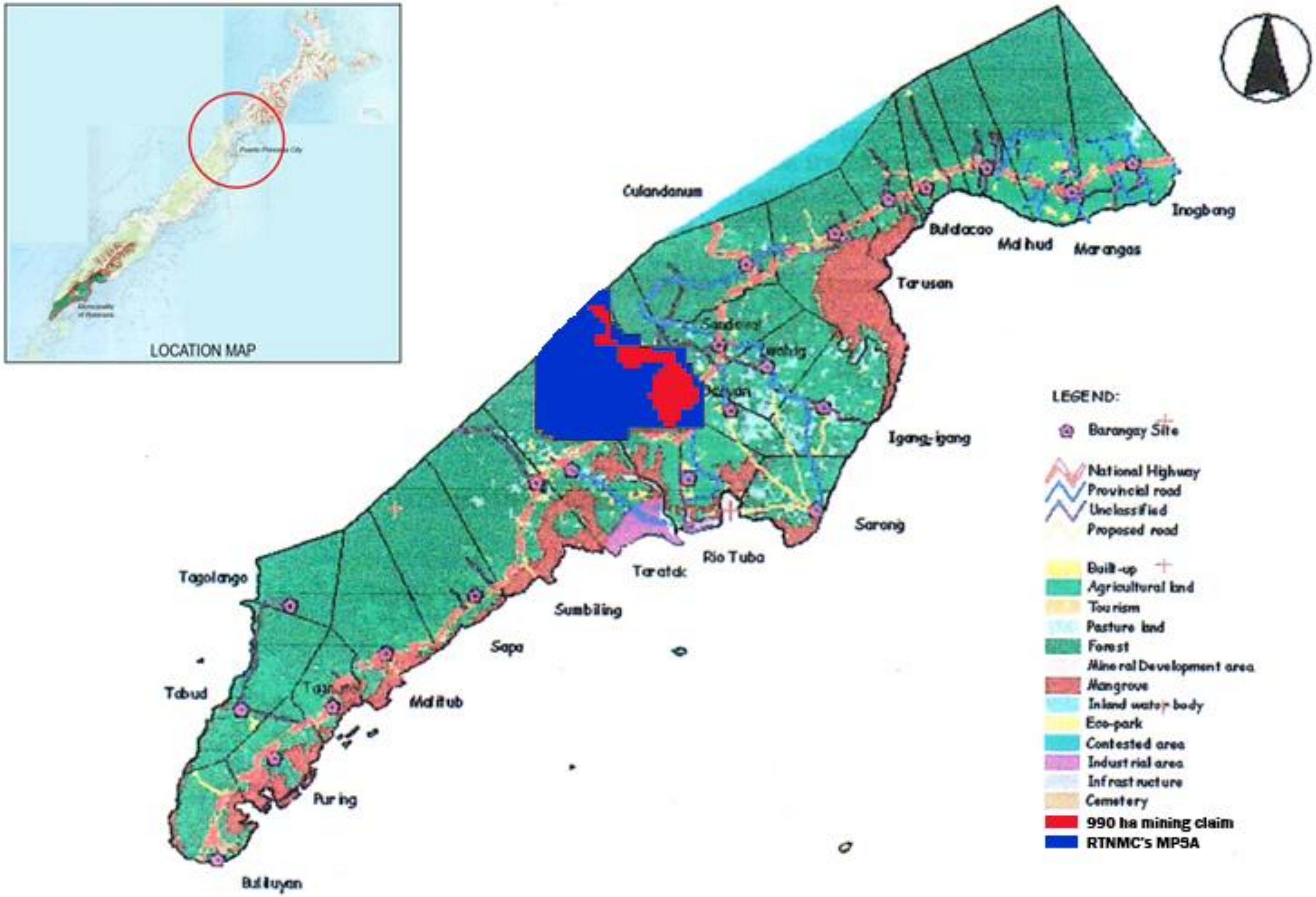


Figure 2.1.2. The Mineral Development Zone of the Municipality of Bataraza (*Source: CLUP, 2009*)

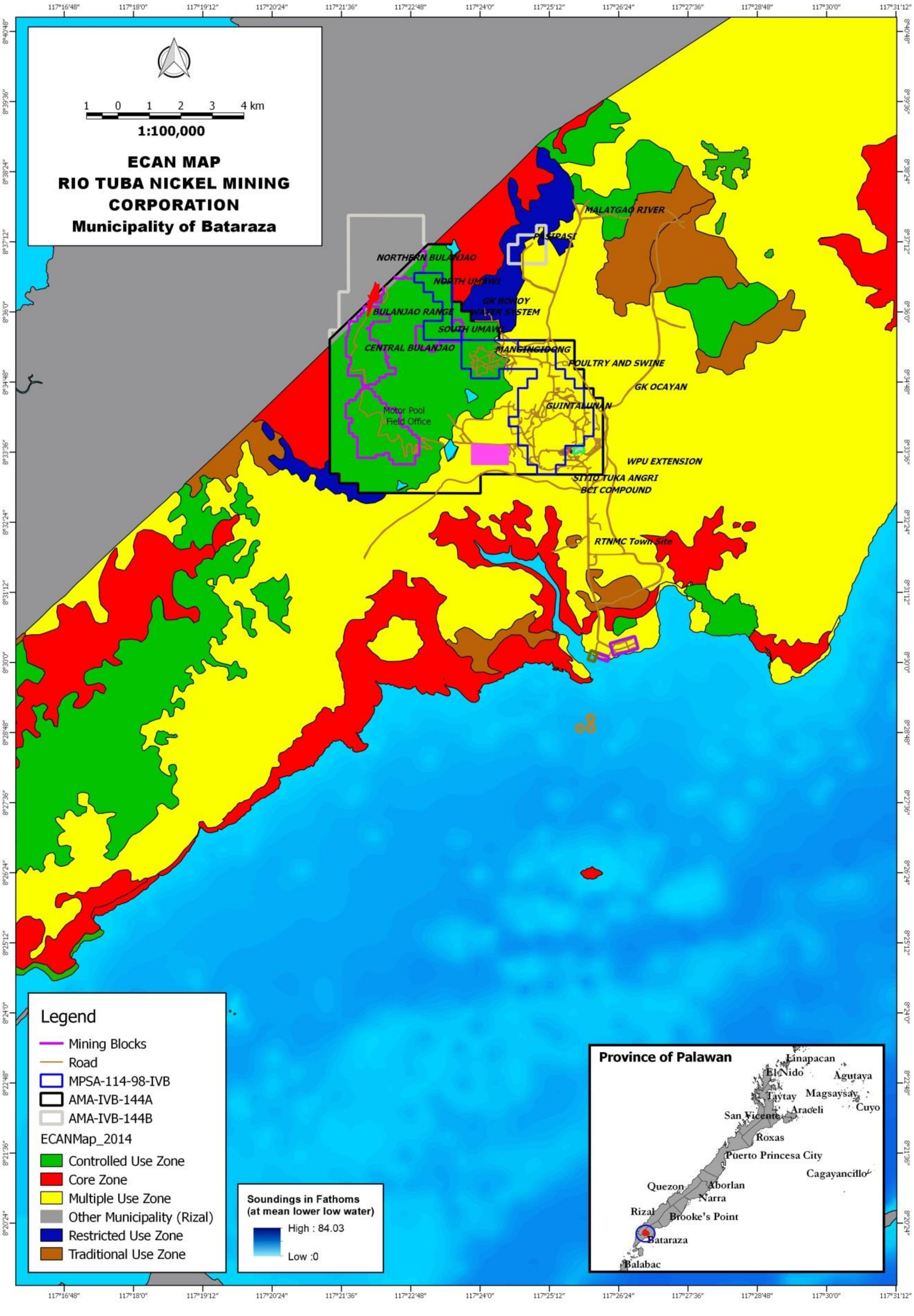


Figure 2.1.3. Proposed 2014 ECAN Zone map of Bataraza

2.1.1.3 Impact Assessment

The key impacts of the proposed project on the Land Use and Land Classification is presented in **Table 2.1.2**. These are:

Table 2.1.2. Impact Assessment for the land use

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
• **Incompatible land use** The land use of the mining area is classified as Mineral Development Area based on the MCLUP approved by the *Sangunniang Panlalawigan* on 10 January 2010.					Although the proposed mining areas have been declared as Mineral Development Area in the MCLUP, management measures will be implemented and will be defined in the Environmental Protection and Enhancement Program (EPEP) to be submitted by RTNMC. The salient feature of the plan will be the conduct of progressive rehabilitation of mined out areas and provision of maintenance support to ensure high survival rate of rehabilitation species, selective clearing, collection of wildings and maintenance of nursery and clonal laboratory to provide viable seedlings, and use of endemic species for rehabilitation. Likewise, RTNMC is required to submit the Final Mine Rehabilitation and/or Decommissioning Plan (FMR/DP), which will outline the steps to return the mined out areas to viable land use that is acceptable to the stakeholders.
• **Encroachment in Environmentally Critical Areas (ECA's)** The 2014 ECAN Map classifies the MPSA area as Controlled-use except for the areas above 1000 m. RTNMC committed to exclude this section from the MPSA. Nevertheless the Philippine EIS System identifies three (3) potential ECAs within the MPSA area including habitat for endangered or threatened species, areas with critical slopes and recharge areas for aquifers.			✓	✓	RTNMC will confine its mining operations along the areas defined in their mining plan and approved by the MGB. A 50-m buffer zone will be maintained at the peripheries of the mining pits. The buffer zones shall be maintained and enhanced. As indicated above, RTNMC will implement the EPEP and will define the appropriate management measures for progressive rehabilitation, selective clearing, maintenance of nursery and clonal laboratory, surface run-off management, water quality management and drainage plans to manage the impacts of mining. The FMD/RP shall also consider the critical areas in the site in the identification of the final use of the rehabilitated mining areas.
• **Possible Tenurial Issue** There are no tenurial or land issue covered within the MPSA. Since 1979, the RTNMC holds a Mineral Lease Contact (MLC) covering the project site and has applied for an MPSA at the Mines and Geosciences Bureau (MGB), which is subject to this EIA.					
• **Impairment of Visual Aesthetics** This is one of the unavoidable impacts of mining activities. The		✓	✓	✓	RTNMC shall ensure that new mining area shall not be opened as long as there is an active mine area. If possible, active mining areas shall be confined within 50 ha at a time. The EPEP as stated above will define the management

List of Key Impacts	Phase Occurrence: Pre-Construction	Construction	Operation	Abandonment	Options for Prevention or Mitigation or Enhancement
mining areas, devoid of any vegetation impair the aesthetic view of the slopes of Mt. Bulanjao. Approximately 701 ha will be opened for the mining areas and facilities from a total of 3,553.4 ha of the AMA-IVB-144A. However, it is expected that the rehabilitation plan will revegetate majority of these areas.					measures to conduct progressive rehabilitation for the project. The implementation of progressive rehabilitation will allow the rehabilitation of decommissioned mine pit as soon as the ores are recovered. The FMR/DP, which subsequently outline the financial aspect of the plan ensure that RTNMC will have the finances to execute the plan.
• **Devaluation of land value as a result of improper solid waste management and other impacts** The mining process is expected to generate solid wastes which are limited to the wastes from the offices and other facilities such as used tires, packaging, papers, busted lamps, and other hazardous materials as well as domestic waste from the townsite.		✓	✓	✓	RTNMC operates its own waste disposal site as well as implement a solid waste management program within the mining site and associated facilities. Hazardous wastes are segregated and stored and then disposed according to the provisions of RA 6969.

2.1.2 Geology and Geomorphology

2.1.2.1 Methodology

The impact of the proposed mining project on the geology and geomorphology of the project site is assessed based on its conceivable effects on the geological materials, processes and values. The site's existing condition is derived from field surveys, available reports, geologic literature and information shared to the consultants by the proponent. Geological and seismological data are mainly lifted from the publicly available international and local sources.

The geological risk assessment employed the semi-quantitative approach, using observations made on similar projects in the country, and in other parts of the world. Statistical information on relevant geological hazards are used whenever available, and modelled to the site and the project as necessary.

The mitigating measures for managing the negative impacts of the project and for managing the risks are based on best practice in similar mining projects. For natural hazards that commonly affect the Philippine countryside, the suggested risk measures are those commonly used for such events, and can also be considered best practice for such situations.

2.1.2.2 Baseline Conditions

Regional Geology

Southern Palawan is predominantly composed of an ophiolite block that is overlain by highly folded and fractured Eocene to middle Miocene sedimentary rocks (MGB, 1982). The ophiolite is referred to as the Palawan Ophiolite. It is pre-middle Eocene in age and is thrusted upon the older pre-Tertiary rocks (Encarnacion, et al. 1995). It exhibits a complete ophiolite sequence consisting of basal mantle harzburgite, dunite, gabbro and pillow basalts that are associated with cherty sediments (Raschka, et al., 1985). Low to moderately dipping middle Miocene to Pleistocene sedimentary rocks and recent deposits rest on the older rocks (MGB, 1982).

Stratigraphy

The Geologic Map of the project site shows seven (7) major rock units that underlie the area. **Figure 2.1.4** presents the geologic map of the central sections of Bataraza and Rizal municipalities in southern Palawan compiled from Cabrera, 1985; Sto. Domingo et al., 1989 and the Mines and GeoSciences Bureau, 1989. They are, from oldest to youngest, the following:

- Late Cretaceous Mt. Beaufort Ultramafics;
- Late Cretaceous to Early Eocene Espina Formation;
- Paleocene to Early Eocene Panas Formation;
- Oligocene Pandian Formation;
- Late Miocene Sayab Formation;
- Pliocene Iwahig Formation; and
- Quaternary Deposits.

The Mt. Beaufort Ultramafics occupies the southern portion of Bulanjao Range at central Bataraza and the core of Mt. Sarab near the eastern coast. It constitutes the lower segment of the Palawan Ophiolite and is made of serpentinized harzburgite, dunite and pyroxenite. This assemblage serves as the parent rocks of the nickel laterite deposit that is being mined by RTNMC at the southeastern flank of Bulanjao Range.

The Espina Formation underlies the northeastern section of Bulanjao Range. It consists of spilitic basalt and chert that represent the upper section of the Palawan Ophiolite. The basalt exhibits abundant pillow structures and is generally highly fractured. The chert is deep red to orange, thinly bedded and laminated. It is commonly found along the borders of the pillow structures (Cabrera, 1985).

Highly folded and indurated, well-bedded quartz-rich sandstone, shale/siltstone and mudstone characterize the Panas Formation. Rocks of this formation surround the ultramafic and basaltic rocks and occur extensively to the southeast and southwest of Bulanjao Range. The sandstone is light brown to gray, thinly bedded and highly indurated, while the shale and siltstone are brown to dark gray, thinly bedded and friable.

The Pandian Formation outcrops extensively at the western side of southern Palawan. It conformably overlies the Panas Formation and consists of massive, porous, arkosic sandstone intercalated with mudstone and shale. The sandstone is light brown to gray and friable. It is primarily made up of fine to coarse grained, sub-angular to sub-rounded quartz and feldspar grains. The mudstone and shale layers are well indurated.

Gently dipping sandstone and shale interbeds of the Sayab Formation unconformably overlie the Panas Formation to the east of Bulanjao Range. The sandstone of light gray to reddish brown consists mainly of fine to medium grained quartz grains. The shale is reddish brown, silty and occasionally displays laminations.

The Iwahig Formation rests on the Sayab Formation. It consists of two (2) members, namely the Panoyan Limestone and the Pusok Conglomerate. Pebbles composed of chert, limestone and indurated sediments make up the Pusok Conglomerate, while the Panoyan Limestone consists of creamy white to beige, massive, coralline limestone. Outcrops of the Panoyan Limestone only are exposed in Bataraza and the surrounding areas. They occur as steep karstic hills that rise above the undulating terrain to the east of Bulanjao Range.

Quaternary alluvial and limestone deposits comprise the youngest rocks. The alluvium consists of consolidated to unconsolidated gravel, pebbles, sand and silt that are derived from the older rocks. They mantle the coast and plains of southern Palawan. The limestone occupies areas adjacent to the shoreline. They consist of raised coral reefs that gently dip seaward. The stratigraphy of southern Palawan is shown in **Figure 2.1.5**.

Structural Geology

The main structural feature in the region is the thrust fault contact between the ultramafic rocks and the older sedimentary and volcanic rocks. The thrusting caused intense shearing and faulting along the margins of the ophiolite and folding, faulting and jointing in the adjacent rocks (Cabrera, 1985). The fault and fold structures that developed as a result of the thrusting generally trend north to northeast. These structures are most prominent around the contacts between lithologic units, and in particular around Ulugan Bay.

Geomorphology

Rugged to gently undulating terrain distinguishes much of Bataraza. The highest land feature in the area is the north-northeast trending Bulanjao Range, which is located at the central portion of the municipality. From there, the land slopes down to the western and eastern coastlines. Steep slopes and sharp peaks characterize the Bulanjao Range whose ridgeline averages 900 meters above sea level (masl). Its highest point is the Escapardo Peak, which rises to 1,036 masl. Ultramafic and volcanic rocks underlie the Bulanjao Range.

Alluvial fan deposits that are topographically expressed as gently sloping land rest at the base of Bulanjao Range. These deposits consist primarily of boulders, cobbles and coarse sand derived from the weathering and erosion of the ultramafic and volcanic rocks.

The areas farther out and up to the western and eastern coast assume a gently to moderately rolling nature. The broad hills that are found in these areas do not rise above 250 masl. Folded and moderate to gently dipping sedimentary rocks underlie the undulating land.

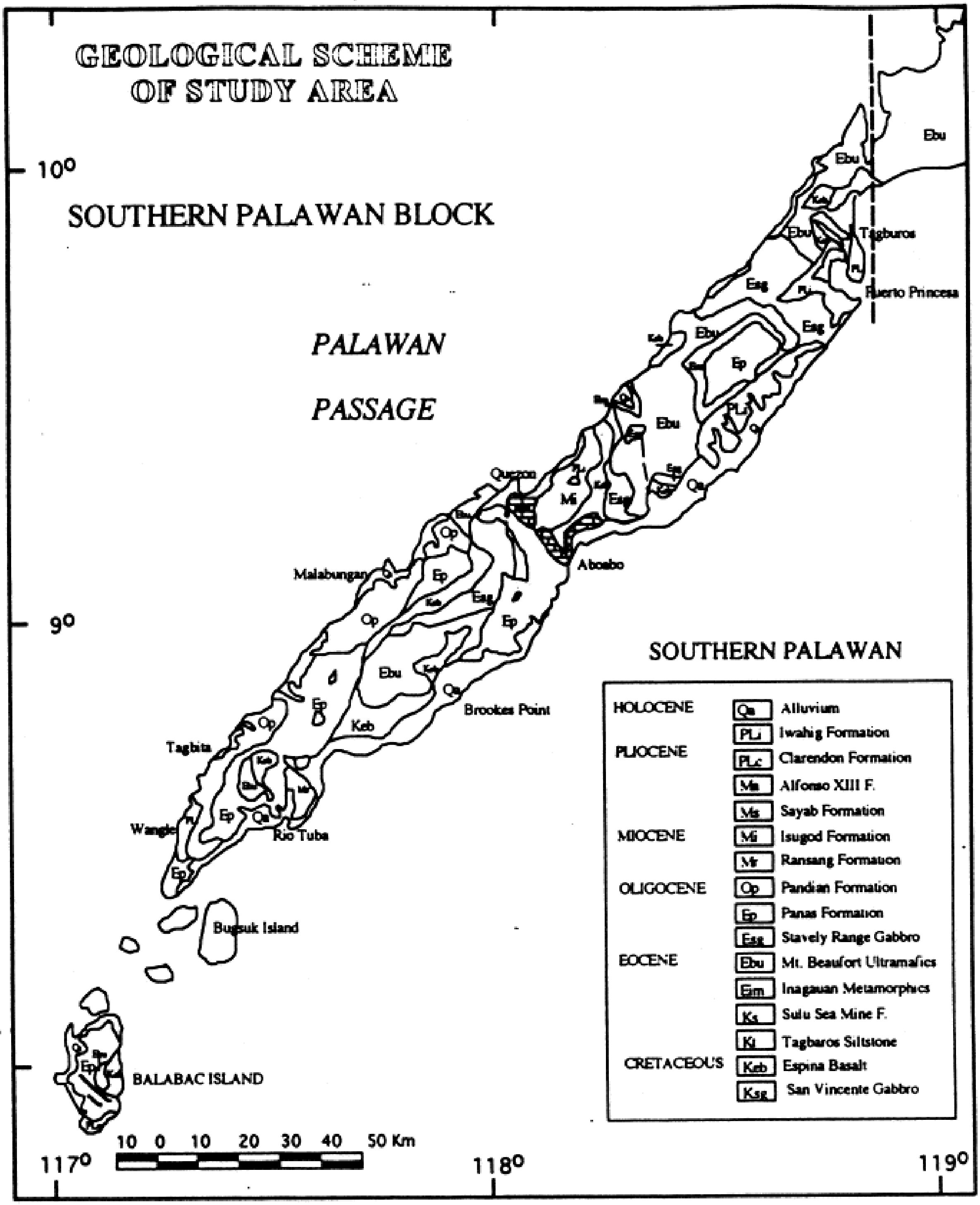


Figure 2.1.4. Regional Geologic Map

STRATIGRAPHY OF PALAWAN

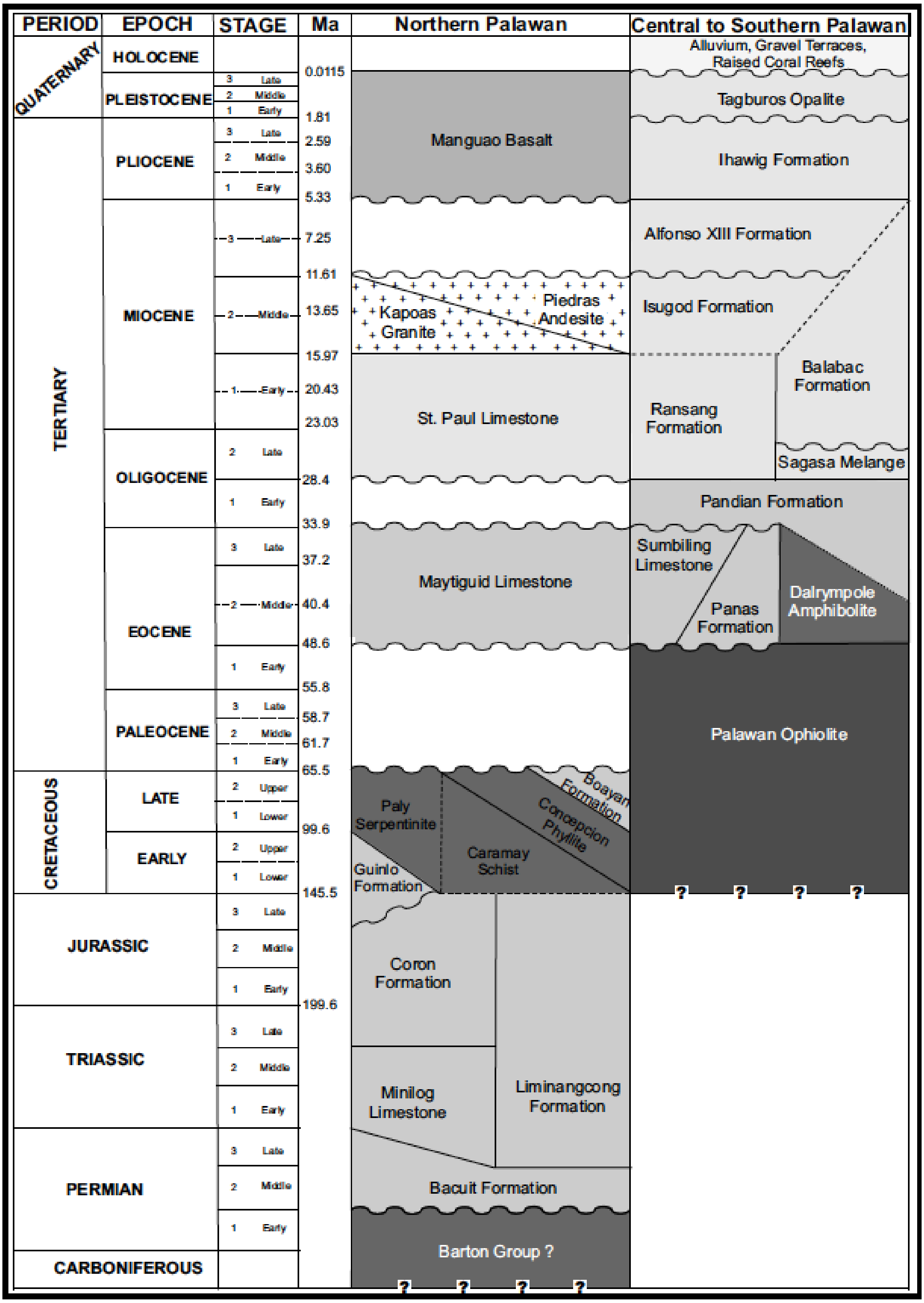


Figure 2.1.5. Stratigraphic Column of Southern Palawan.
Source: MGB (Aurelio and Pena, eds., 2004).

A cluster of small, steep and rugged hills that rarely exceed 100 masl punctuate the undulating ground to the east of Bulanjao Range. The Panoyan Limestone underlies this area, which exhibits typical karstic features such as caves, sinkholes, and springs.

The flat, narrow coastal plains and floodplains are underlain by Quaternary alluvial deposits and raised coral reefs. Please refer to **Figure 2.1.6** for the geomorphological map of the region around the project site.

Drainage Systems

The drainage pattern is locally radial in the vicinity of Bulanjao Range where their headwaters originate. The occurrence of linear channels and sharp bends such as along Sumbiling and Canipan Rivers suggest that in these areas, the rivers may be influenced by geologic structures.

In the low lands, including central Bataraza, the river systems exhibit a dendritic drainage pattern.

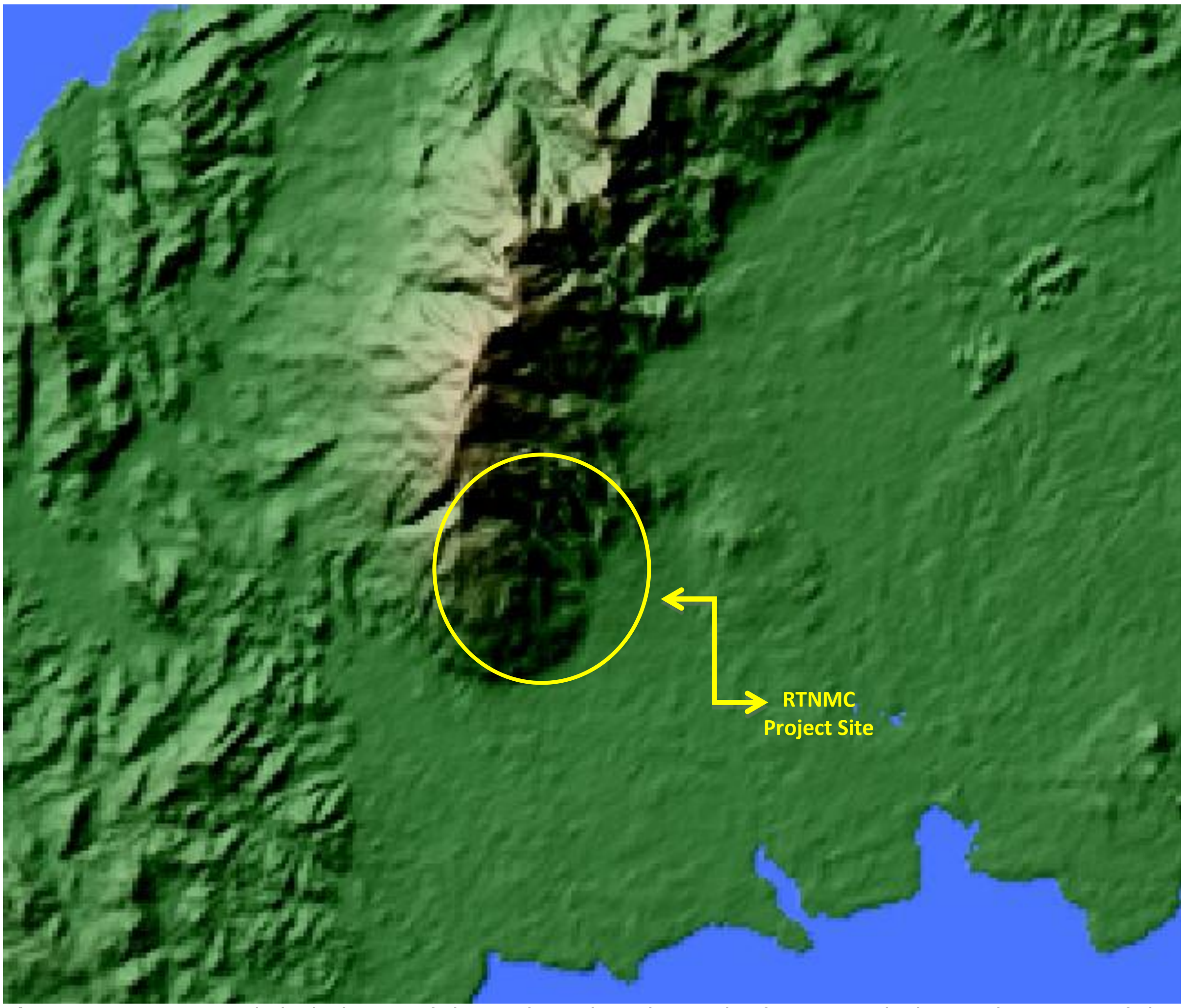


Figure 2.1.6. Geomorphological Map of the Project Site. The peak of Mount Bulanjao at the center of the mountain range influences the radial drainage pattern generally observed in the streams and rivers in the project site.

Site Geology

Figure 2.1.7 presents the geologic map in the vicinity of the MPSA application. The map, adapted from RTNMC with minor modifications, shows that ultramafic rocks underlie most of the MPSA area. They consist of harzburgite, dunite and pyroxenite, in order of decreasing abundance (Cabrera, 1985). The harzburgite is a dark, coarse grained rock. It is composed predominantly of olivine and orthopyroxene minerals that exhibit minor to moderate serpentinization. The dunite is a medium to fine grained rock. It consists entirely of olivine mineral, which renders an olive green color to the rock. Like the harzburgite, it is also commonly serpentinized. The pyroxenite is a dark, coarse grained rock that is essentially composed of pyroxene. It occurs only as small bodies that probably formed as a result of partial magmatic differentiation (Cabrera, 1985).

Spilitic basalt and chert belonging to the Espina Formation adjoin the ultramafics to the northeast. The basalt is fine grained and olive to dark gray while the chert is red to maroon in color. Small lenticular bodies of leucogabbro lie within the weak zones of the Espina Formation. This light colored variety of gabbro consists primarily of plagioclase, hypersthene, biotite, quartz, orthoclase and magnetite (Cabrera, 1985), and are often mistaken for quartz diorite.

Quaternary reef limestones locally fringe the ultramafic rocks to the west, south and southeast. They overlie rocks of the Panas Formation and dip 5-10 degrees to the south. The limestone does not exhibit pronounced karstic development.

Quaternary alluvial fan deposits also locally drape the areas immediately to the east of the ultramafic and basaltic rocks. They consist of poorly sorted and unconsolidated gravels and finer sediments derived from the weathering and erosion of the Bulanjao Range.

Fracture trace analysis using aerial photographs show a dominant northwest lineament trend, with shorter northeast and north-south lineaments. These cut through all the rock units and are most likely faults.

Geochemical Characteristics of the Rio Tuba Nickel Laterite Deposit

Figure 2.1.8 also shows the change in chemical composition from the surface down to the bedrock. High Fe, moderate amounts of Al_2O_3 and low SiO_2 and MgO characterize L-1 and L-2 in the laterite zone. Fe ranges from 40 to over 50% by weight, while SiO_2 and MgO do not exceed 5%. The Al_2O_3 varies between 5 to 10%. A drastic decree se in Fe to less than 15% and an increase in SiO_2 and MgO to more than 30% and 18% distinguish the L-3 and transitional zone, respectively. The Al_2O_3 in these zones also decrease to almost nil. The changes that occur in the L-3 and transitional zone are maintained in the saprolite zone, which exhibits a generally consistent Fe, MgO, SiO_2 and Al_2O_3 content at depth.

Table 2.1.3 presents the average chemical composition of the laterite, transitional zone and saprolite based on the analysis of several samples by Ogura, et. al (1987).

Table 2.1.3. Average chemical composition of the Rio Tuba nickel laterite deposit

Ore Type	SiO_2	Fe	Al_2O_3	Cr_2O_3	MgO	CaO	Ni	Co	Mn
Laterite	6.93	45.37	5.29	4.34	1.32	0.06	1.09	0.09	1.45
Transitional Zone	37.51	25.63	1.80	2.76	7.93	0.82	2.16	0.07	0.42
Saprolite	42.35	13.86	1.62	1.58	21.86	1.09	2.86	0.03	0.25

Source: RTNMC, 2005.

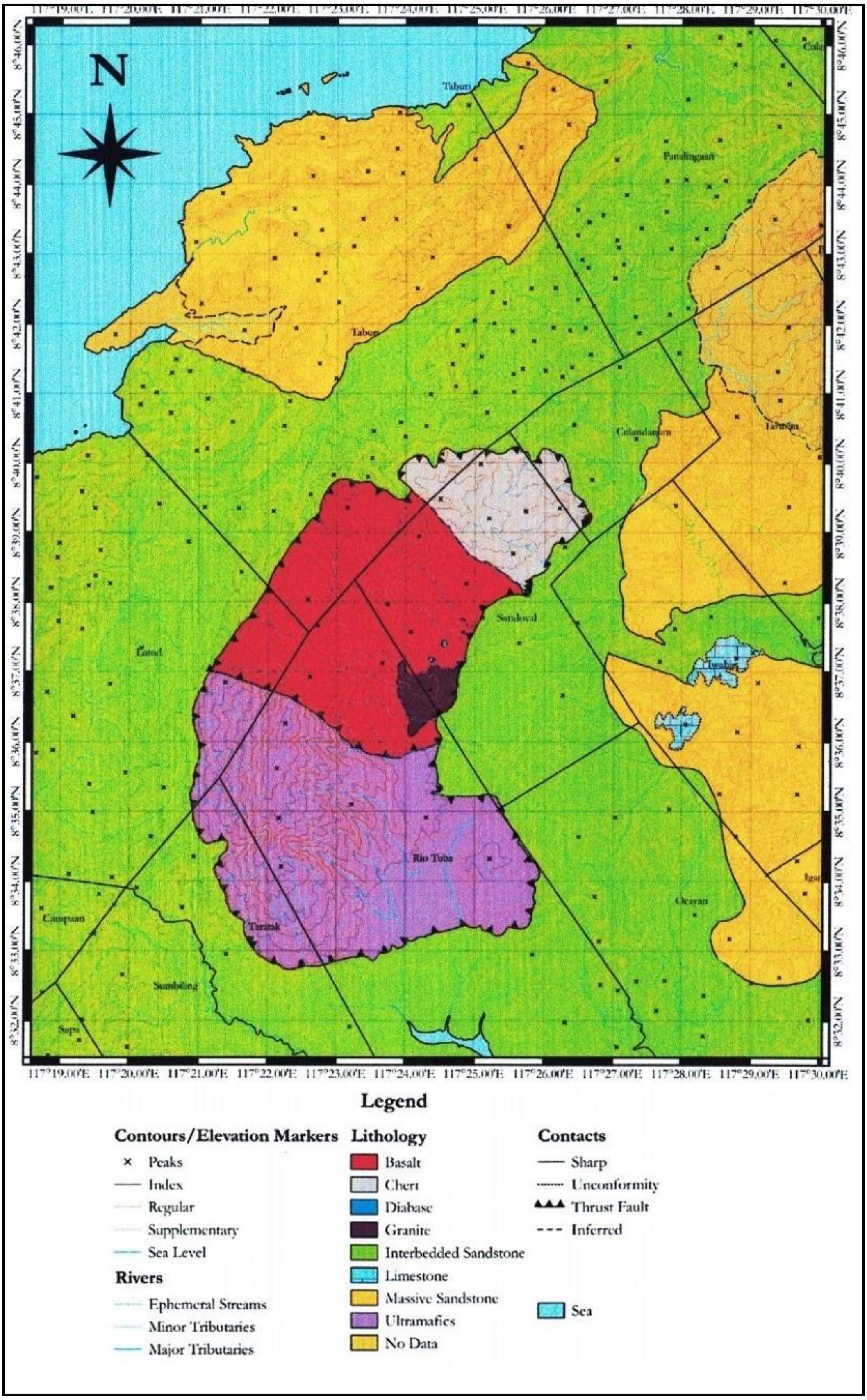


Figure 2.1.7. Site Geological Map

As with other projects, external or physical hazards are also present in the proposed mining project. These hazards range from the natural (e.g., typhoons) to man-related (e.g., accidents, collisions). The discussions on the different hazards will be segregated into two (2) timeframes: during site development and during operation.

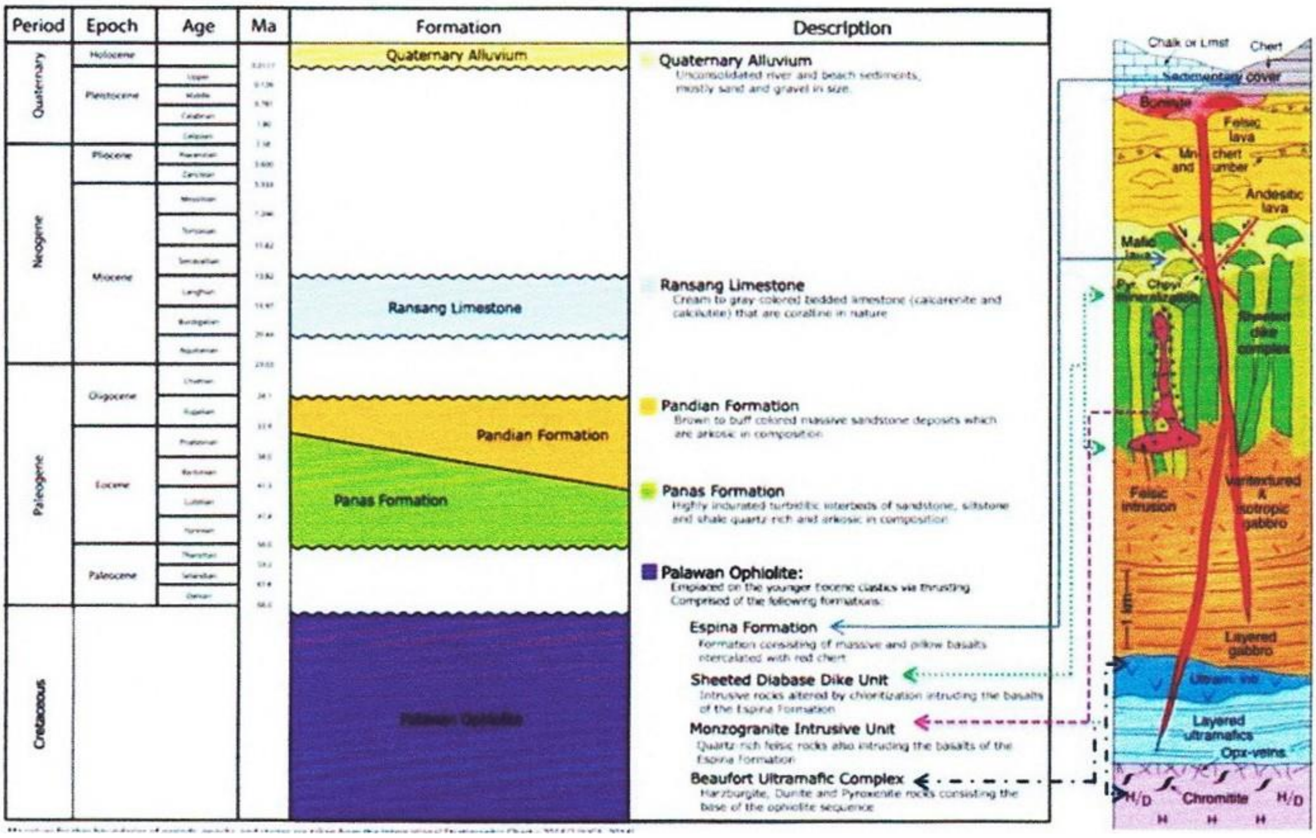


Figure 2.1.8. Stratigraphic position and Physical Features of the Nickel Laterite

Physical Characteristics of the Nickel Laterite Deposit

The nickeliferous laterite deposit at Rio Tuba was formed by the in-situ weathering of the ultramafic rocks. High moisture content and the occurrence of boulders and hard saprolite that hold 2% and above nickel are its outstanding characteristics (Hirai, et al., 1987). **Figure 2.1.9** also delineates the identified nickel laterite ore bodies within the ultramafic rocks, while **Figure 2.1.10** illustrates the generalized profile of the deposit from the surface down to the unweathered parent rock. As shown in the figure, the deposit roughly comprises an upper laterite zone extending from the surface down to about 7 m depth and a lower zone of saprolite that is around 10 m thick (Ogura, et al, 1987).

The upper and lower zones are distinguished by their color and bulk appearance. The upper laterite zone is reddish-brown, homogenous, and occasionally contains weathered rock fragments. It is further classified based on color and texture into the sub-zones L-1, L-2 and L-3. L-2 constitutes the bulk of the laterite zone while L-1 and L-3 are extremely thin or absent in some areas.

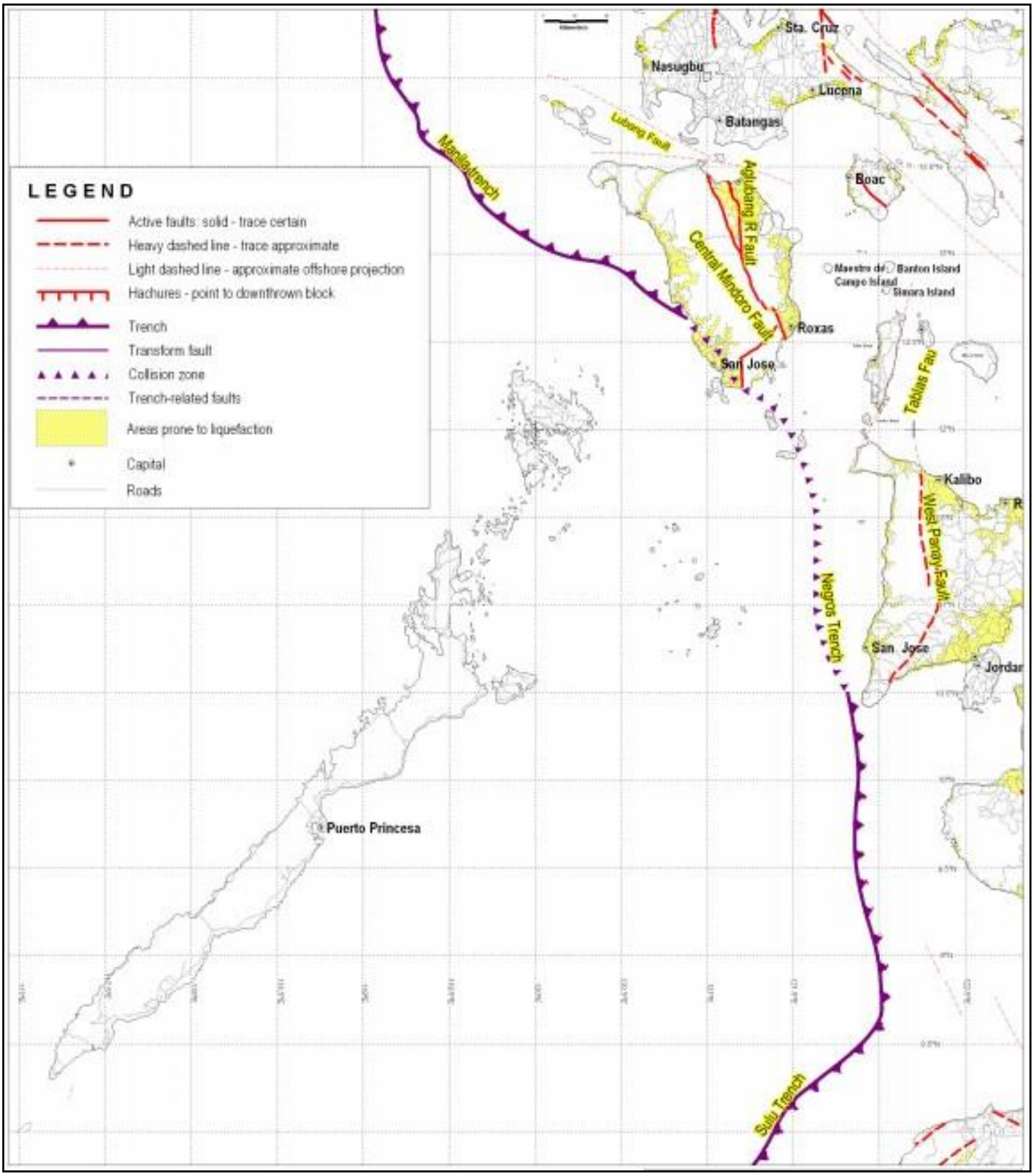


Figure 2.1.9. Structural map of MIMAROPA showing active faults and subduction zones (after PHIVOLCS).

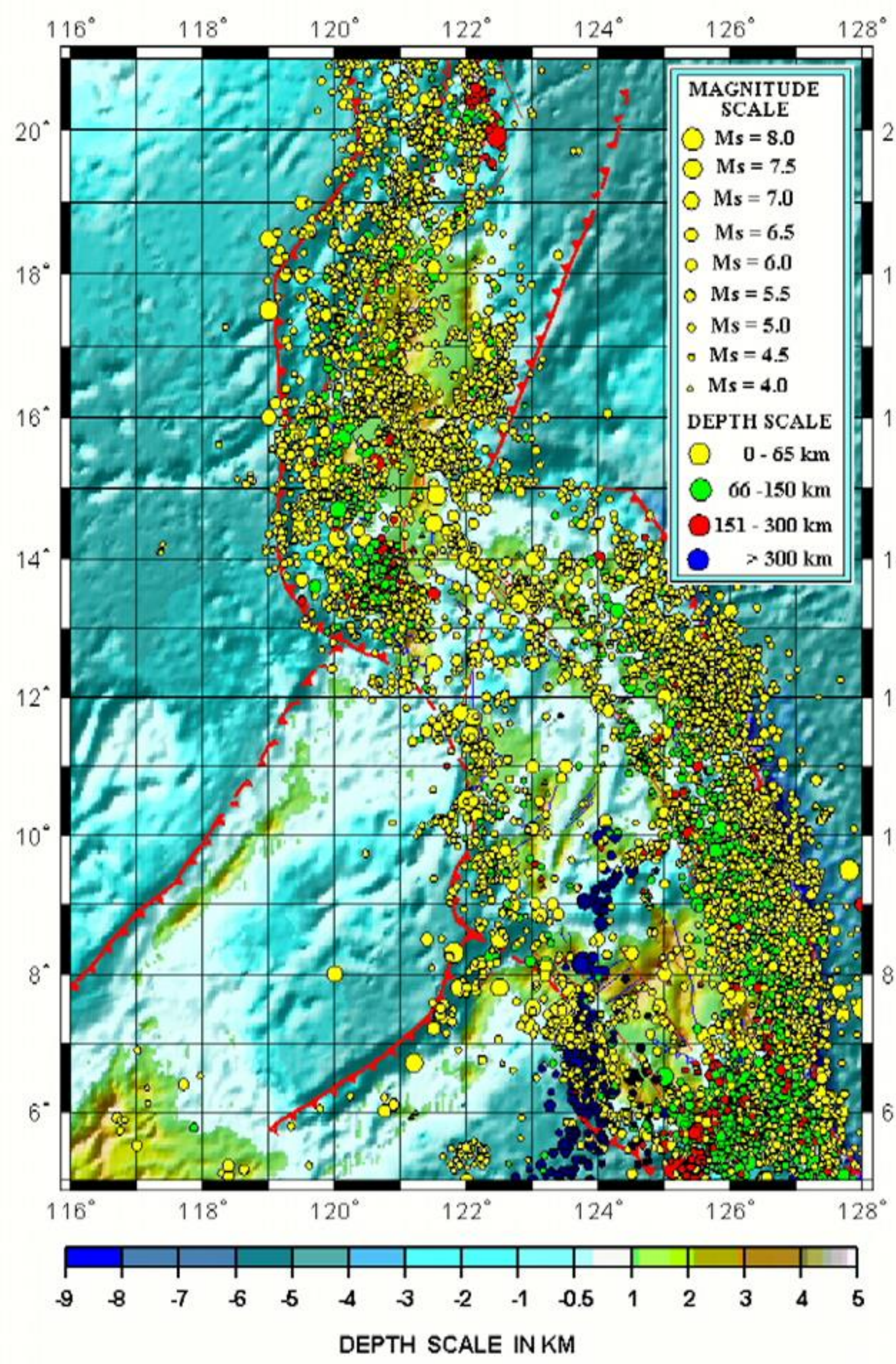


Figure 2.1.10. Earthquakes in the Philippines from 1965 to 2012 (from PHIVOLCS data)

The saprolite zone is generally bluish green, varied in appearance, and contains numerous rock fragments. It also retains the structure and texture of the original rock. The upper section of the saprolite is soft and clayey. The original rock textures and structures are barely recognized in this section. The lower section is hard. It also contains a fairly large amount of rock fragments.

A transitional layer that is usually not more than 10 cm thick often marks the boundary between the laterite and the saprolite. This transitional zone sometimes contains silica boxworks or thin silica layers that display colloform textures.

Structures

The thrust fault contact between the ultramafic rocks and the surrounding rocks constitute the main structural feature in the vicinity. Intense shearing in the ultramafic rocks characterizes the thrust faulted areas.

Fracture trace analysis using aerial photographs show a dominant northwest lineament trend, with shorter northeast and north-south lineaments. These cut through all the rock units and are most likely faults.

Practically, there is no active fault in Palawan, and this there is no threat from faulting or fault ruptures, and local earthquakes. This is illustrated in **Figure 2.1.9**, which shows the location of the active faults in the region, and the stark absence of these active structures in Palawan.

Earthquakes

Palawan is located in the tectonically stable region of the Philippines. A virtual absence of seismicity and Tertiary igneous activity characterizes the island (MGB, 1982). The area is far from active faults and trenches, which are the main earthquake generators in the archipelago. The project site is therefore not prone to earthquake hazards.

Furthermore, Palawan is not exposed to the immediate hazards that accompany a volcanic eruption (another potential earthquake generator) since there are no active volcanoes in the island. Tremendous eruptions from volcanoes in other parts of the Philippines may however subject the area to ash fall depending on the prevailing wind direction.

Notwithstanding the very negligible possibility of the occurrence of earthquake in the project area, whatever hazards posed by any earthquakes that may occur will be somewhat similar during both construction and operation phase. During the construction, the most significant consequence is structural failure or collapse primarily affecting workers on the project site. While during operation phase, structural failure or collapse could lead to loss of containment that may affect nearby population. Failures occurring during the operation phase may also lead to more serious consequences such as fires, explosions and releases of toxic materials among others.

There is no record of destructive earthquakes (magnitude >7) in Palawan. The PHIVOLCS earthquake database revealed that only five (5) earthquakes occurred in the vicinity of the island from 1907 to the present (**Table 2.1.4**). These earthquakes attained magnitudes of less than 6.0. They moreover occurred in the northern end of the island and offshore to the south, which are both far from the project site. **Figures 2.1.10** shows the epicental distribution of shallow focus earthquakes and intermediate/deep focus earthquakes in the Philippines. The apparent lack of seismicity in Palawan is prominently illustrated by the figure.

Table 2.1.4. Historical Earthquake occurrences in Palawan

Year	Month	Day	Hour	Minute	Second	Latitude	Longitude	Depth (km)	Local Magnitude
1956	2	13	22	39	50	10.50	119.50	33	-
1978	6	14	12	49	18.50	7.56	116.38	33	5.7
1981	6	18	22	47	14.50	10.59	119.68	50	4.0
1982	9	24	19	54	7.40	10.65	119.21	33	3.4
2001	7	31	16	41	32.36	8.02	117.66	40	4.6

Source: PHIVOLCS Earthquake Database

Ground Motion

The intensity of ground shaking that result from a seismic event is measured by the horizontal acceleration. It depends on the earthquake magnitude, distance of the site to the earthquake generator, and the soil condition. Thenhaus et al. (1994) estimated peak horizontal ground acceleration that has a 10% probability of being exceeded in 50 years for rocks and soils throughout the Philippines. The ground-motion probabilities were estimated using a return period of 474 years and a model of 21 seismic source zones that describe the geographic extent and frequency of earthquake occurrence for major tectonic elements in the Philippines. Earthquakes smaller than M_s 5.0, which do not cause significant damage, were not considered in the estimation.

Figures 2.1.11 presents the estimates of seismic acceleration in terms of percent of the acceleration due to gravity (g) after Torregoza (2001). The figure shows that none of the peak acceleration contours cross the island of Palawan. This indicates that the peak acceleration amplitudes that Palawan may experience will be considerably less than 0.3g in soft soil and 0.2g in medium soil and rock conditions. This is particularly true for the southern end of the island where the project site is located, since this area is quite far from the contoured region.

Slope

Slope identifies the steepest downhill slope for a location in a surface. For a raster grid, this is the maximum rate of change in elevation over each cell and its eight neighboring cells. The lower the slope value is, the flatter the terrain; the higher the slope value is, the steeper the terrain. This was the approach in the project. The output slope raster can be calculated as percent slope or as degree slope. **Figure 2.1.12** shows the derived Slope Map for the project area along with the landslide susceptibility of various areas in Palawan. The figure shows that majority of the northern portion of the MPSA area has a slope of 19 – 35% while the southern and eastern portions have gentle slopes.

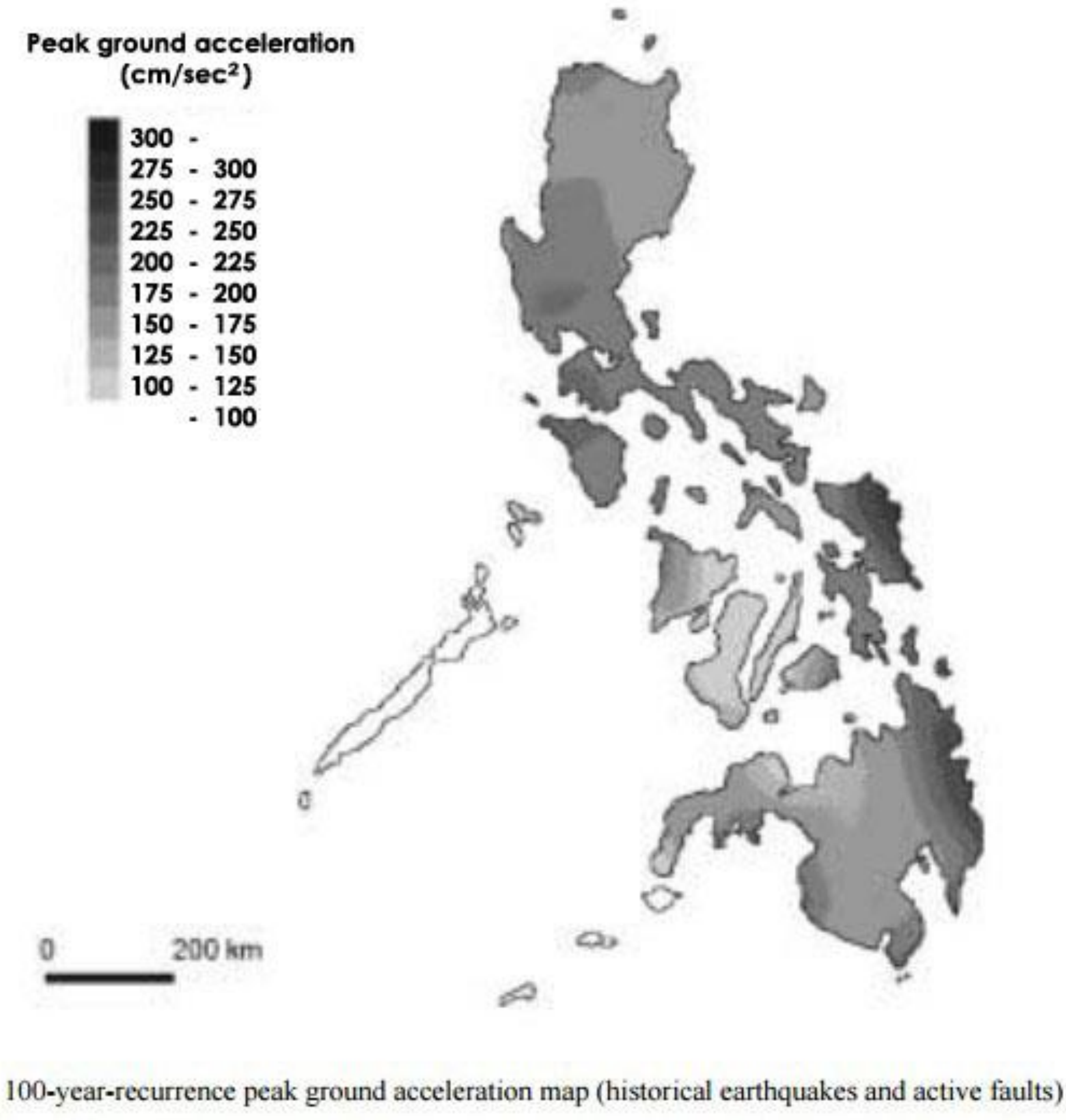


Figure 2.1.11. Peak ground acceleration values for the Philippines (After Torregoza, 2001)

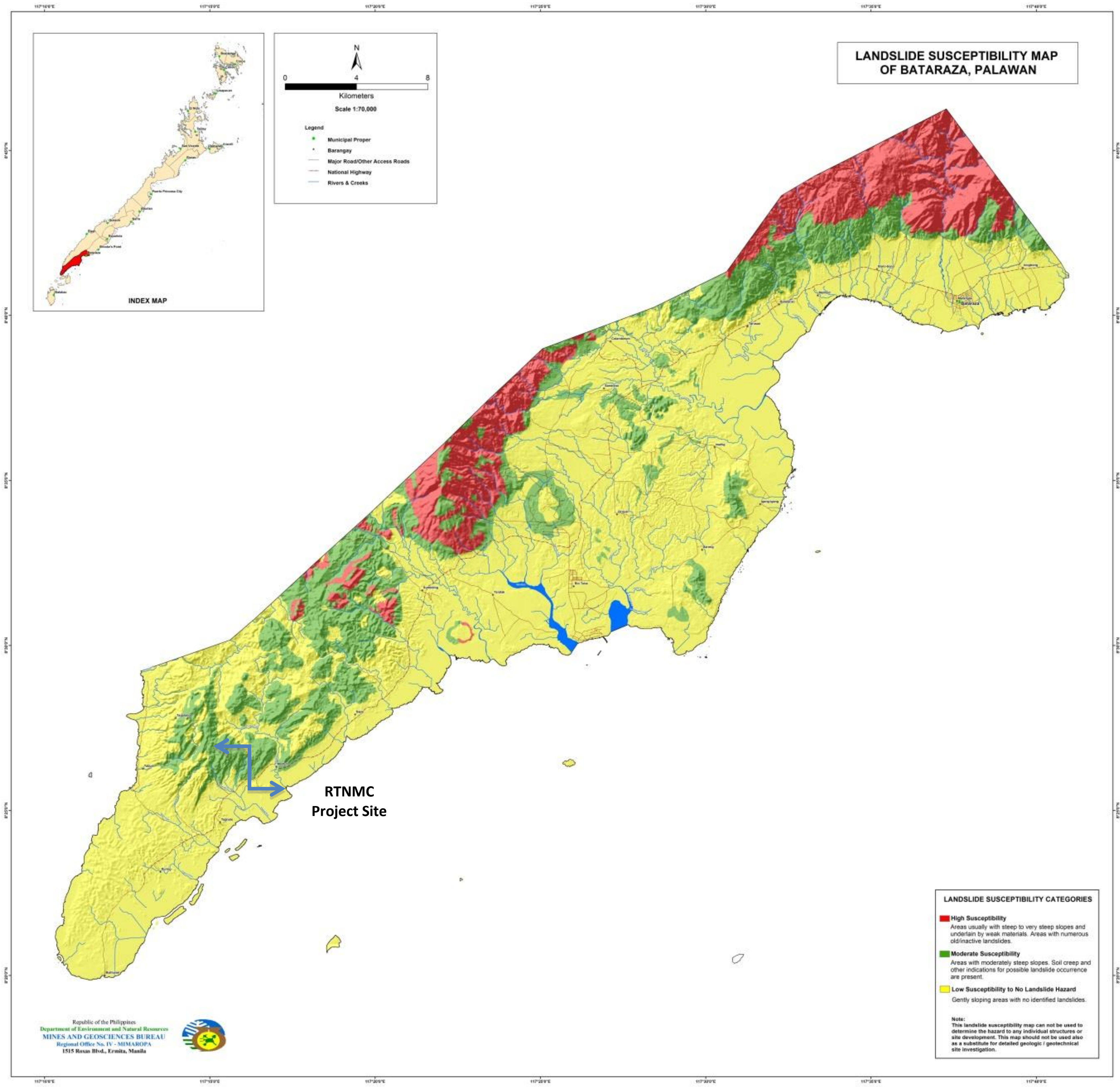


Figure 2.1.12. Landslide Susceptibility Map of the project site which is derived mainly on slope characteristics.

Liquefaction

Liquefaction occurs in seismically active areas that are underlain by thick, saturated deposits of unconsolidated sand and silt. When the ground shakes, the sediments are rearranged in a more compact manner and the pore water is forced upwards. The ground loses its shear strength and behaves like a liquid. This results in the settlement of structures into the soil.

Since Palawan is not seismically active and there are no thick, unconsolidated sand and silt deposits in the vicinity of the project site, the area is not prone to liquefaction.

Volcanic Hazards

There are no active volcanoes in the island. Tremendous eruptions from volcanoes in other parts of the Philippines may however subject the area to ash fall depending on the prevailing wind direction.

Landslides

Heavy and prolonged rainfall may increase the pore pressure within the lateritic soil and the sheared zone contact of the ultramafics. The increase in pore pressure causes a corresponding decrease in shear strength which, depending on the slope angle and the weight of the overlying material, may trigger landslides. Since the lateritic soil on the slopes of Mt. Bulanjao is relatively thin and the underlying ultramafic rocks generally competent, the landslides are expected to be minor.

Two, small and shallow landslides scars were observed in the steep upper slopes of the western side of Bulanjao Range. The landslides apparently occurred in the thin residual soil that covered these slopes and did not cause any damage to the lowland.

Flooding and Tsunamis

RTNMC has three (3) rainfall stations in Rio Tuba, which are located at Guintalunan, Mangingidong and at the Pier site. These rainfall stations have been in operation since 1977, 1983 and 1980, respectively. Data shows that the annual average rainfall of these stations from the time of their operation up to 2003 ranges from 1,510 mm to 2,198 mm. Based on the data, the possibility of flooding in deemed minimal in the project area.

Earthquakes, landslides and volcanic eruptions that occur under the sea can produce giant sea waves called tsunamis. Tsunamis attain great speed and energy and may cause heavy damage when it strikes a populated coastline.

Earthquakes along the Sulu and Negros Trench may generate tsunamis that could travel across the Sulu Sea and reach the eastern coast of Palawan. The project site is however not in direct danger of tsunamis since it is 6 kilometers inland at 27 m elevation. However, in the jetty area, flooding and high waves may occur during extreme weather conditions. **Figure 2.1.13** shows the tsunami hazards map of PHIVOLCS indicating the threat of on the shores of southern Palawan.

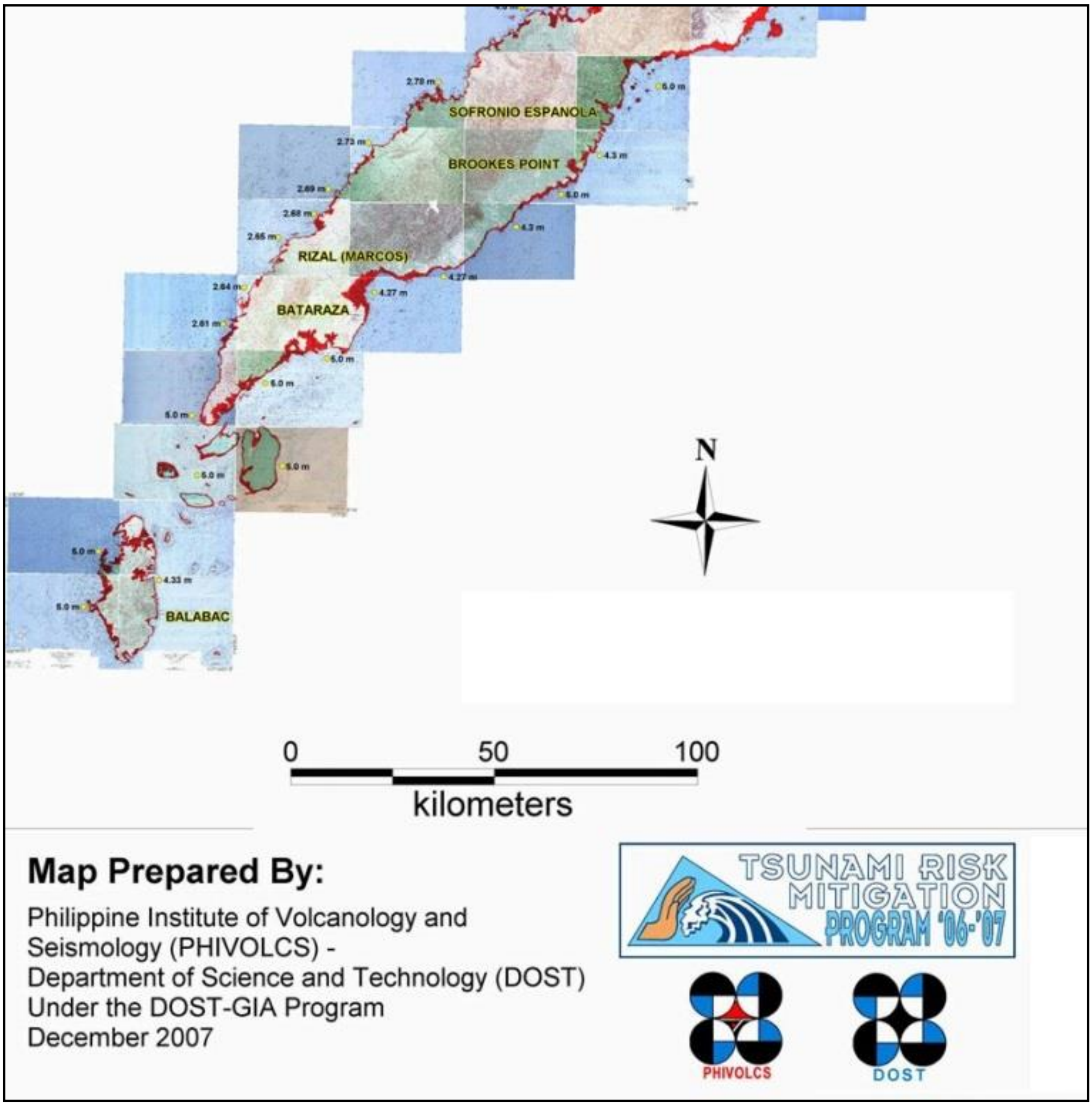


Figure 2.1.13. Tsunami hazards map of Southern Palawan (after PHIVOLCS)

Tropical Cyclones

It had been determined that the area is of Type III under the modified Corona's classification of Philippine climate. This type of climate is relatively dry from January to April and wet throughout the year. The main atmospheric systems controlling rainfall in the area are the southwest monsoon from June to September, northeast monsoon from December to February, and Easterly Waves from March to April. The mean frequency of thunderstorm occurrence ranges from 1 to 15 days per month from January to December. It is during the month of May when the most number of days with thunderstorm is recorded. The mean frequency of lightning occurrence ranges from 1 to 18 days the whole year round. The month of May has the most number of days with lightning observed.

The mean frequency of typhoon passage inside the Philippine Area of Responsibility (PAR) is about 20 typhoons per year. In the Palawan area, the typhoon passage frequency is one (1) cyclone per year mostly in Northern Palawan. This occurs during the last quarter of the year when the tail end of the cold front moves towards the southern part of the country. It is very rare for typhoons to pass in the project area, which is located at the southern tip of mainland Palawan.

For this project, the hazards posed by tropical cyclones are somewhat similar during both construction and operation phase. During the construction, the most significant consequence is structural failure or collapse primarily affecting workers on the project site. While during operation phase, the most significant consequence is associated with the collapse of the bench wall or embankment and/or even mine roads – affecting mainly the workers. On the worst scale scenario, typhoons may affect any water impounding structure or facility in the area – thereby allowing release of wastewater (both untreated or partially treated) to the nearby water body.

Subsidence

Subsidence can be caused by collapse of the ground into subsurface voids, or adjustment due to compaction, water extraction or earthquakes. There are no karst areas in the mine site, nor is groundwater extensively being neither extracted nor liquefiable materials present in the subsurface. Thus there is no significant threat of subsidence in the area. Likewise, there is the absence of indicators that point to seismic activities. In addition, the project area is deemed to be not prone liquefaction. Nonetheless, the possibility of subsidence and similar events exists, and may be triggered by other events such as earthquake, flooding, etc.

2.1.2.3 Impact Assessment

The key impacts of the proposed project on the geology are presented in **Table 2.1.5**. These are:

Table 2.1.5. Impacts Assessment and mitigation for geology

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
• **Change in surface landform/ topography/ terrain/ slope** This is the main and unavoidable impact of the mining project and is caused by the excavation and earthmoving activities associated with mineral extraction and access road development. Based on the proposed mine development plan, approximately 700.82 ha will be opened for the mining area and its support facilities out of the 3	✓	✓	✓	✓	RTNMC will submit an EPEP. The EPEP will define management measures for the progressive rehabilitation of mined out areas including the stabilization of the slopes of the mines out area. RTNMC shall minimize ground disturbance through proper delineation of areas to be mined, areas allotted as access road, office and motor pool. During operation, mining activities shall be confined within the boundaries identified in the mining plan and preferably within a 50 ha area at a time. RTNMC shall also maintain and enhance the vegetation cover in the designated 50 m buffer zones around the mining pits and peripheries of access roads.

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
• **Change in sub-surface/ underground geomorphology** The main impact of the project on subsurface processes is the reduction of groundwater infiltration while surface runoff is increased. This impact is temporary and is expected to revert to its former rates as soon as rehabilitation and revegetation is accomplished in the mined out areas.			✓	✓	As indicated above, RTNMC will implement the EPEP and will define the appropriate management measures for progressive rehabilitation, selective clearing, and surface run-off to manage the impacts of mining to the aquifer recharge. Constructing recharge trenches and pits at the lowlands near the base of Mount Bulanjao and diverting surface runoff to these structures away from the active mining areas will also increase the amount of groundwater recharge to the shallow aquifers in these areas.
• **Inducement of subsidence, liquefaction, landslides, mud/debris flow etc.** The steep slopes in the project site are occasionally affected by landslides while the rivers are flooded during the seasonal monsoon and typhoons, although debris flows have not been documented. No active tectonic features are present in this region. No active faults and volcanoes are found in the region. Very rare occurrence of earthquakes is observed in Palawan, and these have magnitudes of only 5 or lower.		✓	✓	✓	The mining pits are designed to minimized bench collapse. Access roads will be designed and constructed with stable slopes. Vegetation clearing will be selective and will be confined on areas needed for the current mining operations to maintain vegetation cover in surrounding areas. Surface run off will be directed away from active mining areas and access roads will be provided with drainage system to allow unimpeded flow. This will ensure that ponding of water is prevented that can saturate the soils and cause collapse of unstable slopes. As indicated above, RTNMC will implement the EPEP and will define the appropriate management measures for progressive rehabilitation, selective clearing, and surface run-off to manage the impacts of mining to the aquifer recharge.

2.1.3 Pedology

2.1.3.1 Methodology

The study on soils involved the review of existing literature and maps of the project area and site verification and soil sampling was conducted last August 14-15 and September 1-4, 2015 to characterize soils and determine the physico-chemical properties in the project site. Soil characterization was made through soil auger borings in the representative sites of the soil mapping units of the soil type within the project area. Site selection was made with the use of the project location map and the NAMRIA topographic map with a 1:50,000 scale. Geographical position of each observation/sampling location was recorded using a GPS (**Table 2.1.6, Figure 2.1.14**).

Soil profiles were described following the Food and Agriculture Organization (FAO) guidelines for soil profile descriptions. Slope gradient was also determined using an Abney

Hand Level. Soil samples were collected for physico-chemical analyses (texture, pH, N, OM, P, K). The analysis was done at the soils laboratory of the Bureau of Soils and Water Management (BSWM) in Quezon City. Heavy metal analysis (As, Cd, Co, Cr^{6+}, Fe, Hg, Ni, Pb, Cr, Zn) was done at Ostrea Mineral Laboratories Inc. an accredited laboratory by the EMB, DENR.

Table 2.1.6. Geographic coordinates of the soil observation sites

Soil Observation	Northing	Easting
1	8° 33.677"	117º 23.208
2	8°33.568"	117º 23.045"
3	8° 33.793"	117° 22.958"
4	8° 33.607"	117° 22.67"
5	8° 35.603"	117° 25.357"
6	8° 35.733"	117° 24.03"
7	8° 34.687"	117° 24.041"
8	8° 34.247"	117° 23.567"
9	8° 33.793"	117° 23.179"
10	8° 34.639"	117° 23.506"
11	8° 35.138"	117° 21.888"
12	8° 35.016"	117° 21.923"
13	8° 34.911"	117° 22.013"
14	8° 34.550"	117° 22.104"
15	8° 33.947"	117° 22.362"

Qualitative Suitability Classification was made by comparing the plant environmental requirements with the physico-chemical properties of the soils.

Soil erosion susceptibility or erosion potential of the project area was mapped using the soil mapping units. For each soil unit, erosion susceptibility was assessed based on a contributing factor taken at a time. The individual susceptibility assessments were then aggregated to form a composite erosion susceptibility score for the soil unit. The contributing factors include rainfall, soil erodibility, vegetation or landuse and slope. The following data were used;

- For the rainfall, PAGASA's rainfall data as compiled in Puerto Princesa City station.
- Erodibility of the various soil mapping units was determined following the results of the field assessment and physical analysis.
- Vegetation or land use was assessed in the field. This was supplemented by the interpretation of Google earth imageries.
- The slope of the soil mapping unit.

2.1.3.2 Baseline Conditions

Soils of the Project Area

One soil type which was subdivided into four (4) soil mapping units based on differences in slope ranges were identified, characterized and mapped within the project area.
The soil type is Tagburos clay loam with Tagburos clay loam, 3-8 % slopes, Tagburos clay loam, 8-18% slopes, Tagburos clay loam, 18-30% slopes, and Tagburos clay loam, > 30% slopes as the soil mapping units (**Figure 2.1.15: Soil Map**). The Tagburos clay loam developed from the weathering of ultramafic rocks. **Table 2.1.7** summarizes the result of the physico-chemical characteristics of the various soil types. **Annex 2.1.3** shows the certificate of analysis of the soil samples.

Tagburos clay loam in 3-8% slopes

This soil type occurs in the eastern half of the proposed project area from Barangay Ocayan in the north down to Barangay Rio Tuba and Barangay Taratak in the south. This soil type is found in Observation Site No.5 which is a well-drained, deep (**Plate 2.1.3),** clay loam over clay soil.

Plate 2.1.3. Deep to very deep Tagburos clay loam soil on a road cut on the Midslope of Mount Bulanjao

Soil reaction is slightly acid (pH 6.5). Total Nitrogen is low with 0.10%. Organic Matter and potassium are very low with 1.32% and 0.06 cmol/kg, respectively. Zinc is high (2.03 mg/kg), manganese is low (64.44 mg/kg), iron is very low (25.38 mg/kg), while copper was not detected. The natural fertility of this soil is low.

In this soil, the heavy metals (lead, mercury, arsenic, cadmium, chromium hexavalent, cobalt and zinc) are below the contamination levels as prescribed by the Taiwanese and Dutch standards for lead (500 mg/kg), mercury (2 mg/kg), arsenic (40 mg/kg), cadmium (5 mg/kg), chromium hexavalent (2 mg/kg), cobalt (240 mg/kg) and **zinc (500 mg/kg)** (**Table 2.1.7**). Iron content is within the range of iron in soil of 0.3 – 10%. Nickel (200 mg/kg) (borderline) and chromium (1494 mg/kg) are above the contamination levels for nickel (200 mg/kg) and chromium (400mg/kg) as prescribed by the Taiwanese standards.

Tagburos clay loam in 8-18% slopes

This type of soil occurs in the eastern half of the Project area adjacent to Tagburos clay loam at 3-8% slopes and was observed in Observation Site No.6 and is a well-drained, deep loam over clay soil with 8-18% slopes.

Soil reaction is slightly acid (pH 6.08). Total nitrogen, organic matter and potassium are very low with 0.09%, 1.53% and 0.03% cmol/kg, respectively phosphorus was not detected. Zinc and Iron are very low with 0.17 and 12.80mg/kg, respectively. Manganese is low (27.27 mg/kg), while copper was not detected. The natural fertility of this soil is low.

In this soil, the heavy metals (lead, mercury, arsenic, cadmium, chromium hexavalent, and zinc) are below the contamination levels as prescribed by the Taiwanese standards. Cobalt (740 mg/kg), nickel (7,400 mg/kg) and chromium (1,684.46 mg/kg) are above the contamination levels as prescribed by the Taiwanese and Dutch standards for Cobalt (240 mg/kg), Nickel (200 mg/kg), and chromium (400 mg/kg).

Tagburos clay loam in 18-30% slopes

This soil type occurs in the western half of Project area on the mid slopes and along the ridge of Mt. Bulanjao including the core zone with 1,000 masl and above and is found in Observations Site no. 12,13 and 15 is a well-drained, deep, clay loam to sandy clay loam over clay soil with 18-30% slopes.

Soil reaction is medium acid (pH 5.79 to pH 5.8), except for observation 13 with very strongly acid soil reaction of pH 5.04. Total Nitrogen is very low (0.09-0.11%). Organic matter is very low to low (1.22 to 3.49%).

Potassium is very low (0.02-0.03 cmol/kg), while phosphorous was not detected. Zinc is very low (0.13-0.68 mg/kg). Manganese is very low to low (3.92 – 56.01mg/kg). Iron is very low to low (11.39 – 548.5 mg/kg) while copper was not detected. The natural fertility of this soil is low.

In this soil, the heavy metals (lead, mercury, arsenic, cadmium, and zinc) are below the contamination levels as prescribed by the Taiwanese standards. Chromium hexavalent (11.84 and 124.53 mg/kg) is above the contamination level for chromium hexavalent of 2mg/kg, except in soil observation 13 with chromium hexavalent of <0.10 mg/kg which is below the contamination level. Iron (2.43-4.82%) is within the range of iron in the soil. Cobalt, nickel and chromium with 340-1,060 mg/kg, 800-9,400 mg/kg and 938.35-1142.61mg/kg, respectively are above the contamination levels for nickel and chromium as prescribed by the Dutch and Taiwanese standards.

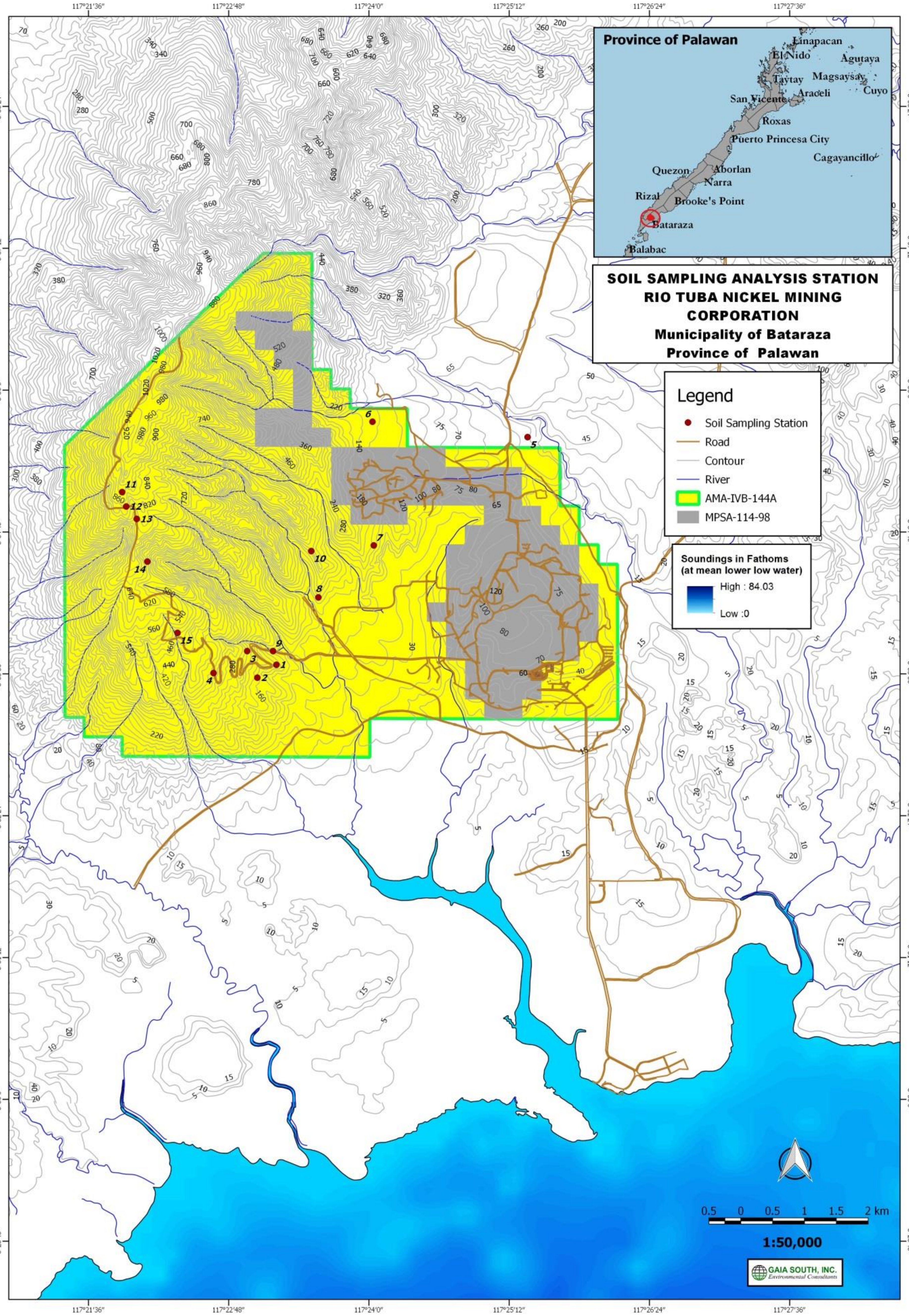


Figure 2.1.14. Soil sampling station map

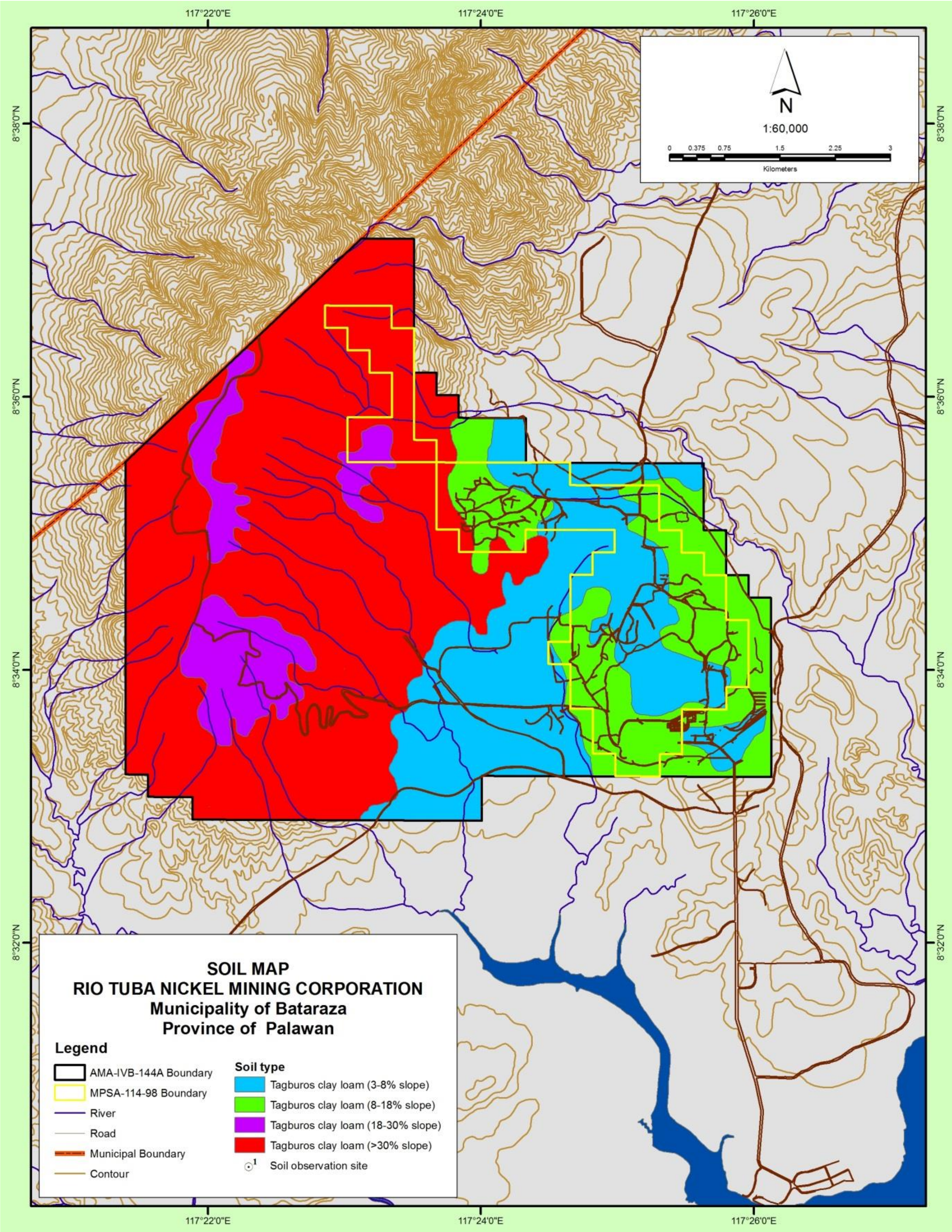


Figure 2.1.15. Soil map

Table 2.1.7. Soil Physico- Chemical Properties of Soils from the Rio Tuba Nickel Mining Corporation Mine Site

Soil Properties	Tagburos clay loam , 3-8% slopes	Tagburos clay loam , 8-18% slopes	Tagburos clay loam, 18-30% slopes		
	Obsv.5	Obsv.6	Obsv. 12	Obsv. 13	Obsv. 15
Physical Properties					
Drainage	Well drained	Well drained	Well drained	Well drained	Well drained
Texture	Clay loam over clay	Loam over clay	Sandy clay loam over clay	Loam over clay	Clay loam over clay
Soil Depth (cm)	>100	>100	>100	>100	>100
Slope (%)	3-8	8-18	18-30	18-30	18-30
Chemical Properties					
pH	6.5	6.08	5.79	5.04	5.80
Total Nitrogen (%)	0.10	0.09	0.09	0.11	0.10
Organic Matter (%)	1.32	1.53	1.38	3.49	1.22
Phosphorus (mg/Kg)	-	ND	ND	-	ND
Potassium (cmol/Kg)	0.06	0.03	0.02	0.03	0.03
Available Micronutrients					
Copper (mg/Kg)	ND	ND	ND	ND	ND
Zinc (mg/Kg)	2.03	0.17	0.19	0.68	0.13
Manganese (mg/Kg)	64.44	27.27	32.80	3.92	56.01
Iron (mg/Kg)	25.38	12.80	25.77	548.5	11.39
Heavy Metals					
Lead (mg/Kg)	<0.10	<0.10	<0.10	<0.10	<0.10
Mercury (mg/Kg)	0.081	0.085	0.172	0.054	0.263
Arsenic (mg/Kg)	2.35	1.63	0.79	<0.01	0.08
Cadmium (mg/Kg)	<0.03	<0.03	<0.03	<0.03	<0.03
Chromium (mg/Kg)	0.56	0.19	11.84	<0.10	124.53
Iron (%)	5.01	2.79	2.43	3.4	4.82
Cobalt (mg/kg)	80	740	20	340	1060
Nickel (mg/Kg)	200	7400	800	4500	9400
Zinc (mg/Kg)	39.32	157.36	198.12	76.25	382.54
Chromium (mg/Kg)	1494	1684.46	938.35	1052.95	1142.61

Table 2.1.7
Continuation…

Soil Properties	Tagburos clay loam, >30% slopes									
	Obsv.1	Obsv.2	Obsv.3	Obsv.4	Obsv.7	Obsv.8	Obsv.9	Obsv.10	Obsv.11	Obsv.14
Physical Properties										
Drainage	Well drained	Well drained	Well drained	Well drained	Well drained	Well drained	Well drained	Well drained	Well drained	Well drained
Texture	Clay loam over clay	Silty clay	Loam over clay	Sandy clay loam over clay	Clay loam over clay	Clay	Clay loam over clay	Clay	Sandy clay loam over clay	Clay loam over clay
Soil Depth (cm)	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100
Slope (%)	>30	>30	>30	>30	>30	>30	>30	>30	>30	>30
Chemical Properties										
pH	6.61	5.99	6.7	6.66	6.33	6.05	5.93	6.64	6.55	5.81
Total Nitrogen (%)	0.13	0.14	0.13	0.02	0.10	0.13	0.16	0.14	0.07	0.09
Organic Matter (%)	2.12	1.6	1.89	0.74	1.5	1.32	1.58	1.43	1.22	1.62
Phosphorus (mg/Kg)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium (cmol/Kg)	0.13	0.09	0.05	0.01	0.04	0.06	0.06	0.03	0.01	0.02
Available Micronutrients										
Copper (mg/Kg)	0.45	0.19	ND	ND	ND	0.10	0.17	0.22	ND	ND
Zinc (mg/Kg)	1.53	1.32	1.30	0.07	1.03	1.11	0.45	0.66	0.09	0.23
Manganese (mg/Kg)	75.50	44.94	95.12	3.50	63.28	22.45	49.94	34.83	32.99	1.26
Iron (mg/Kg)	35.71	28.49	13.72	7.31	25.21	19.01	80.87	74.98	8.64	16.38
Heavy Metals										
Lead (mg/Kg)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Mercury (mg/Kg)	0.193	0.141	0.040	0.193	<0.004	0.067	0.041	0.020	0.219	0.059
Arsenic (mg/Kg)	<0.01	<0.01	<0.01	<0.01	0.91	0.91	<0.01	<0.01	1.14	<0.01
Cadmium (mg/Kg)	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Chromium (mg/Kg)	0.46	1.79	0.43	123.90	116.74	<0.10	0.31	0.48	15.77	<0.10
Iron (%)	4.49	4.05	4.59	1.44	4.42	0.03	147	1.50	4.26	4.83
Cobalt (mg/kg)	990	900	1210	350	1220	520	310	320	670	250
Nickel (mg/Kg)	10400	10500	14100	8400	7700	12700	5900	5700	8200	8400
Zinc (mg/Kg)	291.28	242.19	345.53	369.09	301.33	174.86	95.42	89.62	304.36	307.91
Chromium (mg/Kg)	296.86	1080.20	1335.18	524.62	1105.62	818.02	353.66	414.58	1346.45	1251.44

Notes:
ND= Not Detected
- = No Data
Taiwan standard for assessment of soil contaminated with heavy metals (mg/Kg):
Arsenic=40; Cadmium=5; Copper=200; Nickel=200; Lead=500; Mercury=2; Zinc=500; Chromium=400
Dutch Standard for Cobalt=240
Range of Iron in Soils=0.3-10%
Chromium Hexavalent= 2 mg/Kg (U.S. EPA, 2010)

Tagburos clay loam in >30% slopes

This soil type occurs on the mid slopes of Mt. Bulanjao in the western half of the Project area and is found in Observation Site No. 1,2,3,4,7,8,9,10,11, and 14 and is a well-drained, deep, clay loam to sandy clay loam over clay soil (except in soil observations 8 and 10 with clay throughout the soil profile), with >30% slopes.

Soil reaction is medium acid (pH 5.81) to neutral (pH 6.7). Total nitrogen and organic matter are very low to low with 0.02-0.16% and 1.22-2.12%, respectively. Phosphorus is not detected, except in soil observation 9 with 0.01 mg/kg which is very low. Copper is not detected, except in soil observations 1,2,8,9 and 10 with 0.17-0.45mg/kg which is very low. Zinc, Manganese and Iron are very low to low with 0.45-1.32 mg/kg, 1.26-75.50 mg/kg and 8.64-74.98 mg/kg, respectively. Except for Zinc in soil observation 1 with 1.53 mg/kg which is medium. Manganese (95.12 mg/kg) in soil observation 3 is medium. Iron in Soil Observation 9 with 80.87mg/kg is medium. The natural fertility of this soil is low.

In this soil, the heavy metals (lead, mercury, arsenic, cadmium, and zinc) are below the contamination levels for lead, mercury, arsenic, cadmium and zinc as prescribed by the Taiwanese standards. Chromium hexavalent is below the contamination level for chromium hexavalent of 2 mg/kg, except in soil observations 4, 7, and 11 with chromium hexavalent of 15.77-123.90 mg/kg which is above the contamination level for chromium hexavalent. Cobalt and nickel with 250-1,210 mg/kg and 7,700-14,100 mg/kg, respectively are above the contamination levels for cobalt and nickel as prescribed by the Dutch and Taiwanese standards. Chromium with 414.58-1346.45 mg/kg is above the contamination level for chromium as prescribed by the Taiwanese standard. Except the chromium in Soil Observation 9 with 353.66 mg/kg which is below the contamination level for chromium as prescribed by the Taiwanese standard.

Soil Erosion Susceptibility of the Project Area

The four (4) contributing factors to erosion include rainfall, soil erodibility, vegetation/ landuse and slope. To determine the extent of erosion susceptibility within the project area, three (3) degrees of susceptibility are defined for each of the four contributing factors. These are “slightly susceptible” “moderately susceptible” and “highly susceptible”.

Rainfall

For rainfall, the degree rating is shown in **Table 2.1.8**. **Annex 2.1.4** shows the rainfall data of Puerto Princesa City from 1971 to 2000. Data shows that there are two (2) wet months (with more than 200 mm./mo.) with October as the wettest month having 222.3 mm of rainfall. The remaining 10 months are with low to moderate rainfall with February having the least rainfall of 23.7 mm. Based on these rainfall data, the erosion susceptibility rating for the whole project area is “slight”.

Table 2.1.8. Erosion Susceptibility based on Rainfall

Degree of Susceptibility	Rainfall Type
Slightly	Areas with 5 to 6 dry months and 3 to 4 wet months
Moderately	Areas with 5 to 6 dry months and 5 to 6 wet months
	Areas with 2 to 4 dry months and 5 to 6 wet months
	Areas with 5 to 6 dry months and 3 to 4 wet months with one or more months of 500mm or more rainfall per month

Degree of Susceptibility	Rainfall Type
Highly	Areas with 5 to 6 dry months and 5 to 6 wet months with one or more months of 500mm or more rainfall per month

Source: Bruce,1982

Soil Properties

For soil type, the susceptibility score is shown in (**Table 2.1.9**). The criteria that were used are the soil depth and clay-silt fraction. Tagburos clay loam with more than 100 cm soil depth and <60% clay-silt fraction is with "slight susceptibility to erosion".

Table 2.1.9. Erosion Susceptibility Based on Soil Properties

Degree of Susceptibility	Soil Depth and Texture
Slightly	Areas with 50 to 100cm solum and 60 to 100% clay-silt fraction
	Areas with greater than 100cm solum and 0 to 60 percent clay-silt fraction
	Unclassified soils of the mountain
Moderately	Areas with 50 to 100cm solum and 0 to 60% clay-silt fraction
	Areas with greater than 100cm solum and 60 to 100% clay-silt fraction
Highly	Areas with less than 50cm solum and 0 to 100% clay-silt fraction

Source: Bruce, 1982
Notes: Solum is made up of surface soil and subsoil. Clay-silt fraction is percent total of clay and silt particles determined through mechanical analysis of topsoil.

Landuse/Vegetation

For landuse/vegetation, the degree rating is shown in **Table 3.1.10**, as shown by landuse/vegetation map of the project area (**Figure 2.1.16**), there are five (5) landuse/vegetation types identified in the project area. Based on **Table 3.1.10**, the areas with forest, shrubs and built-up area are with "slight susceptibility to erosion". The grassland is with "moderate susceptibility to erosion". The bare area is with "high susceptibility to erosion".

Table 2.1.10. Erosion Susceptibility based on Vegetation and Crops Grown

Degree of Susceptibility	Type of Crops/Ground Cover
Slightly	Areas grown to paddy rice
	Areas permanently planted to coconut, mixed orchard, fruit trees, etc.
	Areas covered with dense forest/shrubs, tall grasses and pine trees
Moderately	Areas grown to sugar cane
	Open grassland
	Areas with thin growth of deciduous forest with scattered kaingin clearings Areas, sloping planted to coconut or fruit trees intercropped with upland row crops (corn, cassava, sweet potato, etc.)
Highly	Areas of diversified upland row crops – corn, cassava, upland rice, mungbean, pineapple, etc.
	Areas planted to tobacco
	Areas with thin growth of short grasses with patches of kaingin clearings; Sparsely vegetated land; Bare area

Source: Bruce, 1982

Slope

As shown by the slope in the soil map (**Figure 2.1.15**), and based on **Table 2.1.11**, Tagburos clay loam with 3-8% slopes is with "slight susceptibility to erosion". Tagburos clay loam with 8-18% is with "moderate susceptibility to erosion", and Tagburos clay loam with 18-30% and >30% slopes are with "high susceptibility to erosion".

Table 2.1.11. Erosion Susceptibility based on Slope

Degree of Susceptibility	Slope Range
Slightly	Areas with slope between 0 and 8%
Moderately	Areas with slope between 8 and 18%
Highly	Areas with slope greater than 18%

Source: Bruce, 1982

Final Erosion Susceptibility Rating

The four (4) erosion susceptibility ratings of each soil unit are aggregated to form the final rating consistent with **Table 2.1.12**, which shows the decision rule on the composite or final erosion susceptibility index. The Soil Erosion Susceptibility Map *(***Figure 2.1.17***)* displays the result of erosion susceptibility ratings.

As shown by the Soil Erosion Susceptibility Map, the forest on Tagburos clay loam with 3-8%, 8-18%, 18-30% and >30% slopes is with “slight susceptibility to erosion”. The Shrubland on Tagburos clay loam with 3-8%, 8-18% and >30% slopes is with “slight susceptibility to erosion”. The grassland and built-up area on Tagburos clay loam with 3-8% slopes are with "slight susceptibility to erosion", while on Tagburos clay loam with 8-18%, 18-30%, and >30% slopes the grassland is with "moderate susceptibility to erosion". The bare area (mining area) on Tagburos clay loam with 3-8% and 8-18% slopes is with " moderate susceptibility to erosion", while the bare area (Kaingin) on Tagburos clay loam with 18-30% and >30% slopes is with "high susceptibility to erosion".

Table 2.1.12. Composite Erosion Susceptibility Decision Rule

Individual Susceptibilities (Rainfall – landuse – slope – soil)	Final Degree of Erosion Susceptibility
S – S – S – S	Slightly
M – M – M – M	Moderately
H – H – H – H	Highly
H – M – H – H	Highly
H – S – M – M	Moderately
H – M – M – H	Moderately

Source: Bruce, 1982
Note: S is slightly susceptible, M- moderately susceptible, and H- highly susceptible.

Soil Suitability Classification

A qualitative suitability classification was made by comparing the plants environmental requirements with the physico-chemical properties of the soil mapping units (**Table 2.1.13** and **2.1.14**).

Results showed that the forest tree species (Narra, Molave, Auriculiformis and Mahogany) are suitable in all the four (4) soil mapping units in the project area, with low fertility as the limitation. The fruit bearing trees (Tamarind, Jackfruit, Kamachile, and Guyabano/Atis) are all suitable in the four (4) soil mapping units, with low fertility as the limitation. Coconut, Mango and Banana are suitable in Tagburos clay loam with 3 – 30% slopes, with low fertility as the limitation, but not suitable in Tagburos clay loam with >30% slopes. Cassava and Peanut are suitable in Tagburos clay loam with 3-8% slopes, with low fertility as the limitation, but not suitable in Tagburos clay loam with >8% slopes (**Table 2.1.13**).

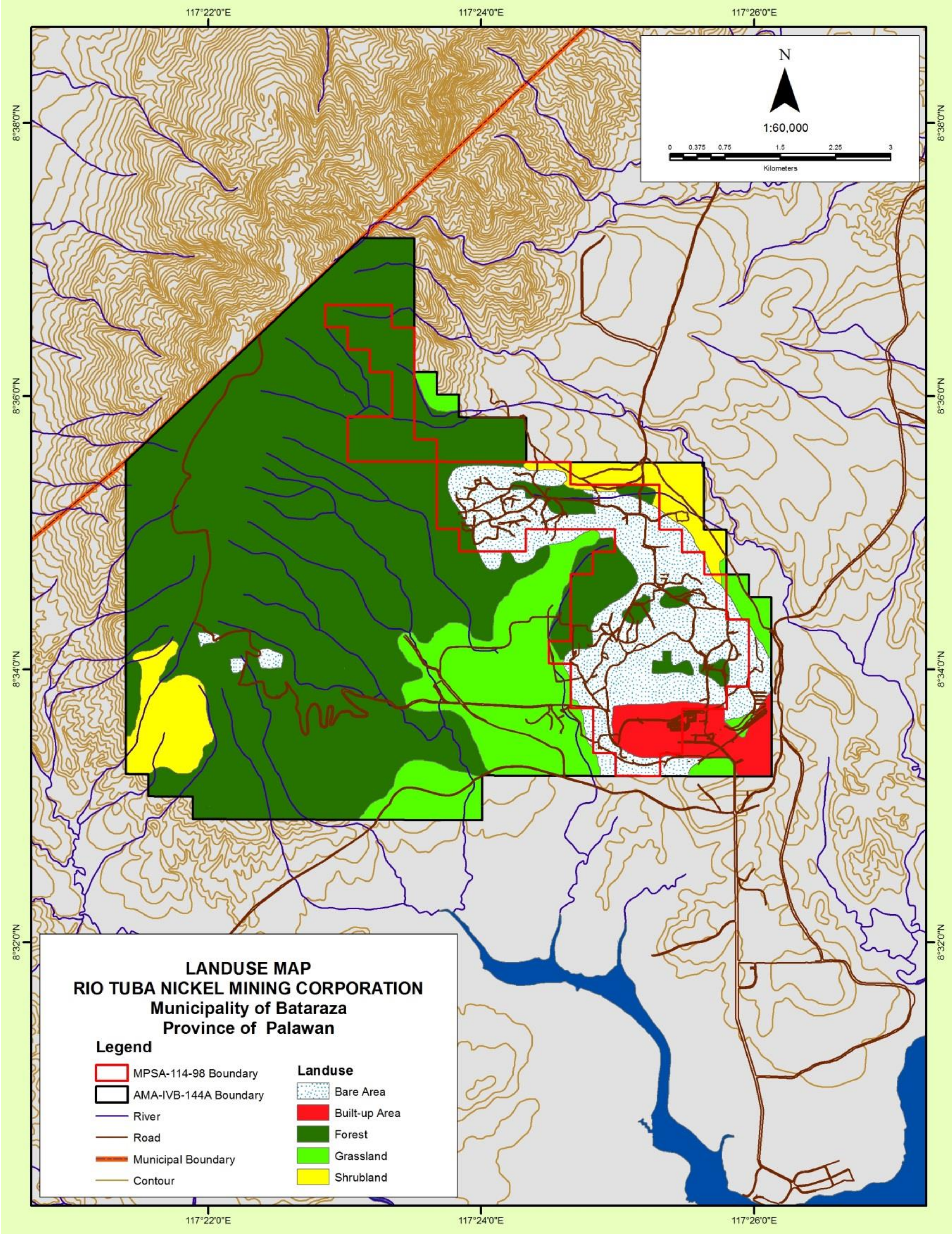


Figure 2.1.16. Landuse/vegetation map of the project site

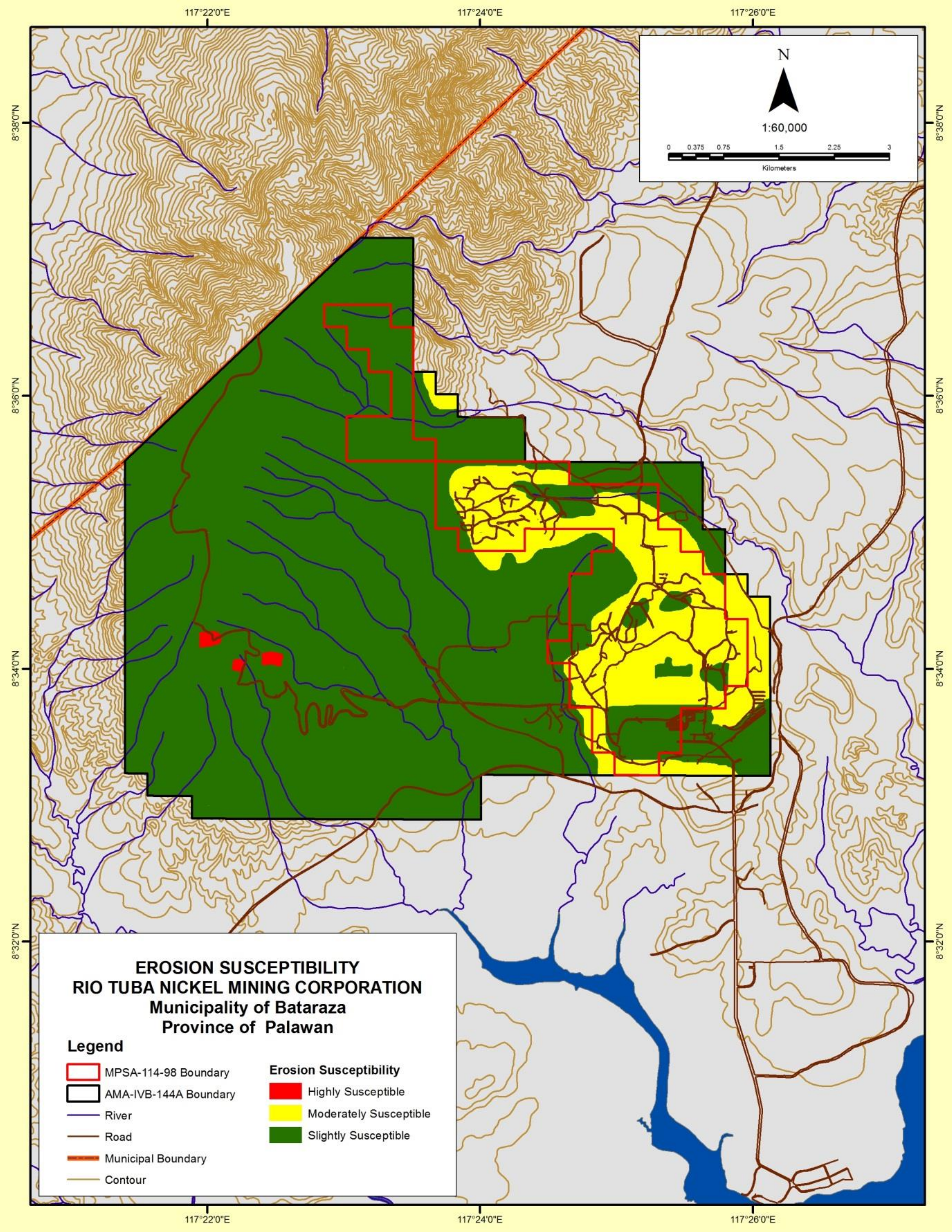


Figure 2.1.17. Erosion susceptibility map of the project site

Table 2.1.13. Environmental Requirements of Selected Plants

Plant	Slope (%)	Soil Depth (cm)	Drainage	Soil pH	Soil Texture	Soil Fertility
Narra	0>50	≥45	Moderately well	5.0-7.5	Loamy to structured clay	Low to medium
Molave	0>50	≥45	Moderately well to well drained	5.0-7.5	Loamy to clay	Low to medium
Auriculiformis	0>50	≥45	Moderately well to well drained	4.5-7.5	Loamy to clay	Low to medium
Mahogany	0>50	>75	Moderately well to well drained	5.0-7.5	Loamy to clayey	Low to medium
Tamarind	0>50	≥45	Moderately well somewhat poorly drained	4.0-8.0	Sandy loam to clay loam	Low to medium
Coconut	0-30	>75	Moderately well	6.0-7.5	Sandy loam to clay loam	Medium
Jackfruit	0>30	≥45	Moderately well somewhat poorly drained	5.0-7.5	Loamy to clayey	Low to medium
Kamachile	0>30	≥45	Moderately well to well drained	5.0- 7.5	Sandy loam to clay loam	Low to medium
Mango	0-30	≥75	Moderately well somewhat poorly drained	4.5-7.0	Loamy to clayey	Medium
Banana	0-30	≥45	Moderately well to well drained	5.0-7.0	Sandy loam to clay loam	Medium
Guayabano/ Atis	0≥45	≥45	Moderately well	4.5-6.5	Sandy loam to clay loam	Low to Medium
Cassava	0-8	≥75	Moderately well to well drained	5.0-7.0	Sandy loam to clay loam	Low to Medium
Peanut	0-8	≥45	Moderately well to well drained	5.0-7.0	Sandy loam to clay loam	Medium to high

Table 2.1.14. Qualitative Suitability Classification

Plant	Soil Type/Mapping Unit			
	Tagburos clay loam, 3-8% slopes	Tagburos clay loam, 8-18% slopes	Tagburos clay loam, 18-30% slopes	Tagburos clay loam, >30% slopes
Narra	S*	S*	S*	S*
Molave	S*	S*	S*	S*
Auriculiformis	S*	S*	S*	S*
Mahogany	S*	S*	S*	S*
Tamarind	S*	S*	S*	S*
Coconut	S*	S*	S*	NS
Jackfruit	S*	S*	S*	S*
Kamachile	S*	S*	S*	S*
Mango	S*	S*	S*	NS
Banana	S*	S*	S*	NS
Guayabano/ Atis	S*	S*	S*	S*
Cassava	S*	NS	NS	NS
Peanut	S*	NS	NS	NS

Notes:
S- Suitable
**- Suitable but with low fertility as limitation*
NS- Not Suitable

2.1.3.3 Impact Assessment

The key impacts of the proposed project on the pedology are presented in **Table 2.1.15.** These are:

Table 2.1.15. Impacts assessment and mitigation for pedology

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
• **Soil erosion/ loss of topsoil/ overburden** Soil erosion will occur once an area is cleared of its vegetation cover particularly areas with steep to very steep slopes. This will be the case when the trees are cut prior to mining activities. Before the extraction of limonite/ saprolite, the topsoil/overburden will be removed.		✓	✓		To manage soil erosion, the following measures are recommended: • Clearing and excavation works should be done during the drier months or days of the year (January -May). • Vegetation cover especially trees within the required legal easements for rivers, creeks, riparian zones, and other identified restricted areas should be maintained. Vegetation cover of the buffer zones surrounding the mine pits and access road shall be restored and enhanced. • Selective clearing of vegetation cover and implementation of progressive rehabilitation programs. • Mining benches and access roads shall be constructed with consideration to stable slopes. Drainage systems shall be installed and all water draining from the mine site should be directed towards the siltation ponds. Surface run off from area outside of active mining areas should be directed away from the drainage system to minimize flow and maintain impounding capacity of the silt ponds. • Top soil from the mine pits shall be recovered and stored in run-off controlled spoils disposal area. The recovered topsoil shall be used in the progressive rehabilitation program defined in the EPEP. • Sediment ponds/traps, check dams and gabions will be constructed on the creeks/rivers to reduce sedimentation in rivers and other bodies of water.
• **Change in soil quality/ fertility** Change in soil quality or fertility on the ground surface will occur when the limonite/saprolite will be extracted or the mining is done, as the surface will be the bare ultramafic rock (non-soil).			✓	✓	To manage the loss of topsoil and soil fertility of the mining areas, he following measures are recommended: • Overburden with topsoil will be saved and placed in appropriate stockpile areas and protected from further soil erosion. • After mining activity the area will be rehabilitated by backfilling followed by slope stabilization. The overburden with topsoil will be returned and the stabilized areas will be replanted with suitable seedlings. • Incorporation of organic fertilizer or compost (500 gm/hole) in the planting hole of the outplanted seedlings will be done to serve as a booster for plant growth. In time, soil fertility may be recovered when considerable volume of leaf litter is accumulated on the rehabilitated sites.
• **Soil contamination with oil and grease**		✓	✓		Regular maintenance of vehicles and heavy equipment to check for leaks. Maintenance activities should be conducted in the motor pool to contain fuel leaks. The motor pool shall be installed with Oil and Water Separator (OWS) to capture spillages. The OWS should be maintained monthly and oil residues removed, stored in airtight container prior to transport and treatment of accredited transporter and treater. Fuel oil storage areas should be provided with concrete bund to protect from spillages. Waste materials contaminated with hydrocarbon residues should be stored in leak proof containers and collected and treated by accredited contractors.

2.1.4 Flora

2.1.4.1 Methodology

Vegetation Sampling Plot Establishment

An assessment of the flora in the proposed project site on Mt. Bulanjao in Bataraza, Palawan was conducted last August 28-30, 2015. The mangrove forest along the Rio Tuba River was also included in the assessment. Prior to the inventory, a reconnaissance survey of the area was undertaken initially to determine the potential locations of the vegetation sampling plots. Using the topographic map provided, the location of the plots was determined. For purposes of this inventory and data analyses, the project site was divided into two (2) major forest formations, *viz.* the forest over ultramafic rocks on Mt. Bulanjao and the mangrove forest along the of Rio Tuba River. Furthermore, the forest over ultramafic rocks was subdivided into four communities, *viz. Xanthostemon*-dominated, *Gymnostoma*-dominated, *Gymnostoma-Xanthostemon*-dominated and mixed-species communities.

A total of 26 sampling plots were established within the proposed site (**Figure 2.1.18; Table 2.1.16**). Each plot (20 m x 10 m) was divided into subplots using the four (4) cardinal directions *i.e.,* subplot 1 (NE), subplot 2 (SE), subplot 3 (SW), subplot 4 (NW). This method was applied so that inventory and assessment of the area will be systematic, and to avoid double counting. In each subplot, an inventory of the vascular plants present was conducted. Measurement of stem diameter at breast height (dbh) and total height (TH) was undertaken for trees with more than 10 cm dbh. Smaller quadrats measuring 5 m x 5 m and 1 m x 1 m were also established within the 20 m x 10 m plot. The 5 m x 5 m quadrat was established to quantify the intermediate vegetation such as poles and saplings with dbh 3–5 cm, while the 1 m x 1 m quadrat was established to account for undergrowth vegetation with less than 3 cm dbh such as seedlings, vines, herbs, ferns, and fern allies. For the intermediate vegetation, the number of individuals, dbh and TH of each species were recorded. Whereas, the number of individuals was counted and percent cover of each species was estimated in the undergrowth vegetation.

Table 2.1.16. Relative location and elevation of the sampling plots within proposed site on Mt. Bulanjao and along the Rio Tuba River, Bataraza, Palawan

Plot	Forest Formation	Northing	Easting	Elevation
1	*FOUR: *Gymnostoma-Xanthostemon*-dominated	8º 35.548	117º 23.539	370 m
2	FOUR: *Gymnostoma-Xanthostemon*-dominated	8º 35.557	117º 23.592	353 m
3	FOUR: *Gymnostoma-Xanthostemon*-dominated	8º 35.387	117º 23.723	297 m
4	FOUR: *Gymnostoma-Xanthostemon*-dominated	8º 34.639	117º 23.506	220 m
5	FOUR: *Gymnostoma-Xanthostemon*-dominated	8º 34.520	117º 23.577	185 m
6	FOUR: *Gymnostoma-Xanthostemon*-dominated	8º 34.255	117º 23.549	152 m
7	FOUR: *Gymnostoma-Xanthostemon*-dominated	8º 34.140	117º 23.622	124 m
8	FOUR: *Xanthostemon*-dominated	8º 33.665	117º 23.308	175 m
9	FOUR: *Xanthostemon*-dominated	8º 33.793	117º 23.179	145 m
10	FOUR: *Xanthostemon*-dominated	8º 33.687	117º 23.145	212 m
11	FOUR: *Xanthostemon*-dominated	8º 33.554	117º 23.055	230 m
12	FOUR: *Xanthostemon*-dominated	8º 33.533	117º 22.985	275 m
13	FOUR: *Gymnostoma-Xanthostemon*-dominated	8º 33.534	117º 22.906	295 m
14	FOUR: *Gymnostoma-Xanthostemon*-dominated	8^{o} 33.790	117^{o} 22.896	331 m
15	FOUR: *Gymnostoma*-dominated	8^{o} 33.767	117^{o} 22.544	483 m
16	FOUR: *Gymnostoma*-dominated	8^{o} 33.947	117^{o} 22.362	552 m
17	FOUR: *Gymnostoma*-dominated	8^{o} 34.207	117^{o} 22.305	620 m
18	FOUR: mixed-species	8^{o} 34.317	117^{o} 22.059	654 m
19	FOUR: mixed-species	8^{o} 34.550	117^{o} 22.104	709 m
20	FOUR: mixed-species	8^{o} 34.799	117^{o} 22.102	790 m
21	FOUR: mixed-species	8^{o} 34.911	117^{o} 22.013	842 m

Plot	Forest Formation	Northing	Easting	Elevation
22	FOUR: mixed-species	8° 35.016	117° 21.923	843 m
23	FOUR: mixed-species	8° 35.138	117° 21.888	847 m
24	FOUR: mixed-species	8º 35.700	117º 21.494	849 m
25	Mangrove forest	8° 31.853	117° 24.642	13 m
26	Mangrove forest	8° 32.041	117° 25.119	10 m

*Note: * FOUR: Forest over ultramafic rocks*

Collection of Specimens

Specimens (about 30 cm of twig with leaves and flowers and/or fruits) of species that were not readily identifiable in the field were collected, inserted between sheets of old newspapers, placed in large plastic bags, and preserved with denatured alcohol. These were subsequently processed as herbarium material for proper identification in the laboratory later.

Photo-documentation of the sampling conducted is presented as **Annex 2.1.5**.

Data Analysis

The data was analyzed using the following formula:

$$\text{Density} = \frac{\text{Number of Individuals of a Species}}{\text{Area of the Plot}}$$

$$\text{Dominance} = \frac{\text{Basal Area of a Species}}{\text{Area of the Plot}}$$

$$\text{Frequency} = \frac{\text{Number of Quadrats where a species occurs}}{\text{Total Number of Quadrats}}$$

$$\text{Relative Density (RDe)} = \frac{\text{Density of a Species}}{\text{Total Density of all Species}} \times 100$$

$$\text{Relative Dominance (RDo)} = \frac{\text{Dominance of a Species}}{\text{Total Dominance of all Species}} \times 100$$

$$\text{Relative Frequency (RF)} = \frac{\text{Frequency of a Species}}{\text{Total Frequency of all Species}} \times 100$$

$$\text{Importance Value (IV)} = \text{RDe} + \text{RDo} + \text{RF}$$

Shannon-Weiner Index (H') = $-\Sigma p_i \ln p_i$

Where: pi = proportion of individuals; ln = natural logarithm

Table 2.1.17 will be used to qualitatively express the level of biodiversity in the area based on diversity index, **H'.**

Table 2.1.17. Biodiversity scale as used by Fernando (1998)

Relative Values	Shannon-Weiner Index (H')
Very High	3.5–4.0
High	3.0–3.49
Moderate	2.5–2.99
Low	2.0–2.49
Very Low	1.0–1.99

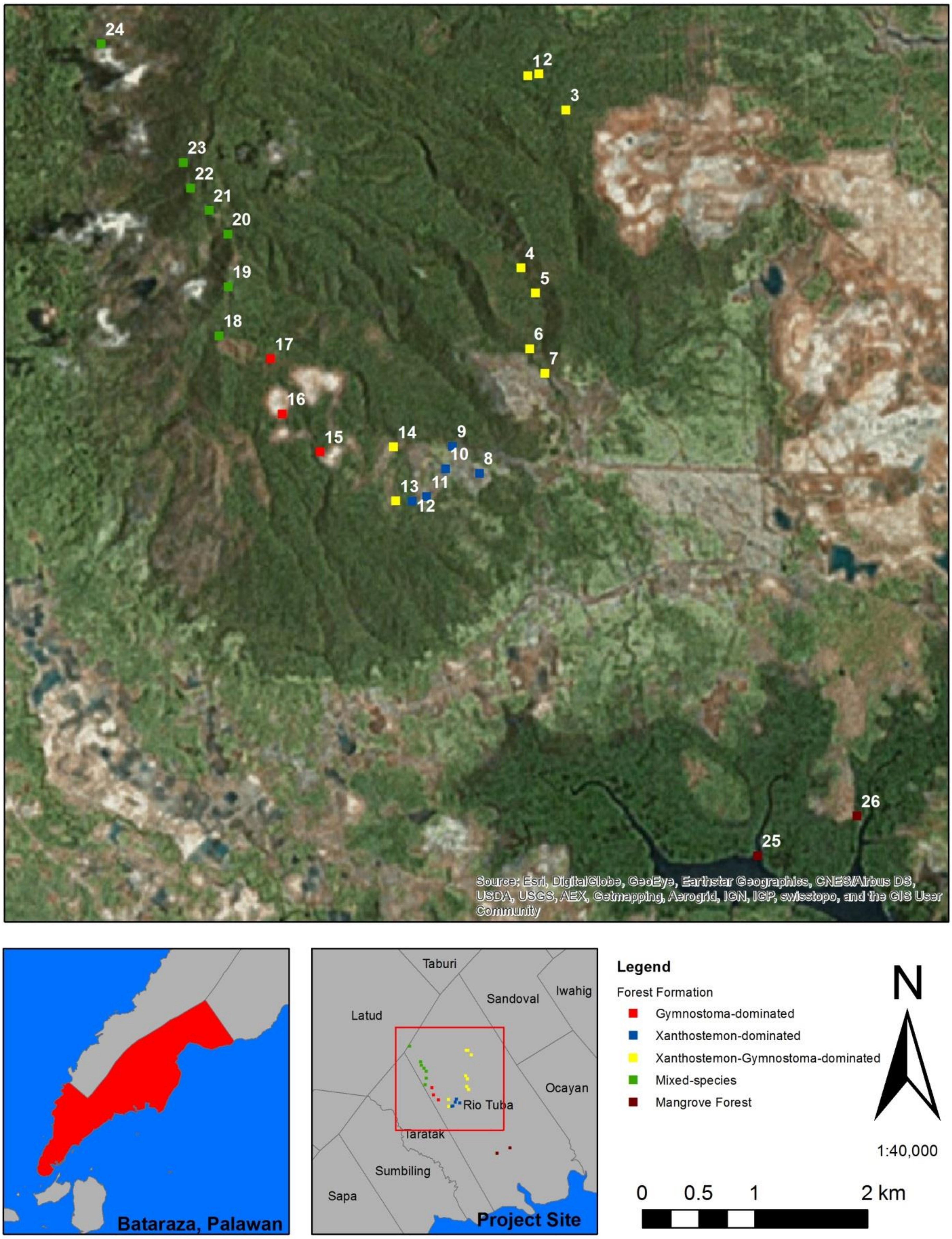


Figure 2.1.18. An overview of the sampling plots within the proposed site on Mt. Bulanjao and along the Rio Tuba River, Bataraza, Palawan.

2.1.4.2 Baseline Conditions

General Description and Species Composition of the Site

A complete list of species for the inventoried project site is provided in **Table 2.1.18**. There were a total of 147 species of vascular plants belonging to 67 families recorded in the project site. The species richness of the project site constitutes about 4.20% of the estimated flowering plants (roughly 3,000–3,500) found in Palawan (Madulid 2002). The checklist provided in **Table 2.1.18** also includes several species that were recorded outside of the sampling plots. In the list, the most speciose of all genera is *Syzygium* represented by nine species followed by *Elaeocarpus* and *Ardisia* with five species each. Most of the species are classified under family Myrtaceae (13), Rubiaceae (12) Lauraceae (8) Euphorbiaceae (7) and Primulaceae (6). The number of species recorded is quite many which suggest that the project site is highly diverse and home to many unique plant species.

Table 2.1.18. Checklist of the vascular plants on Mt. Bulanjao and along the Rio Tuba River, Bataraza, Palawan

Family	Scientific Name	Common Name	Notes
Pteridaceae	*Adiantum cupreum* Copel.	*coppery maidenhair fern*	Terrestrial fern. Philippines (Palawan, Sibuyan).
	Adiantum sp.		Terrestrial fern.
Meliaceae	*Aglaia angustifolia* Miq.	*kaníuing-kitíd*	Tree. Philippines (Palawan, Samar, Mindanao), Borneo, Sumatra
	Aglaia sp.		
Fabaceae	*Albizia* sp.		
Zingiberaceae	*Alpinia foxworthyi* Ridley		Herb. Endemic to Palawan.
Apocynaceae	*Alstonia iwahigensis* Elmer	*palawan ditá*	Tree. Philippines (Palawan), Borneo
	Alstonia macrophylla Wall. ex G.Don	*batíno*	Tree. Philippines (Luzon, Palawan), Borneo
Chrysobalanaceae	*Angelesia palawanensis* (Prance) Sothers & Prance		Small tree. Endemic to Palawan.
	Angelesia splendens Korth.	*amáyan*	Tree. Philippines (Palawan, Panay, Samar, Mindanao), SE Asia
Phyllanthaceae	*Antidesma ghaesembilla* Gaertn.	*binayúyu*	Tree. Widespread species. India, SE Asia including Philippines, New Guinea, and NE Australia
Rubiaceae	*Antirrhea caudata* (M.E.Jansen) Chaw		Shrub-small tree. Endemic to Palawan
Fabaceae	*Archidendron clypearia* (Jack) Nielsen var. *clypearia*	*tiágkot*	Tree. Philippines (Palawan, Luzon, Negros, Panay), Borneo, Sumatra, Malay Peninsula, Java.
Primulaceae	*Ardisia romanii* Elmer	*Roman tágpo*	Small tree. Endemic to Palawan
	Ardisia sp. 1		
	Ardisia sp. 2		
	Ardisia sp. 3		
	Ardisia sp. 4		
Phyllanthaceae	*Baccaurea lanceolata* (Miq.) Muell.-Arg.	*limpáhung*	Medium tree. Philippines (Palawan), Borneo, Java, Malay Peninsula, Thailand
	Baccaurea odoratissima Elmer	*dílak-bangúhan*	Small tree. Medium tree. Philippines (Palawan), Borneo
	Baccaurea sp.		
Ochnaceae	*Brackenridgea fascicularis* (Blanco) Fern.-Villar	*bítas*	Small tree. Philippines (Palawan, Luzon, Sibuyan, Mindanao)
Rhizophoraceae	*Bruguiera gymnorhiza* (L.) Lam.	*busaín*	Small-medium sized mangrove tree
	Bruguiera sexangula (Lour.) Poir.	*potótan laláki*	Small-medium sized mangrove tree
Anacardiaceae	*Buchanania microphylla* Engl.	*palínlin*	Tree. Hainan and Philippines (Luzon, Palawan, Panay, Guimaras, Cebu).
Arecaceae	*Calamus microsphaerion*	*kulakling*	Rattan. Philippines (Palawan),

Family	Scientific Name	Common Name	Notes
	Becc.		Borneo
	Calamus filispadix Becc.	*pangan-panganan*	Rattan. Philippines (Luzon, Polillo, Catanduanes, Samar, Palawan, Mindanao)
Acanthaceae	*Calophanoides* sp.		
Calophyllaceae	*Calophyllum blancoi* Planch. & Triana	*bitánghol*	
	Calophyllum pentapetalum (Blanco) Merr.	*pamitóyen*	Small tree.
Rubiaceae	*Canthium* sp.		
Capparidaceae	*Capparis* sp.		
Rhizophoraceae	*Carallia borneensis* Oliver	*magtúngod*	Tree. Philippines (Palawan, Mindanao), Borneo, New Guinea
	Ceriops tagal (Perr.) C.B.Rob.	*tangál*	Small-medium sized mangrove tree
Oleaceae	*Chionanthus coriaceus* (Vidal) Yuen P. Yang & S.Y.Lu	*pulát*	
Lauraceae	*Cinnamomum* sp.		
Euphorbiaceae	*Cleistanthus* sp.		
Commelinaceae	*Commelina benghalensis* L.	*alikbangon*	Herb.
Cyatheaceae	*Cyathea* sp.	*tree fern*	
Myrtaceae	*Decaspermum parviflorum* (Lam.) Scott		
	Decaspermum philippinum A.J.Scott		Small tree. Endemic to Palawan.
Lauraceae	*Dehaasia* sp.		
Dichapetalaceae	*Dichapetalum* sp.		
Saxifragaceae	*Dichroa* sp.		
Gleicheniaceae	*Dicranopteris linearis* (Burm.) Underw.	*agsam*	Terrestrial fern.
Dilleniaceae	*Dillenia luzoniensis* (Vidal) Martelli ex Durand & Jackson	*malakátmon*	Scandent shrub-small tree. Endemic to Philippines.
Euphorbiaceae	*Dimorphocalyx* sp.		
Poaceae	*Dinochloa* sp.	*bikal*	
Ebenaceae	*Diospyros* sp. 1		
	Diospyros sp. 2		
Primulaceae	*Discocalyx sp.*		
Puntranjivaceae	*Drypetes sp.*		
Elaeocarpaceae	*Elaeocarpus cuernosensis* Elmer	*nangkáon bundók*	
	Elaeocarpus sp. 1		
	Elaeocarpus sp. 2		
	Elaeocarpus sp. 3		
	Elaeocarpus sp. 4		
Pentaphylacaceae	*Eurya* sp.		
Simaroubaceae	*Eurycoma longifolia* Jack	*linátog*	Shrub-small tree.
Flagellariaceae	*Flagellaria indica* L.	*baling-uái*	Vine. Africa, tropical Asia, to Australia, Marianas Islands
Moraceae	*Ficus bataanensis* Merr.	*Bataan fig*	Small-medium tree.
	Ficus glareosa Elmer		Shrub-small tree. Endemic to Palawan.
Pandanaceae	*Freycinetia* sp.		
Clusiaceae	*Garcinia lateriflora* Blume	*kandis*	
Rubiaceae	*Gardenia merrillii* Elmer	*bagáoi*	Shrub-small tree. Endemic to Philippines (Palawan, Luzon, Romblon, Panay, Negros, Leyte, Mindanao)
	Glycosmis sp.		
Stemonuraceae	*Gomphandra bracteata* Schori		Small tree. Endemic to Palawan.
Thymelaeaceae	*Gonystylus* sp.		
Sapindaceae	*Guioa koelreuteria* (Blanco) Merr.	*aláhan*	Small tree.
Casuarinaceae	*Gymnostoma nobile* (Whitmore) L.A.S.Johnson	*Palawan agohó*	Medium –large tree. Philippines (Palawan, Borneo).

Family	Scientific Name	Common Name	Notes
Simaroubaceae	*Harrisonia brownii* A.Juss.	*kankasira*	Scandent shrub.
Malvaceae	*Heritiera sylvatica* Vidal	*dungón*	Medium –large tree.
	Heritiera littoralis Ait.	*dungón-láte*	Small-medium sized mangrove tree
Apocynaceae	*Kibatalia* sp.		Small-medium tree.
Celastraceae	*Kokoona ochracea* (Elmer) Merr.	*repetek, layéng*	Medium tree. Philippines (Palawan), Borneo.
Urticaceae	*Leucosyke capitellata* (Poir.) Wedd.	*alagási*	Small-medium tree.
Lindsaeaceae	*Lindsaea* sp.		Terrestrial fern.
Fagaceae	*Lithocarpus* sp.		Medium –large tree.
Lauraceae	*Litsea* sp. 1		
	Litsea sp. 2		
	Litsea sp. 3		
Combretaceae	*Lumnitzera littorea* (Jack) Voigt	*tábau*	Small-medium sized mangrove tree
Cyperaceae	*Machaerina disticha* (C.B. Clarke) T.Koyama	*tikog, barokibok*	Herb. Philippines (Luzon, Mindoro, Palawan, Mindanao. Also in Boneo, Sulawesi, Waigeo Is.
Sapotaceae	*Madhuca* sp.		
Magnoliaceae	*Magnolia liliifera* Baill.	*patangis*	Small tree.
Melastomataceae	*Medinilla* sp.	*medinilla*	
Memecylaceae	*Memecylon* sp.		
Rubiaceae	*Mussaenda grandifolia* Elmer	*Palawan mussaenda*	Shrub. Endemic to Palawan.
Myristicaceae	*Myristica* sp.		
Lauraceae	*Neolitsea* sp. 1		
	Neolitsea sp. 2		
	Neolitsea sp. 3		
Euphorbiaceae	*Neoprevia* sp.		
Nepenthaceae	*Nepenthes philippinensis* Macfarl.	*Palawan pitcher plant*	Scandent herb. Endemic to Palawan.
Arecaceae	*Nypa fruticans* Wurmb	*nípa*	Mangrove palm.
Sapotaceae	*Palaquium obovatum* (Griff.) Engl.	*lahás*	Medium-large tree.
	Palaquium sp.		
Pandanaceae	*Pandanus* sp.	*pandan*	
Annonaceae	*Papualthia* sp.		
Phyllanthaceae	*Phyllanthus balgooyi* Petra Hoffm. & A.J.M.Baker	*manglás*	Shrub-small tree. Philippines (Palawan), Borneo
Arecaceae	*Pinanga curranii* Becc.	*Curran abíki*	Small tree palm. Endemic to Palawan.
Pittosporaceae	*Pittosporum ferrugineum* Aiton	*mamális-pulá*	Small tree.
Arecaceae	*Plectocomia elongata* Mart. ex Blume var. *philippinensis* Madulid	*laánan*	Rattan. Samar, Leyte, Mindanao, Palawan
Podocarpaceae	*Podocarpus palawanensis* de Laub. & Silba	*Palawan malakauáyan*	Small-medium tree. Endemic to Palawan.
Araliaceae	*Polyscias aherniana* (Merr.) Lowry & G.M.Plunkett	*doklói*	Small-medium tree. Philippines, Borneo, Moluccas.
Lamiaceae	*Premna depauperata* Merr.		Small-medium tree. Endemic to Palawan.
Burseraceae	*Protium connarifolium* (Perkins) Merr.	*marángub*	Small tree. Endemic to Palawan.
Rosaceae	*Prunus sp.*		
Rubiaceae	*Psychotria* sp. 1		
	Psychotria sp. 2		
	Psychotria sp. 3		
Malvaceae	*Pterospermum elongatum* Korth.	*rayók*	
Rhizophoraceae	*Rhizophora apiculata* Blume	*bakáuan laláki*	Small-medium sized mangrove tree
	Rhizophora mucronata Lam.	*bakáuan babáe*	Small-medium sized mangrove tree
Violaceae	*Rinorea bengalensis* (Wall.) Kuntze	*tuák*	Medium-large tree. India to Caroline Islands.
Meliaceae	*Sandoricum koetjape* (Burm.f.) Merr.	*malasántol*	

Family	Scientific Name	Common Name	Notes
Goodeniaceae	*Scaevola micrantha* C.Presl		Shrub.
Cyperaceae	*Scleria scrobiculata* Nees & Meyen	*ararat*	Herb
Salicaceae	*Scolopia* sp.		
Rubiaceae	*Scyphiphora hydrophyllacea* Gaertn.f.	*nílad*	Mangrove tree. India to New Caledonia.
Selaginellaceae	*Selaginella plana* (Desv. ex Poir.) Hieron.	*kamariang gubat*	
Anacardiaceae	*Semecarpus cuneiformis* Blanco	*ligás*	Small tree
	Swintonia acuta Engl.	*lomárau*	Medium tree
Myrtaceae	*Syzygium merrillii* (C.B.Rob.) Merr.	*Merrill malarúhat*	Small tree. Endemic to the Philippines (Palawan, Sibuyan)
	Syzygium striatulum (C.B.Rob.) Merr.	*malarúhat-sápa*	
	Syzygium subfoetidum (C.B.Rob.) Merr.	*bíntang*	
	Syzygium sp. 1		
	Syzygium sp. 2		
	Syzygium sp. 3		
	Syzygium sp. 4		
	Syzygium sp. 5		
	Syzygium sp. 6		
Apocynaceae	*Tabernaemontana* sp.	*pandakáki*	
Tectariaceae	*Tectaria* sp.		Terrestrial fern
Combretaceae	*Terminalia* sp.		Medium-large tree
Malvaceae	*Thespesia populnea* (L.) Soland.	*banálo*	Mangrove associate species
Rubiaceae	*Timonius* sp. 1		
	Timonius sp.2		
	Timonius sp.3		
Euphorbiaceae	*Trigonostemon sp.*		
Myrtaceae	*Tristaniopsis oblongifolia* (Merr.) Peter G. Wilson & Waterhouse	*tígang-habá*	Medium-large tree. Endemic to the Philippines (Palawan, Luzon)
Cunoniaceae	*Weinmannia* sp.		
Thymelaeaceae	*Wikstroemia indica* (L.) C.A.Mey	*salágong-liítan*	Shrub. India, SE Asia (including Philippines), Malesia to Australia and Melanesia
Apocynaceae	*Wrightia palawanensis* D.J.Middleton	*Palawan lanéte*	Small-medium tree. Endemic to Palawan.
Myrtaceae	*Xanthostemon speciosus* Merr.	*Palawan mangkono*	Medium-large tree. Endemic to Palawan.
Meliaceae	*Xylocarpus granatum* Koen.	*tabígi*	Small-medium sized mangrove tree
		unidentified sp.1	
		unidentified sp.2	
		unidentified sp.3	
		unidentified sp.4	
		unidentified sp.5	

Two forest formations were observed in the project site. These are **forest over ultramafic rocks** or serpentine soils found on Mt. Bulanjao, Bataraza and **mangrove forest** along the Rio Tuba River. On Mt. Bulanjao, the species observed suggest that the vegetation is a forest over ultramafic rocks. Palawan mangkono (*Xanthostemon speciosus*) (**Plate 2.1.4**) and Palawan agohó (*Gymnostoma nobile*) (**Plate 2.1.5**) were the dominant species. Distinct communities dominated by these two (2) species were observed especially on lower elevation between 124-620 m elevations. Other tree species observed associated with Palawan mangkono and Palawan agoho were Bitanghol (*Calophyllum blancoi*), pamitoyen (*Calophyllum pentapetalum*), Limpahung (*Baccaurea lanceolata*), and *Dichapetalum* sp.

Below the canopy of these species, small trees of Malakátmon (*Dillenia luzoniensis*), Marángub (*Protium connarifolium*) and *Angelesia palawanensis* were thriving.

Plate 2.1.4. *Xanthostemon speciosus* in Plot 13 with stem diameter of 71 cm. This species is listed as Endangered (EN) by the DENR

Plate 2.1.5. *Gymnostoma nobile* near Plot 11 at 230 m elevation

Along the Rio Tuba River, on the other hand, long strips of mangrove forest occur on both sides of the river. Only few true mangrove species were recorded such as Bakauan lalaki (*Rhizophora apiculata*), Bakáuan babae (*Rhizophora mucronata*), Nilad (*Scyphiphora hydrophyllacea*) and Tabigi (*Xylocarpus granatum*) inside the sampling plots. However, other mangrove species were observed while traversing the river. These include Tangal (*Ceriops tagal*), Busain (*Bruguiera gymnorhiza*), Pototan lalaki (*Bruguiera sexangula*) and Tabau (*Lumnitzera littorea*). Several mangrove associates were also seen such as Banálo (*Thespesia populnea*), Dungon-late (*Heritiera littoralis*), and Nipa (*Nypa fruticans*). Large areas of mangrove forest still occur in Brgy. Rio Tuba, Bataraza which is approximately 893.31 hectares (NAMRIA, 2010).

Structure, Relative Values, and Importance Values of the different Forest Formations
Forest over ultramafic rocks

The forests over ultramafic rocks are distinguished by the presence of reddish-brown serpentine soil that is clayish in texture (Fernando *et al.* 2008). The serpentine soils have high concentration of heavy metals such as nickel (Ni), chromium (Cr), magnesium (Mg), and iron (Fe) (Proctor 2003). On Mt. Bulanjao, four (4) distinct communities of forest over ultramafic rocks were identified. These communities are *Gymnostoma-Xanthostemon*-dominated (**Plate 2.1.6**), *Xanthostemon*-dominated (**Plate 2.1.7**), *Gymnostoma*-dominated, and Mixed-species communities. Each community is unique from one another due to their dominant species. The dominant species of each community is named after the community.

***Xanthostemon*-dominated community**

The *Xanthostemon*-dominated community is represented by a total of five (5) sampling plots between 145–275 m elevation. Canopy and intermediate strata (**Tables 2.1.19** and **2.1.20**). This species had and average dbh of 12 cm and average height of 8.8 m in the canopy stratum. Its basal area is quite large with a value of 1.58 m^2 per hectare when compared with other species present in this community. This might be attributed due to its abundance and relatively large dbh. This species had a total IV of 76.76 which comprised about almost 26% of the total.

Plate 2.1.6. Portion of the *Xanthostemon-Gymnostoma* dominated community in Plot 3 at 297 m elevation.

Plate 2.1.7. Portion of the *Xanthostemon*-dominated community in Plot 8 at 175 m elevation

Table 2.1.19. Density, average dbh and TH, basal area and Importance Value of the species found in canopy stratum of *Xanthostemon*-dominated community on Mt. Bulanjao, Bataraza

Species	Density (per ha)	Average dbh (cm)	Average Ht (m)	Basal Area (m^2 per ha)	Importance Value
Xanthostemon speciosus	130	12.0	8.8	1.58	76.76
Protium connarifolium	50	13.7	6.8	0.78	34.32
Elaeocarpus sp. 1	40	15.5	9.5	0.80	32.10
Calophyllum pentapetalum	30	11.3	7.7	0.31	25.79
Brackenridgea fascicularis	40	11.4	7.8	0.41	25.71
Buchanania microphylla	10	25.0	10.0	0.49	15.02
Angelesia palawanensis	10	23.0	7.0	0.42	13.77
Antidesma ghaesembilla	10	22.0	10.0	0.38	13.19
Ardisia sp. 4	10	16.0	12.0	0.20	10.23
Timonius sp. 1	10	16.0	7.0	0.20	10.23
Calophyllum blancoi	10	14.0	7.0	0.15	9.45
Swintonia acuta	10	12.0	9.0	0.11	8.78
Alstonia iwahigensis	10	10.0	8.0	0.08	8.21
Alstonia macrophylla	10	10.0	9.0	0.08	8.21
Dillenia luzoniensis	10	10.0	5.0	0.08	8.21
TOTAL	390	-	-	6.06	300.00

Marangub (*Protium connarifolium*) (**Plate 2.1.7**) ranks second to Palawan mangkono in terms of IV with a value of 34.32, followed by *Elaeocarpus* sp. *1* with an IV of 32.10. Marangub had an average dbh of 13.7 cm and an average height of 6.8 while *Elaeocarpus sp.* 1 had an average dbh of 15.5 cm and average height of 9.5m. Although these two (2) species have larger dbh than Palawan mangkono, their IV is still quite far from the IV of Palawan mangkono which further gives emphasis to the dominance of the latter.

In the intermediate stratum, Palawan mangkono had the highest IV with a value of 52.37 (**Table 2.1.20**). This is followed by *Timonius* sp. *1* with an IV of 43.81 and *Dillenia luzoniensis* (Plate 5A) with an IV of 33.36. Both *Timonius* sp. 1 and *Dillenia luzoniensis* have 720 individuals per ha. These two (2) species are relatively abundant in this community in the intermediate vegetation. Together with Palawan mangkóno, these three (3) species comprised about 43.18% of the total IV. Other ecologically important species in this community are *Protium connarifolium* and *Calophyllum blancoi*. The estimated density of the intermediate vegetation is 4,960 individuals per hectare.

Plate 2.1.8. *Protium connarifolium,* one of two (2) common species in the intermediate vegetation on Mt. Bulanjao. This species is endemic to Palawan.

Table 2.1 20. Density, average dbh and TH, basal area and Importance Value of the species found in intermediate stratum of *Xanthostemon*-dominated community on Mt. Bulanjao, Bataraza

Species	Density (per ha)	Average dbh (cm)	Average Ht (m)	Basal Area (m^2 per ha)	Importance Value
Xanthostemon speciosus	1,040	5.1	5.6	2.35	52.37
Timonius sp. 1	720	5.9	5.7	2.09	43.81
Dillenia luzoniensis	720	5.0	4.5	1.57	33.36
Protium connarifolium	480	4.4	4.7	0.79	28.56
Calophyllum blancoi	400	5.2	5.6	0.89	21.49
Calophyllum pentapetalum	160	9.0	7.3	1.02	17.66
Kokoona ochracea	160	8.0	4.0	0.82	12.92
Alstonia iwahigensis	80	9.0	4.0	0.51	8.83
Angelesia palawanensis	80	9.0	7.0	0.51	8.83
Psychotria sp. 3	80	9.0	9.0	0.51	8.83
Polyscias aherniana	160	4.0	5.0	0.21	8.07
Drypetes sp.	160	4.0	5.5	0.21	8.07
Neolitsea sp. 1	160	4.0	5.0	0.21	8.07
Buchanania microphylla	80	5.0	6.0	0.16	6.00
Archidendron clypearia var. *clypearia*	80	4.5	5.0	0.13	5.76
Ardisia sp. 3	80	4.0	5.0	0.10	5.55
Ficus bataanensis	80	4.0	4.0	0.10	5.55
Glycosmis sp.	80	4.0	5.0	0.10	5.55
Kibatalia sp.	80	4.0	2.5	0.10	5.55
Gardenia merrillii	80	3.0	4.0	0.06	5.19
TOTAL	4,960	-	-	12.44	300.00

Like in the canopy and intermediate stratum, *Palawan mangkono* had the highest IV with a value of 25.58 in the undergrowth stratum (**Table 2.1.21**). This species is not the most abundant in this community. The estimated density of this species is only 320 individual per 100 m^2. The most abundant species in this stratum is Manglás (*Phyllanthus balgooyi*) with

680 individuals per 100 m^2, followed by *Adiantum* sp. with 560 individuals per 100 m^2 and *Protium connarifolium* with 520 individuals per 100 m^2. Palawan mangkono slightly edged these three species in terms of IV because this species is well distributed in the area, unlike the other three species which are abundant only in localized and/or certain area. For instance, *Phyllanthus balgooyi* is present only in Plot 9, *Adiantum* sp. is found only in Plots 11–12 and *Protium connarifolium* in Plots 10–11. The over-all dominance of Palawan mangkono in this community is attributed mainly due to their abundance, frequent occurrence and larger dbh. This species is also well distributed in the area, even in all the strata.

***Gymnostoma*-dominated community.**

The *Gymnostoma*-dominated is represented by a total of three (3) sampling plots between 483–620 m elevation. The dominant species of this community is Palawan agoho (*Gymnostoma nobile*). This species is abundant, well represented and distributed in this community as well as in the ecosystem strata. In the canopy stratum, the IV of *Palawan agoho* is 93.46 which comprised almost 1/3 of the total IV (**Table 2.1.22**). Palawan agoho had a density of 217 individuals per hectare with an average dbh of 19.5 cm and average height of 13.8 m. Its corresponding basal area is 7.18 m^2. The dominance of Palawan agoho in this community is attributed mainly due to their abundance, frequent occurrence and larger dbh.

Table 2.1.21. Density and Importance Value of the species found in undergrowth stratum of *Xanthostemon*-dominated community on Mt. Bulanjao, Bataraza.

Species	Density (per 100m^2)	Importance Value
Xanthostemon speciosus	320	25.58
Adiantum sp.	560	24.77
Phyllanthus balgooyi	680	24.36
Dinochloa sp.	400	23.98
Protium connarifolium	520	23.57
Machaerina disticha	220	14.59
Dillenia luzoniensis	220	14.59
Alpinia foxworthyi	160	12.79
Scleria scrobiculata	100	6.99
Brackenridgea fascicularis	60	5.80
Calophyllum pentapetalum	20	4.60
Carallia borneensis	20	4.60
Gardenia merrillii	20	4.60
Neolitsea sp. 1	20	4.60
Scolopia sp.	20	4.60
TOTAL	3,340	200.00

Table 2.1.22. Density, average dbh and TH, basal area and importance value of the species found in canopy stratum of *Gymnostoma*-dominated community on Mt. Bulanjao, Bataraza

Species	Density (per ha)	Average dbh (cm)	Average Ht (m)	Basal Area (m^2 per ha)	Importance Value
Gymnostoma nobile	217	19.5	13.8	7.18	93.46
Baccaurea lanceolata	117	17.4	12.9	3.32	45.11
Dichapetalum sp.	133	14.2	10.0	2.28	37.11
Palaquium obovatum	100	17.5	11.5	2.62	36.48
Elaeocarpus sp. 1	67	15.0	9.8	1.30	20.11
unidentified sp. 4	17	31.0	20.0	1.26	13.92
Kokoona ochracea	50	14.2	9.3	0.81	13.45
Prunus sp.	33	11.5	8.5	0.35	7.15
Syzygium sp. 1	17	19.5	7.0	0.50	6.67
Calophyllum blancoi	17	16.0	10.0	0.34	5.12

Species	Density (per ha)	Average dbh (cm)	Average Ht (m)	Basal Area (m^2 per ha)	Importance Value
Dimorphocalyx sp.	17	13.5	9.0	0.24	4.20
Elaeocarpus sp. 2	17	12.0	8.0	0.19	3.72
Swintonia acuta	17	12.0	8.0	0.19	3.72
Guioa koelreuteria	17	11.0	10.0	0.16	3.43
Alstonia iwahigensis	17	10.0	9.0	0.13	3.17
Gomphandra bracteata	17	10.0	7.0	0.13	3.17
TOTAL	867	-	-	20.97	300.00

Baccaurea lanceolata ranks second to Palawan agoho in terms of IV with a value of 45.11. This species is followed by *Dichapetalum* sp. and *Palaquium obovatum* with IV of 37.11 and 36.48, respectively. These three (3) species are the only species in the canopy stratum with more than 30 IV and density of above 100 individuals per ha. The estimated density of the trees in the canopy stratum is 867 individuals per hectare.

Poles and saplings in the intermediate stratum are quite dense. The estimated density is 4667 individuals per ha (**Table 2.1.23**) with Palawan agohó (*Gymnostoma nobile*) and *Gomphandra bracteata* as the dominant species. Palawan agohó had an IV of 46.38 while *Gomphandra bracteata* had an IV of 41.82. *Gomphandra bracteata* is the most abundant species in the community with 933 individuals per ha. Other species abundant are *Dichapetalum* sp., Binayuyu (*Antidesma ghaesembilla*) and *Palaquium obovatum*. *Palawan agoho* had the highest IV because this species is present in all sampling plots, aside from having larger dbh than the other species.

Table2.1. 23. Density, average dbh and TH, basal area and importance value of the species found in intermediate stratum of *Gymnostoma*-dominated community on Mt. Bulanjao, Bataraza

Species	Density (per ha)	Average dbh (cm)	Average Ht (m)	Basal Area (m^2 per ha)	Importance Value
Gymnostoma nobile	533	7.6	8.0	2.47	46.38
Gomphandra bracteata	933	5.3	5.4	2.12	41.82
Dichapetalum sp.	667	5.0	5.2	1.35	34.96
Antidesma ghaesembilla	400	5.7	5.0	1.06	22.00
Palaquium obovatum	400	4.4	6.7	0.68	18.90
Angelesia splendens	267	6.5	5.0	0.89	17.85
Palaquium sp.	133	9.0	5.0	0.85	14.73
Memecylon sp.	267	3.8	6.0	0.30	12.98
Polyscias aherniana	133	7.5	7.0	0.59	12.61
Alstonia iwahigensis	133	6.0	6.0	0.38	10.87
Timonius sp. 1		6.0	5.0		10.87
Gonystylus sp.	133	5.4	6.0	0.31	10.28
Calophyllum blancoi	133	4.8	7.0	0.24	9.76
Eurycoma longifolia	133	4.0	3.0	0.17	9.15
Kokoona ochracea	133	4.0	4.0	0.17	9.15
Syzygium sp. 1	133	4.0	5.0	0.17	9.15
Baccaurea lanceolata	133	3.0	7.0	0.09	8.55
TOTAL	4667	-	-	11.82	300.00

In the undergrowth layer, there is greater abundance of terrestrial pteridophytes and herbs in this community. For instance, *Lindsaea* sp. dominates this stratum with an IV of 46.90 (**Table 2.1.24**). Another dominant species is Bikal (*Dinochloa* sp.) with a value of 19.87 IV. *Lindsaea sp.* had a density of 433 individuals per 100 m^2 while *bikal* had a density of 100 individuals per 100 m^2. Kulakling (*Calamus microsphaerion*) is also present in this stratum. Only few seedlings of tree species were observed for *Palaquium obovatum*, Linatog (*Eurycoma longifolia*) and Palawan agohó (*Gymnostoma nobile*). This may be attributed to the presence of dense pteridophytes and herbs, as well as, thick forest litter.

Table 2.1.24. Density and Importance Value of the species found in undergrowth stratum of *Gymnostoma*-dominated community on Mt. Bulanjao, Bataraza

Species	Density (per 100m^2)	Importance Value
Lindsaea sp.	433	46.90
Dinochloa sp.	100	19.87
Palaquium obovatum	100	19.87
Eurycoma longifolia	167	19.40
Gymnostoma nobile	67	17.17
Commelina benghalensis	100	13.99
Calamus microsphaerion	67	11.29
Archidendron clypearia var. *clypearia*	33	8.59
Cinnamomum sp.	33	8.59
Memecylon sp.	33	8.59
Neolitsea sp. 1	33	8.59
Sandoricum koetjape	33	8.59
Swintonia acuta	33	8.59
TOTAL	1,200	200.00

Gymnostoma-Xanthostemon-dominated community.

The *Gymnostoma-Xanthostemon*-dominated community (**Annex 2.1.5**) is represented by a total of nine sampling plots between 124-370 m elevation. This community is the transition zone between the *Gymnostoma* and *Xanthostemon* communities. The dominant species of this community are Palawan agohó and Palawan mangkono. Palawan agohó is the most abundant species in the canopy stratum having a density of 172 individuals per hectare with an average dbh of 16.8 cm and average total height of 13.2 m (**Table 2.1.25**). Its corresponding basal area is 4.16 m^2 per hectare. This species had the highest total importance value of 55.05.

Table 2.1.25. Density, average dbh and TH, basal area and Importance Value of the species found in canopy stratum of *Gymnostoma-Xanthostemon*-dominated community on Mt. Bulanjao, Bataraza

Species	Density (per ha)	Average dbh (cm)	Average Ht (m)	Basal Area (m^2 per ha)	Importance Value
Gymnostoma nobile	172	16.8	13.2	4.16	55.05
Xanthostemon speciosus	44	20.4	11.5	2.77	25.39
Angelesia palawanensis	61	16.2	10.5	1.36	17.84
Elaeocarpus sp. 1	28	15.0	9.2	0.63	10.96
Semecarpus cuneiformis	17	24.7	16.7	1.04	10.20
Gonystylus sp.	22	14.8	9.0	0.42	9.15
Dillenia luzoniensis	33	10.8	6.8	0.30	8.72
Elaeocarpus sp. 4	11	28.5	19.8	0.87	8.57
Calophyllum blancoi	17	22.0	14.7	0.67	8.31
Timonius sp. 1	28	12.8	8.4	0.36	8.27
Syzygium striatulum	17	18.0	9.7	0.52	7.57
Memecylon sp.	22	12.9	10.0	0.32	7.28
Aglaia angustifolia	6	46.0	22.0	0.92	6.76
Diospyros sp. 1	11	19.3	10.0	0.38	6.07
unidentified sp. 2	6	37.0	23.0	0.60	5.11
Elaeocarpus sp. 3	17	14.3	15.3	0.30	5.10
Timonius sp. 2	11	12.5	8.0	0.14	4.86
Gomphandra bracteata	11	10.8	9.0	0.10	4.68
Trigonostemon sp.	17	11.0	10.0	0.16	4.40
Syzygium sp. 5	6	31.0	15.0	0.42	4.21
Syzygium striatulum	11	14.5	11.5	0.19	3.79
Syzygium sp. 2	6	27.0	17.0	0.32	3.70
Cinnamomum sp.	6	25.5	9.0	0.28	3.52
Dichroa sp.	11	12.0	12.0	0.13	3.49
Garcinia lateriflora	11	11.0	7.0	0.11	3.37
Ficus bataanensis	6	23.0	8.0	0.23	3.26

Species	Density (per ha)	Average dbh (cm)	Average Ht (m)	Basal Area (m^2 per ha)	Importance Value
Podocarpus palawanensis	6	20.5	9.0	0.18	3.01
Drypetes sp.	6	20.0	20.0	0.17	2.97
Tristaniopsis oblongifolia	6	19.0	12.0	0.16	2.88
Swintonia acuta	6	18.0	19.0	0.14	2.80
Alstonia macrophylla	6	16.0	11.0	0.11	2.65
Neoprevia sp.	6	15.0	7.0	0.10	2.58
Cleistanthus sp.	6	14.0	9.0	0.09	2.52
Terminalia sp.	6	14.0	9.0	0.09	2.52
unidentified sp.3	6	14.0	9.0	0.09	2.52
Syzygium sp. 3	6	13.5	11.0	0.08	2.49
Polyscias aherniana	6	13.0	8.0	0.07	2.46
Dehaasia sp.	6	13.0	8.0	0.07	2.46
Diospyros sp. 2	6	13.0	7.0	0.07	2.46
Syzygium sp. 1	6	13.0	9.0	0.07	2.46
unidentified sp.1	6	13.0	6.0	0.07	2.46
Timonius sp.3	6	12.0	12.0	0.06	2.40
Lithocarpus sp.	6	11.5	15.0	0.06	2.38
Brackenridgea fascicularis	6	11.0	1.5	0.05	2.35
Calophanoides sp.	6	11.0	12.0	0.05	2.35
Capparis sp.	6	11.0	6.0	0.05	2.35
Madhuca sp.	6	11.0	9.0	0.05	2.35
Ardisia sp. 4	6	10.0	9.0	0.04	2.31
Protium connarifolium	6	10.0	7.0	0.04	2.31
Psychotria sp. 1	6	10.0	9.0	0.04	2.31
TOTAL	739	-	-	19.73	300.00

Palawan mangkono ranks second to Palawan agohó in terms of IV in the canopy stratum with a value of 25.39. Only few large trees of Palawan mangkono were recorded in this community, however, many small-diametered trees were encountered in the intermediate stratum. This species is the most dominant in the intermediate stratum together with *Angelesia splendens*. Both species have more than 700 individuals per hectare (**Table 2.1.26**). The average dbh of these two species in the intermediate stratum are 4.6 cm and 4.8 cm, respectively. The estimated intermediate vegetation density is approximately 4,578 individuals per hectare. Of this density, about 15.29% comprised of Palawan mangkono.

Table 2.1.26. Density, average dbh and TH, basal area and Importance Value of the species found in intermediate stratum of *Gymnostoma-Xanthostemon*-dominated community on Mt. Bulanjao, Bataraza

Species	Density (per ha)	Average dbh (cm)	Average Ht (m)	Basal Area (m^2 per ha)	Importance Value
Xanthostemon speciosus	756	4.6	6.2	1.48	46.38
Angelesia splendens	711	4.8	6.0	1.38	43.57
Psychotria sp. 2	133	9.8	8.3	1.66	20.82
Timonius sp. 1	267	5.1	5.5	0.59	16.95
Magnolia liliifera	222	5.6	5.6	0.58	14.97
Calophyllum blancoi	267	3.2	3.9	0.33	14.65
Gardenia merrillii	267	3.7	4.5	0.29	14.31
Dillenia luzoniensis	222	3.7	4.2	0.25	11.96
Angelesia palawanensis	133	7.5	6.7	0.66	11.78
Brackenridgea fascicularis	89	8.5	4.5	0.72	10.37
Protium connarifolium	133	6.0	6.0	0.42	9.61
Polyscias aherniana	133	4.3	5.7	0.21	7.71
Calophyllum pentapetalum	89	6.0	10.0	0.27	6.30
Timonius sp.3	89	5.3	5.0	0.23	5.95
Papualthia sp.	44	9.0	8.0	0.28	4.50
Elaeocarpus sp. 4	89	3.0	4.5	0.06	4.45
Ardisia sp.2	89	1.5	2.0	0.02	4.03
unidentified sp.3	44	8.0	10.0	0.22	3.97

Species	Density (per ha)	Average dbh (cm)	Average Ht (m)	Basal Area (m^2 per ha)	Importance Value
Syzygium striatulum	44	7.0	10.0	0.17	3.49
Dehaasia sp.	44	6.5	6.0	0.15	3.28
Gymnostoma nobile	44	6.0	7.0	0.13	3.08
Memecylon sp.	44	6.0	6.0	0.13	3.08
Canthium sp.	44	5.5	6.0	0.11	2.90
Swintonia acuta	44	5.5	5.0	0.11	2.90
Neolitsea sp.3	44	5.0	6.0	0.09	2.73
Psychotria sp.1	44	5.0	5.0	0.09	2.73
Gomphandra bracteata	44	4.5	4.0	0.07	2.58
Syzygium sp.2	44	4.5	5.0	0.07	2.58
Calophanoides sp.	44	4.0	6.0	0.06	2.45
Syzygium sp.1	44	4.0	5.0	0.06	2.45
Diospyros sp.2	44	3.5	4.0	0.04	2.33
Ardisia sp.1	44	3.0	4.5	0.03	2.23
Carallia borneensis	44	3.0	4.0	0.03	2.23
Diospyros sp.1	44	3.0	5.0	0.03	2.23
Leucosyke capitellata	44	3.0	4.0	0.03	2.23
Phyllanthus balgooyi	44	3.0	1.5	0.03	2.23
TOTAL	4,578	-	-	11.04	300.00

In the undergrowth stratum, only few saplings and seedlings of Palawan agohó and Palawan mangkono were recorded. *Calophanoides* sp. and *Phyllanthus balgooyi* are the dominant species in this stratum with an IV of 20.81 and 20.22, correspondingly (**Table 2.1.27**). Both species have more than 300 individuals per 100 m^2. Other ecologically important species in this community are Malakatmon (*Dillenia luzoniensis*), *Calophyllum blancoi*, *Brackenridgea fascicularis* and *Protium connarifolium*.

Table 2.1.27. Density and Importance Value of the species found in undergrowth stratum of *Gymnostoma-Xanthostemon*-dominated community on Mt. Bulanjao, Bataraza

Species	Density (per 100m^2)	Importance Value
Calophanoides sp.	322	20.81
Phyllanthus balgooyi	311	20.22
Drypetes sp.	189	11.86
Calophyllum blancoi	100	11.03
Brackenridgea fascicularis	67	9.28
Tectaria sp.	89	8.52
Psychotria sp.1	44	8.11
Dinochloa sp.	78	7.94
Scleria scrobiculata	67	7.35
Papualthia sp.	44	6.19
Protium connarifolium	44	6.19
Xanthostemon speciosus	78	6.02
Eurycoma longifolia	33	5.60
Magnolia liliifera	22	5.02
Scolopia sp.	56	4.85
Machaerina disticha	44	4.26
Calamus microsphaerion	33	3.68
Kokoona ochracea	33	3.68
Litsea sp.3	22	3.09
Scaevola micrantha	22	3.09
Timonius sp.1	22	3.09
Albizia sp.	11	2.51
Alstonia macrophylla	11	2.51
Ardisia sp.1	11	2.51
Commelina benghalensis	11	2.51
Decaspermum parviflorum	11	2.51
Dillenia luzoniensis	11	2.51

Species	Density (per 100m²)	Importance Value
Gleichenia linearis	11	2.51
Guioa koelreuteria	11	2.51
Heritiera sylvatica	11	2.51
Angelesia splendens	11	2.51
Neolitsea sp.1	11	2.51
Nepenthes philippinensis	11	2.51
Swintonia acuta	11	2.51
Timonius sp.2	11	2.51
Wikstroemia indica	11	2.51
Wrightia palawanensis	11	2.51
TOTAL	**1,900**	**200.00**

Mixed-species community

Mixed-species community is represented by a total of seven sampling plots between 654–849 m elevation. This is unique from the other three communities because not a single but several species dominates in this community. This is also a forest over ultramafic rocks because plant indicators such as *Calophyllum pentapetalum*, *Pittosporum ferrugineum*, Palawan mangkono (*Xanthostemon speciosus*), *Antirrhea caudata*, *Scaevola micrantha*, among others occur in this community. The mentioned plant species are few of the typical residents of a forest over ultramafic rocks.

Kandis (*Garcinia lateriflora*) is the dominant species in this community. This species had the highest IV with a value of 30.54 in the canopy stratum. Kandis is a medium sized tree with an average dbh of 17.2 cm and average height of 9.7 m. The estimated density of Kandis is 64 individuals per hectare. *Palaquium obovatum* ranks second to Kandis in terms of IV. This species had an IV of 21.56, followed by *Dichapetalum* sp. with an IV of 21.12 and *Lithocarpus* sp. with an IV of 20.68. *Dichapetalum* sp. is the most abundant species in this community with 71 individuals per hectare. The combined IV of these four species is about 31.30% of the total. It is noticeable that the IV of the species in this community does not vary much. The IV gradually decreases from the most dominant species to the uncommon species.

Table 2.1.28. Density, average dbh and TH, basal area and importance value of the species found in canopy stratum of mixed-species community on Mt. Bulanjao, Bataraza

Species	Density (per ha)	Average dbh (cm)	Average Ht (m)	Basal Area (m^2 per ha)	Importance Value
Garcinia lateriflora	64	17.2	9.7	1.76	30.54
Palaquium obovatum	50	14.5	9.4	0.92	21.56
Dichapetalum sp.	71	12.5	9.3	0.93	21.12
Lithocarpus sp.	50	14.0	8.3	0.81	20.68
Scolopia sp.	57	12.5	9.4	0.72	17.38
Neolitsea sp. 1	29	22.2	12.3	1.19	15.58
Calophyllum pentapetalum	29	14.0	7.0	0.45	11.17
Cinnamomum sp.	21	11.1	6.7	0.21	9.98
Gomphandra bracteata	29	11.3	9.5	0.29	9.85
Pittosporum ferrugineum	21	18.2	9.3	0.58	9.53
Xanthostemon speciosus	21	13.3	7.3	0.30	9.01
Carallia borneensis	21	11.1	7.3	0.21	8.23
Weinmannia sp.	14	14.8	7.5	0.27	7.73
Discocalyx sp.	14	14.5	10.0	0.24	7.45
Litsea sp.3	21	13.0	9.3	0.29	7.13
Semecarpus cuneiformis	14	12.8	7.0	0.19	7.03
Canthium sp.	14	17.6	11.5	0.35	6.63
Syzygium merrillii	7	24.0	7.0	0.32	5.43
Decaspermum parviflorum	14	13.4	9.5	0.20	5.41

Species	Density (per ha)	Average dbh (cm)	Average Ht (m)	Basal Area (m^2 per ha)	Importance Value
Elaeocarpus sp.1	14	13.3	9.5	0.20	5.37
Pandanus sp.	14	11.3	4.0	0.14	4.93
Baccaurea odoratissima	14	10.5	8.0	0.12	4.76
Medinilla sp.	14	10.0	6.5	0.11	4.67
Podocarpus palawanensis	7	18.0	11.0	0.18	4.25
Palaquium sp.	7	15.5	10.0	0.13	3.86
Decaspermum philippinum	7	15.0	10.0	0.13	3.79
Prunus sp.	7	14.0	10.0	0.11	3.66
Dichroa sp.	7	13.0	5.0	0.09	3.53
Syzygium sp.6	7	12.5	8.0	0.09	3.47
Syzygium sp.4	7	12.0	9.0	0.08	3.42
Antirrhea caudata	7	11.5	8.0	0.07	3.36
Scaevola micrantha	7	10.9	4.0	0.07	3.30
Baccaurea sp.	7	10.5	5.0	0.06	3.26
Elaeocarpus cuernosensis	7	10.5	8.0	0.06	3.26
Neolitsea sp.2	7	10.5	7.0	0.06	3.26
Myristica sp.	7	10.0	8.0	0.06	3.21
unidentified sp.5	7	10.0	9.0	0.06	3.21
TOTAL	721	-	-	12.04	300.00

In the intermediate layer, Dokloi (*Polyscias aherniana*) and *Lithocarpus* sp. were the dominant species. The IVs of the two (2) species are 22.84 and 18.50, respectively (**Table 2.1.29**). Dokloi had a density of 457 individuals per hectare while *Lithocarpus* sp. had a density of 286 individuals per hectare. Similar with the canopy stratum, it is also noticeable that the IV of the species in this stratum does not vary much and is gradually decreasing from the most common species to the uncommon species.

Table 2.1.29. Density, average dbh and TH, basal area and importance value of the species found in intermediate stratum of mixed-species community on Mt. Bulanjao, Bataraza

Species	Density (per ha)	Average dbh (cm)	Average Ht (m)	Basal Area (m^2 per ha)	Importance Value
Polyscias aherniana	457	4.7	4.5	0.83	22.84
Lithocarpus sp.	286	6.5	5.3	1.02	18.50
Garcinia lateriflora	229	6.6	6.7	0.90	15.50
Prunus sp.	229	6.0	5.5	0.72	13.97
Palaquium obovatum	286	4.0	4.6	0.37	13.06
Rinorea bengalensis	286	3.9	2.6	0.37	13.02
Cinnamomum sp.	286	3.8	4.3	0.34	12.75
Syzygium sp.7	229	4.6	4.8	0.43	11.53
Calophyllum pentapetalum	114	8.3	5.0	0.61	9.13
Pittosporum ferrugineum	171	4.4	4.0	0.29	8.40
Dichapetalum sp.	171	4.2	5.7	0.25	8.04
Aglaia sp.	171	4.0	4.2	0.22	7.82
Antirrhea caudata	171	3.3	3.3	0.15	7.20
Litsea sp.1	114	6.3	4.5	0.38	7.16
Gomphandra bracteata	114	6.0	6.0	0.36	7.00
Scaevola micrantha	114	5.8	2.5	0.31	6.59
Chionanthus coriaceus	114	5.5	4.3	0.29	6.43
Angelesia splendens	114	5.5	4.3	0.29	6.43
Eurya sp.	114	5.6	5.0	0.28	6.37
Litsea sp.2	114	5.6	5.0	0.28	6.35
Kokoona ochracea	114	4.7	5.0	0.21	5.76
Weinmannia sp.	114	4.5	4.0	0.18	5.48
Guioa koelreuteria	114	4.2	4.5	0.16	5.35
Baccaurea sp.	114	4.3	3.5	0.16	5.34
Scolopia sp.	114	4.2	5.0	0.15	5.27
Tabernaemontana sp.	114	3.9	3.8	0.14	5.18
Dinochloa sp.	114	3.5	-	0.13	5.06
Alstonia iwahigensis	57	9.0	6.0	0.36	5.05

Species	Density (per ha)	Average dbh (cm)	Average Ht (m)	Basal Area (m^2 per ha)	Importance Value
Ardisia romanii	114	3.1	4.0	0.08	4.67
Elaeocarpus cuernosensis	57	8.4	6.0	0.32	4.66
Syzygium merrillii	57	8.0	7.0	0.29	4.41
Pinanga curranii	57	7.0	4.0	0.22	3.84
Palaquium sp.	57	5.5	5.0	0.14	3.13
Cyathea sp.	57	5.3	1.5	0.13	3.05
Mussaenda grandifolia	57	4.5	5.0	0.09	2.75
Carallia borneensis	57	4.2	4.0	0.08	2.65
Aglaia angustifolia	57	4.0	4.0	0.07	2.59
Buchanania microphylla	57	3.5	4.0	0.05	2.45
Pandanus sp.	57	3.5	5.0	0.05	2.45
Premna depauperata	57	3.0	3.0	0.04	2.32
Psychotria sp.3	57	3.0	3.0	0.04	2.32
Lindsaea sp.	57	2.0	-	0.02	2.13
Ficus glareosa	57	1.0	-	0.00	2.02
Memecylon sp.	57	1.0	-	0.00	2.02
Selaginella plana	57	1.0	-	0.00	2.02
TOTAL	5,771	-	-	11.83	300.00

Bikal (*Dinochloa* sp.) is the dominant species in the undergrowth stratum in this community with an IV of 48.91. This species is very dense and thick, with an estimated density of 443 individuals per 100 m^2, making the inventory and assessment difficult. Ferns such as *Lindsaea* sp. and Kamariang gubat (*Selaginella plana*) were also evident in the community. Aside from the dominant species, the herbaceous vegetation has a mixed species composition with representatives of Myrtaceae, Euphorbiaceae, Primulaceae, and Anacardiaceae, among others. Woody lianas are frequent and vascular epiphytes are occasional to frequent in this community.

Table 2.1.30. Density and Importance Value of the species found in undergrowth stratum of mixed-species community on Mt. Bulanjao, Bataraza.

Species	Density (per 100m^2)	Importance Value
Dinochloa sp.	443	48.91
Selaginella plana	200	26.36
Lindsaea sp.	200	24.04
Calamus microsphaerion	71	16.89
Cinnamomum sp.	57	8.86
Harrisonia brownii	29	6.76
Memecylon sp.	29	6.76
Tectaria sp.	29	6.76
Ardisia romanii	43	5.48
Freycinetia sp.	43	5.48
Eurycoma longifolia	29	4.43
Gomphandra bracteata	29	4.43
Kokoona ochracea	29	4.43
Polyscias aherniana	14	3.38
Ficus glareosa	14	3.38
Angelesia splendens	14	3.38
Mussaenda grandifolia	14	3.38
Neolitsea sp.1	14	3.38
Nepenthes philippinensis	14	3.38
Pterospermum elongatum	14	3.38
Scolopia sp.	14	3.38
Swintonia acuta	14	3.38
TOTAL	1,357	200.00

Mangrove forest

This ecosystem uniquely inhabits the tidal sea fringes usually above the mean sea level in the intertidal zones of coastal environments and river estuaries of Rio Tuba (**Plate 2.1.8**). Trees in this ecosystem have special adaptations that allow them to survive in the tidal wetland habitat. Eleven species of mangrove and mangrove associates were observed along the Rio Tuba Rver. Of the 11 species, eight (8) are considered as true mangroves and three are mangrove associates.

Plate 2.1.9. The mangrove forest along the Rio Tuba River viewed from the southern slopes of Mt. Bulanjao

In the canopy stratum, the estimated density of the mangrove forest along the Rio Tuba River is 750 individuals per ha. (**Table 2.1.31**). Bakáuan lalaki (*Rhizophora apiculata*) and Bakáuan babae (*R. mucronata*) are the most abundant and dominant true mangrove species in this site and only few Nilad (*Scyphiphora hydrophyllacea*) were recorded. The true mangrove species in the site have small dbh. For instance, the average dbh of Bakáuan babae is only 8 cm. The largest dbh recorded in the site is only 15.5 cm. About 73.33% of the inventoried mangrove species have dbh below 10 cm. Only eight (8) individuals have more than 10 cm in dbh. Similarly, the height of the mangrove species is low ranging from 4-9 m only. These values indicate that the area is disturbed because of the absence of large-diametered trees. ERBD et al. (2013) reported that the greatest threat to the mangrove forest in Rio Tuba River is the massive cutting and utilization of the large-diametered trees for charcoal making and housing construction materials.

Table 2.1.31. Density, average dbh and TH, basal area and importance value of the species found in canopy stratum of Mangrove forest along the Rio Tuba River, Bataraza

Species	Density (per ha)	Average dbh (cm)	Average Ht (m)	Basal Area (m^2 per ha)	Importance Value
Rhizophora apiculata	425	7.6	6.8	2.18	153.33
Rhizophora mucronata	300	8.0	6.6	1.85	120.00
Scyphiphora hydrophyllacea	25	7.0	6.0	0.10	26.67
TOTAL	750	-	-	4.13	300.00

In the intermediate stratum, the estimated density of the poles and saplings of the mangrove species is 2,400 individuals per hectare (**Table 2.1.32**). Similar to the canopy stratum, Bakauan lalaki and Bakáuan babae are the most abundant and dominant in the site. *Bakáuan lalaki* had an IV of 133.33 while Bakáuan babae had an IV of 116.67. Only few individuals of Tabigi (*Xylocarpus granatum*) have been recorded. The estimated density of this species is only 200 individuals per hectare. With regards to the undergrowth stratum, very limited seedlings have been observed in the area.

Table 2.1.32. Density, average dbh and TH, basal area and importance value of the species found in intermediate stratum of mangrove forest along the Rio Tuba River, Bataraza.

Species	Density (per ha)	Average dbh (cm)	Average Ht (m)	Basal Area (m^2 per ha)	Importance Value
Rhizophora apiculata	1200	2.3	4.8	0.57	133.33
Rhizophora mucronata	1000	3.6	5.0	1.01	116.67
Xylocarpus granatum	200	5.5	4.0	0.48	50.00
TOTAL	2400	-	-	2.05	300.00

Diversity

Diversity index is a mathematical measure of species diversity in a particular community. It provides more information about community composition than simply species richness (*i.e.* the number of species present) and it also take the relative abundances of different species into account. **Table 2.1.33** shows the diversity indices of the two forest formations as well as the four communities in the forest over ultramafic rocks. The diversity index (H') of the forest over ultramafic rocks ranges from 2.185-3.447 and the Shannon evenness (J') ranges from 0.788-0.93. While the diversity index of the mangrove forest is very low (H'=0.925) and uneven in distribution (J'=0.842). The overall Shannon diversity indices of the four communities in the forest over ultramafic rocks are expected to be higher than the overall Shannon diversity index of the mangrove forest because of the presence of more species and individuals. The mangrove forest had very low diversity because only four species were recorded in the area. In the Philippines, there are 13 true mangrove species and 26 associated mangrove species (Fernando *et al.* 2008). Another factor that contributed to the low diversity is that Bakauan lalaki (*R. apiculata*) and Bakáuan babae (*R. mucronata*) dominated the mangrove forest. Only few individuals were observed for Tabígi (*Xylocarpus granatum*) and Nilad (*Scyphiphora hydrophyllacea*).

Table 2.1.33.Overall diversity indices of the forest formations in the project site.

Forest Formation	Species Richness	Shannon's Diversity Index	Shannon Evenness
Forest over ultramafic rocks	136	-	-
Xanthostemon-dominated community	34	2.424	0.895
Gymnostoma-dominated community	32	2.185	0.788
Gymnostoma-Xanthostemon-dominated community	83	3.447	0.881
Mixed community	71	3.36	0.93
Mangrove forest	4	0.925	0.842

Among the four (4) communities in the forest over ultramafic rocks, *Gymnostoma-Xanthostemon*-dominated community is the most diverse because this community had a total of 83 species present. This is followed by the mixed-species community with H'=3.36. Based on the 1998 Fernando biodiversity scale (**Table 2.1.17**), the diversity indices of the *Gymnostoma-Xanthostemon*-dominated and mixed-species communities is high. High diversity index means that this ecosystem supports many species and has the ability to withstand some environmental impacts. On the other hand, *Xanthostemon*-dominated and *Gymnostoma*-dominated communities have low diversity. This is probably due to the dominance of few species in their respective community. However, in general, the forest over ultramafic rocks had high diversity because about 136 species were recorded in the project site. Although there is an indication of several species dominates the project site, the number of individuals is somehow relatively well distributed among the dominant species.

Conservation Status

Threatened species is a general term to denote species or subspecies considered as critically endangered, endangered, vulnerable or other accepted categories of wildlife whose population is at risk of extinction (DENR DAO 2007-01). Each category is defined below and adopted from Fernando *et al.* (2008).

1. **Critically endangered (CR)** species refers to a species or subspecies that is facing extremely high risk of extinction in the wild in the immediate future.

2. **Endangered (EN)** species refers to species or subspecies that is not critically endangered but whose survival in the wild is unlikely if the causal factors continue operating.

3. **Vulnerable (VU)** species refers to species or subspecies that is not critically endangered or endangered but is under threat from adverse factors throughout their range and is likely to move to the endangered category in the near future.

4. **Other Threatened Species (OTS)** refers to a species or subspecies that is not critically, endangered, endangered nor vulnerable but is under threat from adverse factors such as over collection, throughout its range and is likely to move to the vulnerable category in the near future. This shall include varieties, formae, or other infraspecific categories. This is similar to the Lower Risk / near threatened (LR/nt) category of IUCN.

5. **Other Wildlife Species (OWS)** refers to non-threatened species of plants that have the tendency to become threatened due to destruction of habitat or other similar causes as may be listed by the Secretary upon recommendation of the National Wildlife Management Committee. This shall include varieties, formae, or other infraspecific categories. This is similar to the Lower Risk / least concern (LR/lc) category of IUCN.

At least 15 species in the proposed project site are endemic to Palawan, *viz., Alpinia foxworthyi, Angelesia palawanensis, Antirrhea caudata, Ardisia romanii, Decaspermum philippinum, Ficus glareosa, Gomphandra bracteata, Nepenthes philippinensis, Pinanga curranii, Podocarpus palawanensis, Premna depauperata, Protium connarifolium, Mussaenda grandifolia, Wrightia palawanensis,* and *Xanthostemon speciosus* (**Table 2.1.18**). These are not necessarily restricted to this particular site or to Bataraza, but most are confined only to ultramafic soils in Palawan. Several of these Palawan endemic species are currently also included in the Philippine threatened plants list (DAO 2007-01, Fernando et al. 2008), viz. *Nepenthes philippinensis* (EN category), *Podocarpus palawanensis* (EN category), *Xanthostemon speciosus* (EN category), *Ardisia romanii* (OTS category), and *Protium connarifolium* (OTS category) (**Table 2.1.34**). *Adiantum cupreum* (VU Category) is a Philippine endemic known from Palawan and Sibuyan. *Dillenia luzoniensis* (OTS category) and *Aglaia angustifolia* (VU category), although not Philippine endemics, are also listed as threatened.

Table 2.1.34. List of Philippine threatened plant species found within the proposed site

Family	Scientific Name	Common Name	IUCN Status	DENR DAO 2007-01
Pteridaceae	*Adiantum cupreum*	*coppery maidenhair fern*	-	VU
Meliaceae	*Aglaia angustifolia*	*Kaniuing-kitid*	VU	VU
Primulaceae	*Ardisia romanii*	*Roman tágpo*	-	OTS
Dilleniaceae	*Dillenia luzoniensis*	*malakátmon*	VU	OTS
Nepenthaceae	*Nepenthes philippinensis*	*Palawan pitcher plant*	-	EN
Podocarpaceae	*Podocarpus palawanensis*	*Palawan malakauayan*	CR	EN
Burseraceae	*Protium connarifolium*	*Marangub*	VU	OTS
Myrtaceae	*Xanthostemon speciosus*	*Palawan mangkono*	-	EN

Podocarpus palawanensis is the rarest and most threatened species present in the area; only two (2) individuals of this species have been recorded in the project site, one in *Gymnostoma-Xanthostemon* dominated community and the other in the mixed-species community. *Protium connarifolium* and *Dillenia luzoniensis* are two of the dominant species in the intermediate vegetation on Mt. Bulanjao.

All other species, although not currently in the Threatened Plants List, should also be of concern and may need to be physically transferred to other areas should development proceed.

2.1.4.3 Impact Assessment

The key impacts of the proposed project on flora are presented in **Table 2.1.35.**

Table 2.1.35. Impacts assessment and mitigation for terrestrial flora

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
• **Vegetation removal and loss of habitat** The biggest impact of the RTNMC Project to the terrestrial flora biodiversity on the project site will be the removal and loss of habitat, the loss of native and endemic species, and the threat to the their population abundance, frequency, and distribution. These impacts will be concentrated in the areas where the access roads and main mining excavation sites will be established.		✓	✓	✓	Prior to any physical development on the site (*e.g.* road access development and construction for mining operations), RTNMC shall prepare and implement a comprehensive Biodiversity Conservation Action Plan. This Plan shall identify and quantify the company's impacts and risks to the native biodiversity and explain how they will be managed according to a structured approach to achieve the company's biodiversity conservation commitments. The Plan shall include, among others, the following relevant components: (i) An inventory and mapping of the affected plants and trees in the area; (ii) A plant nursery with complete facilities and adequate professional staff will be established. The nursery shall store and propagate representative specimens of rescued (balled and transplanted) plants and propagules from the project site for use in the progressive rehabilitation activities;
• **Threat to the existence and/or loss of native species** The native plants in the project site are unique in that they have evolved biological mechanisms to resist, tolerate, and thrive on the toxic metal-rich soils. Thus, they are often endemic to this type of soil. Because of the restricted distribution		✓	✓	✓	

of the plant species and the rather destructive activities of mining and road construction - many species are actually at risk of local extinction. Much of the area is still covered with forest vegetation.					(iii) Mining activities should be confined within the defined mining areas to protect the surrounding native vegetation from physical damage Representative specimens of the 15 species of plants endemic to Palawan (**Table 2.1.8**) including those listed as threatened, should be protected, and where necessary, transplanted to a secure area in the nursery and provided with utmost care. These species, along with others, should be part of the restoration program for the project site.
• **Threat to the abundance, frequency, and distribution of species**		✓	✓	✓	

2.1.5 Fauna

2.1.5.1 Methodology

<u>Field Data Gathering Techniques</u>

All opportunities for gathering information on terrestrial vertebrates were considered. Field equipment and materials including the following were used during the survey; binoculars, GPS, digital camera, 3 m x 12 m nylon mist nets, live traps, flashlights, bird bags, and field notebooks. Sstandard procedures employed during the assessment last August 29 to 30, 2015 and surveys of terrestrial vertebrates are as follows:

<u>Birds</u>

Direct observations while doing the transect walk coupled with mist netting were employed for this taxon. Transect walks in the three (3) sites were conducted simultaneously to avoid duplication of data. These were conducted from 6:00 AM to 10:00 AM and from 3:00 PM to 6:00 PM. Point counts were done to observe the birds and count individuals by stopping every 10 minutes.

Mist nets used for volant mammals were set at 1600H and checked before dusk and early in the morning of the next day. Mist nets were used to confirm species occurrence and distribution as well as identification of cryptic species. Identification, nomenclature, classification and conservation status of birds were determined based on the Wild Bird Club of the Philippines (WBCP) - Checklist of Birds of the Philippines 2013 (edited by Desmond Allen, Robert Hutchinson, Arne Jensen, Christian Perez, Steve Pryor and Mark Villa) and Kennedy et al., 2000.

<u>Mammals</u>

Methods used in the observation of mammals included mist netting for volant or flying species (e.g., bats). Mist nets were located and positioned in strategic points in each of the sampling sites. The nets were set at 1600H. Net watching for insectivores was done at 1800H to 2000H. The nets were checked early in the morning at 0600H. Bats and birds were retrieved from the nets and identified before being set free.

Live trapping and direct sighting techniques were used for terrestrial and arboreal (but non-volant) species. Live traps baited with roasted coconut laced with peanut butter were placed in strategic areas to verify presence of mammals and confirm identification. Trap lines were established near the vicinity of mist nets and were checked for any capture early in the morning of the next day.

Identification, nomenclature, classification and conservation status were determined using Heaney et al. (1998).

Reptiles and Amphibians (Herpetofauna)

The Visual Encounter Survey was used in the inventory of herps while conducting the transect walks passing through established transect lines. Frogging was done in the rivers in Lower Bulanjao and in Buhoy for two (2) hours (1800H-2000H).

Analyses of Data

Diversity indices were computed using the Paleontological STatistics (PAST), ver. 1.42 by Hammer, Harper and Ryan (2006).

2.1.5.2 Baseline Conditions

Description of Sampling Sites

The assessment of terrestrial vertebrates was conducted in three (3) sites: Bohoy, Lower Bulanjao, and Upper Bulanjao. The vegetation in Upper and Lower Bulanjao are mostly secondary forest with some old growth. Bohoy is composed of dipterocarps near the river but towards the higher elevation, the vegetation is more dense, however, trees have smaller diameter (<30cm).

The transects were established along the old abandoned road from the Ibelnan Creek at 151 meters above sea level (masl) up to 467 masl in Lower Bulanjao. A distance of 1 km separated Lower Bulanjao from Upper Bulanjao which started at 734 masl up to 846 masl. The Bohoy transect was established through the trail from the water pumping station (151masl) to the other side of the mountain (467 masl). The location and elevations of each site are presented in **Table 2.1.36** and **Figure 2.1.19**. The weather was mostly warm, dry and sunny the whole duration of the field work.

Table 2.1.36. Location and elevation of survey sites

Sites		North	East	Elevation (masl)
Bohoy	Start	08°35'45.9"	117°24'01.5"	151
	End	08°35'26.8"	117°23'09.1"	467
Lower Bulanjao	Start	08°33'46.9"	117°23'11.5"	146
	End	08°34'11.2"	117°23'11.5"	643
Upper Bulanjao	Start	08°34'29.7"	117°22'04.8"	734
	End	08°35'32.5"	117°21'53.1"	846

Species Richness

Birds

Twenty-three species of birds belonging to 17 families were observed and recorded from the three (3) survey sites; five (5) from Bohoy, 11 from Lower Bulanjao and eight (8) from Upper Bulanjao. No species were common to the three (3) sites. It was observed that only one (1) or two (2) species comprise each family indicating very low species diversity of birds during the assessment and survey.

The paucity of species may be explained by the weather and climate during the survey and/or the distance of the sites to the mining sites where mining activities generates dust as well as higher noise level. The removal of trees near the sites may be the main reason why there are very few birds observed during the survey, specially in Bohoy which is very near a mining area where it was dusty, noisy and devoid of vegetation. **Table 2.1.37** shows the list of species and the families in which these belong.

Table 2.1.37. List of bird species observed and recorded from three sites at the RTNMC AMA-IVB-144A

Family	Scientific Name	Common Name	Sites		
			Buhoy	Lower Bulanjao	Upper Bulanjao
Accipitridae	*Haliaeetus leucogaster*	White-bellied Sea Eagle	-	-	1
	Spilornis cheela	Crested Serpent Eagle	-	-	1
Aegithinidae	*Aegithina tiphia*	Common Iora	5	-	-
Apodidae	*Collocalia esculenta*	Glossy Swiftlet	-	-	2
	Collocalia troglodytes	Pygmy Swiftlet	-	-	2
Chloropseidae	*Chloropsis palawanensis*	Yellow-throated Leafbird	-	-	3
Cisticolidae	*Orthotomus sericeus*	Rufous-tailed Tailorbird	-	2	-
Columbidae	*Chalcohaps indica*	Common Emerald Dove	-	2	-
Corvidae	*Corvus enca*	Slender-billed Crow	-	2	-
Cuculidae	*Phaenicophaeus curvirostris*	Chestnut-breasted Malkoha	-	1	-
Dicaeidae	*Dicaeum pymeaum*	Pygmy Flowerpecker	3	5	-
	Prionochilus plateni	Palawan Flowerpecker	-	2	-
Irenidae	*Irena puella*	Asian Fairy Bluebird	-	2	-
Muscicapidae	*Cyornis rufigastra*	Mangrove Blue Flycathcer	3	-	-
	Muscicapa griseisticta	Grey-checked Flycatcher	-	-	1
Nectarinidae	*Cynniris juglaris aurora*	Olive-backed Sunbird	6	5	-
Phylloscopidae	*Phylloscopus borealis*	Arctic Warbler	-	-	2
Picidae	*Dryocopus javensis*	White-bellied Woodpecker	-	-	-
Pycnonotidae	*Alophoixus frater*	Palawan Bulbul	-	6	-
	Pycnonotus plumosus-	Olive-winged Bulbul	4	-	1
Sturnidae	*Aplonis panayensis*	Asian-glossy Starling	-	-	-
	Gracula religiosa	Common Hill Myna	-	2	-
Timaliidae	*Macronous gularis*	Pin-striped Tit-Babbler	-	2	-

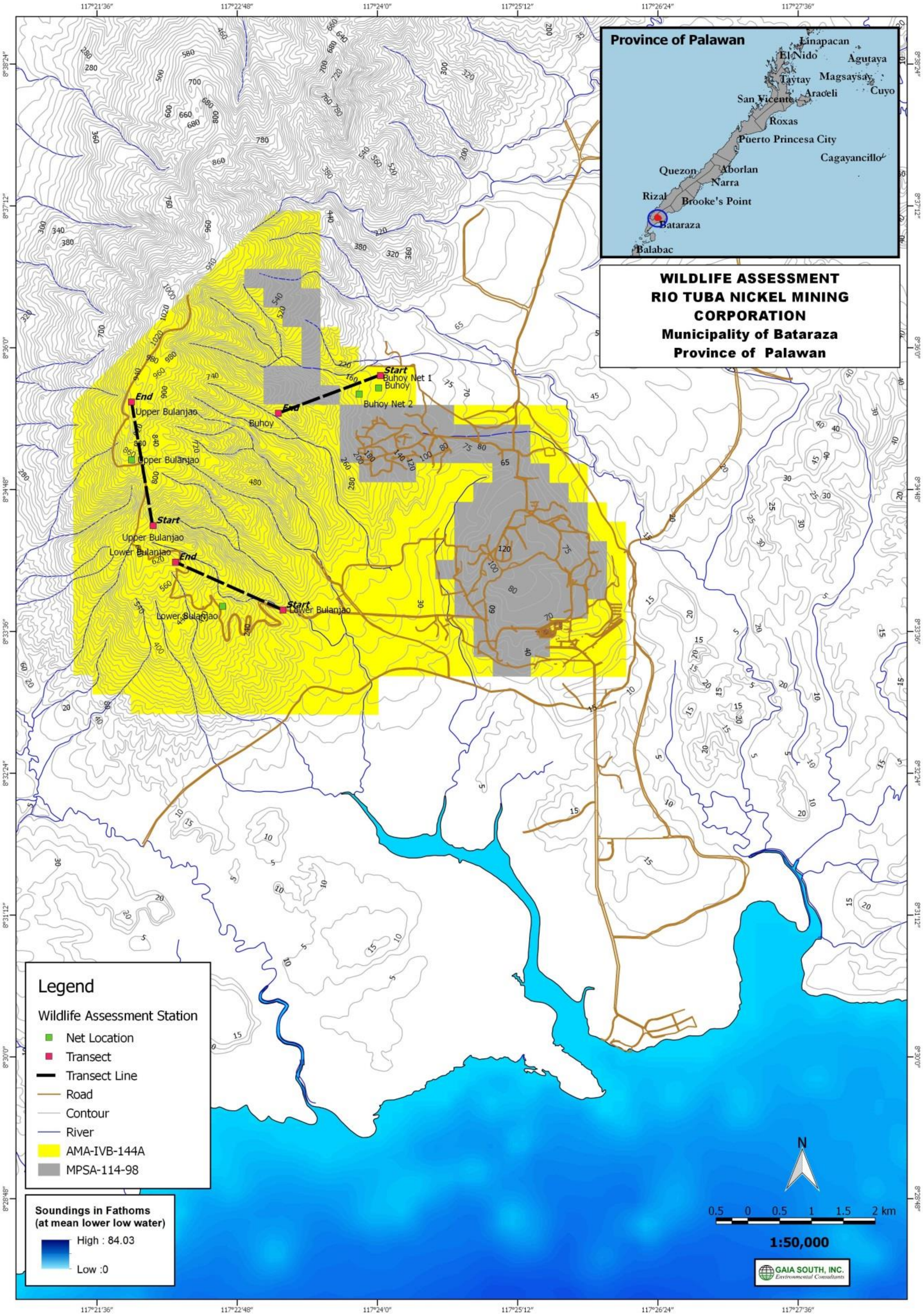


Figure 2.1.19. An overview of the survey sites within the proposed site on Mt. Bulanjao.

Table 2.1.38 shows the habitat, feeding guild, distribution and conservation status of each species. Birds recorded during the survey occupy 14 different habitats with those inhabiting forests having the highest number of species with seven (7) followed by species occupying forest/grassland/open country with three (3), and two (2) species occupying lowland and mangrove forests. The rest of the habitats are occupied by only one (1) species each.

Table 2.1.38. Habitat, feeding guilds distribution and conservation status of birds observed within the AMA-IVB-144A

Species	Habitat	Feeding Guild	Distribution	Conservation Status (IUCN)	DENR 2004-15	Palawan PCSDS No. 15-521
Aegithina tiphia	Forest and Scrublands	Insectivore	Resident	LC	LC	LC
Alophoixus frater	Grassland/open country	Frugivore/ Insectivore	Resident	LC	LC	VU
Aplonis panayensis	Lowland, Mangrove Forests	Frugivore	Resident	LC	LC	LC
Chalcohaps indica	Lowland and montane Forests	Frugivore	Resident	LC	LC	LC
Chloropsis palawanensis	Forests/ forest edges/ scrubland	Omnivore (fruits and insects)	Endemic	LC	LC	VU
Collocalia esculenta	Forest/ Grassland/ open country	Insectivore	Resident	LC	LC	LC
Collocalia troglodytes	Forests/ open country	Insectivore	Endemic	LC	LC	LC
Corvus enca	Forest/ grassland /open country	Scavenger	Resident	LC	LC	LC
Cynniris juglaris aurora	Forest/grassland/ open country	Insectivore/ Nectarivore	Resident	LC	LC	LC
Cyornis rufigastra	understorey, second growth and disturbed forests	Insectivore	Resident	LC	LC	LC
Dicaeum pygmeaum	Forest	Nectarivore	Endemic	LC	LC	LC
Dryocopus javensis	Forest	Insectivore	Resident	LC	LC	VU
Gracula religiosa	treetops on forest edge	Omnivore	Resident	LC	VU	Critically Endangered
Haliatus leucogaster	Forest	Carnivore	Resident	LC	LC	Endangered
Irena puella	Forest and forest edge (canopy)	Insectivore-frugivore	Resident	LC	LC	LC
Macronous gularis	forests and forest edges (understorey)	Insectivore-frugivore	Resident	LC	LC	LC
Muscicapa griseisticta	Forests/ forest edges/open country	Insectivore	Migrant	LC	LC	LC
Orthotomus sericeus	Lowland/ mangrove Forests	Insectivore	Resident	LC	LC	LC
Phaenicophaeus curvirostris	Forest	Insectivore	Endemic	LC	LC	LC
Phylloscopus borealis	Understorey/ ground nesters	Insectivore	Migrant	LC	LC	LC
Prionochilus plateni	Forest	Herbivore	Endemic	LC	LC	VU
Pycnonotus plumosus-	Forests	Frugivore	Resident	LC	LC	LC
Spilornis cheela	Forest	Carnivore	Resident	LC	LC	LC

The percentage of species occupying different habitats are presented in **Figure 2.1.20** with 31% occupying forests, 13% occupy forest/grassland/open country, 9% occupy lowland/mangrove forests. This shows that most of the birds are forest dependent.

To provide a tool to monitor the effects of forest destruction and disturbance to the species of birds in the area, the feeding guilds of each were determined (**Figure 2.1.21**). The figure shows that 39% of the species are insectivores, 13% each are frugivores/insectivores and

13% pure frugivores while omnivores and carnivores comprise 9% each. There was one (1) species each of carnivore, herbivore and scavenger.

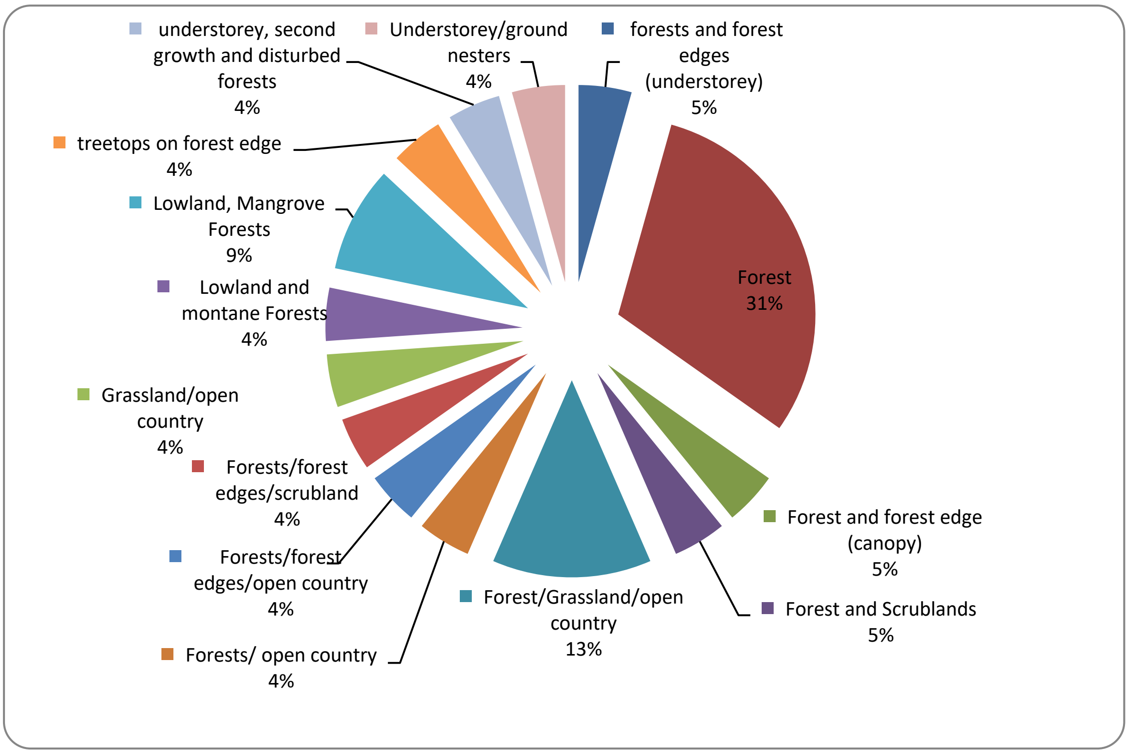


Figure 2.1.20. Percentage of species occupying different habitats

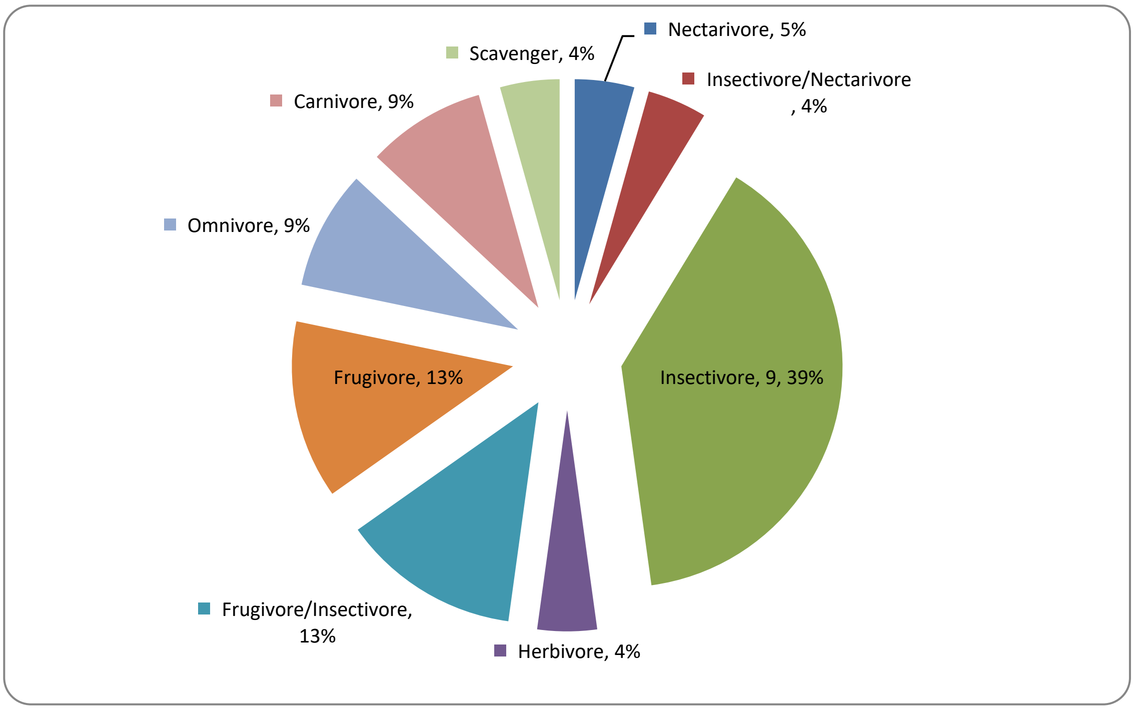


Figure 2.1.21. Percentage of species belonging to different feeding guilds.

Most of the species are residents comprising 65%, 26% are endemic and 9% are migratory (**Figure 2.1.22**).

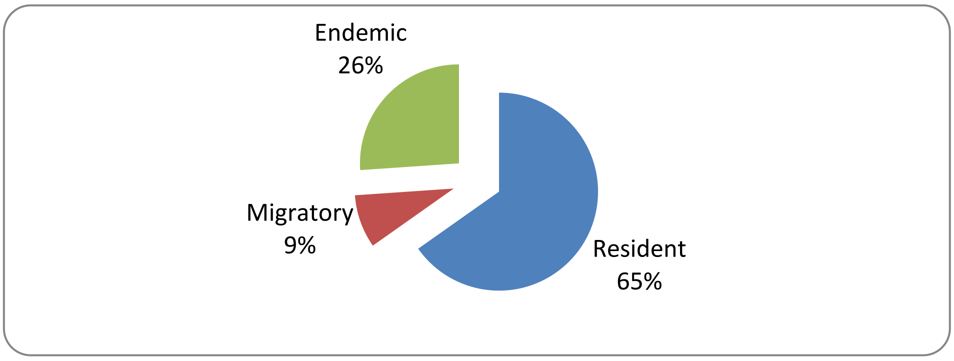


Figure 2.1.22. Percentage of bird species according to distribution.

According to the IUCN 2016.3 list, all of the species of birds are under the Least Concern category which means that there is no indication that the species are threatened and their population is not decreasing. DENR Administrative Order 2004-15 placed *Gracula religiosa* or Common Hill Mynah under the Vulnerable category.

PCSD Resoution No. 15-521 series of 2015 listed *Gracula religiosa* under the Critically Endangered category and *Haliaetus leucogaster* as Endangered. Four species are placed under the Vulnerable category, these are *Alophoixus frater*, *Chloropsis palawanensis*, *Dryocopus javensis* and *Prionochilus plateni*. **Figure 2.1.23** shows the percentage of species of birds under different conservation categories.

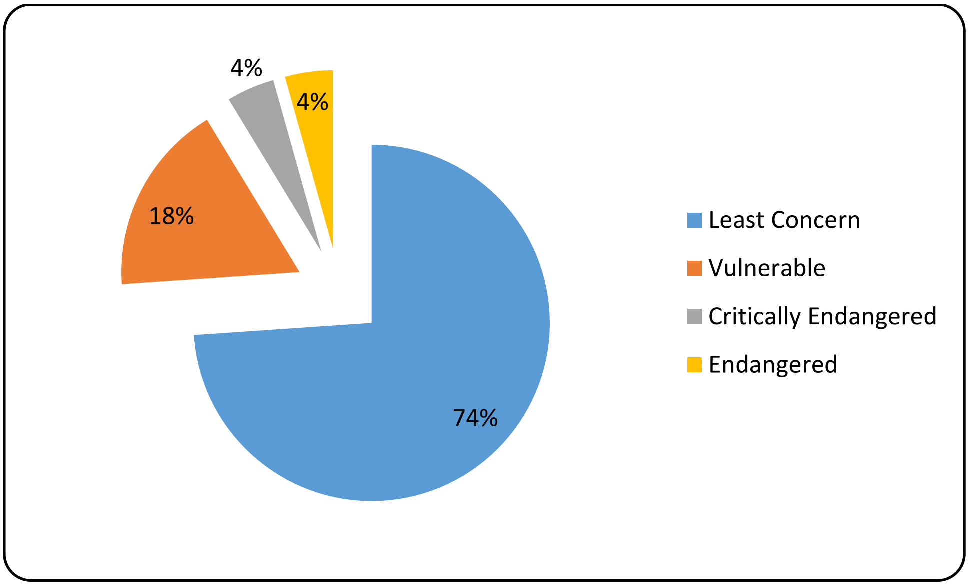


Figure 2.1.23. Percentage of bird classified according to PCSD Res. 15-521 ser. 2015.

Mammals

The areas surveyed are depauperate when it comes to mammals. Only two (2) species of Volant mammals were caught in the mist nets, *Cynopterus brachyotis* and *Megaderma spasma*, and there were no non-volant mammals caught through live trapping. *Cynopterus brachyotis* was the only species observed in all three (3) sites with 15 individuals netted in

Lower Bulanjao and only three (3) in Bohoy. Two individuals of *Megaderma spasma* were caught in Bohoy during the net watch.

Table 2.1.39. Species of mammals observed and recorded from three (3) survey sites

Family	Scientific Name	Common Name	Sites		
			Buhoy	Lower Bulanjao	Upper Bulanjao
Pteropodidae	*Cynopterus brachyotis*	Common short nosed fruit bat	3	15	8
Megadermatidae	*Megaderma spasma*	Lesser False Vampire bat	2	-	-

Both *Cynopterus brachyotis* and *Megaderma spasma* are forest dependent species although one is a fruit bat (*Cynopterus brachyotis*) and one is an insectivore (*Megaderma spasma*). Both species are residents and are of Least Concern according to the IUCN. The paucity of species of mammals during the survey may be caused by the scarcity of food in the survey sites. There were no fruit-bearing trees observed in the three sites which may explain the scarcity of fruit bats. It was also humid and dry during the survey period which may have affected mammalian species from foraging in the forest floor or on the trees.

Table 2.1.40. Habitat, distribution and conservation status of mammalian species

Species	Habitat	Distribution	Conservation Status (IUCN 2013)	DENR 2004-15	Palawan PCSDS No. 15-521
Cynopterus brachyotis	Lower montane forests, dipterocarp forests, gardens, mangrove and strand vegetation	Resident	LC	LC	LC
Megaderma spasma	dense tropical humid forest; caves	Resident	LC	LC	LC

Herpetofauna

Observation of herps (amphibians and reptiles) during the transect walk and the evening frogging activitiy yielded eight (8) species; four (4) amphibians and four (4) reptiles. The list is presented in **Table 2.1.41**.

Table 2.1.41. List of amphibians and reptiles observed and recorded from the three (3) survey sites

Family	Scientific Name	Common Name	Sites		
			Buhoy	Lower Bulanjao	Upper Bulanjao
Ranidae	*Sanguirana sanguinea*	Southeast Asian Wood Frog	20	1	-
Ranidae	*Staurois natator*	Mindanao Splash Frog	10	5	-
Bufonidae	*Ingerophrynus phillipinicus*	Philippine Toad	1	-	-
Ranidae	*Hylarana moellendorfi*	Culion Frog	1	-	-
Gekkonidae	*Gekko palawanensis*	Palawan Narrow-disked Gecko	-	2	1
Gekkonidae	*Cyrtodactylus philippinicus*	Philippine Bent-toed Gecko	1	-	-
Colubridae	*Dendrelaphis pictus*	Painted Bronzeback	-	-	1
Colubridae	*Gonyosoma oxycephalum*	Red-Tailed Racer (Rat Snake)	1	-	-

Except for the Philippine Toad, *Ingerophrynus philippinicus* which is terrestrial, all the other amphibians inhabit streams in forests and mountains. The reptiles are tree and forest dwellers too.

Table 2.1.42. Habitat, distribution and conservation status of herpetofauna

Species	Habitat	Distribution	Conservation Status	DENR 2004-15	Palawan PCSDS No. 15-521
Sanguirana sanguinea	forests streams	Resident	LC	LC	VU
Staurois natator	clear, small, rocky streams in primary forests	Endemic	LC	LC	LC
Ingerophrynus phillipinicus	degraded habitats;non-forested areas at lower elevation	Endemic	LC	LC	LC
Hylarana moellendorfi	mountain streams	Endemic	NT	LC	VU
Cyrtodactylus philippinicus	riparian forests low to mid-elevation	Endemic	LC	LC	LC
Dendrelaphis pictus	found in a variety of habitats including beach, scrub, forests	Resident	LC	LC	LC
Gekko palawanensis	Tropical moist Forests in rocky substrates	Endemic	LC	LC	LC
Gonyosoma oxycephalum	trees and in tree cavities	Resident	LC	LC	LC

Endemicity among herps is high at 62% while residents comprise 38% (**Figure 2.1.24)**. One species, *Hylarana moellendorfi* is classified as Near Threatened (13%) by the IUCN because its population is threatened by habitat destruction, pollution from dust and other environmental factors. Most of the species according to the IUCN, are of Least Concern. As for DENR, all of the species are of Least Concern. PCSDS Resolution 15-521 ser. 2015 placed *Hylarana moellendorffi* and *Sanguirana sanguinea* under the Vulnerable category while all the other species are of Least Concern which means that 25% of the species are of Least Concern while 25% are Vulnerable (**Figure 2.1.25**).

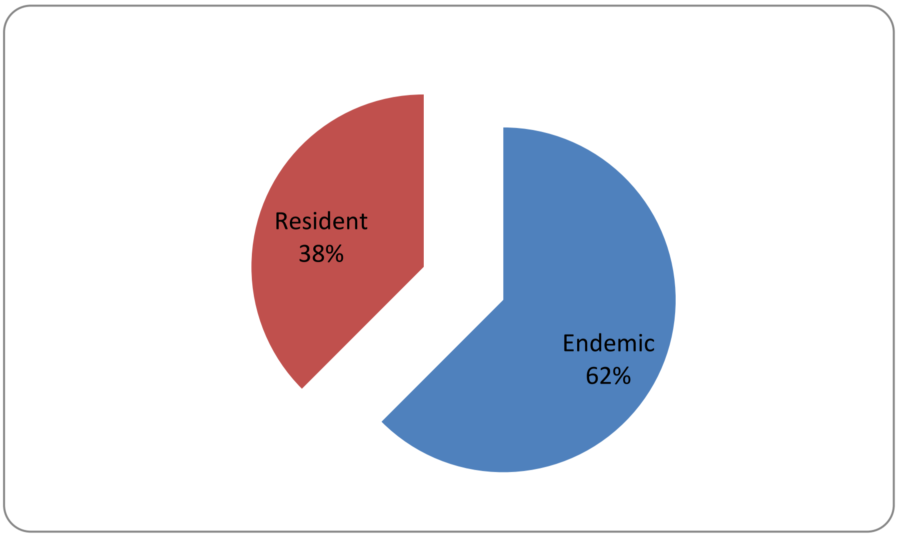


Figure 2.1.24. Percentage of species of herps according to distribution.

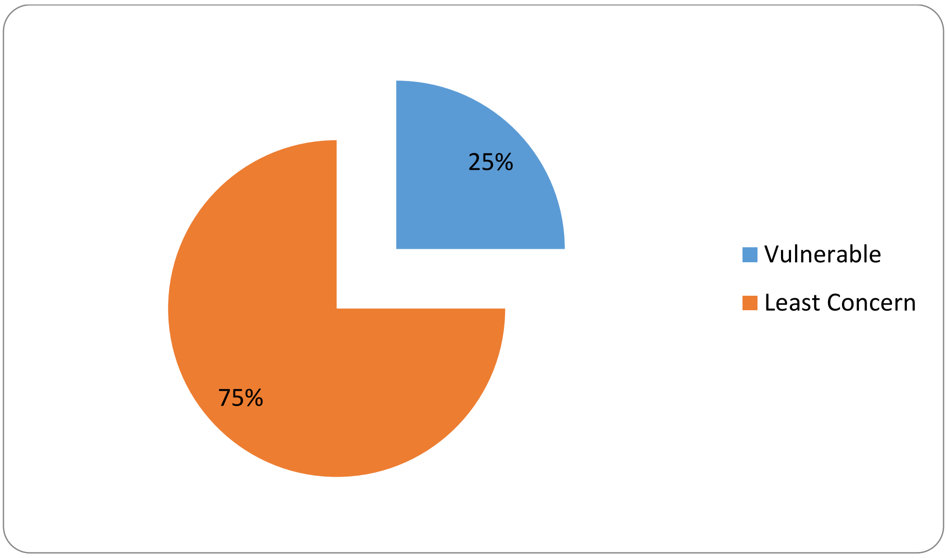


Figure 2.1.25. Percentage of herps classified according to PCSD Res. 15-521 ser. 2015.

Ecological Parameters and Diversity Indices

Birds

Values of diversity indices were compared among the three (3) sites (**Table 2.1.43, Figure 2.1.26**). The number of species was highest in Lower Bulanjao and lowest in Bohoy. Abundance was highest again in Lower Bulanjao followed by Buhoy and lowest in Upper Bulanjao. Species Diversity and Richness are highest in Lower Bulanjao followed by Upper Bulanjao then Bohoy. Evenness is very high among the sites.

Table 2.1.43. Values of diversity indices in three sites where birds were observed and recorded.

Diversity Indices	Buhoy	Lower Bulanjao	Upper Bulanjao
No. of Species	5	11	8
Abundance	21	32	13
Species Diversity	1.571	2.28	1.992
Species Richness	1.314	2.885	2.729
Evenness	0.9764	0.9509	0.9577

Values of diversity indices in both Buhoy and Lower Bulanjao are very low while it is low in Upper Bulanjao. Species Richness on the other hand is moderate in both Lower and Upper Bulanjao while it is very low in Buhoy. Evenness is very high in all the sites.

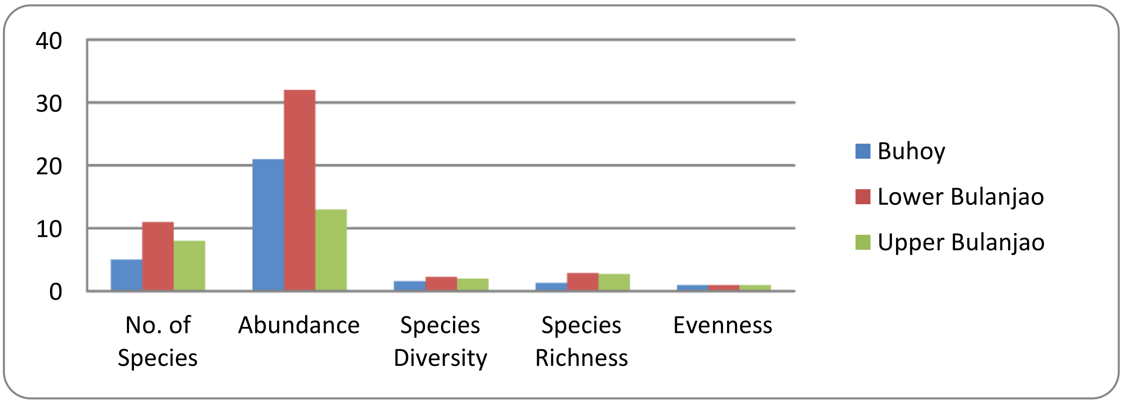


Figure 2.1.26. Comparison of diversity indices of bird species observed and recorded from three (3) sampling sites

Mammals

The sites surveyed were very poor when it comes to mammalian species. Comparison of the three (3) sites (**Figure 2.1.27**) showed that the number of species was highest in Bohoy while abundance was highest in Lower Bulanjao where about 15 individuals of *Cynopterus brachyotis* were caught in the mist nets.

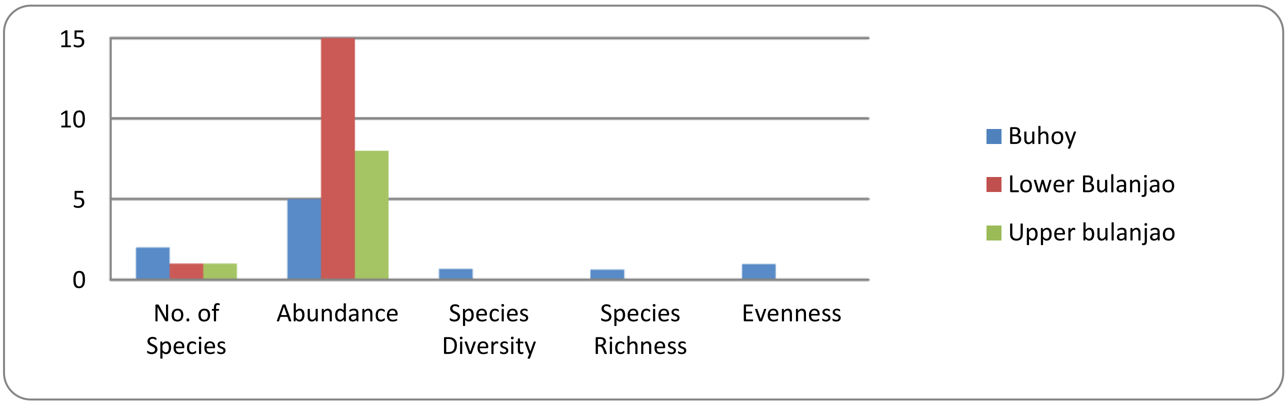


Figure 2.1.27. Comparison of diversity indices of mammalian species observed and recorded from three sampling sites.

Table 2.1.44 shows that species diversity, richness and evenness is very low in Bohoy and nil in Lower and Upper Bulanjao. This is the first time that only one species of mammal was observed and recorded in Bulanjao, whether at lower or high elevation. This may be caused by the scarcity of food sources, precipitation and the hot weather and climate prevailing in the sites.

Table 2.1.44. Values of diversity indices in three sites where mammals were observed and recorded

Diversity Indices	Sites		
	Buhoy	Lower Bulanjao	Upper Bulanjao
No. of Species	2	1	1
Abundance	5	15	8
Species Diversity	0.673	0	0
Species Richness	0.6213	0	0
Evenness	0.971	-	-

Herpetofauna

Comparison of diversity indices in the three sites shows that the number of species, abundance, species diversity and richness were highest in Bohoy. The lowest species diversity is recorded in Upper Bulanjao while species richness was lowest in Lower Bulanjao. Evenness is very high for all the sites (**Figure 2.1.28**).

Diversity values in all sites show that species diversity and richness are very low while evenness is very high (**Table 2.1.45**). Due to the hot weather and dry climate, only a few species of amphibians were caught during frogging specially in Lower Bulanjao where there were parts of the river with no riparian vegetation or trees along the banks, specially near the old mining road going up Bulanjao.

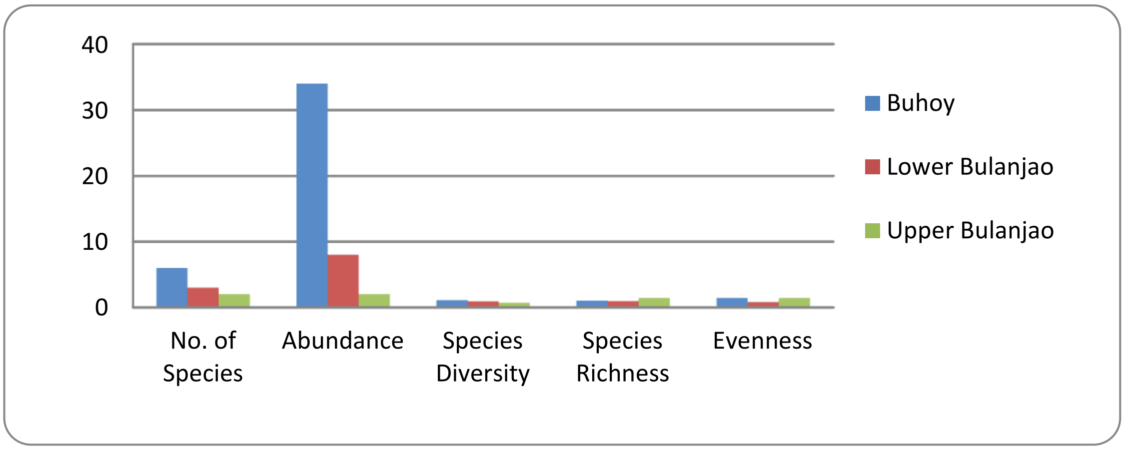


Figure 2.1.28. Comparison of diversity indices of herpetofauna species observed and recorded from three sampling sites.

Table 2.1.45. Values of diversity indices in three sites for herpetofauna

Diversity Indices	Sites		
	Buhoy	Lower Bulanjao	Upper Bulanjao
No. of Species	6	3	2
Abundance	34	8	2
Species Diversity	1.087	0.9003	0.6931
Species Richness	1.029	0.9618	1.414
Evenness	1.418	0.8194	1.443

Comparison of Diversity Indices among the Three (3) Sites

The highest number of species of terrestrial vertebrates was recorded in Lower Bulanjao with a total of 15 followed by Bohoy with 13 and Upper Bulanjao with 11. However, there were more individuals counted in Bohoy than in Lower Bulanjao. Species diversity and richness were highest in Bohoy followed by Upper Bulanjao and the least in Lower Bulanjao. Evenness was higher in Upper Bulanjao than in Bohoy (**Figure 2.1.29**).

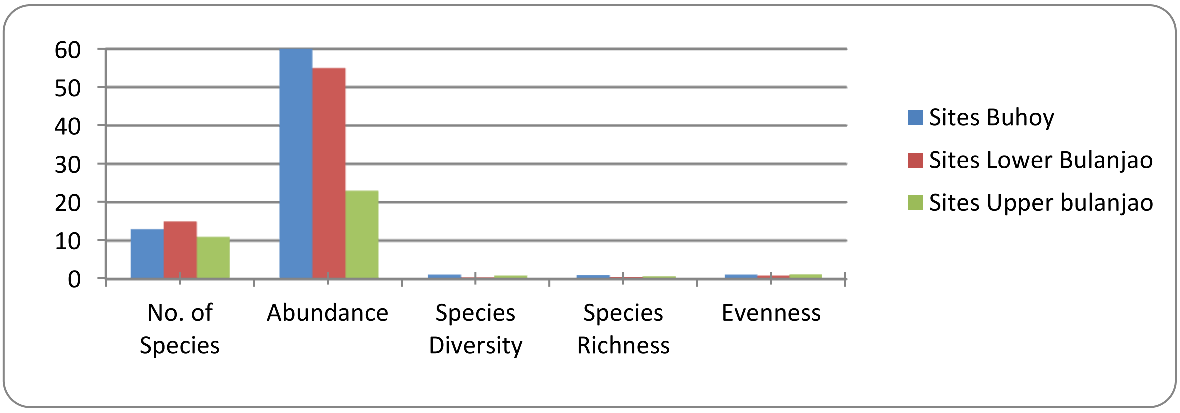


Figure 2.1.29. Comparison of diversity indices among the three sampling sites.

Compared to the other two (2) sites, there were very few species of birds in Bohoy but it had the highest number of species when it comes to mammals and herps. Species diversity and richness were very low in all the sites surveyed but evenness was very high for all sites (**Table 2.1.46**). The very species diversity may be a result of the disturbance caused by mining activities near the sites surveyed, dust pollution, tree cutting/felling and the constant noise of machinery in the vicinity of the sites. These may have caused habitat destruction and degradation of species specially those sensitive to changes and pollution in the environment, such as fruit bats, rodents and other mammals as well as amphibians and reptiles which depend on the forest.

Table 2.1.46. Values of diversity indices in three sites for terrestrial vertebrates

Diversity Indices	Sites		
	Bohoy	Lower Bulanjao	Upper Bulanjao
No. of Species	13	15	11
Abundance	60	55	23
Species Diversity	1.1103	0.4502	0.8950
Species Richness	0.9881	0.4809	0.707
Evenness	1.1218	0.8852	1.2004

2.1.5.3 Impact Assessment

The key impacts of the proposed project on fauna are presented in **Table 2.1.47.**

Table 2.1.47. Impacts assessment and mitigation for terrestrial fauna

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
• **Loss of Habitat of endemic and native species/threat to existence and/or loss of important local species** Habitat of endemic and native species are lost when vegetation cover especially trees are cleared prior to mining. The thick vegetation cover hosts faunal (vertebrates and invertebrates) species while providing food sources. The removal of vegetation cover will eventually result to the gradual loss and/or disappearance of endemic species.		✓	✓	✓	• The mining operations shall selectively clear vegetation cover and limit only to areas needed for mining operations based on the approved mining plans. Cleared areas shall be limited within 50 ha at a time if possible and immediately rehabilitated once all ores are recovered. • Clearing shall be done by phase to allow migration and movement of faunal species. • Opening of new mining areas shall be considered only when all ores are recovered from an existing mine area. • Progressive rehabilitation shall be implemented to allow faster rehabilitation of mined out areas and provide pockets of shelter to faunal species. • RTNMC shall implement enhancement planting other open areas within the mining claims to compensate the vegetation loss during the mining operations and provide alternative habitat for faunal species.
• **Threat to abundance, frequency and distribution of important species** The loss of roosting, nesting and feeding sites brought about by the cutting of trees will result in the e decrease in the number of species due to the loss in food availability (insects and other invertebrates eaten by birds and bats) and roosting trees. Those that inhabit the forest floor will be devoid of food and shelter Eventually, these species will die		✓	✓	✓	

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
or will transfer to other areas especially those which are forest and tree dependents.					
• **Hindrance to access to wildlife** Formost terrestrial vertebrates specially understorey birds and ground dwelling vertebrates such as mammals. The felling of trees and the clearing of vegetation will hinder the mobility of wildlife species specially tree and ground dwellers. Eventually, loss of access will result to loss of species.		✓	✓		

2.2 The Water

2.2.1 Hydrology

2.2.1.1 Methodology

Meteorologic data were sourced from the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA) and from the mine site rainfall monitoring station established by RTNMC from 1980 to 1999 and the automatic weather station established by the CBNC that monitored maximum, minimum and mean temperature, among other parameters.

The monthly and annual PET in the vicinity of AMA-IVB-144A was computed using the Thornthwaite Method (Knödel, et al, 2007). This method is useful when only a few weather parameters are available since it only requires the mean monthly temperature and the mean monthly duration of daylight for the area. The mean monthly temperature was taken from the RTNMC and CBNC temperature data while the mean monthly daylight duration was taken from daylight duration data presented in Cruff and Thompson (1967). The monthly and annual AET were then estimated from the PET values using the Turc-Pike Equation (Xu and Singh, 2004).

There are no long-term stream flow measurements for any river in Palawan. However, discharge of the rivers that drain AMA-IVB-144A may be estimated from the long-term water balance. The long-term water balance is expressed by the equation $P = AET – Q – GR$, where P, AET, Q and GR represent rainfall, actual evapotranspiration, stream discharge and groundwater recharge respectively (Sokolov and Chapman, 1974). These values were multiplied by the areas of the river catchments to convert them to volume.

On the other hand, the amount of groundwater recharge is estimated from the hydraulic conductivities of the rocks that underlie the watersheds of these rivers which consist of fractured ultramafic rocks and generally clayey to sandy sedimentary rocks. Fractured ultramafic rocks and clayey to sandy sedimentary rocks attain hydraulic conductivity values ranging from 10^0 to 10^1 meters per day (m/d) and 10^{-3} to 10^2 m/d respectively (Brassington, 2007). These are low to high hydraulic conductivity values such that a groundwater recharge of approximately 8% of the rainfall is deemed to be appropriate for the area.

Monthly and annual estimates of stream discharge for the rivers that drain AMA-IVB-144A are then generated using the water balance equation and the rainfall, actual evapotranspiration and groundwater recharge values for their respective watersheds.

Flood Modeling was conducted to determine the impacts of a short-term storm event simulation module by overflow from river and deals with the flash flood event with a time scale within a couple of hours to one day in the watersheds covering the RTNMC MPSA Area. Direct Rainfall Model (DRM) used for the purpose is an integrated hydrological and hydraulic modeling computation that directly applies rainfall on the catchment to generate runoff which is simultaneously routed downstream across the topographic 2D grid. 2D refers to the hydraulic modeling where the floodplain is modeled using two-dimensional methods. Using a grid of topography data the model will estimate not only how high and how fast water will flow but will also calculate the direction of flow across the 2D grid.

2.2.1.2 Baseline Conditions

Meteorologic Conditions

Much of the southern half of Palawan, as demarcated lengthwise, experiences a Type III Climate based on the Modified Coronas climate classification scheme of the Philippine Atmospheric, Geophysical, Astronomical Services Administration (PAGASA, 1992). The Type III climate is characterized by a long rainy season that does not have a pronounced maximum rain period and a short dry season lasting only 1 to 3 months.

Data from the three (3) RTNMC rainfall monitoring stations indicates that the project site receives an average rainfall of 2,611 mm per year. The rainy season apparently begins at April and lasts up to January where the monthly rainfall exceeds 160 mm and peaks at 362 mm in October. February and March constitute the dry season with the monthly rainfall averaging 75 mm.

Table 2.2.1 enumerates the minimum, maximum and mean monthly temperature culled from the weather data of RTNMC and CBNC in the last 20 years. The table indicates that the area is generally warm, having an average annual temperature of 27.1 ^{0}C. The hottest period occurs on April and May where the average monthly temperature reached 28.1^{0}C. The coldest month is January, which has an average temperature of 26.4^{0}C.

Table 2.2.1. Minimum, Maximum and Mean Temperature

Month	Temperature (^{0}C)		
	Minimum Temp. (^{o}C)	Maximum Temp. (^{o}C)	Mean Temp. (^{o}C)
January	22.5	29.0	26.4
February	22.5	30.3	27.0
March	23.2	30.8	27.6
April	24.0	31.9	28.3

Month	Temperature (°C)		
	Minimum Temp. (°C)	Maximum Temp. (°C)	Mean Temp. (°C)
May	24.3	31.4	28.2
June	23.5	31.0	27.2
July	23.1	30.5	26.8
August	23.3	30.0	27.0
September	23.0	29.9	26.8
October	23.1	29.9	26.8
November	23.2	30.4	27.0
December	23.0	29.5	26.7
Annual	23.2	30.4	27.1

Source: 1994-2013 temperature data of RTNMC and CBNC

Evapotranspiration

Evapotranspiration is the amount of water released to the atmosphere through evaporation from soil and surface-water bodies and through plant transpiration. Potential evapotranspiration (PET) is the evapotranspiration that would occur if sufficient water is always available while actual evapotranspiration (AET) is the evapotranspiration that occurs from the actual water available. **Table 2.2.2** summarizes the computed monthly and annual PET and AET values. The table indicates that the AET varies widely throughout the year. It is highest in June where it averages of 100 mm per month. It begins to drop thereafter until it attains its lowest monthly average of 56 mm in February before increasing again. The annual estimated AET in the area is 1,035 mm. This constitutes 40% of the total annual rainfall in the area.

Table 2.2.2. Monthly and Annual PET and AET

Period	PET (mm/mo)	AET (mm/mo)
January	88.4	80.5
February	96.0	56.0
March	105.0	64.3
April	116.9	96.5
May	117.5	99.7
June	105.2	100.2
July	99.4	92.9
August	101.0	94.2
September	97.0	92.6
October	94.5	91.5
November	95.2	86.9
December	90.9	80.2
Annual	1,207.2	1,035.4

Drainage Systems

The area occupied by AMA-IVB-144A lies within the catchments of five (5) drainage systems, which are the Canipan, Sumbiling, Tuba, Ocayan and Iwahig river systems. The Canipan River flows within Rizal Municipality and drains at the southwest coast of Palawan, while the rest of the rivers are situated within Bataraza and reach the southeast coast of the island. Large sections of these rivers pass through cultivated lowlands and are used for irrigation and also for bathing and washing clothes. **Figure 2.2.1** displays these river systems.

Canipan River

Canipan River is a large river system that occupies a watershed area of 10,097 hectares. It drains the northern and western slopes of Bulanjao Range and the lowlands to the west of the mountain range. The main trunk of this river flows generally southwest before shifting west at Brgy. Canipaan, Rizal to empty at Canipan Bay in the West Philippine Sea. Four large tributaries of this river drain the northwestern to western sections of AMA-IVB-144A.

Sumbiling River

Sumbiling River spans a catchment area of 4,994 hectares. It drains the southwest slopes of Mount Bulanjao and the hilly to undulating area to the southwest of the mountain range. The river moves through large portions of barangays Sumbiling and Taratak before draining at Coral Bay in Sulu Sea.

Four tributaries of Sumbiling River drain the western to southwestern sections of AMA-IVB-144A. These tributaries were observed to flow clear water at the time it was inspected in the 2nd half of August 2015. Their creek beds contain a slight to moderate amount of mud sediments which suggest that the water in these tributaries become turbid during heavy rains. **Plate 2.2.1** shows Pipiniton Creek, one of the tributaries that drain the southwestern section of AMA-IVB-144A.

Plate 2.2.1. Pipiniton Creek has a rocky creek bed that displays slight mud staining. The waterfalls in this creek is a picnic site and is being considered as a Level 2 water source for Brgy. Sumbiling.

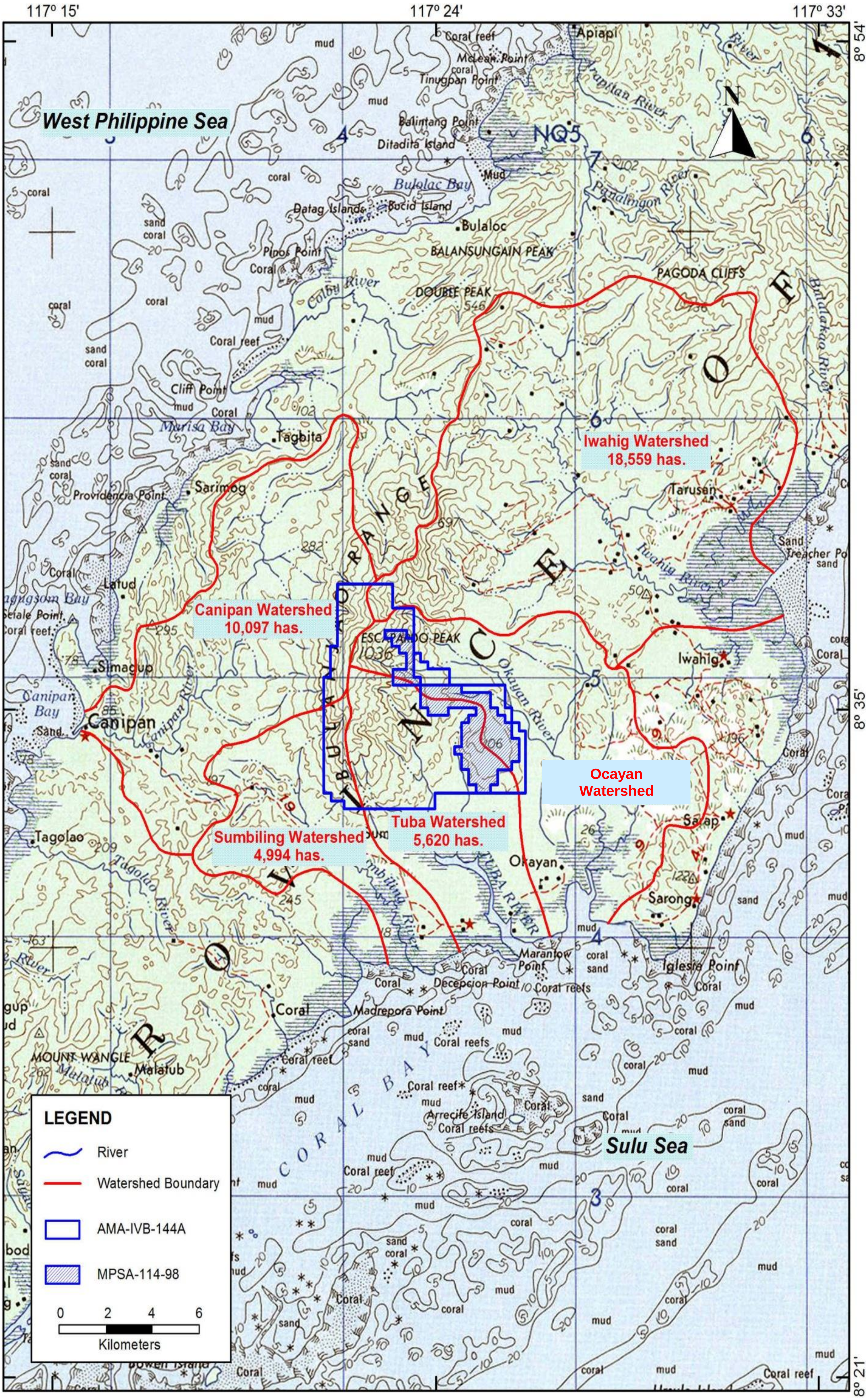


Figure 2.2.1. Drainage and Watershed Map

Tuba River

Tuba River encompasses a watershed area 5,620 hectares. The river drains the southeastern section of Bulanjao Range and the lowlands southeast of the mountain range, which comprises the large portions of Barangays Taratak and Rio Tuba. It then empties at reaches Coral Bay in Sulu Sea.

Four tributaries of this river drain the central and southern sections of AMA-IVB-144A. Two of these likewise pass through areas occupied by the present mining area and its facilities. These tributaries are therefore channeled to the Upper and Lower Togpon Siltation Ponds and the Upper and Lower Kinurong Siltation Ponds to allow suspended solids to settle and clarify the water first before being discharged back to the main trunk of Tuba River. **Plate 2.2.2** shows Gadsan Creek, the confluence of the East and West Ibelnan Creeks, which are some of the tributaries of Tuba River that drain the central and southern sections of AMA-IVB-144A.

Plate 2.2.2. Gadsan Creek has a muddy to gravelly creek bed. It is used for bathing and washing by residents in the area, particulary during the dry season.

Ocayan River

Ocayan River (**Plate 2.2.3**) spans a catchment area of 8,764 hectares. This river originates at the central and eastern sections of Bulanjao Range and flows through lowlands to the southeast of the mountain range, which includes large portions of Barangays Rio Tuba and Ocayan, and smaller sections of Barangays Sandoval, Iwahig, Igang-Igang, and Sarong. It then empties at Coral Bay in Sulu Sea.

Some of its tributaries drain the central to eastern sections of AMA-IVB-144A and also a large portion of the present mining area. Those that move through the present mine area are channeled to the Tagpisa Siltation Pond first to allow suspended solids to settle and clarify the water first before it is re-directed to the river. One of these tributaries is Umawi Creek, which is the source for the Level 3 water system that supplies Barangay Rio Tuba and the RTNMC townsite and mine offices.

Iwahig River

Iwahig River constitutes the largest river system in the area, encompassing an 18,559-ha watershed. However, only the northeast corner of AMA-IVB-144A is drained by this river. The headwaters of Iwahig River originate at the eastern flank of Bulanjao Range and flow in a general east direction. The river then moves through undulating lowlands that comprises a large portion of Barangay Tarusan and smaller sections of Barangays Culandanum, Sandoval, and Iwahig before reaching San Antonio Bay in Sulu Sea.

Plate 2.2.3. The main trunk of Ocayan River as viewed from Ocayan Bridge along the highway. The river, which has a muddy to gravelly bed, is used for irrigating farmlands and for bathing and washing clothes.

Tributaries of Iwahig River that are located in the alluvial plain near the base of Mount Bulanjao were observed to flow generally clear water and have sandy to gravelly riverbeds. **Plate 2.2.4** shows Baracbaracan Creek, the tributary that drains the northeast corner of AMA-IVB-144A and serves as the source of one of the Level 2 community water systems installed by RTNMC and CBNC.

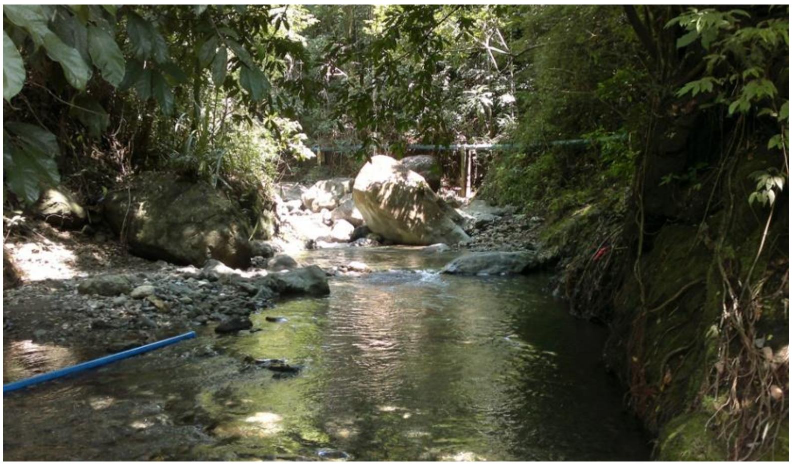


Plate 2.2.4. Baracbaracan Creek has rocky, bouldery creek bed and flows clear water except during heavy rains when the water becomes slight to moderately turbid

Water Balance and Stream Discharge

Table 2.2.3 summarizes the water balance for the area. The rainfall, actual evapotranspiration, groundwater recharge, and stream discharge values in the tables are already converted to million cubic meters (MCM). **Table 2.2.3** also reveals that the annual rainfall in the Canipan, Sumbiling, Tuba, Ocayan and Iwahig watersheds amounts to 263.6, 130.4, 146.7, 228.8 and 484.5 MCM, respectively. Stream discharge, actual evapotranspiration and groundwater recharge take up 52%, 40%, and 8% of the rainfall, respectively.

Table 2.2.3. Water Balance Summary

Period	Canipan Watershed (10,097 hectares)				Sumbiling Watershed (4,994 hectares)				Tuba Watershed (5,620 hectares)				Ocayan Watershed (8,764 hectares)				Iwahig Watershed (18,559 hectares)			
	P	AET	GWR	Q	P	AET	GWR	Q	P	AET	GWR	Q	P	AET	GWR	Q	P	AET	GWR	Q
	Million Cubic Meters (MCM)																			
Jan	19.6	8.1	1.6	9.9	9.7	4.0	0.8	4.9	10.9	4.5	0.9	5.5	17.0	7.1	1.4	8.6	36.0	14.9	2.9	18.2
Feb	7.0	5.6	0.6	0.7	3.4	2.8	0.3	0.4	3.9	3.1	0.3	0.4	6.0	4.9	0.5	0.6	12.8	10.4	1.0	1.4
Mar	8.2	6.5	0.7	1.1	4.1	3.2	0.3	0.5	4.6	3.6	0.4	0.6	7.1	5.6	0.6	0.9	15.1	11.9	1.2	2.0
Apr	17.2	9.7	1.4	6.1	8.5	4.8	0.7	3.0	9.6	5.4	0.8	3.4	15.0	8.5	1.2	5.3	31.7	17.9	2.5	11.2
May	19.0	10.1	1.5	7.4	9.4	5.0	0.8	3.7	10.6	5.6	0.8	4.1	16.5	8.7	1.3	6.5	35.0	18.5	2.8	13.7
Jun	33.2	10.1	2.7	20.4	16.4	5.0	1.3	10.1	18.5	5.6	1.5	11.4	28.8	8.8	2.3	17.7	61.1	18.6	4.9	37.6
Jul	26.2	9.4	2.1	14.8	13.0	4.6	1.0	7.3	14.6	5.2	1.2	8.2	22.8	8.1	1.8	12.8	48.2	17.2	3.9	27.2
Aug	26.3	9.5	2.1	14.7	13.0	4.7	1.0	7.3	14.6	5.3	1.2	8.2	22.8	8.3	1.8	12.7	48.3	17.5	3.9	27.0
Sep	31.6	9.4	2.5	19.7	15.6	4.6	1.3	9.8	17.6	5.2	1.4	11.0	27.4	8.1	2.2	17.1	58.1	17.2	4.6	36.3
Oct	36.6	9.2	2.9	24.4	18.1	4.6	1.4	12.1	20.3	5.1	1.6	13.6	31.7	8.0	2.5	21.2	67.2	17.0	5.4	44.8
Nov	21.5	8.8	1.7	11.0	10.6	4.3	0.9	5.4	12.0	4.9	1.0	6.1	18.7	7.6	1.5	9.5	39.5	16.1	3.2	20.2
Dec	17.2	8.1	1.4	7.7	8.5	4.0	0.7	3.8	9.6	4.5	0.8	4.3	14.9	7.0	1.2	6.7	31.6	14.9	2.5	14.1
Annual	263.6	104.5	21.1	138.0	130.4	51.7	10.4	68.2	146.7	58.2	11.7	76.8	228.8	90.7	18.3	119.8	484.5	192.2	38.8	253.6
% of P		40	8	52		40	8	52		40	8	52		40	8	52		40	8	52

Hydrogeology

Geology

The basement rocks in Southern Palawan consist of the pre-Middle Eocene Palawan Ophiolite which thrusted upon older pre-Tertiary rocks (Encarnacion, et al, 1995). The ophiolite exhibits an almost complete sequence consisting of basal mantle harzburgite, dunite, gabbro and pillow basalts that are associated with cherty sediments (Raschka, et al., 1985). Highly folded and fractured Eocene to Middle Miocene sedimentary rocks overlie the ophiolite and are in turn overlain by low to moderately dipping Middle Miocene to Pleistocene sedimentary rocks and Recent deposits (MGB, 1982).

Figure 2.2.2 depicts the geologic map of the central sections of Bataraza and Rizal municipalities in southern Palawan as compiled from Cabrera, 1985; Sto. Domingo et al., 1989 and the Mines and GeoSciences Bureau, 1989. The map shows that seven major rock units underlie the area. They are from oldest to youngest, the Late Cretaceous Mt. Beaufort Ultramafics, the Late Cretaceous to Early Eocene Espina Formation, the Paleocene to Early Eocene Panas Formation, the Oligocene Pandian Formation, the Late Miocene Sayab Formation, the Pliocene Iwahig Formation and the Quaternary Alluvium.

The Mt. Beaufort Ultramafics comprises the southern portion of Bulanjao Range at central Bataraza and the core of Mt. Sarab near the eastern coast. It constitutes the lower segment of the Palawan Ophiolite and is made of serpentinized harzburgite, dunite and pyroxenite. This assemblage serves as the parent rocks of the nickel laterite deposit that is being mined by RTNMC.

The Espina Formation underlies the northeastern section of Bulanjao Range. It consists of spilitic basalt and chert that represent the upper section of the Palawan Ophiolite. The basalt exhibits abundant pillow structures and is generally highly fractured. The chert is deep red to orange, thinly bedded and laminated, and is commonly found along the borders of the pillow structures (Cabrera, 1985).

Highly folded and indurated, well-bedded quartz-rich sandstone, shale/siltstone and mudstone characterize the Panas Formation. Rocks of this formation surround the ultramafic and basaltic rocks and occur extensively to the southeast and southwest of Bulanjao Range. The sandstone is light brown to gray, thinly bedded and highly indurated, while the shale and siltstone are brown to dark gray, thinly bedded and friable.

The Pandian Formation outcrops extensively at the western side of southern Palawan. It conformably overlies the Panas Formation and consists of massive, porous, arkosic sandstone intercalated with mudstone and shale. The sandstone is light brown to gray, friable, and is primarily composed of fine to coarse grained, sub-angular to sub-rounded quartz and feldspar grains. The mudstone and shale layers are well indurated.

Gently dipping sandstone and shale interbeds of the Sayab Formation unconformably overlie the Panas Formation to the east of Bulanjao Range. The sandstone of this formation is light gray to reddish brown and is made up mainly of fine to medium grained quartz grains. The shale is reddish brown, silty and occasionally displays laminations.

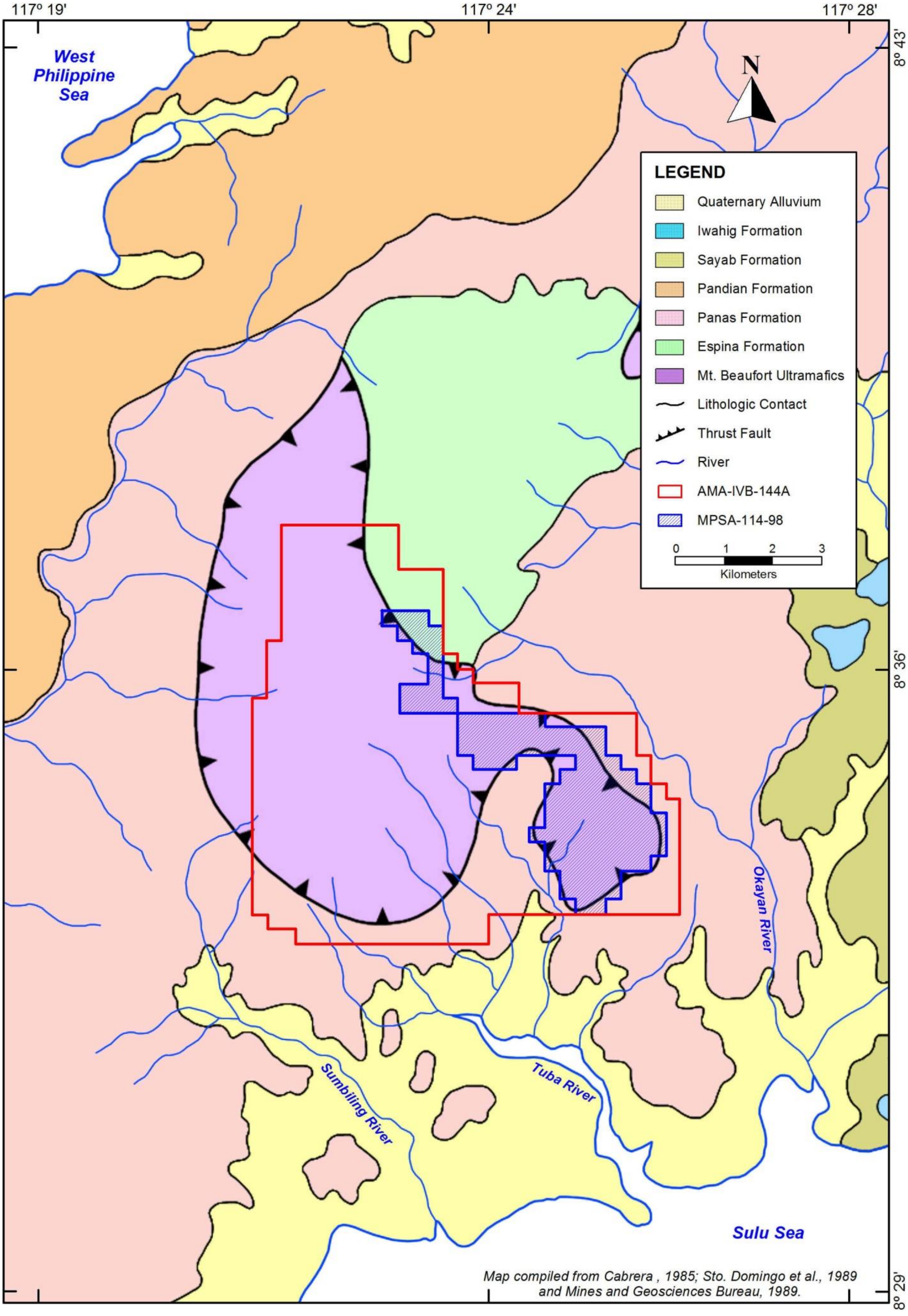


Figure 2.2.2. Geologic Map

The Iwahig Formation rests on the Sayab Formation. It consists of two (2) members, namely the Panoyan Limestone and the Pusok Conglomerate. Pebbles composed of chert, limestone and indurated sediments comprise the Pusok Conglomerate, while the Panoyan Limestone consists of creamy white to beige, massive, coralline limestone. Outcrops of the Panoyan Limestone only are exposed in Bataraza and the surrounding areas. They occur as steep karstic hills that rise above the undulating terrain to the east of Bulanjao Range.

Quaternary alluvial and limestone deposits comprise the youngest rocks. The alluvium consists of consolidated to unconsolidated gravel, pebbles, sand and silt that are derived from the older rocks. They mantle the coast and plains of southern Palawan. The limestone occupies areas adjacent to the shoreline. They consist of raised coral reefs that gently dip seaward.

Geologic Structures

The main structural feature in the region is the thrust fault contact between the ultramafic rocks and the older sedimentary and volcanic rocks. The thrusting caused intense shearing and faulting along the margins of the ophiolite and folding, faulting and jointing in the adjacent rocks (Cabrera, 1985). The fault and fold structures that developed as a result of the thrusting generally trend north to northeast.

Water Source Inventory

The barangays of Bataraza surrounding AMA-IVB-144A used to rely on wells and some springs for their domestic water requirements. The wells are public and private shallow dug wells and drilled wells cased with 38 to 102 mm diameter G.I. pipes (**Plate 2.2.5**). They reach 6 to 49 m depth and are fitted with hand pumps and sometimes electric centrifugal pumps. The more reliable and durable public wells are those installed by the Pilipino-Aleman Proyekto ng Tubig sa Palawan (PALTUBIG) project in the 1990s, which was funded by the Federal Republic of Germany (**Plate 2.2.6**). Many of the PALTUBIG wells function up to present.

Plate 2.2.5. Shallow cased wells such as this one provide water for drinking, washing and bathing for many residents in Brgy. Taratak.

The springs on the other hand, are depression springs whose water comes from the intersection of the water table with an abrupt break in the land slope (**Plate 2.2.7**). The springs were mainly used for bathing and washing clothes.

Plate 2.2.6. The PALTUBIG well of Sitio Tagpisa, Ocayan was constructed in the mid 1990s. It is still an important water source particularly when the supply from the Level 2 water system is temporarily disrupted.

Plate 2.2.7. The Oning Spring in Brgy. Sandoval was a major source of water for residents in the are prior to the installation of the Level 2 water system. It is still being used occasionally for washing an bathing.

Since 2010 however, Barangay Rio Tuba was supplied by a Level 3 water system installed by RTNMC and CBNC (**Plate 2.2.8**). The barangay almost exclusively relies on this water system whose source is the Umawi Creek, which is a tributary of Ocayan River that originates at the eastern slopes of Mount Bulanjao.

Plate 2.2.8. The raw water treatment facility of the Level 3 water system beside Umawi Creek has several screens and settling ponds to filter and settle suspended solids prior to chlorination.

Barangays Sandoval and Iwahig and many portions of Ocayan, Culandanum, Igang-Igang and Sarong were also connected to a Level 2 water system likewise developed by RTNMC and CBNC in 2013 (**Plate 2.2.9**). The source of this water system is Baracbaracan Creek, which is a tributary of Iwahig River that similarly originates at the eastern slopes of Mount Bulanjao.

Both water systems employ intake dams to divert raw surface water to a series of screens and settling ponds to filter debris and settle suspended sediments. The water is then chlorinated before distribution by gravity flow through a network of pipes along the national road and barangay roads.

Plate 2.2.9. A series of screens and settling ponds at the raw water treatment facility beside Baracbaracan Creek ensures that the water of the Level 2 water system is clear and free of debris before it is chlorinated and piped to the users.

Barangays Taratak and Sumbiling still depend on shallow dug wells and deep wells and also on creeks that drain the western and southwestern slopes of Mount Bulanjao for their water requirements.

RTNMC also installed five (5) deep wells in the 1980s and 1990s to supply water to its townsite and mine offices. These sites now also rely on the Umawi Creek water system for its water supply. Except for the first well that has been abandoned in the 1990s because of saltwater contamination problems, the RTNMC wells are presently maintained on standby mode for emergency purposes.

Figure 2.2.3 shows the location of the Umawi and Baracbaracan intake facilities and the more important wells in the vicinity of AMA-IVB-144A. It must be noted that many shallow wells with hand pumps exist in the lowlands to the east of Mount Bulanjao. However, since this area is already supplied by a water system, these wells are barely used and are often left to deteriorate. These wells have not been included in the inventory. **Table 2.2.4** summarizes the water source data.

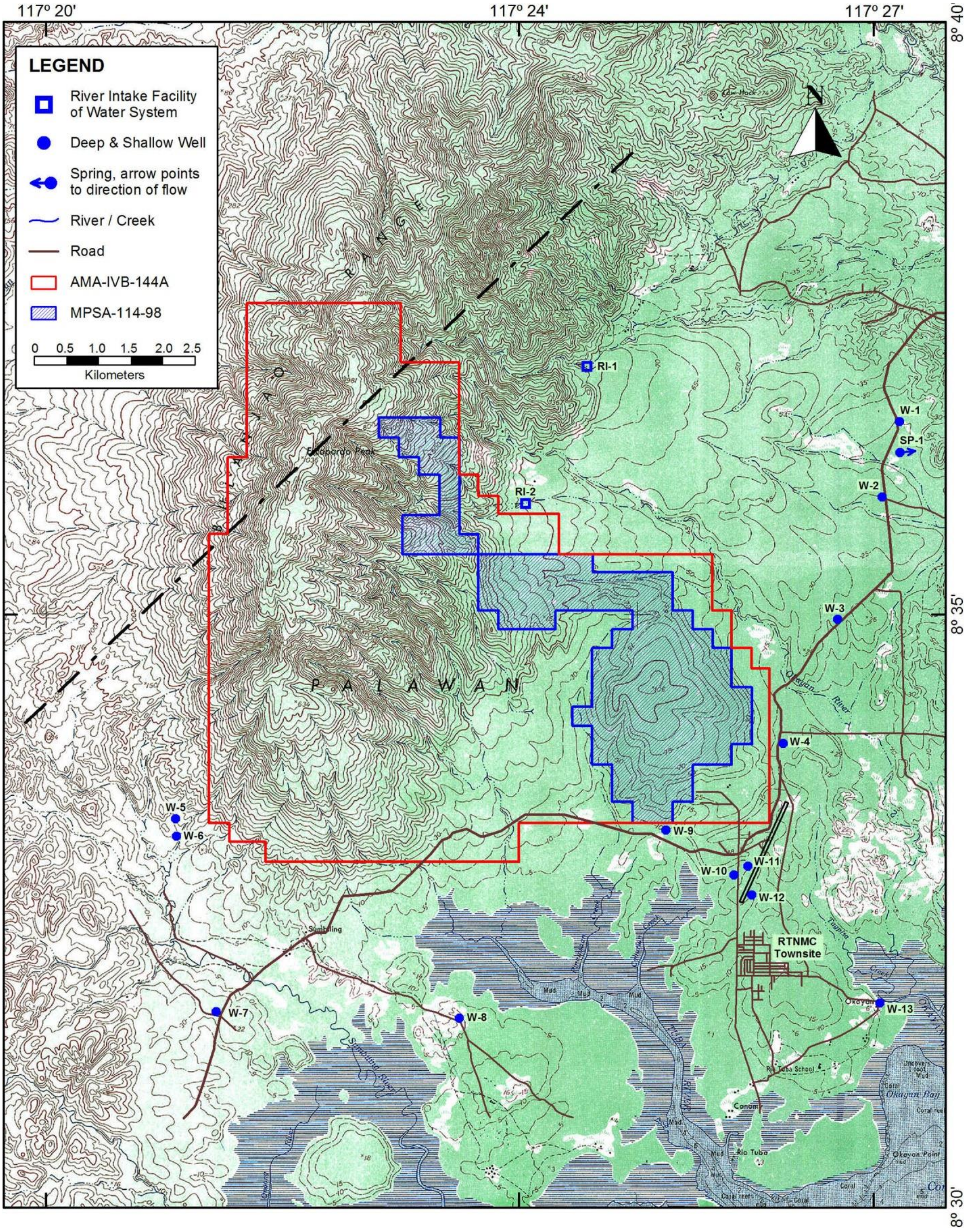


Figure 2.2.3. Water Source Location Map

Table 2.2.4. Summary of Water Source Inventory

Water Source ID	Type	Location	Owner	Depth (m)	Casing Φ (mm)	EC* (µS/cm)	pH	Physical Appearance	Remarks
RI-1	River intake	Sandoval	RTNMC & CBNC	---	---	160	7.7	Clear, odorless	Supplies Sandoval, Iwahig, Ocayan, Kulandanum, Igang-Igang and Sarong
RI-2	River intake	Ocayan	RTNMC & CBNC	---	---	170	7.5	Clear, odorless	Supplies Bgy. Rio Tuba and RTNMC townsite and mine offices
W-1	Deep Well	Sandoval	BWSA Bicol Village	21	102	---	---	Clear, odorless	Not operational, needs gasket replacement
W-2	Deep Well	Sandoval	BWSA Gotok	22.4	102	580	7.6	Clear, odorless	Used for drinking, washing and bathing particularly when supply from Level 2 water system is disrupted
W-3	Deep Well	Ocayan	BWSA Ocayan	45.7	100	490	7.3	Clear, odorless	Used for drinking, washing and bathing particularly when supply from Level 2 water system is disrupted
W-4	Deep Well	Ocayan	BWSA Tagpisa	15.6	102	460	7.5	Clear, odorless	Used for drinking, washing and bathing particularly when supply from Level 2 water system is disrupted
W-5	Shallow Well	Taratak	Kennedy Coreo	6	32	500	7.6	Clear, odorless	Used for drinking, washing and bathing
W-6	Dug Well	Taratak	Paquito Bartolome	3	800	530	7.4	Clear, odorless	Used for drinking, washing and bathing
W-7	Deep Well	Sumbiling	BWSA Sumbiling	---	102	190	7.5	Clear, odorless	Used for drinking, washing and bathing, main water source of barangay proper
W-8	Deep Well	Taratak	BWSA Taratak	---	102	660	7.3	Clear, odorless	Used for drinking, washing and bathing, main water source of barangay proper
W-9	Deep Well	Rio Tuba	RTNMC	18.7	300	---	---	---	RTNMC WW5, Presently inactive because of defective pump
W-10	Deep Well	Rio Tuba	RTNMC	34	300	750	7.3	Clear, odorless	RTNMC WW2, on standby for water supply of townsite and mine offices
W-11	Deep Well	Rio Tuba	RTNMC	35	300	670	7.2	Clear, odorless	RTNMC WW3, on standby for water supply of townsite and mine offices
W-12	Deep Well	Rio Tuba	RTNMC	49	300	680	7.3	Clear, odorless	RTNMC WW4, on standby for water supply of townsite and mine offices
W-13	Deep Well	Rio Tuba	BWSA Bukid-Bukid	33	102	---	---	---	Not operational, needs gasket replacement
SP-1	Spring	Sandoval	---	---	---	360	7.3	Slightly cloudy, odorless	Used only for washing and bathing

*Note: *electrical conductivity*

Aquifer Characteristics

The geology of the area and the findings of the water source inventory, particularly the presence of wells that range from 3 to 49 m depth, indicate that shallow unconfined aquifers as well as deeper, presumably confined aquifers exist in the lowlands surrounding Mount Bulanjao. The shallow confined aquifers consist of the silty to gravelly deposits in the Quaternary Alluvium, the upper, weathered portions of the sandstones in the Panas and Sayab Formations, and also the upper, weathered portions of the limestone in the Iwahig Formation. The confined aquifers also consist of these types of deposits that occur at more than 20 m depth and are overlain by generally impermeable clay, mudstone and shale layers.

Considering the shifting, intertonguing nature of alluvial deposition, folded and bedded nature of the Panas and Sayab formations, and the limited coverage of the limestone and conglomerate members of the Iwahig Formation, both unconfined and confined aquifers are not expected to be thick nor extensive but instead thin and locally disconnected.

Both types of aquifers yield generally clear and odorless groundwater that is abundant during the rainy season. During the dry season, the yield of the shallow unconfined aquifers sharply diminishes compared to the deeper aquifers.

Distribution of Hydrogeologic Units

Based on the geology of the area and the findings of the water source inventory, the area comprising AMA-IVB-144A and its immediate surroundings may be delineated into three (3) hydrogeologic units.

The first hydrogeologic unit consists of the rugged mountains and foothills of Bulanjao Range. These are underlain by ultramafic rocks, spilitic basalt flows, pillow basalts, and chert of the Mt. Beaufort Ultramafics and Espina Formation. Being generally hard and dense but moderately fractured, these rocks are deemed to be slightly permeable only and are expected to yield little amounts of groundwater.

The gently undulating terrain that is underlain by folded and dipping rocks of the Panas, Pandian, Sayab, and Iwahig formations constitute the second hydrogeologic unit. The moderately consolidated nature of the sandstones in the Panas, Pandian and Sayab formations and the massive but vuggy characteristic of the limestone in the Iwahig Formation render them relatively porous and permeable. They are able to store and yield slight to moderate amounts of groundwater.

The Quaternary Alluvium makes up the third hydrogeologic unit. This consists of unconsolidated to loosely consolidated gravel, sand, silt and clay, and also the raised coral reefs of Quaternary age to along river valleys and beaches. Their high degree of porosity and permeability permit them to store and transmit relatively large amounts of groundwater. However, alluvial deposits near the shoreline are prone to saltwater intrusion.

Figure 2.2.4 illustrates the hydrogeologic map of the area prepared according to this classification scheme.

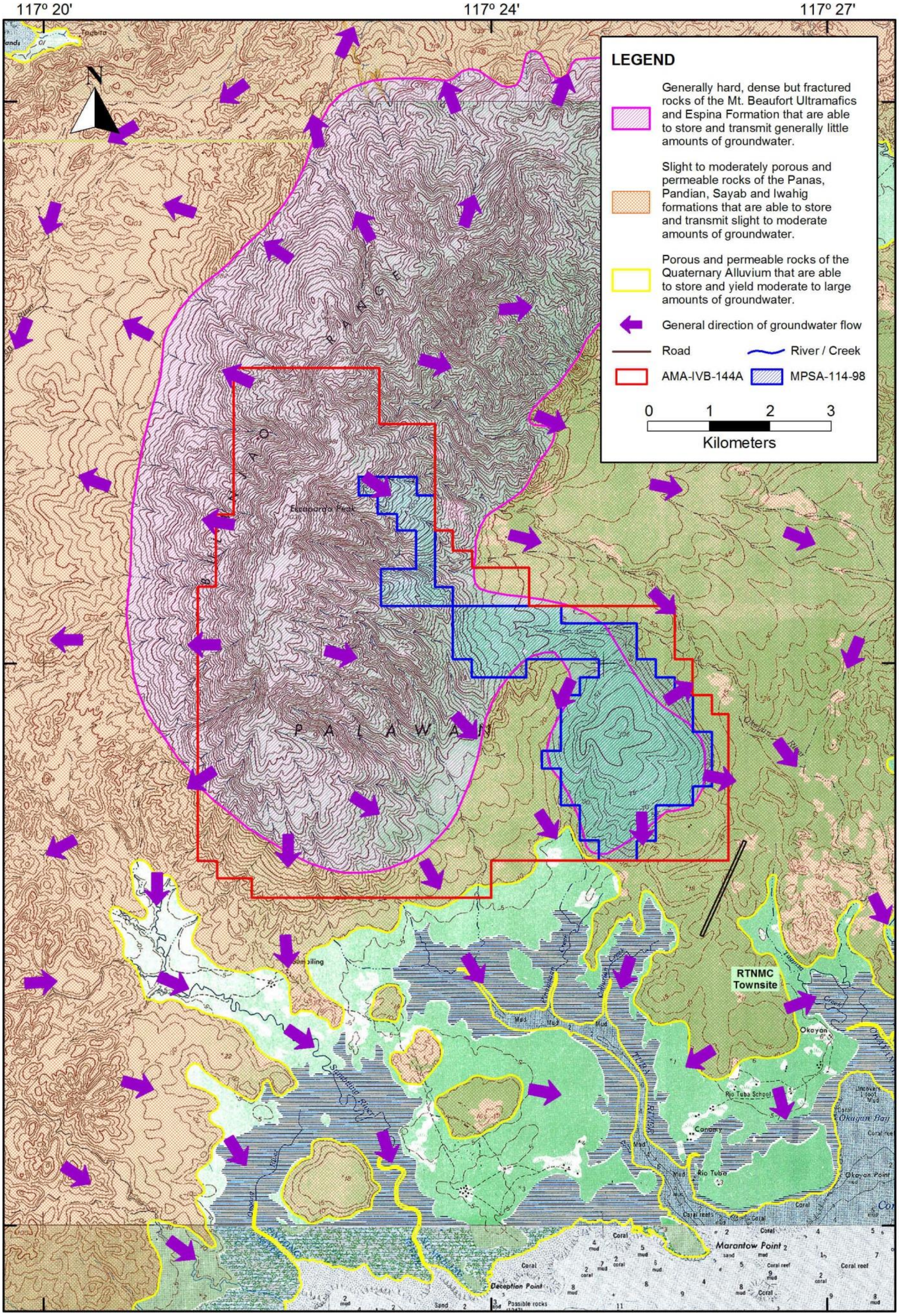


Figure 2.2.4. Hydrogeologic Map

Groundwater Levels, Flow Direction and Recharge

The presence of dug wells and shallow wells in the lowlands surrounding AMA-IVB-144A indicates that the groundwater level in these areas is not more than 6 m below the ground level. In low-lying areas, the groundwater level even intersects the surface as indicated by the presence of depression springs like the Oning Spring.

Groundwater moves from high to low elevation head and will therefore follow the topographic gradient. This means that from Mount Bulanjao, the groundwater will move downward in all directions and travel across the surrounding alluvial and coastal plains following the general flow direction of the drainage systems in the area. The groundwater will ultimately discharge at the surrounding seas.

The aquifers in the vicinity of the project site are replenished from direct rainfall infiltration, infiltration from the tributaries of the Iwahig and Ocayan rivers and groundwater movement from high to low areas. Based on the water balance, the area takes in approximately 8% of the rainfall as groundwater recharge.

2.2.1.3 Impact Assessment

The key impacts of the proposed project on hydrology and hydrogeology are presented in **Table 2.2.5.** Flood modelling was also conducted to determine the possibility of flooding in the project site and surrounding communities. The full flood modeling study is attached as **Annex 2.2.1.**

Flood Modeling

Areal Coverage of the Flood Model

The sub-basins covered by the river network are delineated for use in the rainfall-on-the-mess flood modeling taking into consideration the location of the proposed mining development. The sub-basins were delineated using GIS and are based on freely available 30 m digital elevation model (DEM) for Bataraza, Palawan and its various river systems surrounding the project area, the result of which is shown as **Figure 2.2.5.**

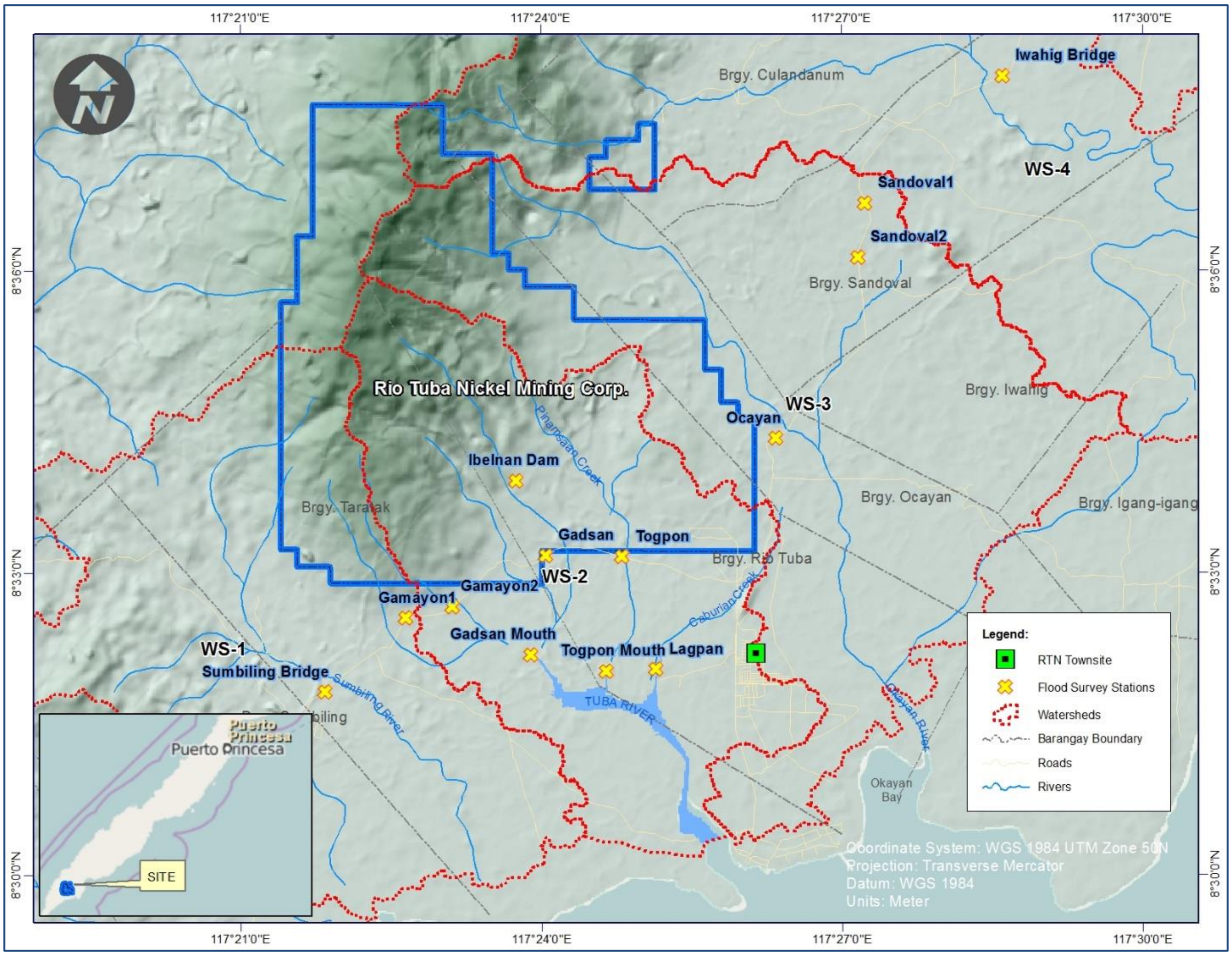


Figure 2.2.5. The GIS-generated sub-basins surrounding the Project Area using the 30-m DEM. Polygons outlined in red represent the extent of each sub-basin used for flood simulations.

<u>Hydrodynamic Model</u>

Hydraulically, the river systems surrounding the project area are within the sub-basins denoted in the map as WS-1, WS-2 and WS-3 that eventually converge to the Ocayan River. The interconnected network of rivers and creeks upstream are partly affected by tidal fluctuations due to its connection to the open sea. Broadly speaking, channel flows are easier to model accurately with a 1D hydraulic network model (e.g. based on the 1D St-Venant Equations), while 2D models are better suited to modelling overland flows (e.g. based on the 2D shallow water equations).

To simulate extreme flood situation in the proposed project area, a flood magnitude that may occur at least once in a hundred years on average (a 100-year flood) is used to run the hydraulic model.

As for the initial conditions in the model runs, it was assumed that the water surface elevation at the downstream boundary (at the river mouth) is taken to be about one (1) meter above the mean sea level which corresponds to high tide level. Specifying higher-than-normal tide level would ensure decreased water surface profiles in the river mouth, which may provide backwater effects and is therefore representative as extreme event for flood scenario modeling.

An initial simulation runs for about 6 hours using 3 mm of rainfall to the catchment is used for appropriate antecedent condition (so called 'warm start') before running the computations for the design storm to remove depressions in the DEM that were not directly connected to the drainage system. The 3 mm was based on the magnitude of rainfall before and after the design 24-hour storm hyetograph.

Figures 2.2.6 and **2.2.7** show the simulated maximum flood depth including portions of the floodplain for a 100-year return period. The model shows the general trends of floodplain inundation. Most of the floodwaters are confined in the main rivers and tributaries, with some patches of inundation visible near the riverbanks indicating overflows and those isolated areas representative of depression storages in the catchment.

For convenience of displaying results, the flood study area was zoomed in to the RTNMC site to show and exhibit the flood map in sufficient detail. Given these maps, the modeling predicts that the majority of the RTNMC mining areas are not prone to riverine floods for both simulations of pre and post-development. This is due to the fact that the area is located quite far upstream of the watershed.

For the post-development scenario, the DEM used for topographic representation of the area is reduced by 10 meters to represent mining development within the RTNMC Property (shown as blue polygon). Using this reduced elevation in the proposed mining area in the simulation, it revealed no major changes in the flood characteristics of the areas downstream of the project area based on comparative results of the two scenarios. Within the project area, however, depression storage at the downstream-most portion of the mining area which is visible under the pre-development scenario would become moderately larger in scope once the project becomes operational. This can be attributed to the potential changes in topography in that particular area during project implementation.

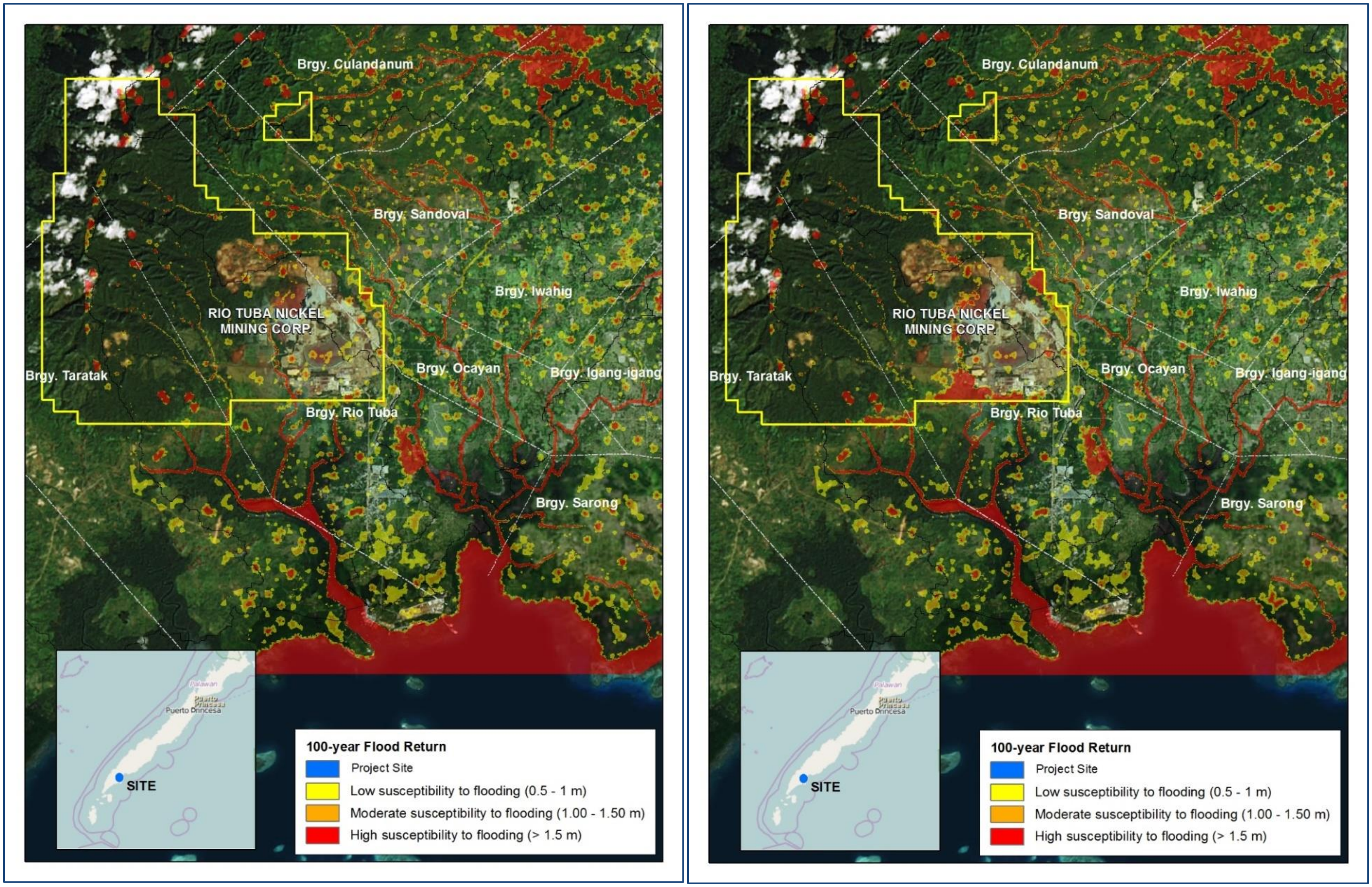


Figure 2.2.6. The predicted flood inundation maps within the sub-basins surrounding the RTNMC proposed project area for a 100-year flood event using the baseline condition (pre-development, left) and with project (right figure).

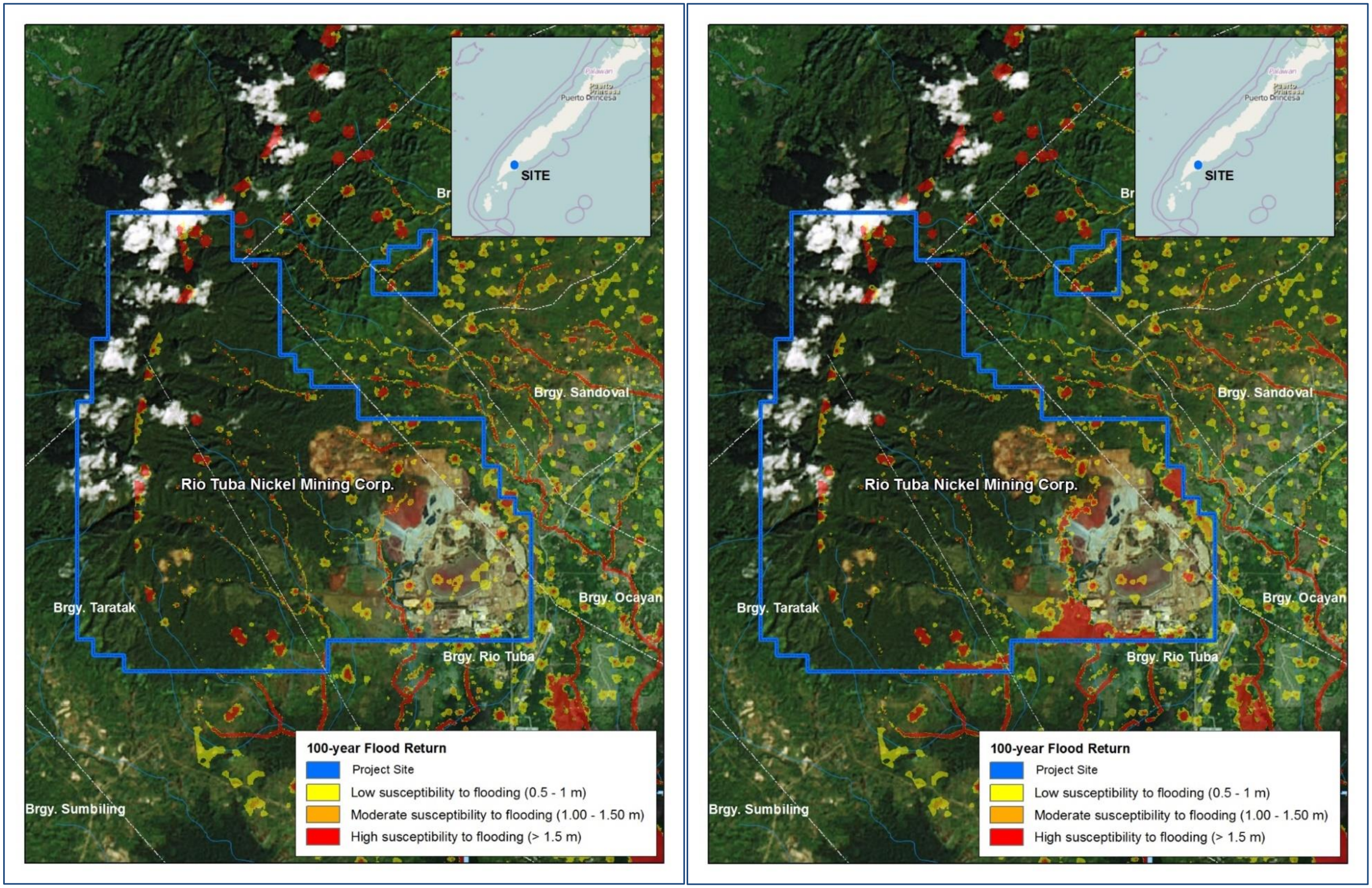


Figure 2.2.7. A closer perspective on the RTNMC proposed site showing predicted flood inundation for a 100-year flood event using the baseline condition (pre-development, left) and with Proposed project (right figure).

From the velocity vector plots overlaid in the given map, high flood events occur at the main channel while the inundation areas are within the riverbanks and depression areas specially those located in the downstream and midstream portions of the catchment.

From the maps, it can be seen that some portions in the project site have become prone to overland flooding due to some changes in elevation brought by physical development of the site. With appropriate engineering interventions once the project is operational, however, flooding in the area will remain to be minimal.

Note that while the model output is highly dependent on the topographic inputs, which in this study, is too coarse to warrant micro-level analysis of flooding, the result is quite promising. With better detailed model inputs, the maps generated can be used to determine which areas are vulnerable to flood which can then serve as guides in the preparation of flood defenses and other flood mitigating measures.

Table 2.2.5. Impacts assessment and mitigation for hydrology

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
• **Change in stream depth** Rivers and creeks that carry a high sediment load will eventually silt up. When siltation reaches the drainage systems at the lowlands, the normal flow of water is impeded and will cause localized flooding during the rainy season. Areas near heavily silted drainage lines will be more prone to this type of flooding. Siltation may also invade and ruin farmlands and residential areas adjacent to the rivers and creeks. The river bed af the downstream portion of Ocayan River may be affected during operation due to earth movement.		✓	✓		The development plan proposed by RTNMC includes the construction of interceptor canals that will surround the mining area to north, northwest, west and southwest. These interceptor canals are meant to catch surface runoff coming from the mining area that would otherwise reach the creeks and rivers draining these areas. The intercepted surface runoff will then be directed to four (4) settling ponds that will be constructed to the east of the mining area. Once the suspended sediments in the water have settled, the water will be discharged to the tributaries that drain the eastern section of the mining area. These are tributaries of the Tuba and Ocayan rivers. The construction of the interceptor canals will already involve stripping of vegetation and trenching. Prior to their construction, temporary sediment control measures should be installed at the downstream side of the interceptor canals. These should include silt fences to prevent loose excavated soil and weathered rock from moving downslope and silt traps along gullies and creeks that will be intersected by these canals. Vegetation cover especially trees within the required legal easements for rivers, creeks, riparian zones, and other identified restricted areas should be maintained. Vegetation cover of the buffer zones surrounding the mine pits and access road shall be maintained and enhanced. The vegetation cover is expected to minimize soil erosion and subsequent siltation of water bodies.
• **Inducement of flooding**			✓	✓	

List of Key Impacts	Phase Occurrence: Pre-Construction	Phase Occurrence: Construction	Phase Occurrence: Operation	Phase Occurrence: Abandonment	Options for Prevention or Mitigation or Enhancement
No major changes in the flood characteristics of the areas downstream of the project area based on comparative results of the models. Within the project area, however, depression storage at the downstream-most portion of the mining area which is visible under the pre-development scenario would become moderately larger in scope once the project becomes operational. This can be attributed to the potential changes in topography in that particular area during project implementation Some portions in the project site have become prone to overland flooding due to some changes in elevation brought by physical development of the site (**Annex 2.2.1, Figures 2.1.2** and **2.1.3**) The climate change projections of PAGASA indicate that rainfall will become more during the rainy season and become less during the dry season. Increasing rainfall intensities will increase the frequency of flooding.					Inundation depths at the areas north and east of the project site are predicted to decrease due to the diversion of the flow that were otherwise directed to the site if there are no development. The frequency of flooding may be lessened by increasing the transporting capacity of the rivers and creeks near the project area. This may be done by regularly desilting and deepening their channels and regularly removing debris and water plants that would impede the flow of water.
• **Depletion of water resoures** The exposure of soil and bare rock at AMA-IVB-144A when it is mined will speed up surface runoff and lessen the time for water to infiltrate into ground at the disturbed sites. This will correspondingly lessen groundwater recharge within these sites. However, the excess water could still percolate into the ground outside the disturbed sites. The overall effect to the amount of groundwater at the surrounding alluvial plains is therefore considered to be negligible. Areas beside rivers and creeks at the lowlands that become silted up will have less surface			✓	✓	Keeping bare or exposed areas to a minimum through selective clearing and progressive rehabilitation will allow more water to infiltrate into the ground. It is recommended that approximately 50 ha at a time will be opened for the mining operations and rehabilitation will be immediately implemented after all ores are recovered and prior to opening of another site. Building more and efficient settling ponds and silt traps will lessen siltation at the lowlands and permit more water to infiltrate the surface and recharge the shallow aquifers in these areas. Constructing recharge trenches and pits at the lowlands near the base of Mount Bulanjao and directing surface runoff to these structures will also increase the amount of groundwater recharge to the shallow aquifers in these areas.

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
permeability and will correspondingly receive less groundwater recharge coming from direct rainfall infiltration. This may significantly lessen the amount of available groundwater from the shallow aquifers within these areas. The climate change projections of PAGASA indicate an increase in monthly temperature of up to 1 and 2 degrees for 2020 and 2050 respectively. The projections also reveal a general increase in rainfall during the rainy season and a general decrease during the dry season. These changes will increase evaporation rates and decrease the amount of time for rainfall and surface runoff to percolate into the ground. These will ultimately lessen the amount of groundwater recharge in the area.					

2.2.2 Oceanography

2.2.2.1 Methodology

The discussion presented in this section is based on secondary data from past environmental studies done within the project area and vicinity, from NAMRIA, and from other relevant reference materials gathered by the EIS consultants.

2.2.2.2 Baseline Conditions

The maximum depth of the Tuba River estuary is 20 m from about 3 km from the coastal side. The seabed is generally muddy including shallow coral outcrops. **Figures 2.2.8** and **2.2.9** show the bathymetry and digitized plot of Rio Tuba estuary, respectively (10 km x 6 km).

Tides

The nearest tidal station is located at Balabac Pier, Palawan which is about 50 km from the project area with geographical location of 8°00" N latitude and 117°04' E longitude.

The two (2) types of tide for the Balabac tidal station are the diurnal and semidiurnal. The diurnal type is characterized by one high water and one low water in a lunar day. This type exists when the moon reaches its maximum declination and the maximum tide range occurs during this period. The semidiurnal type exhibits two high waters and two low waters in a lunar day which begins to occur when the moon's declination approaches zero.

The various tidal levels at Balabac station above the mean lower low water (MLLW) are:

Mean Sea Level (MSL)	=	0.628 m
Mean Higher High Water (MHHW)	=	1.308 m
Mean High Water (MHW)	=	1.150 m
Mean Low Water (MLW)	=	0.129 m
Bench Mark Elevation	=	4.597 m

The benchmark in Balabac (BM-3) is placed at the town hall's flagpole 20 m away from the frontage of the municipal building. The mark is a copper nail set in a drilled hole and cemented flush on top of the concrete pedestal of the flagpole with inscription "BM-3, 1986 PCGS".

On December 27 to 28, 2000 the tidal pattern predicted by NAMRIA is of semi-diurnal type.

Figure 2.2.7 indicates that the Rio Tuba pier showed a semi-diurnal type on December 27 to 28, 2000 with tidal range from 0.70 to 2.6 m.

Ocean Currents

On December 27, 2000, the measurements of ocean currents were done while ebb tide current measurements were conducted on December 28, 2000. The mechanical current meter showed that the current speeds range from 1.1 to 5.1 cm/s during flood tide (**Table 2.2.6**) and from 1.2 to 11.3 cm/s during ebb tide (**Table 2.2.7**). **Figures 2.2.11** and **2.2.12** show the plotted current velocity vectors for flood tide and ebb tide, respectively. The currents during ebb tide are generally directed towards the west. The observed current was generally directed to the northeast during the flood tide.

Table 2.2.6. Observed ocean current speed and direction in Rio Tuba River estuary during Flood Tide

Station	Coordinates	Time & Date	Current	
			Speed (cm/s)	Direction
A	8°27'14''N and 117°23'14''E	(9:20 a.m.) 27Dec2000	1.8	NNE (13°)
B	8°28'28''N and 117°24'09''E	(9:55 a.m.) 27Dec2000	2.7	NNE (28°)
C	8°29'07''N and 117°25'54''E	(10:25 a.m.) 27Dec2000	5.1	NE (41°)
D	8°29'40''N and 117°26'37''E	(10:50 a.m.) 27Dec2000	4.5	N (4°)
E	8°30'09''N and 117°27'18''E	(11:15 a.m.) 27Dec2000	1.1	NNE (22°)
F	8°30'10''N and 117°28'41''E	(11:40 a.m.) 27Dec2000	2.2	E (96°)

Source: RTNMC HPP EIS, 2001.

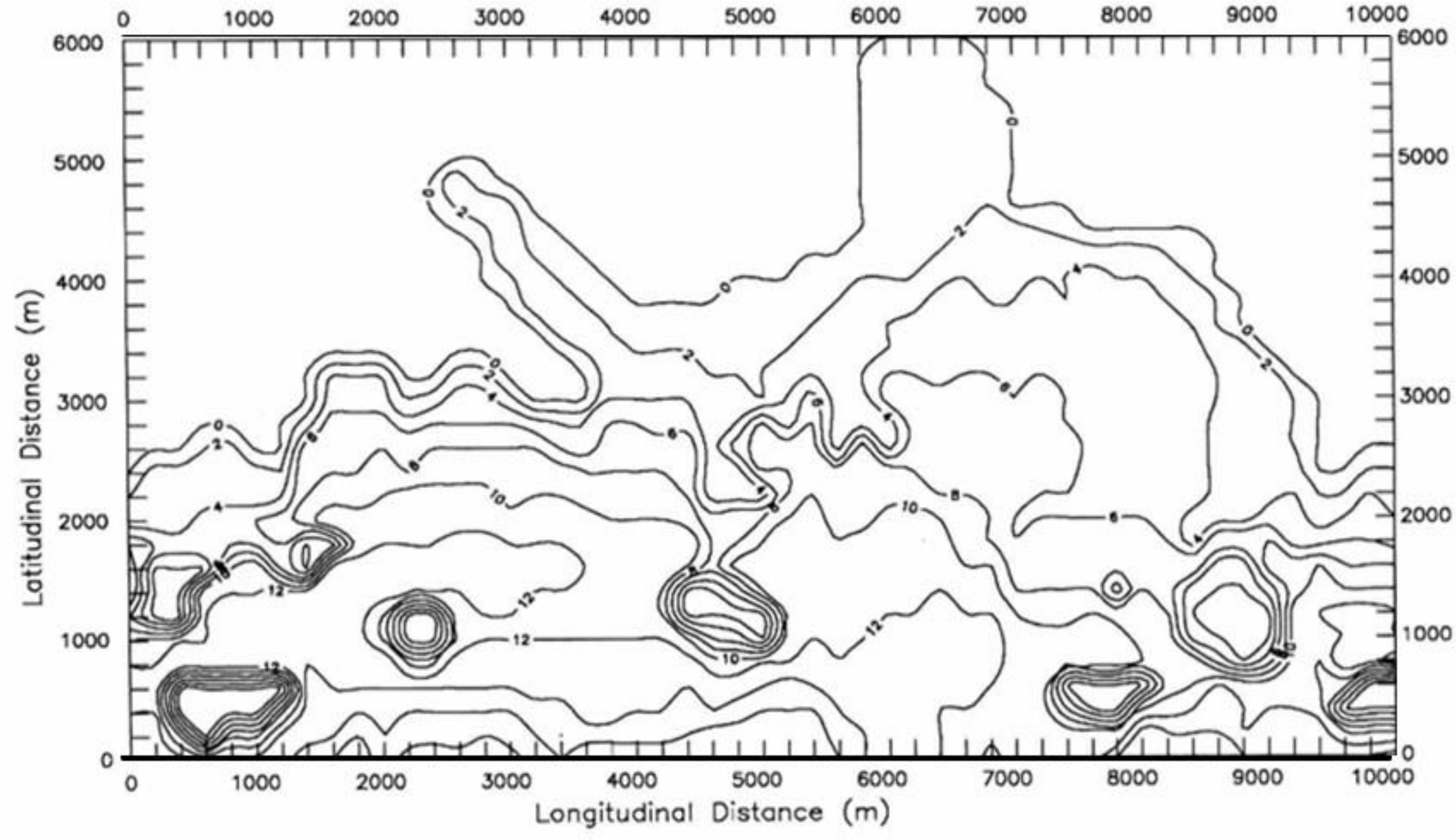


Figure 2.2.8. Bathymetry map of the area

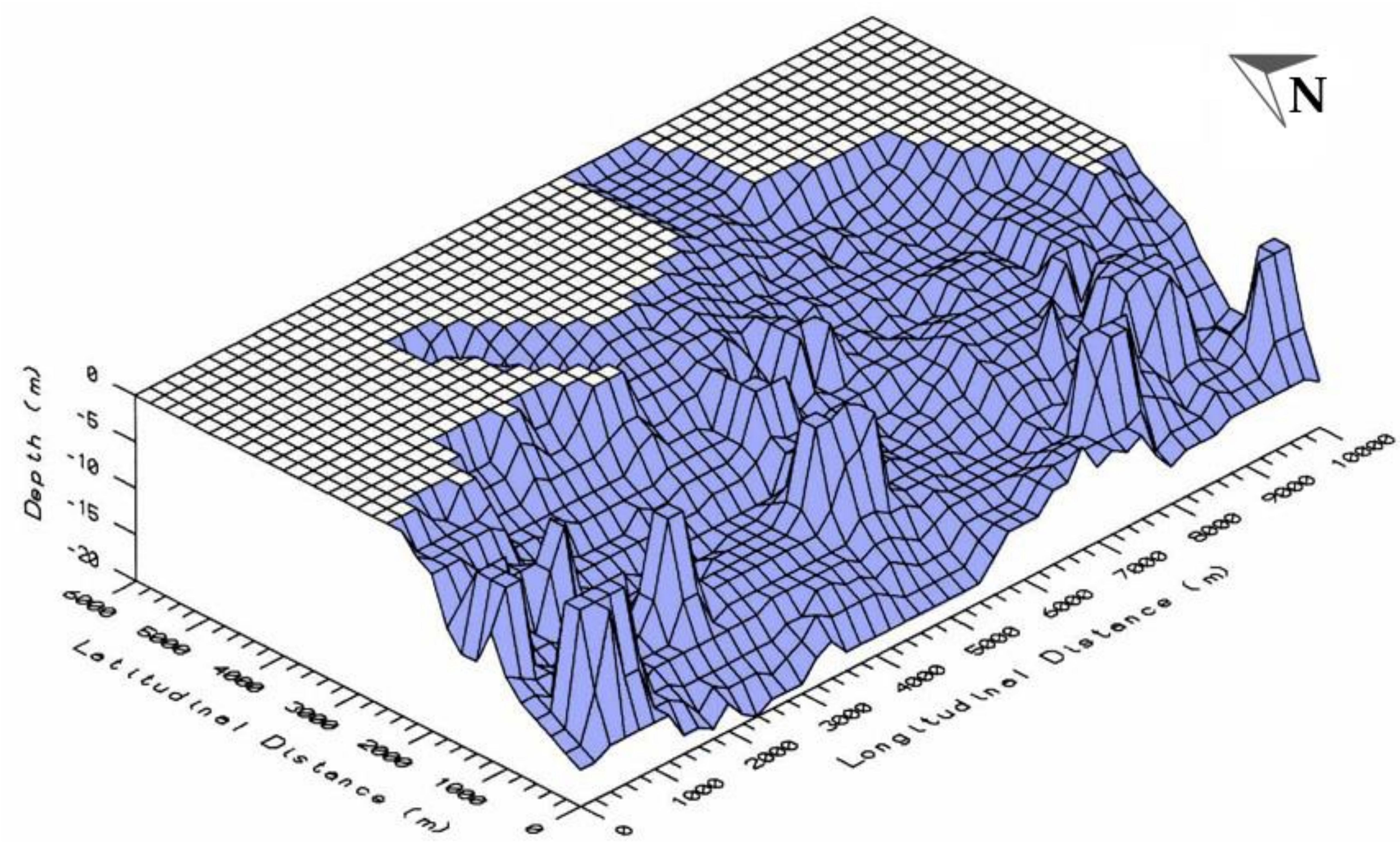


Figure 2.2.9. Digitized Plot of Rio Tuba Estuary

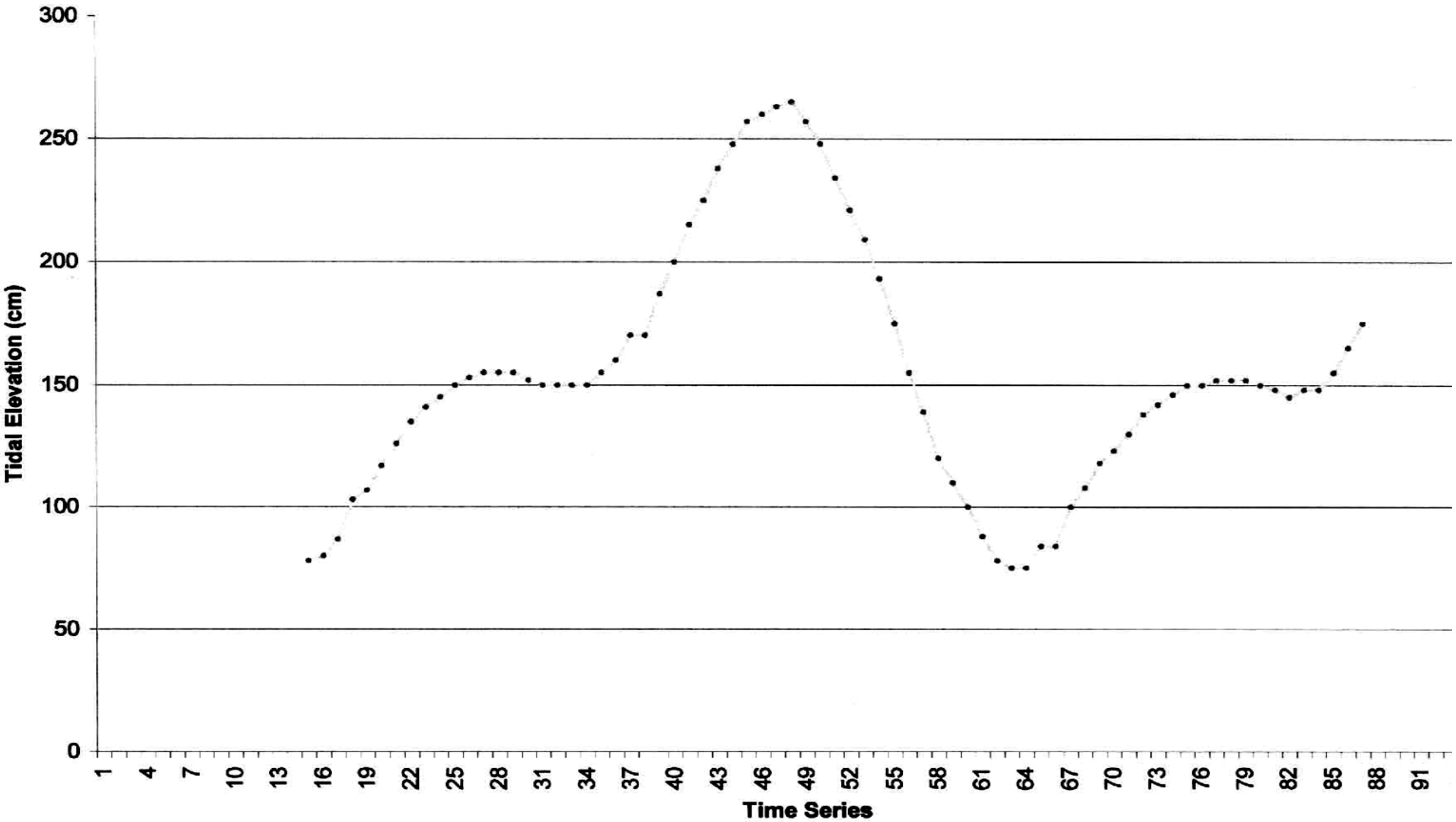


Figure 2.2.10. Semi-diurnal type of tide observed at the Rio Tuba pier

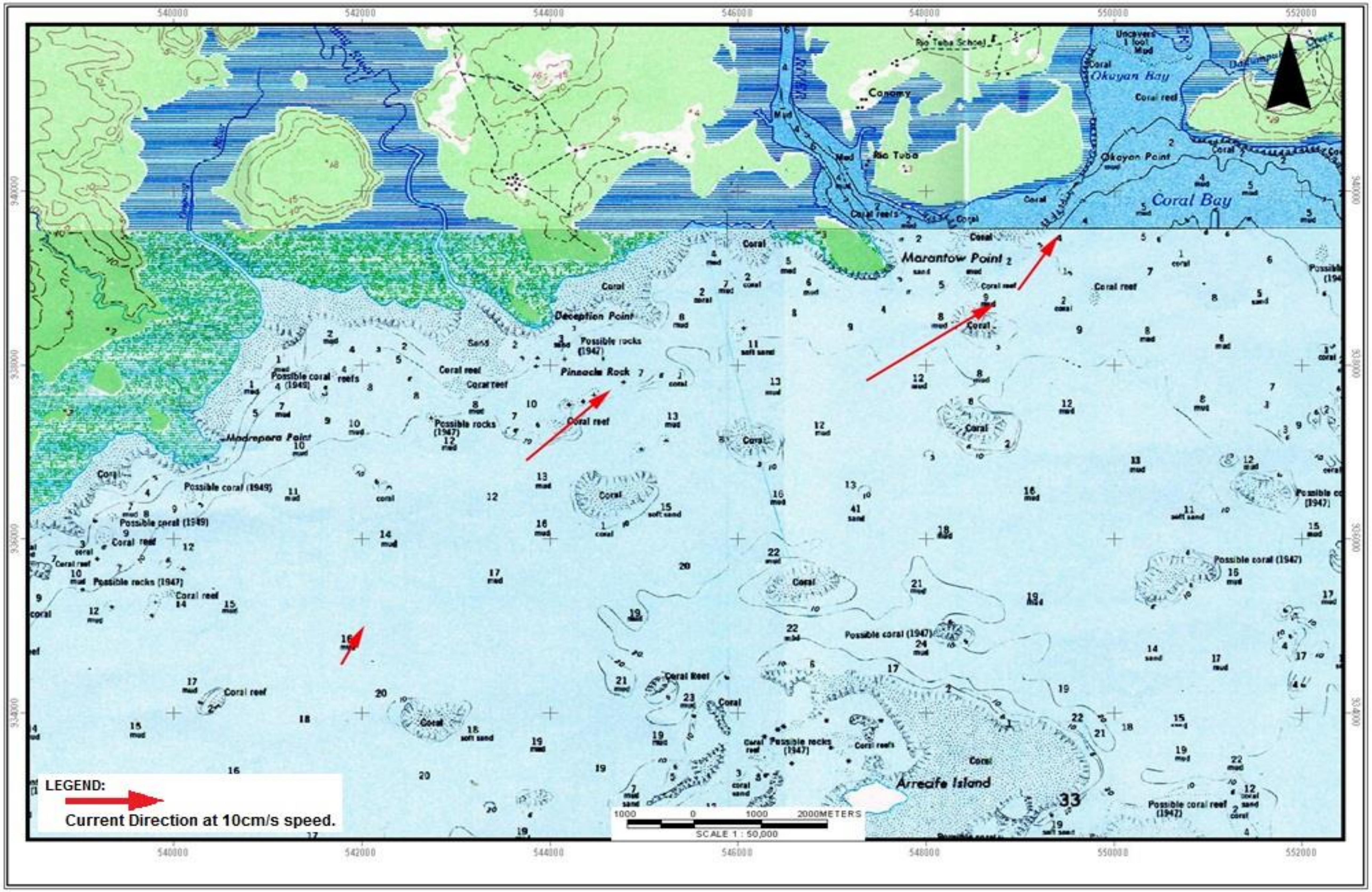


Figure 2.2.11. Observed current vectors during flood tide measurements

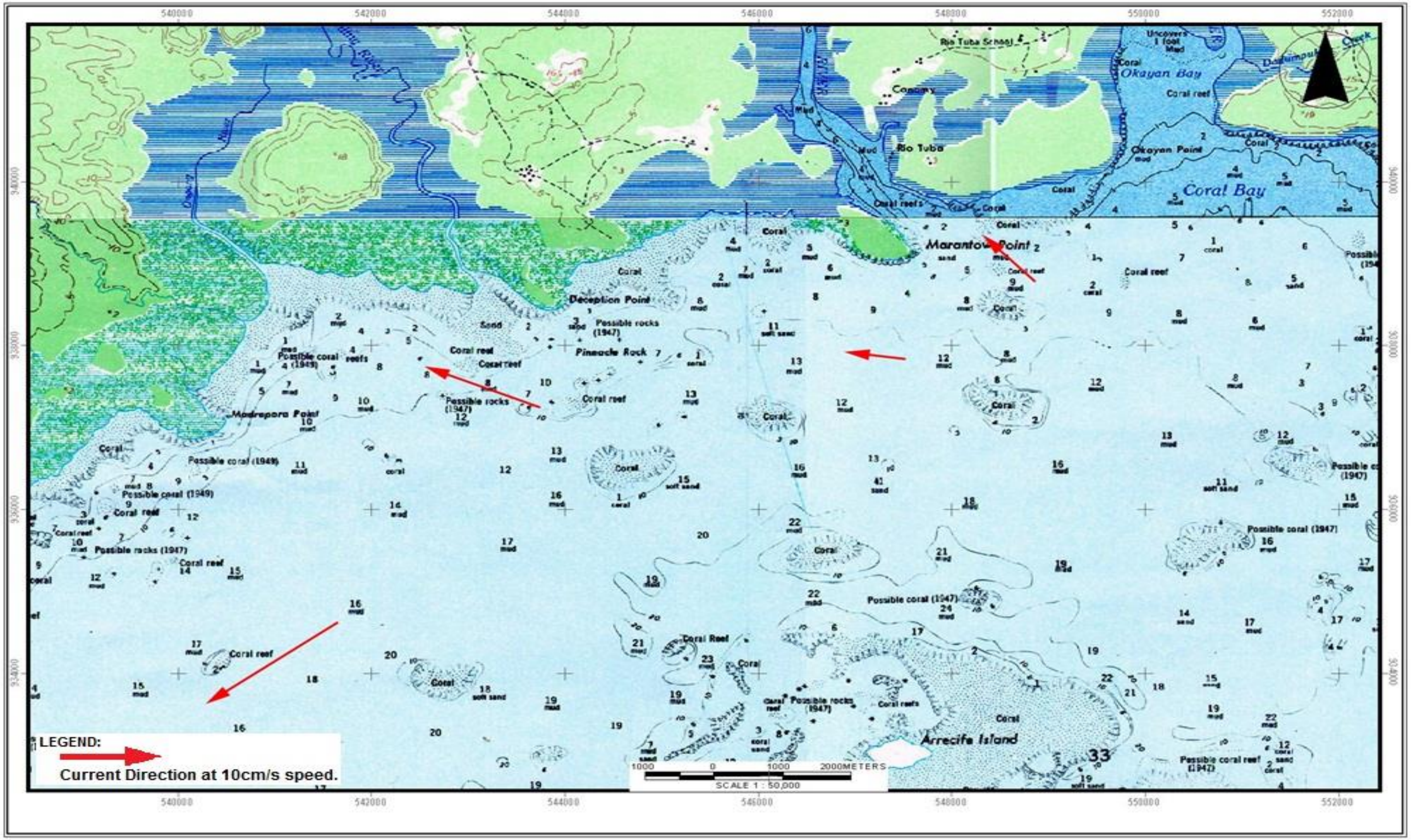


Figure 2.2.12. Observed current vectors during ebb tide measurements

Table 2.2.7. Observed ocean current speed and direction in Rio Tuba River estuary during Ebb Tide

Station	Coordinates	Time & Date	Current	
			Speed cm/s	Direction
A	8°27'14''N and 117°23'14''E	(5:40 a.m.) 28Dec2000	11.3	WSW (246°)
B	8°28'28''N and 117°24'09''E	(6:05 a.m.) 28Dec2000	7.4	WNW (292°)
C	8°29'07''N and 117°25'54''E	(6:30 a.m.) 28Dec2000	3.3	WSW (287°)
D	8°29'40''N and 117°26'37''E	(6:45 a.m.) 28Dec2000	4.6	NW (308°)
E	8°30'09''N and 117°27'18''E	(7:05 a.m.) 28Dec2000	3.2	WSW (254°)
F	8°30'10''N and 117°28'41''E	(7:20 a.m.) 28Dec2000	1.2	NW (313°)

Source: RTNMC HPP EIS, 2001.

In 2015, through the conduct of hydrodynamic modeling, the depth-average current for *habagat* wind conditions (wind speed of 4 m/s from the southwest) during tidal flooding and ebbing. The bottom panels show the predicted current speeds as a function of time. The direction axis indicates the direction the current is heading towards.

While both winds and tidal forces significantly influence current circulation in coastal environments, currents were predominantly governed by tides in Coral Bay (and Sulu Sea), particularly in the study area. The results of the hydrodynamic simulation demonstrated tidal ebbing and flooding dictating current movement and mass transport within and out of the Bay. This may have been brought by the complicated topography and coastal configuration of the study site.

Using a wind speed of 4 $m \cdot s^{-1}$ blowing from the southwest (the so-called habagat wind), the model runs revealed that from the open waters off Sulu Sea, the flow velocity field is directed towards the northeast with magnitudes in range of 2- 8 $cm \cdot s^{-1}$ near the coast and moderately exceeding 10 $cm \cdot s^{-1}$ far offshore. Swift surrents are also predicted at the vicinity of Arrecife Island and the adjoining shallow coral reef areas with magnitudes in the range of 15 $cm \cdot s^{-1}$ shown as yellow arrows in the figures.

Near the shore, the direction of alongshore currents follows more or less the direction the wind is blowing into, which is towards the north and is flowing parallel to the configuration of the coast.

During tidal ebbing, the flow velocity field far offshore is directed to flow outwards of the Bay with weak clockwise movement (or 'gyre') formed near the Arrecife Island and adjoining waters with flow magnitudes of about 8 to 15 $cm \cdot s^{-1}$ which is a bit weaker than during high tides. This predicted circular movement is formed due to the counteracting flows from the Sulu Sea which is directed northeast and of the southwest direction flow visible near the area of Iglesia Point.

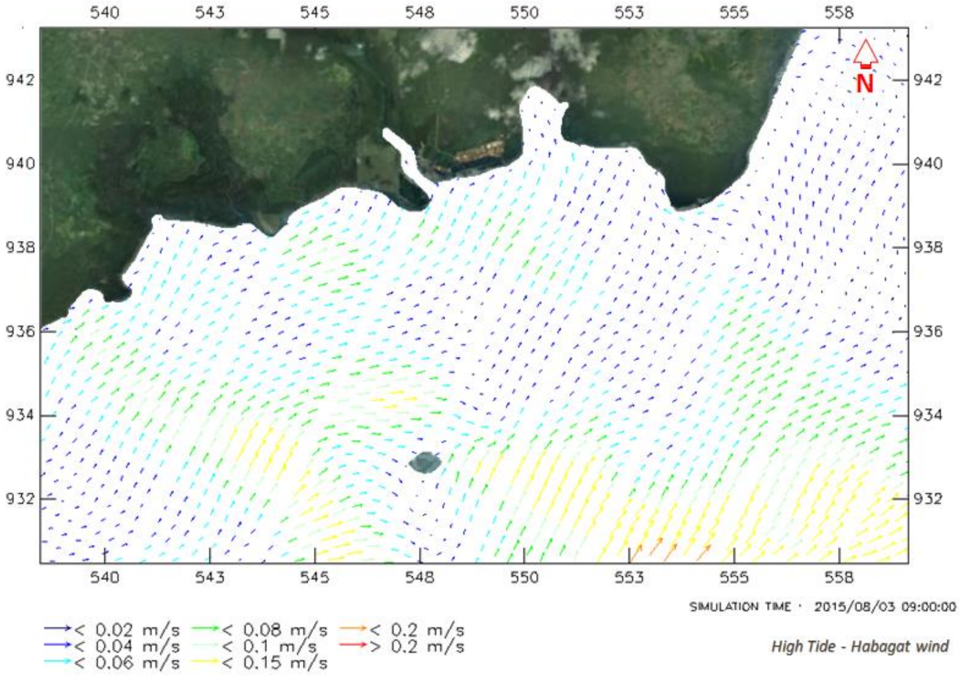


Figure 2.2.13. Predicted currents in the project area during tidal flooding (habagat wind condition).

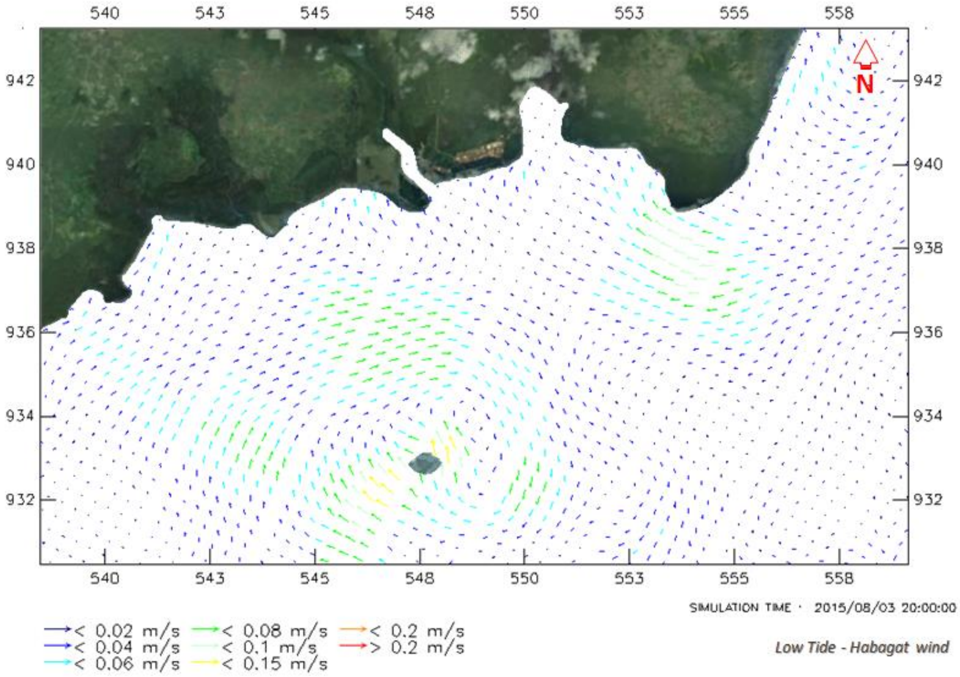


Figure 2.2.14. Predicted currents in the Bay during low tidal event (*habagat* wind condition).

Under *amihan* wind conditions scenario, with a wind velocity input of 4 $m \cdot s^{-1}$ and blowing from the northern direction, the model results revealed similar eastward flow direction in the Bay during tidal flooding, with flow velocity fields in the range of 4 to 8 $cm \cdot s^{-1}$ near the coastline, regardless of tidal conditions. Compared with the habagat wind scenario, the flow velocities in the middle of the Bay is weaker due to influence of the wind blowing opposite to the direction of the tidal flood which is coming from the open waters of Sulu Sea.

During tidal ebbing, the model predicts similar trend wherein flow is directed towards the southwest and out of the Bay with weak northeast flow vectors influenced by the influx of waters by the open Sulu Sea. Just offshore of Iglesia Point, the flow rushes out towards the southwest similar to the predicted currents for Habagat wind scenario but with higher flow magnitudes exceeding 10 $cm \cdot s^{-1}$, with generally weaker velocities near the coast than is predicted during tidal flooding.

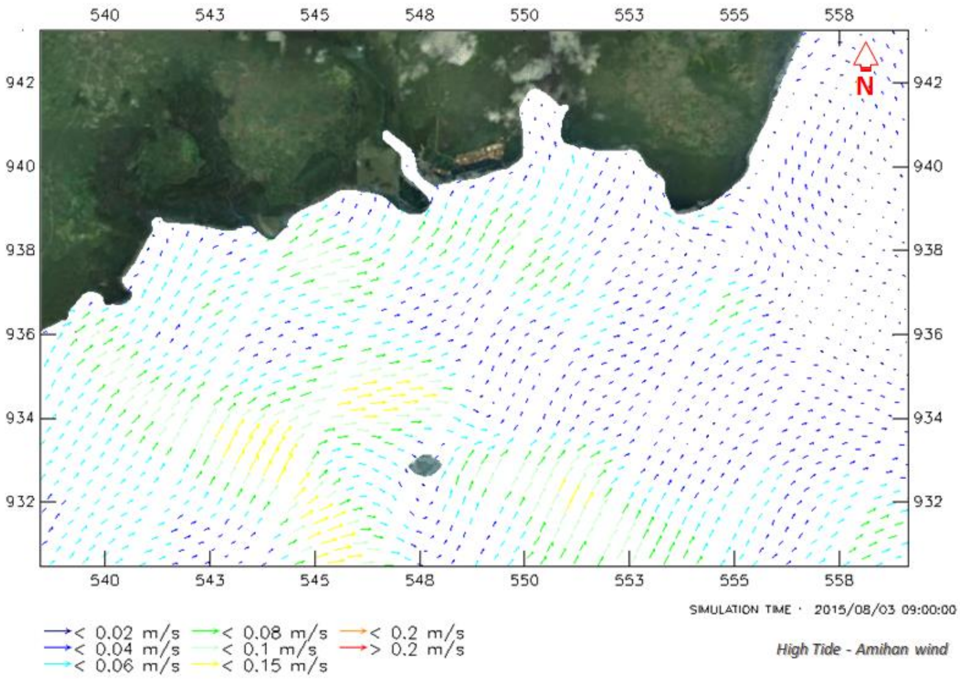


Figure 2.2.15. Predicted currents in the Bay during high tidal event for *amihan* wind condition (wind speed of 4 m/s blowing from the northeast).

From examination of the predicted currents in the study area during these two wind conditions, it follows that the tidal conditions dictates the direction of current although wind shear also had a significant influence in steering the currents especially near the coast.

During tidal flooding conditions, the currents near the coast exhibit a bias towards the north and northeast, regardless of prevailing wind directions. The high tidal event induces current speeds reaching a maximum of about 10 to 15 $cm \cdot s^{-1}$ while the currents during tidal ebbing were generally weaker, reaching a maximum of ~ 8 $cm \cdot s^{-1}$ near the coast. Far offshore, the predicted swift currents in the Bay near Arrecife Island and adjoining shallow coral reef areas are generally about 10 to 15 $cm \cdot s^{-1}$ for both *amihan* and *habagat* wind conditions for a wind speed of 4 m/s. For higher wind magnitude, it is expected that high flow velocities would occur, but for a more conservative pollutant plume dispersal prediction, low magnitude winds are used.

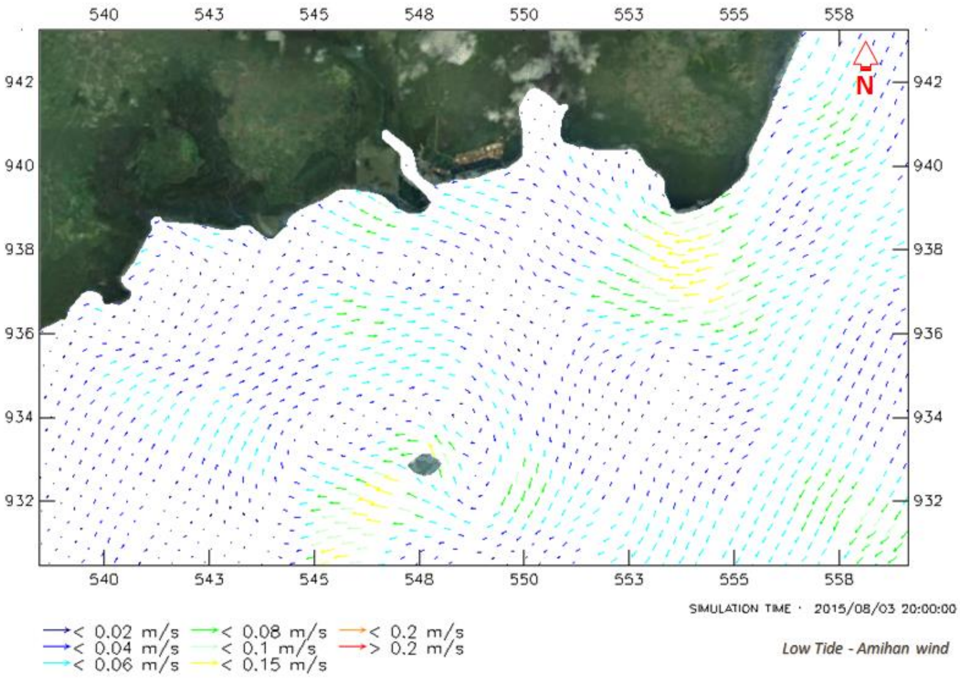


Figure 2.2.16. Predicted currents in the Bay during low tidal event for *amihan* wind condition (wind speed of 4 m/s blowing from the northeast).

2.2.2.3 Impact Assessment

The key impact of mining is siltation of water bodies draining the mining areas and the subsequent deposition of silt in any receiving body, which in this case, the Coral Bay where Tuba and Ocayan Rivers drain (**Table 2.2.8**). A model to track particle movement was developed to determine the impacts of mining to circulation patter and sediment deposition along Coral Bay and summarized below. The result of the modeling is attached as **Annex 2.2.3.**

Particle Dispersion in the Coastal Vicinity Downstream of the Proposed Project
This section assesses the water quality transport and simple water quality processes by means of a particle tracking method. In particular, dispersal, dilution and accumulation patterns of an unspecified pollutant (say polluted storm water runoff or particulate matter, for example) released within the immediate vicinity of the mouths of the two (2) river systems, Tuba and Ocayan, as it is transported by the ambient current circulations were investigated.

The model considers the release of 20,000 particles for each of the mouths of the subject rivers (which is the downstream pathways of the proposed mining area) to visualize and quantify the dispersion patterns in the offshore area. Scenarios incorporating the effect of south-westerly and north-easterly winds investigate the propagation and dispersal of the pollutant as current is forced by wind, particularly near the surface.

The dispersal patterns of particles were assessed with the end in view of determining how the proposed project will potentially impact the existing coastal water quality process assuming that siltation ponds and sediment control measures upstream of the Bay failed. Note that storm water flowing from disturbed areas of the mining site will be directed into existing siltation ponds. At present, there is a series of siltation ponds for the mine site which include diversion canals and settling ponds to arrest possible release into the coastal area of undesirable pollutants. Thus the scenarios presented here are deemed to be extreme with probability of occurrence to be low. However, for purposes of planning during accidental spillage, these scenario simulations can serve as guide to determine which areas are vulnerable to prevent and minimize further spreading.

The transport and dilution of continuous release of particles for two (2) days in the assumed discharge point were simulated for at least 20 days in the model, to allow build up of the far field particle concentrations over many tidal cycles. Results were examined over a spring cycle using tidal data from August 2015. The time duration of pollutant released in the project area is assumed to be 2 days as it is unrealistic that accidental release of pollutants goes unnoticed beyond 2 days and that usually, a few hours after such accidental release, emergency measures are started to be in place to contain the same.

The results of the model runs are shown in the next succeeding figures. Some of the results of the 20-day simulation of particles incorporating the effects of surface winds, and the rise and fall of tides are presented. Therefore, the snapshots cover most of the interesting patterns that may be expected during flooding and ebbing and also during slack water.

Scenario A – South-westerly (*Habagat*) Wind Condition

This scenario incorporated the influence of wind on coastal current circulation and particle transport and movement in the study area. This was accomplished with the use of a uniform wind forcing (southwesterly wind, ranging from 180 to 225 degrees from the north, with a speed of 4 $m \cdot s^{-1}$), representative of the southwest monsoon conditions.

From the results of the model runs, it appears that in the initial period of time after the release of the particles, the patch of particles is relatively small and the mixing of the particles is caused by small-scale turbulence effects only. However, after some time, the ‘cloud’ of particles will have spread sufficiently such that larger-scale eddies and circulations will contribute to the mixing effect.

It can be seen in **Figures 2.2.17** to **2.2.23** below that after a couple of hours, the released particles spread farther from the release points in the river mouths moving toward the middle part of Coral Bay for a prevailing south-westerly wind field in effect. Some of those released particles drifted north-eastwards past Iglesia Point depending on the direction of the tides while significant amount were transported towards the area of Batangas Port north of the project.

Also, due to *habagat* wind, the assumed accidental release of particles from the two river mouths move southward and are dispersed within the Bay with significant amount of particles staying within the study area. This is mainly due to the weak flow velocities as it is protected by land protrusions of Iglesia Point that serves as a natural barrier to deflect the otherwise high flow velocities emanating from Sulu Sea.

In the series of figures presented below, the legend refers to the resulting level of concentrations, in kilograms per cubic meter, of the unspecified pollutant. Black dots represent the very low concentration level (less than 0.004 kg/m^3 in the legend) that can be seen spreading farther than the 'cloud' of relatively high pollutant concentration.

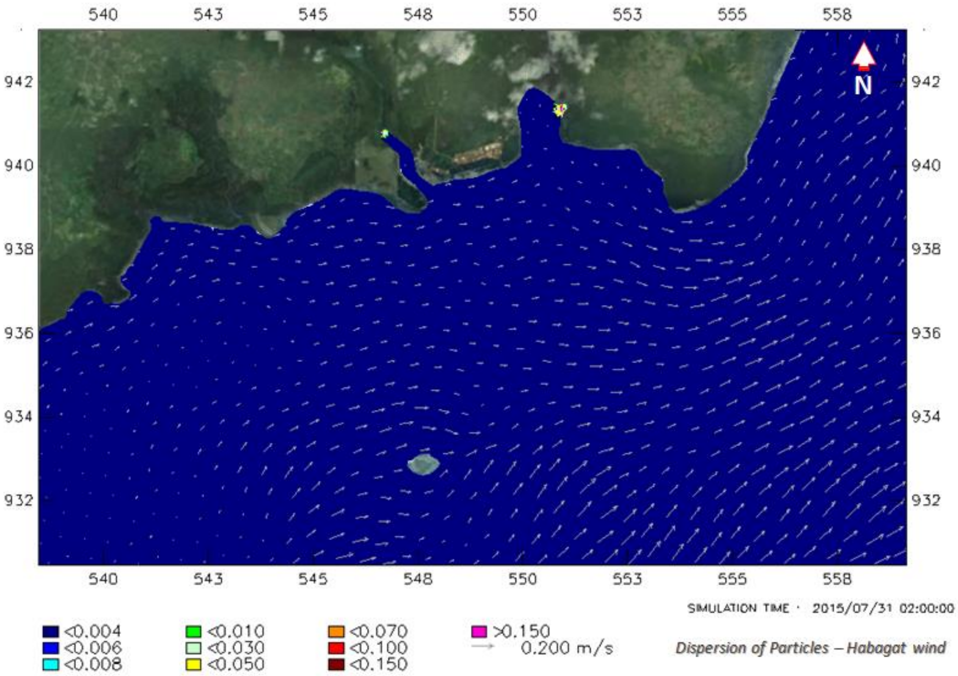


Figure 2.2.17. Predicted transport of particles after two (2) hours of continuous release, under *habagat* wind condition. The black dots in the figure represent low concentration particles.

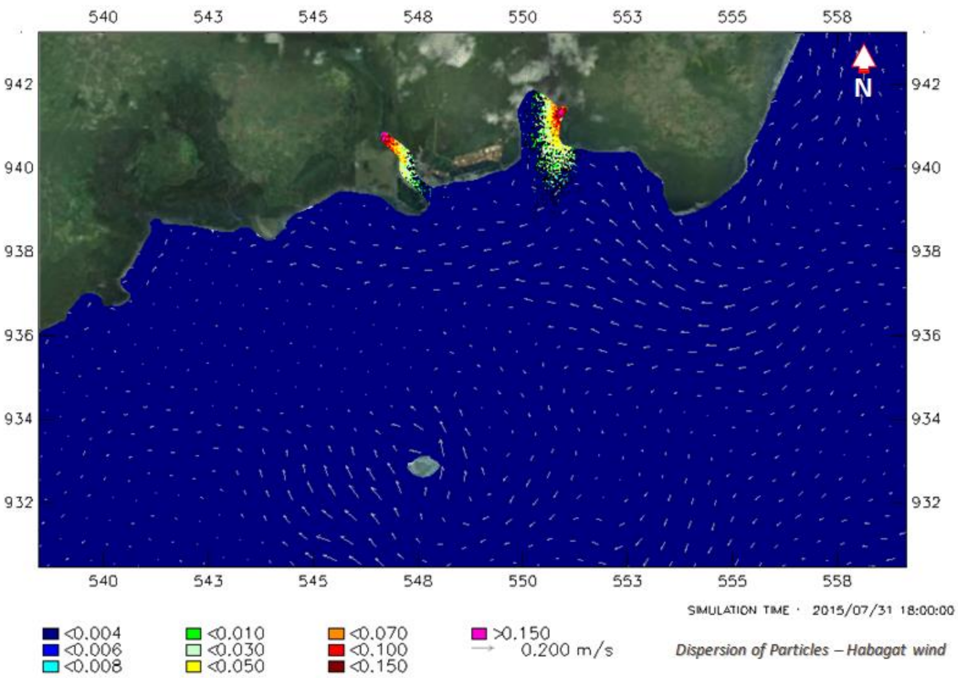


Figure 2.2.18. Predicted transport of particles after 18 hours of continuous release,

under *habagat* wind condition.

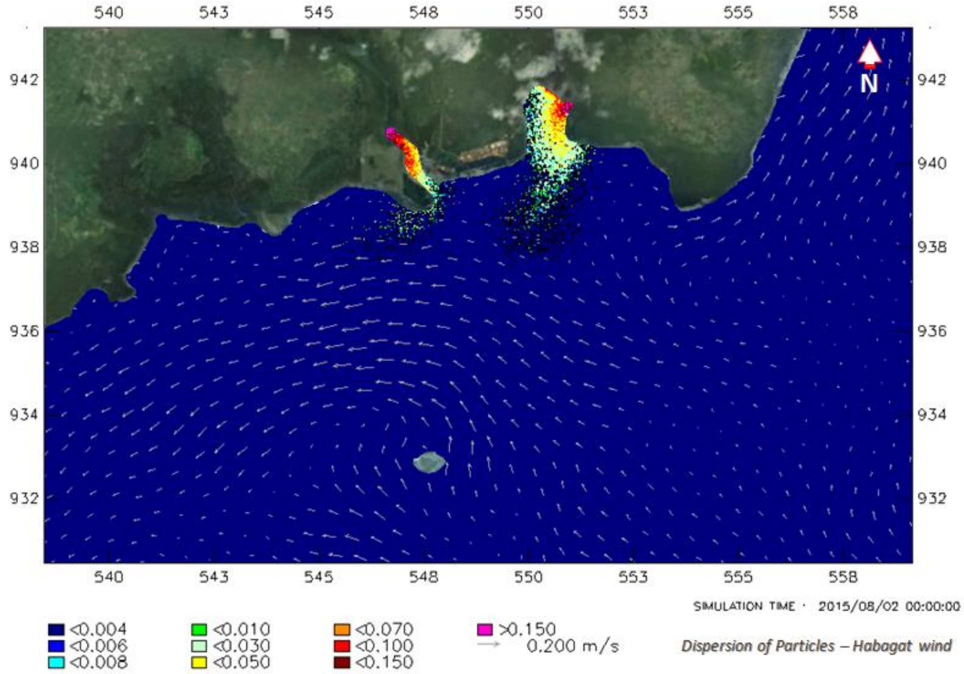


Figure 2.2.19. Predicted transport of particles after 48 hours of continuous release, under *habagat* wind condition.

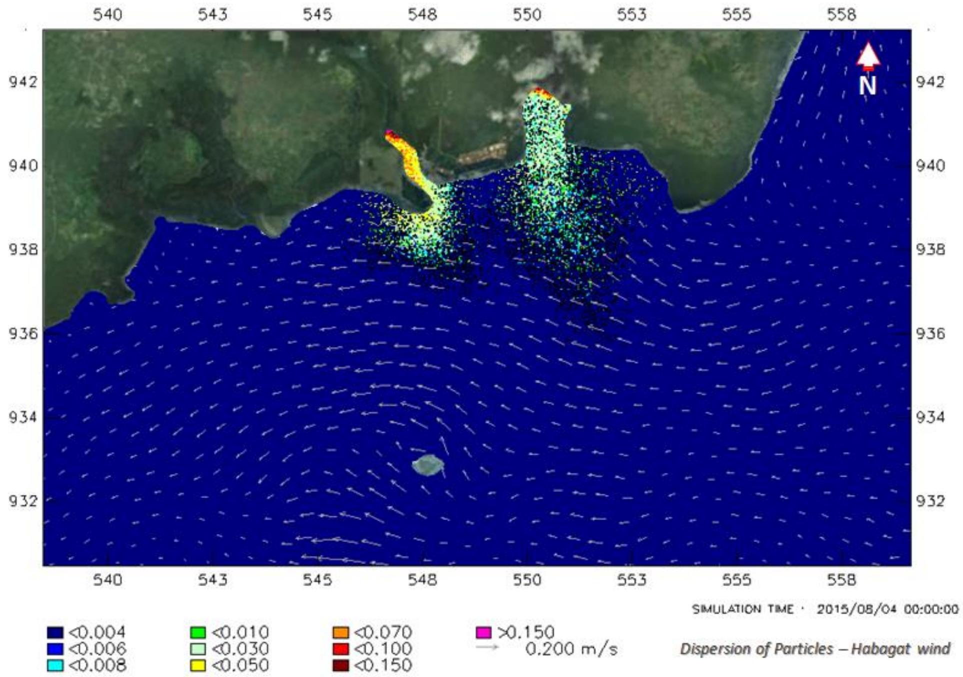


Figure 2.2.20. Predicted transport of particles four (4) days after initial release, under *habagat* wind condition.

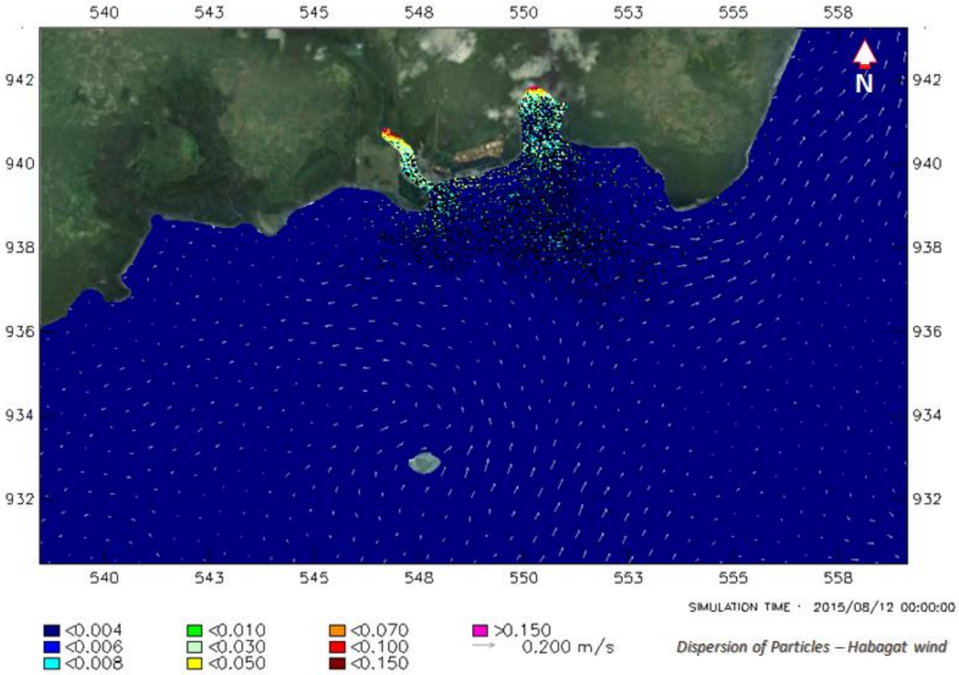


Figure 2.2.21. Predicted transport of particles 12 days after release, under *habagat* wind condition.

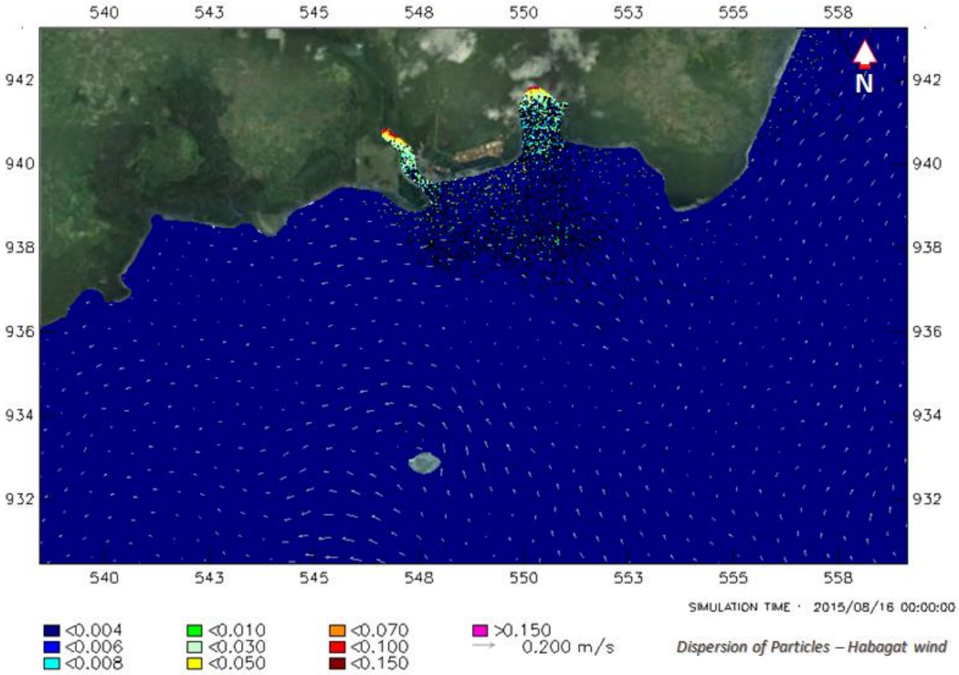


Figure 2.2.22. Predicted transport of particles 16 days after release, under *habagat* wind condition.

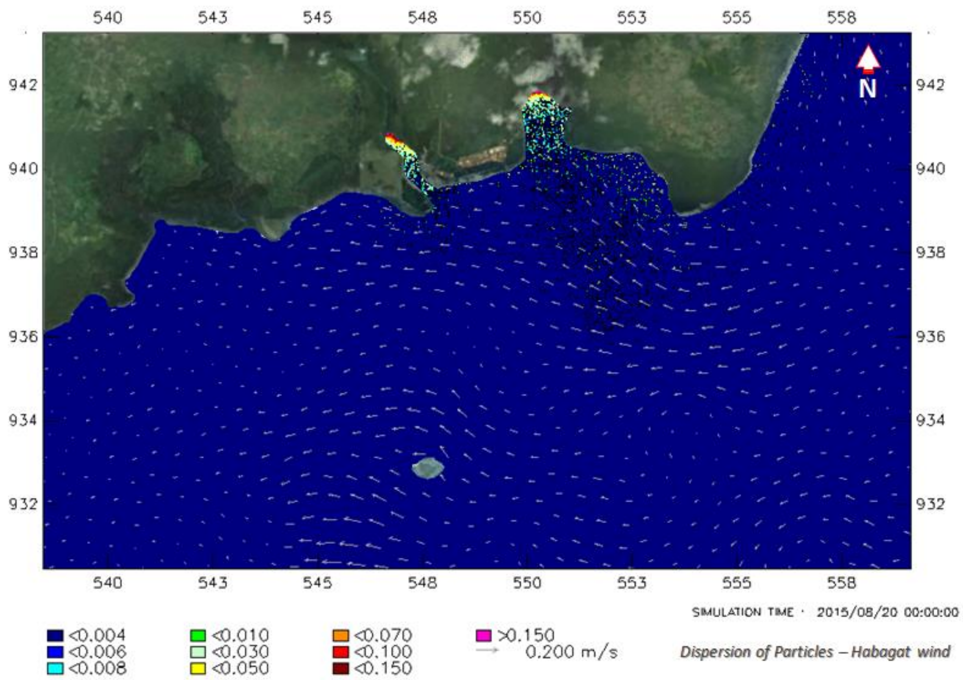


Figure 2.2.23. Predicted transport of particles 20 days after release, under *habagat* wind condition.

Scenario B – North-easterly (*Amihan*) Wind Condition

This scenario incorporated the influence of amihan wind on coastal current circulation and particle transport and movement in the study area. A uniform wind forcing (southwesterly wind, ranging from 10 to 45 degrees from the north, with a speed of 4 $m \cdot s^{-1}$), representative of the southwest monsoon conditions is used as one of the model inputs to simulate hydrodynamic and pollutant transport in the coastal area of Coral Bay.

Similar to *habagat* wind scenario results, at the start of the simulation, the unspecified pollutant dispersed initially in a radial pattern just at the mouths of the rivers connecting into the open sea and after a few hours starts to scatter in a southward direction following the topography of the coast. Because of the counter-clockwise eddies formed due to high flow velocities along the shallow coral reef areas within Arrecife Island, the pollutant dispersed southward and also due to wind field that blows towards the southwest.

During periods of slack tides however, significant amount of released particles stays within a few hundred meter distance south of the release points and with some particles move towards the vicinity of Iglesia Point east of the release points due to the absence of, or weak currents in the area.

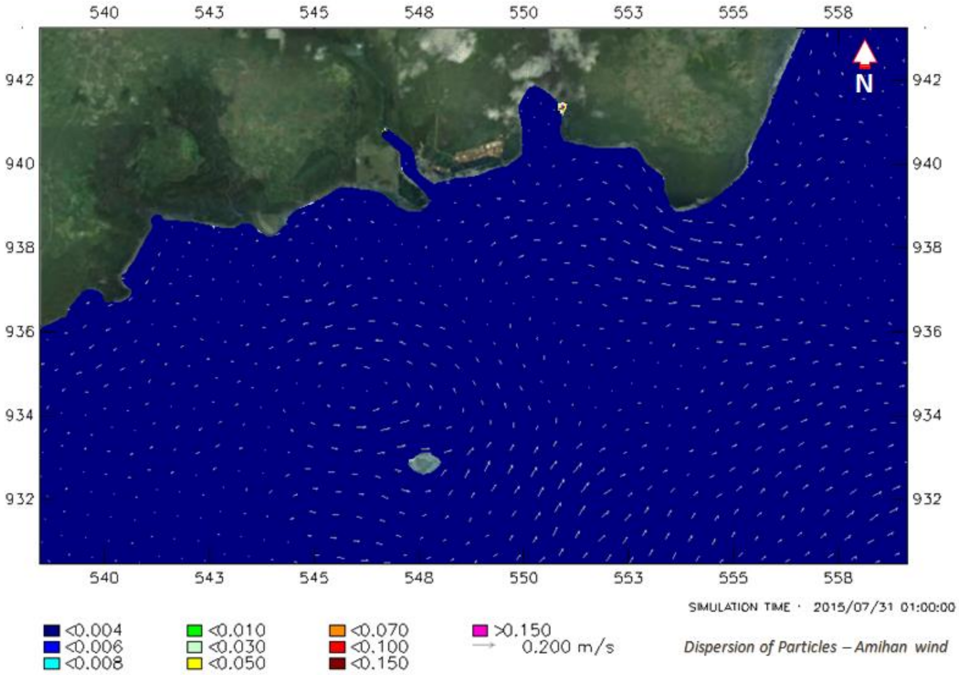


Figure 2.2.24. Predicted transport of particles after 1 hour of continuous release, under *amihan* wind condition. The black dots in the figure represent low concentration particles.

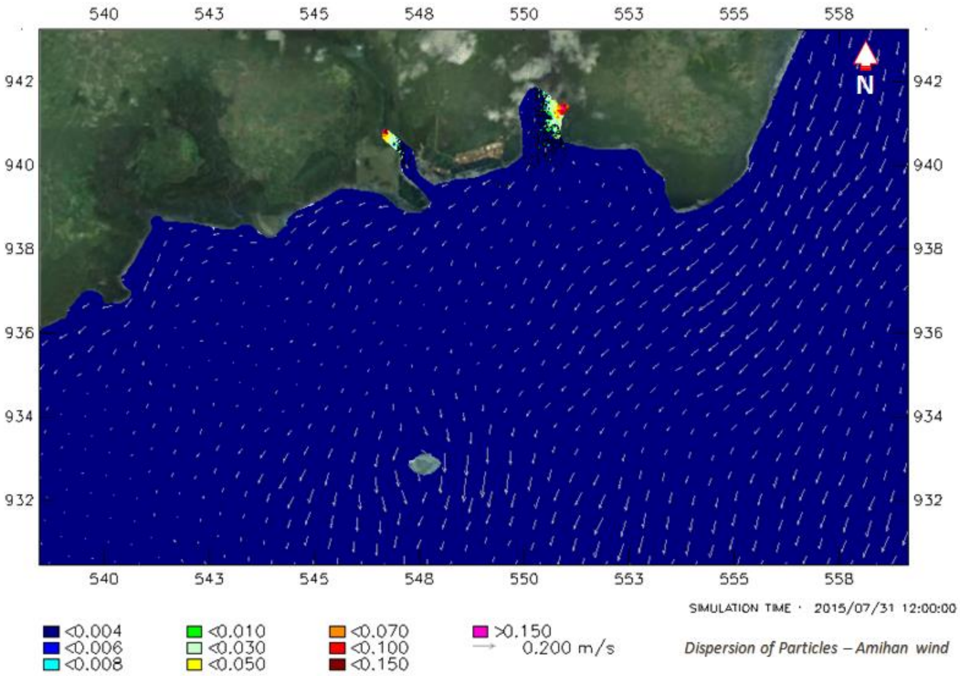


Figure 2.2.25. Predicted transport of particles after 12 hours of continuous release, under *amihan* wind condition.

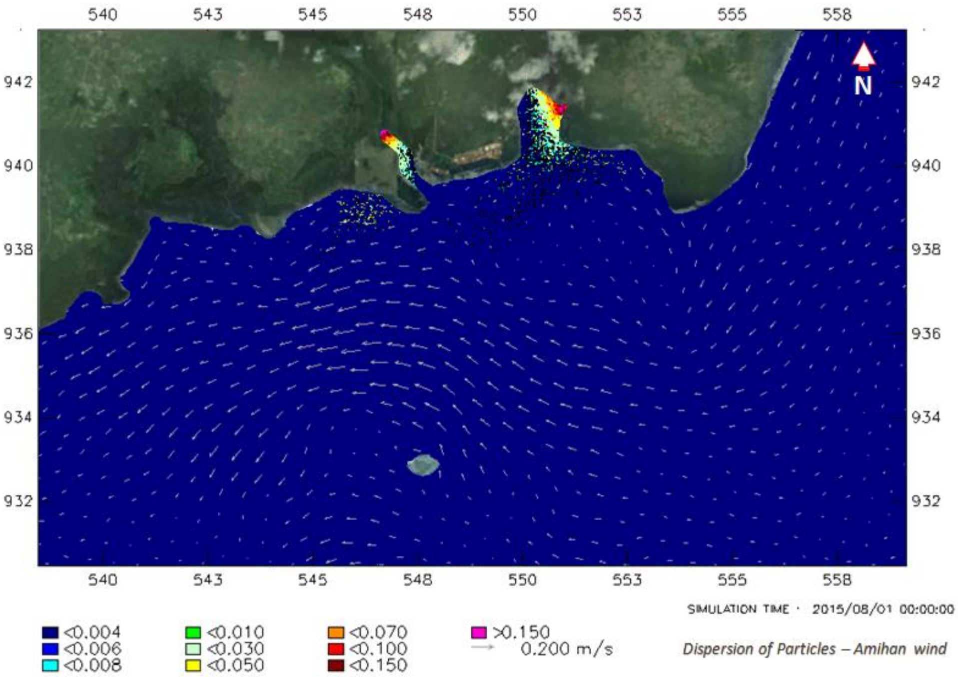


Figure 2.2.26. Predicted transport of particles after 24 hours of continuous release, under *amihan* wind condition.

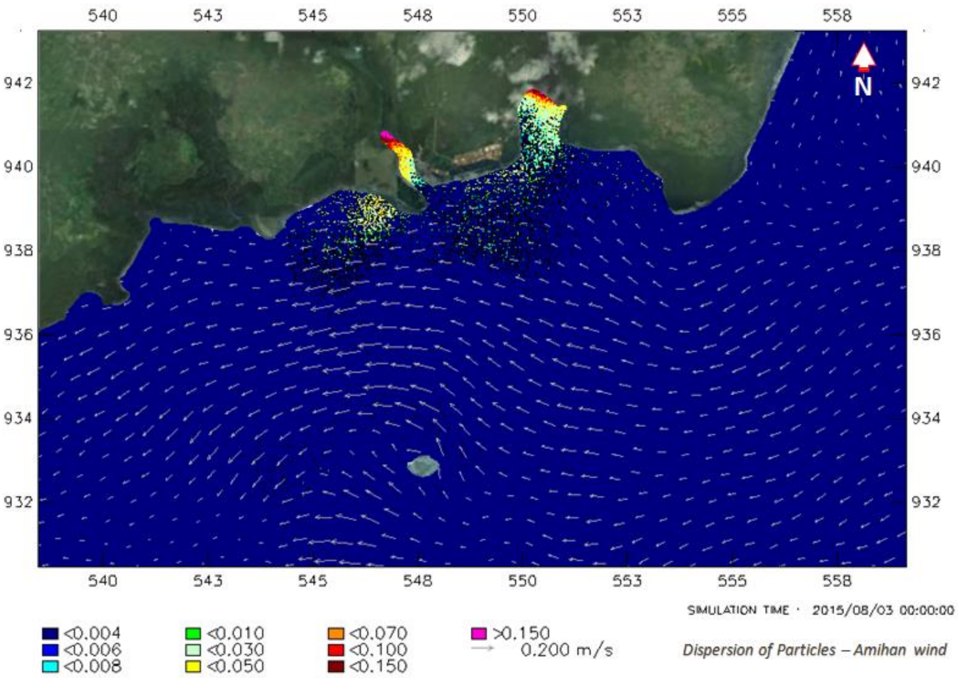


Figure 2.2.27. Predicted transport of particles three (3) days after initial release, under *amihan wind condition.*

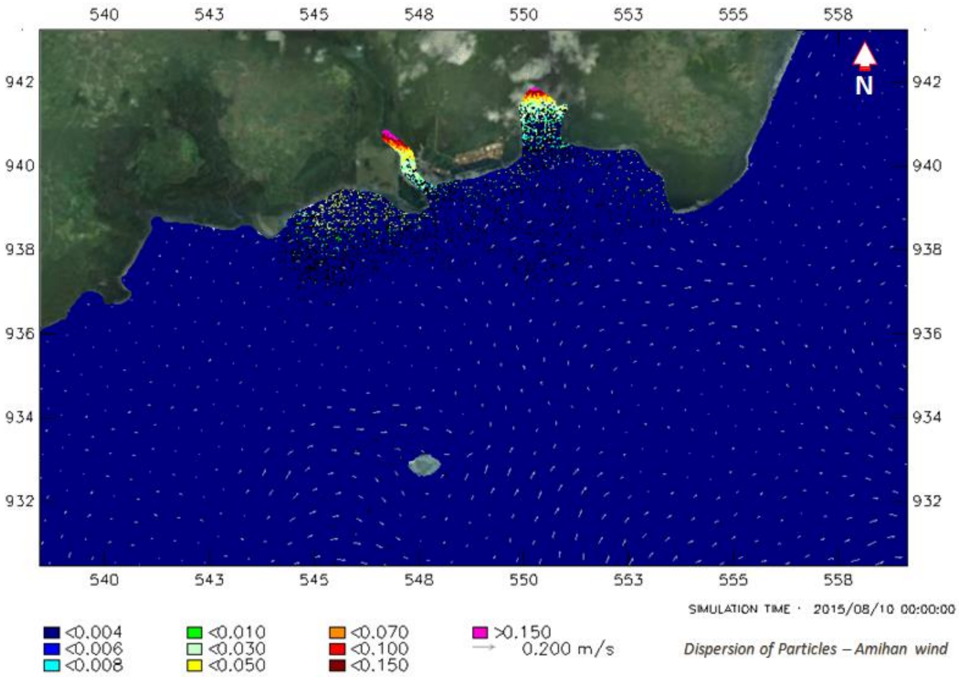


Figure 2.2.28. Predicted transport of particles 10 days after the start of pollutant release, under *amihan* wind condition.

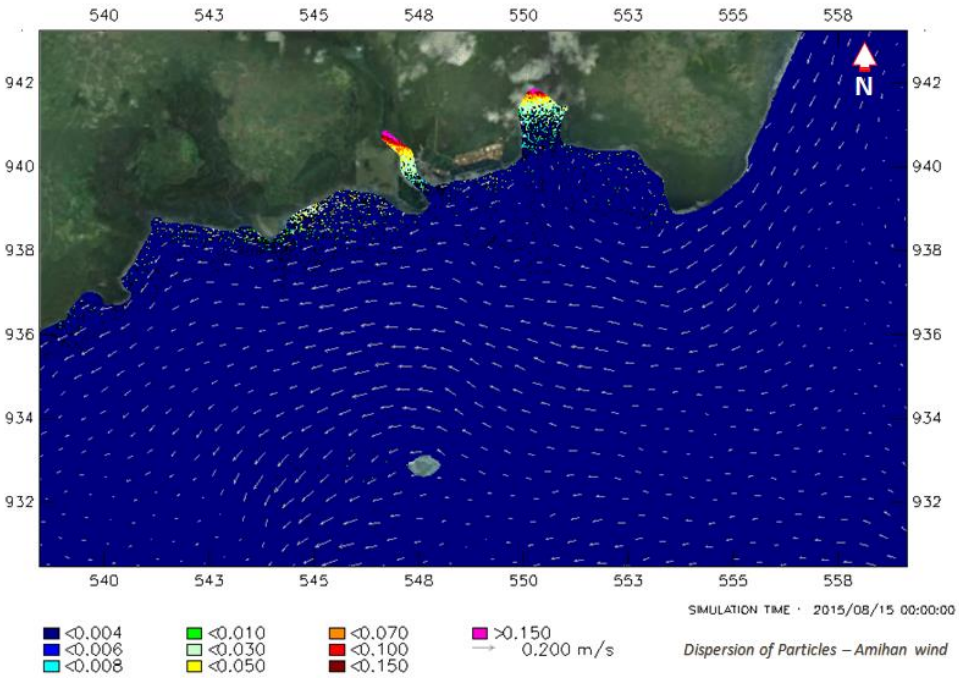


Figure 2.2.29. Predicted transport of particles 15 days after the start of pollutant release, under *amihan* wind condition.

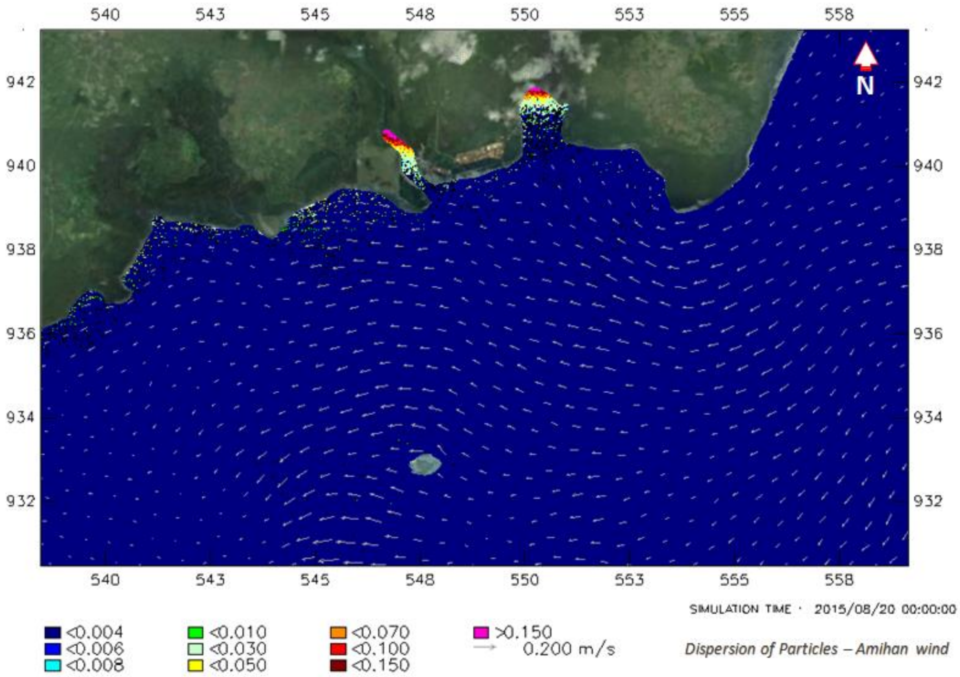


Figure 2.2.30. Predicted transport of particles 20 days after the start of pollutant release, under *amihan* wind condition.

Scenario C – Calm Wind Condition

One potential combination of oceanographic and meteorological conditions that may produce low dispersion of the particle plume is a period of low ambient current which would correspond to the period of lowest transport and mixing potential, thereby allowing the plume to sustain its release concentration under normal conditions. Thus, this scenario specifies low wind speed conditions to determine the likely fate and transport of released pollutant during this type of wind field where a uniform wind forcing speed of less than 1 $m \cdot s^{-1}$ is used with random wind directions.

The results of the model simulation using zero wind speed are shown in the next succeeding figures. The predicted currents were tidal induced as surface wind-driven turbulence and flow component were obliterated from the model forcing due to low speed specified. The figures provide easy visualization of the pollutant dispersal patterns and trajectories.

Based on the model results, the level of pollutant concentration is inversely proportional to the tide levels. Higher concentrations were predicted during low tides while lower pollutant particle concentrations were observed during high tides. This is not unusual as the dilution and mixing process is less when the water level becomes shallower. During high tide, the pollutant particles with a very low concentration (less than 0.004 $kg \cdot m^{-3}$ shown in the legend of the figures or less than 4 $mg \cdot L^{-1}$) veered towards the western direction of the adjacent coast. The high flow velocity in the shallow reef areas near Arrecife Island seemed to prevent the transport and dispersion of the pollutant particles farther offshore and outward into the open sea. Much of the particles appeared to remain and concentrate adjacent to the discharge locations and veered towards the east during periods of high and slack tides, but these are then swept further to the east and south during transition and high tidal events due to reversal of the current and the influence of the resulting formation of circular eddies near Arrecife Island.

Notice also the higher concentration of the scattered particles at the immediate area south of the river mouths; this is also due to the absence of wind drag resulting to weak flow velocities in the area as well as the 'sheltering' effect of the land protrusion of Iglesia Point.

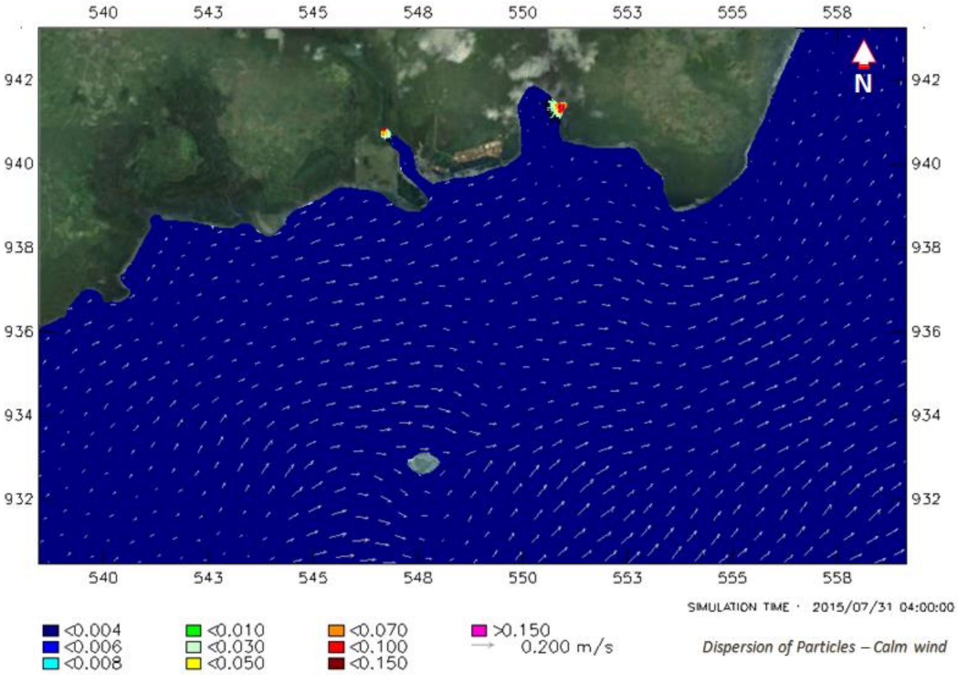


Figure 2.2.31. Predicted transport of particles after four (4) hours of continuous pollutant release, under calm wind condition. The black dots in the figure represent low concentration particles.

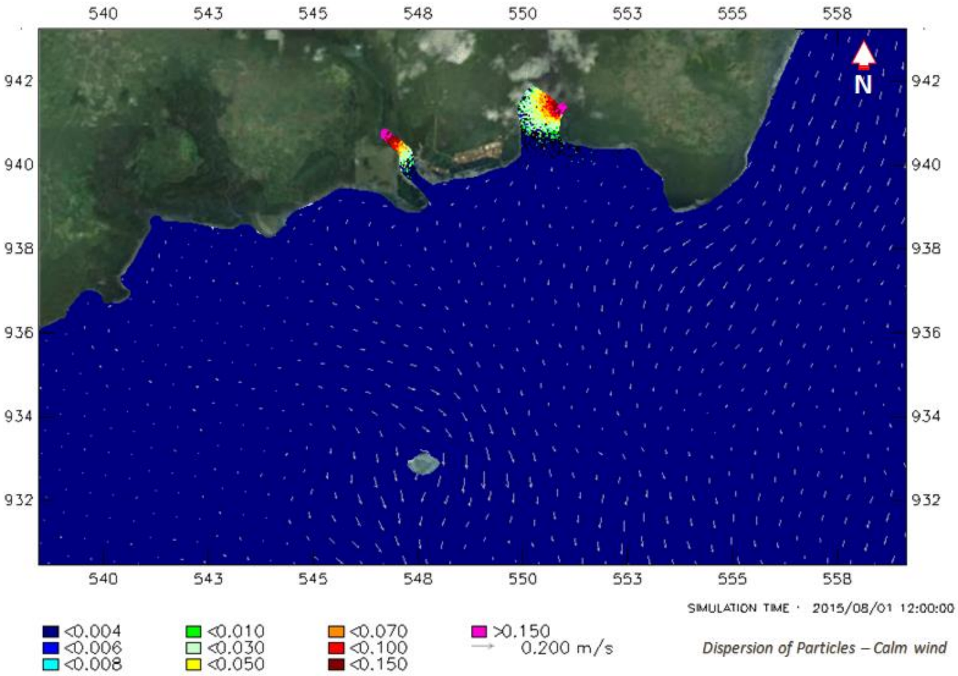


Figure 2.2.32. Predicted transport of particles after 36 hours of continuous pollutant release, under calm wind condition.

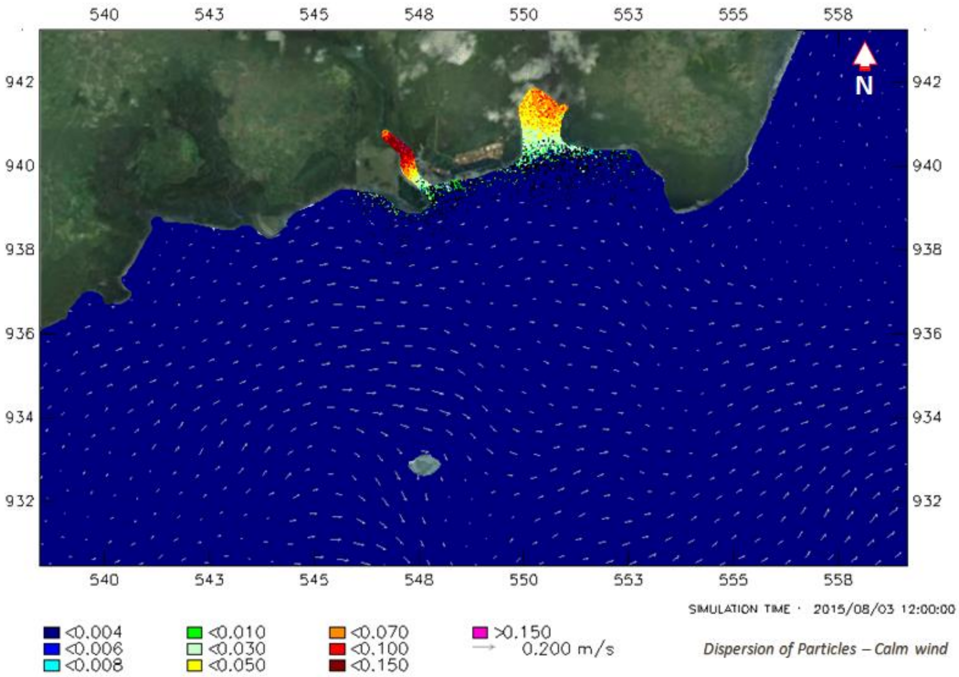


Figure 2.2.33. Predicted transport of particles 3.5 days after pollutant release, under calm wind condition.

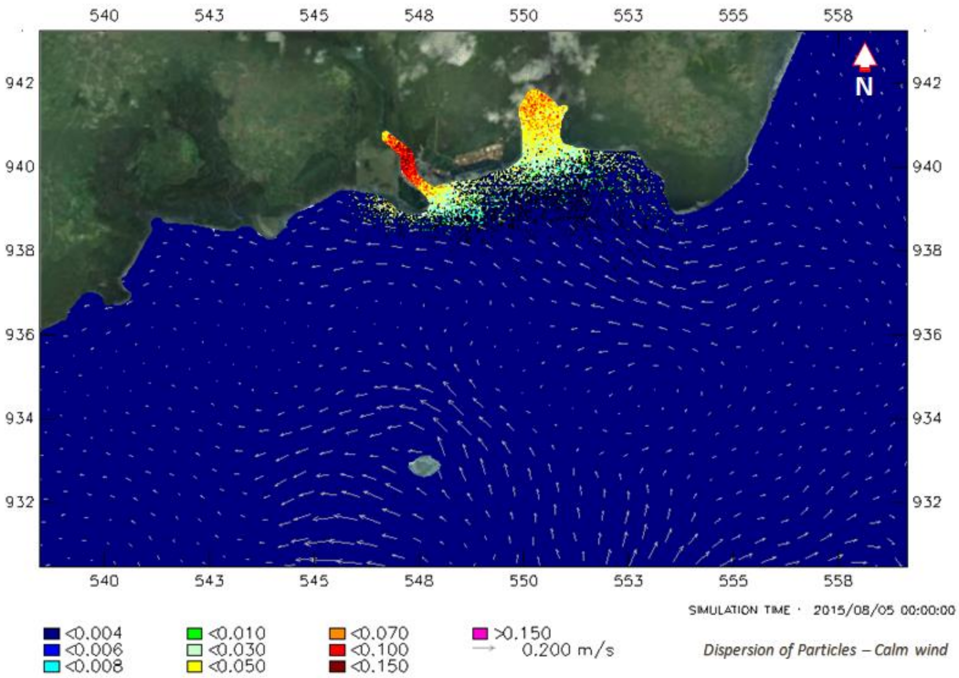


Figure 2.2.34. Predicted transport of particles five (5) days after pollutant release, under calm wind condition.

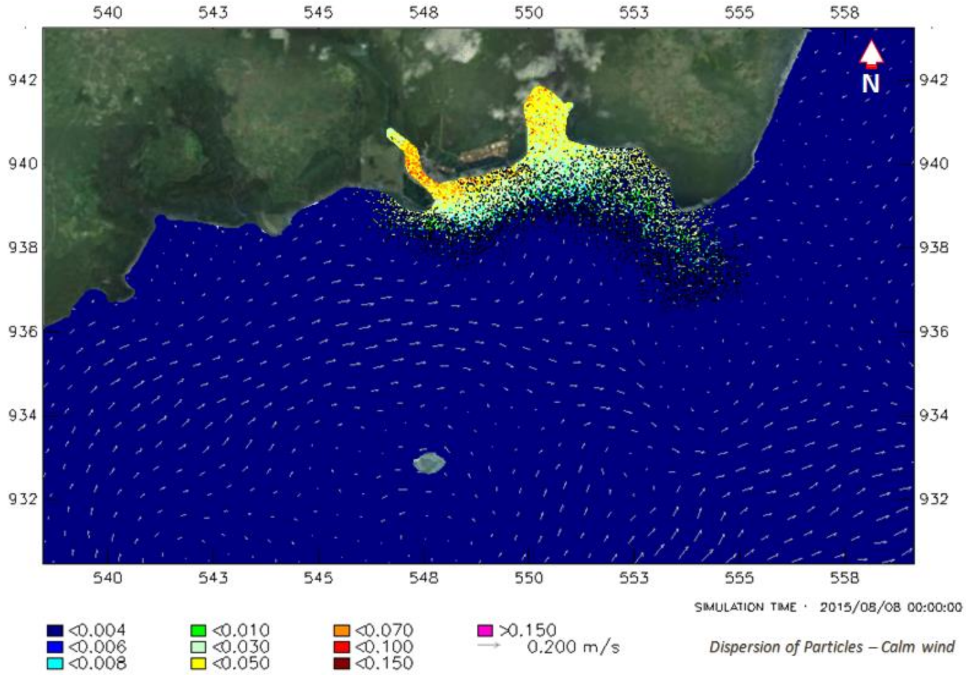


Figure 2.2.35. Predicted transport of particles eight (8) days after the start of pollutant release, under calm wind condition.

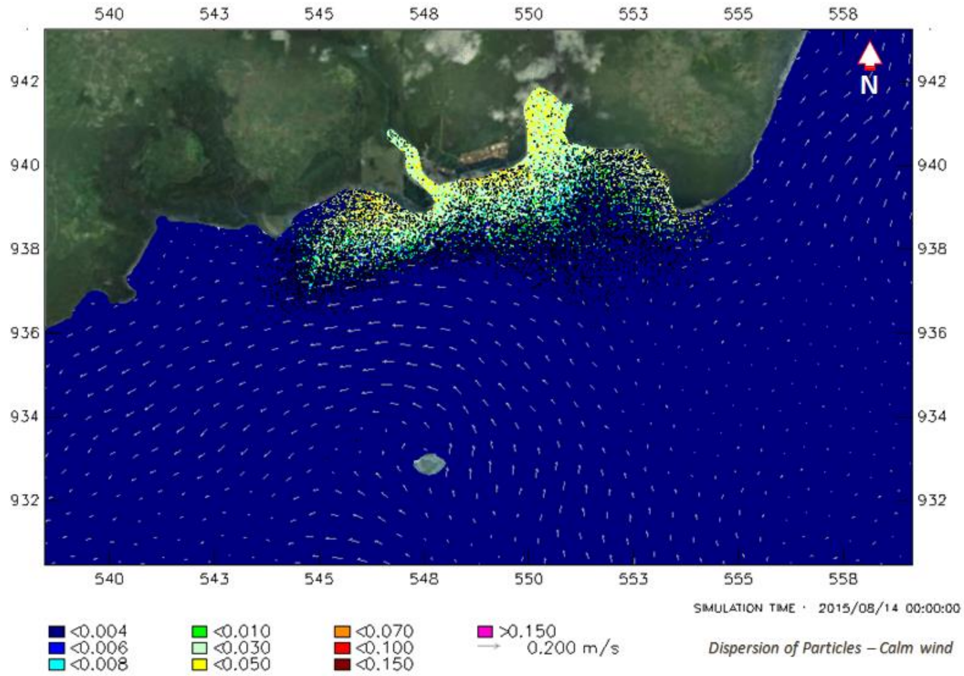


Figure 2.2.36. Predicted transport of particles 14 days after the start of pollutant release, under calm wind condition.

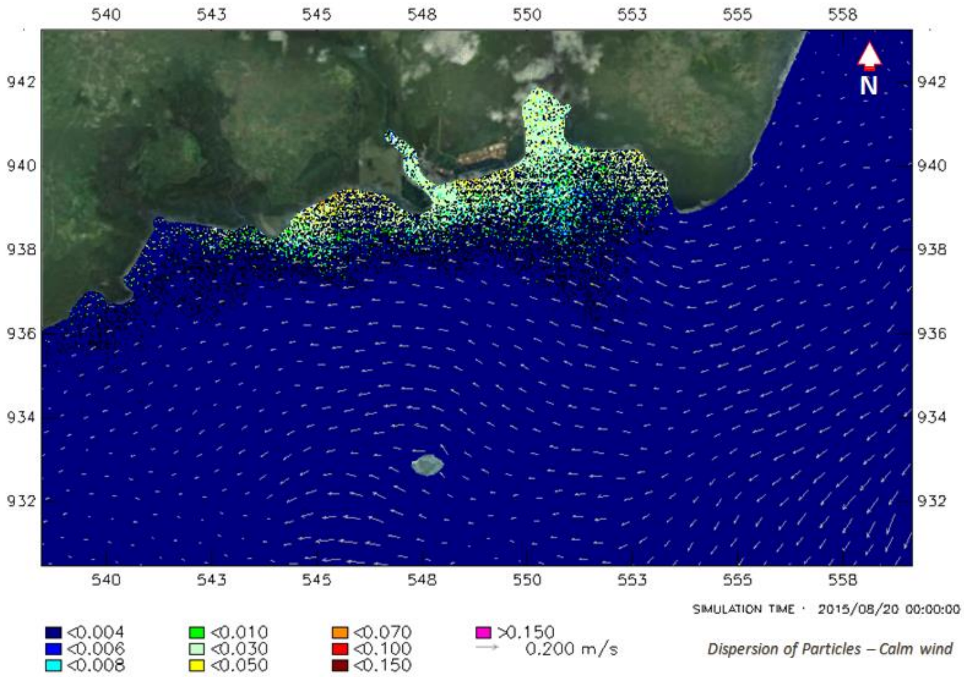


Figure 2.2.37. Predicted transport of particles 20 days after the start of pollutant release, under calm wind condition.

The key impacts of the proposed project on the physical oceanography are presented in **Table 2.2.8**.

Table 2.2.8. Impacts assessment and mitigation for physical oceanography

List of Key Impacts	Phase Occurrence: Pre-Construction	Phase Occurrence: Construction	Phase Occurrence: Operation	Phase Occurrence: Abandonment	Options for Prevention or Mitigation or Enhancement
• **Change in circulation pattern of Coral Bay** The hydrodynamics in the Coral Bay are influenced by the tidal current flows from the open waters of Sulu Sea. Thus, the development far upstream of the watersheds of Mt. Bulanjao once the project become operational will not significantly alter the existing hydrodynamic patterns in the downstream coastal waters.					
• **Change in Bathymetry** Based on the hydrodynamic and particle tracking modeling studies conducted, pollutant particles transported away from the coastal zone are minimal and that in case of accidental spillage of particulate matter or pollutant in the project		✓	✓	✓	Although the model indicates that particle transport from the mine site and and deposition along Coral Bay is minimal, the proper maintenance of existing and proposed mitigating measures to control silt shall be maintained. It is also recommended that RTNMC invest in the rehabiltation of the mangrove areas along the different

area, most of the particles released are dispersed mainly towards the south and small portions move towards east of the river mouth					river system to help control the dispersion of silt along the coastal areas of Coral bay
• **Particle dispersion** The model results revealed that the particle dispersion fluctuates depending on the rise and fall of the tides. Higher pollutant concentration is predicted to be consistent with low tidal level event. Simulation results demonstrated that hydrodynamics in the Bay are influenced by the tidal current flows from the open waters of Sulu Sea. Thus, the development far upstream of the watersheds of Mt/ Bulanjao once the project become operational will not significantly alter the existing hydrodynamic patterns in the downstream coastal waters. Likewise, the scenario simulations revealed pollutant particles released in the immediate vicinity of the project area were not transported far offshore in the direction of Arrecife Island and into the open sea. High velocity flows in the shallow reef areas within the vicinity of island, especially during periods of flood and ebb tides, appeared to prevent the cross-shore transport of pollutant between the Bay and the Island, seemingly providing a natural blocking mechanism for the transport of particulate matter between the mainland and the said Island. In summary, based from hydrodynamic and particle tracking modeling studies so far conducted, pollutant particles transported away from the coastal zone are minimal and that in case of accidental spillage of particulate matter or pollutant in the project area, most of the particles released are dispersed mainly towards the south and small portions move towards east of the river mouths. Also, after the two (2) days continuous release of particles, the concentration of pollutant become minimal a few days after such release, mainly due to efficient transport and mixing processes in the area.			✓		Proper maintenance of existing and proposed mitigating measures are strongly recommended to ensure the confinement of the suspended material during the operational phase of the project in case of accidental spillage of siltation ponds, materials, high sediment laden flows during strong rainfall events, during transport of materials, etc. for maintaining the environmental integrity of the downstream coastal zone. Thus, adequate siltation ponds and effective drainage system located at strategic locations within the mines must be established and regularly maintained.

2.2.3 Water Quality

2.2.3.1 Methodology

To assess the baseline condition of water bodies in the project area, both primary and secondary data were used. The primary data was obtained through actual survey of the water bodies, field measurements, sampling and analysis. Secondary data was obtained from the quarterly self-monitoring report of RTNMC. Information from the EIA preparation of 2010 was also extracted and used in this study.

The methodology for conducting the water quality assessment study in the project area was based on the Water Quality Monitoring Manual issued by the DENR-Environment Management Bureau. The procedure for field assessment, site selection, sampling and analysis are specified therein. Results of the analysis were compared with standard values cited in the new Water Quality Guidelines and General Effluent Standards (Department Administrative Order No.2016-08).

Water bodies in the impact areas include: Rio Tuba River, Ocayan River, and Sumbiling. The potential impact of the mining project on these water bodies was considered in the selection of sampling stations. The coastal areas where these rivers drain were also included in this study. Sampling sites were plotted along the tributaries of these rivers all the way to its downstream portions.

Practically all of the sampling stations in this study are new sites as they take into account the extent of the proposed development sites. The existing sampling stations of RTN, as seen in the Self-Monitoring Reports, monitor the impact of discharges from the mine site's siltation ponds to Rio Tuba R (Stations 8-10). In this study, the sampling site equivalent to these stations is RTN-MW1 which is downstream of the confluence of streams passing through these stations (Stations 8-10) and draining to Rio Tuba River. The description of the sampling stations of RTNMC for its self-monitoring is presented in *Chapter 6* of this EPRMP.

The sampling was carried out in September 2-3, 2015 in the following stations (**Table 2.2.9, Figure 2.2.38**) and for the following parameters (**Table 2.2.10** to **2.2.11**):

Table 2.2.9. Rio Tuba Nickel Mining Project (AMA-IVB-144A) sampling stations for the water quality assessment, September 2, 2015

Station ID	Northing	Easting	Site Description
RTN OR-1	8˚35'40.6"	117˚24'0.5"	Ocayan R. tributary upstream, adjacent to Rio Tuba Water System
RTN OR-2	8˚36'24.4"	117˚23'59.5"	Ocayan R. tributary midstream, Sitio Bohoy
RTN OR-3	8˚35'43.9"	117˚25'30.6"	Ocayan R tributary downstream, before merging with another tributary
RTN OR-4	8˚34'20"	117˚26'20.1"	Ocayan R, under Ocayan bridge
RTN RTR-1	8˚32'34.1"	117˚22'38.7"	Rio Tuba R. tributary 1
RTN RTR-2	8˚32'40.5"	117˚23'6.4"	Rio Tuba R. tributary 2
RTN RTR-3	8˚33'8.6"	117˚24'1.1"	Rio Tuba R. tributary 3, under bridge
RTN SR-1	8˚33'14.9"	117˚20'54.3"	Sumbiling R. tributary, near rice fields
RTN- SR-2	8˚33'16.2"	117˚21'11.0"	Sumbiling R. tributary, near paddle wheel
RTN-SR-3	8˚31'34.7"	117˚21'31.4"	Sumbiling R. tributary downstream, near roadside
RTN GW-1	8˚33'51.2"	117˚26'18.6"	Tagpisa water pump
RTN GW-2	8˚32'44.5"	117˚25'53.8"	RTN Supply Pump
RTN GW-3	8˚31'36.1"	117˚21'30.4"	Water pump at Sumbiling
RTN MW-1	8˚31'32.2"	117˚25'5.3"	Mouth of Rio Tuba R.

Station ID	Northing	Easting	Site Description
RTN MW-2	8°29'14.4"	117°23'46.9"	Mouth of Sumbiling R.

Table 2.2.10. Water quality parameters for groundwater use

Constituent	Parameter
Groundwater	
Microbiological	E. Coli or thermotolerant (fecal) coliform bacteria (#/100 ml), Total Coliform
Inorganic Constituents	arsenic, cadmium, chromium (total and hexavalent), lead, nickel
Aesthetics	pH, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Color, Turbidity, Hardness
Additional parameters	Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD)

Table 2.2.11. Water quality parameters for surface water (freshwater and marine)

Constituent	Parameter
Freshwater	
Conventional	Color, BOD5, COD, TSS, TDS, Surfactants, Oil and Grease, Nitrate-N, Phosphate-P, Total Coliforms, Chloride, Copper
Toxic & deleterious	arsenic, cadmium, chromium (VI), lead, mercury, nickel
Marine Water	
Conventional	Color, BOD5, Total Suspended Solids, Surfactants, Oil and Grease, Total Coliforms, Copper
Toxic & deleterious	arsenic, cadmium, chromium (VI), lead, mercury, nickel

Water samples were compared with guide values found in DENR Department Administrative Order (DAO) 2016-08. The Philippine National Standards for Drinking Water (PNSDW) 2007 was also used as reference in the analysis of groundwater.

2.2.3.2 Baseline Conditions

2015 Water Sampling

Domestic/Groundwater Quality

The results of laboratory analysis of domestic/groundwater quality assessment as compared to DAO 2016-08 and PNSDW 2007 are shown in **Table 2.2.12**. The actual laboratory reports are in **Annex 2.2.2**.

Table 2.2.12. Results of groundwater sampling analysis in Rio Tuba Nickel Mining Corporation

Parameters	Analysis Method/ Instrument	DAO 2016-08 Class A and PNSDW	RTN-GW1	RTN-GW2	RTN-GW3
pH	Glass Electrode	6.5-8.5	7.33	8.52	5.68
Fecal Coliform, MPN/100 ml	Multiple Tube Fermentation	<1.1	<1.1	>23	16
E. coli	APHA 9225 B&D	Negative*	negative	negative	negative
Color, PCU	Visual Comparison	50	<3	<3	8
Total Suspended Solids (TSS)	Gravimetric	50	8.0	<2.5	14
Arsenic (As)	Gaseous Hydride AAS	0.01	<0.001	<0.001	<0.001
Cadmium (Cd)	Flame AAS	0.003	<0.003	<0.003	<0.003
Hexavalent Chromium (Cr+6)	Diphenylcarbazide	0.01	<0.003	0.012	<0.003
Nickel (Ni)	Flame AAS	0.02	<0.01	<0.01	<0.01
Lead (Pb)	Graphite Furnace AAS	0.01	<0.0001	<0.0001	<0.0001
Turbidity, NTU	Nephelometry	5	<0.05	<0.05	4.2
Hardness (as $CaCO_3$)	Trimetry	300	189	336	20
Total Dissolved Solids (TDS)	Gravimetric (180^{o}C)	500	298	446	148

*Notes: * Coliform analysis normally includes a confirmation test for E coli*
MPN – Most Probable Number
All units in mg/L except as otherwise stated

Primary Parameters

All stations exceeded the standard with respect to microbial quality with the exception of the water pump at Tagpisa (RTN-GW1). The level of fecal coliform present in the samples exceeded the Class A standard and also that of the DOH standard for drinking water (PNSDW 2007), with fecal coliform value of >23. A negative result for *E.* coli was exhibited and may indicate a false positive for the fecal coliform test. Additional microbiological tests are required to confirm these findings. Treatment may be needed to achieve drinking water quality. In the meantime, the water should only be used for Class B requirements (bathing and primary contact recreation) or additional measures such as boiling should be implemented for drinking water purpose.

Two of the groundwater sampling stations RTN-GW1 and RTN-GW2 had pH values within the range of the drinking water standard. RTN-GW3, the groundwater pump at Sumbiling, however, exhibited pH of 5.68 which is below the lower limit of the drinking water standard of 6.5. Groundwater that is acidic may contain excessive amounts of iron. Iron causes reddish stains on plumbing fixtures and clothing.

Other primary parameters such as color and TSS were within the guide values for all samples analyzed.

Secondary Parameters

Physical and chemical quality parameters of health significance that were measured for this study were the heavy metals arsenic, cadmium, chromium (total and hexavalent), lead, and nickel. For all three groundwater samples, the heavy metals were below the standard criteria for drinking water. This implies that metals found in the ore body do not readily leach and permeate to the groundwater table. It may also be that, despite their presence in the soil, conditions (e.g. permeability) do not favor their mobilization and transport to the water table.

Additional Groundwater Quality Parameters

The level of TDS in all samples ranged between 148-446 mg/L which was below the 500 ppm threshold under PNSDW 2007. TDS comprise inorganic salts and small amounts of organic matter that are dissolved in water. The principal constituents are usually the cations calcium, magnesium, sodium and potassium and the anions carbonate, bicarbonate, chloride, sulphate and nitrate.

TDS values also correlate to the hardness measurements. Water that contains a lot of calcium and magnesium is said to be hard. The hardness of water is expressed in terms of the amount of calcium carbonate. Water is considered soft if it contains 0 to 60 mg/L of hardness, moderately hard from 61 to 120 mg/L, hard between 121 and 180 mg/L, and very hard if more than 180 mg/L. Thus, RTN-GW1 can be considered as hard, RTN-GW2 is very hard water, while only RTN-GW3 is soft water. Very hard water is not desirable for many domestic uses.

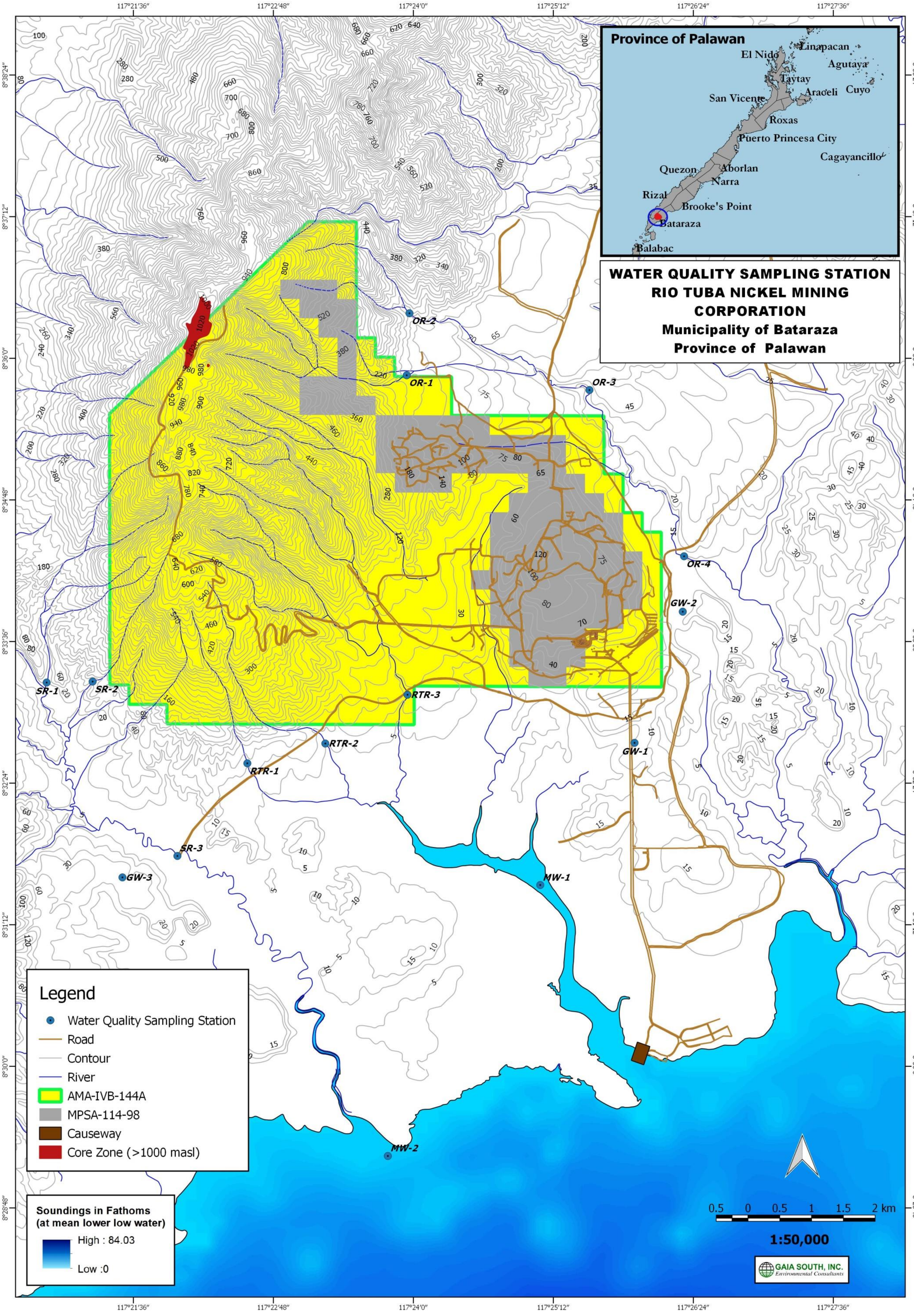


Figure 2.2.38. Water quality sampling stations

Freshwater Quality

Of the three (3) rivers draining the RTNMC site, both Rio Tuba and Ocayan have been classified as Class C by the DENR. No DENR classification has been reported for Sumbiling R. but for this study, Class C comparison will be made. **Tables 2.2.13a** to **13c** show the results of the laboratory analyses for the samples taken from the three (3) rivers.

Table 2.2.13a. Results of freshwater sampling analysis in RTNMC (Ocayan River tributaries)

Parameters	Analysis Method/ Instrument	DAO 2016-08 Class C	RTN OR-1	RTN OR-2	RTN OR-3	RTN OR-4
pH	On-site,	6.5 – 8.5	8.0	8.26	8.05	7.94
Temperature, C^{o} rise	On-site,	25-31	26	25	28.4	27.4
Dissolved Oxygen (DO)	On-site,	5.0	8.0	8.0	8.6	8.0
Color, PCU	Visual Comparison	75	<3	5	3	5
Biochemical Oxygen Demand (BOD)	Azide Modification (Dilution Technique)	7	<1	<1	<1	<1
Total Suspended Solids (TSS)	Gravimetric (dried at 103 – 105 ^{o}C)	80	<2.5	4.0	<2.5	<2.5
Oil & Grease	Petroleum Ether Extraction	2	0.3	<0.3	0.3	<0.3
Total coliform, MPN/100ml	Multiple Tube Fermentation	-	540	240	2400	5400
Fecal Coliforms	Multiple Tube Fermentation	200	21	240	1600	2400
Escherichia Coli	APHA 9225 B & D	-	negative	negative	negative	positive
Arsenic (As)	SDDC, Spectrophotometry	0.02	<0.01	<0.01	<0.01	<0.01
Cadmium (Cd)	Flame AAS	0.005	<0.006	<0.006	<0.006	<0.006
Hexavalent Chromium (Cr^{+6})	Diphenylcarbazide	0.01	<0.003	<0.003	<0.003	<0.003
Lead (Pb)	Flame AAS	0.05	<0.05	<0.05	<0.05	<0.05
Nickel (Ni)	Flame AAS	0.2	<0.03	<0.03	<0.03	<0.03

Note: all units in mg/L unless otherwise specified

Table 2.2.13b. Results of freshwater sampling analysis in RTNMC (Tuba River tributaries)

Parameters	Analysis Method/ Instrument	DAO 2016-08 Class C	RTN RTR-1	RTN RTR-2	RTN RTR-3
pH	On-site	6.5 – 8.5	8.05	8.11	7.66
Temperature, C^{o} rise	On-site,	25-31	26.8	26.7	28.2
Dissolved Oxygen (DO)	On-site,	5.0	8.5	9.0	8.6
Color, PCU	Visual Comparison	75	3	3	3
Biochemical Oxygen Demand (BOD)	Azide Modification (Dilution Technique)	7	<1	<1	<1
Total Suspended Solids (TSS)	Gravimetric (dried at 103 – 105 ^{o}C)	80	5.5	3.5	<2.5
Oil & Grease	Petroleum Ether Extraction	2	<0.3	<0.3	<0.3
Total coliform, MPN/100ml	Multiple Tube Fermentation		3500	920	2400
Fecal Coliforms	Multiple Tube Fermentation	200	400	540	1600
Escherichia Coli	APHA 9225 B & D		negative	negative	negative
Arsenic (As)	Hydride Generation – AAS	0.02	<0.01	<0.01	<0.01
Cadmium (Cd)	SDDC, Spectrophotometry	0.005	<0.006	<0.006	<0.006

Parameters	Analysis Method/ Instrument	DAO 2016-08 Class C	RTN RTR-1	RTN RTR-2	RTN RTR-3
Hexavalent Chromium (Cr^{+6})	Diphenylcarbazide	0.01	0.019	0.017	<0.003
Lead (Pb)	Flame AAS	0.05	<0.05	<0.05	<0.05
Nickel (Ni)	Flame AAS	0.2	<0.03	<0.03	<0.03

Note: all units in mg/L unless otherwise specified

Table 2.2.13c. Results of freshwater sampling analysis in RTNMC (Sumbiling River tributaries)

Parameters	Analysis Method/ Instrument	DAO 2016-08 Class C	RTN SR-1	RTN SR-2	RTN SR-3
pH	On-site	6.5 – 8.5	8.39	8.47	7.55
Temperature, C^{o} rise	On-site,	25-31	28.2	27.9	28.2
Dissolved Oxygen (DO)	On-site,	5.0	8.9	7.6	8.0
Color, PCU	Visual Comparison	75	27	20	25
Biochemical Oxygen Demand (BOD)	Azide Modification (Dilution Technique)	7	<1	<1	<1
Total Suspended Solids (TSS)	Gravimetric (dried at 103 – 105 ^{o}C)	80	9.0	27	13
Oil & Grease	Petroleum Ether Extraction	2	0.6	0.6	<0.3
Total coliform, MPN/100ml	Multiple Tube Fermentation		1,300	790	16,000
Fecal Coliforms	Multiple Tube Fermentation	200	790	790	9,200
Escherichia Coli	APHA 9225 B & D		negative	negative	negative
Arsenic (As)	SDDC, Spectrophotometry	0.02	<0.01	<0.01	<0.01
Cadmium (Cd)	Flame AAS	0.005	<0.006	<0.006	<0.006
Hexavalent Chromium (Cr^{+6})	Diphenylcarbazide	0.01	<0.003	0.017	<0.003
Lead (Pb)	Flame AAS	0.05	<0.05	<0.05	<0.05
Nickel (Ni)	Flame AAS	0.2	<0.03	<0.03	<0.03

Note: all units in mg/L unless otherwise specified

The primary parameters used to measure water quality include pH, DO, BOD5, fecal coliform and TSS. All stations showed values within their prescribed Class C water quality classification, except for fecal coliform in RTN-OR4 and RTN SR-3. Both are downstream stations situated in relatively high population areas. Current practices in the area include animal bathing in these streams. Throwing of solid wastes was also observed around this site

For all the stations sampled, all the secondary parameters were below the respective detection limits for the analytical methods used, indicating the correctness of the prescribed classification with respect to these parameters.

Nickel concentration in the stations sampled was all below 0.03 mg/L, suggesting that there is no mobilization and transport of nickel from the ore body.

The new DAO 2016-08 now specifies a lower concentration threshold for Hexavalent Chromium, from the previous 0.05 mg/L to 0.01 mg/L. The Cr^{+6} guide value of 0.01 mg/L was not exceeded at Ocayan R. However, for both Sumbiling R and Rio Tuba R (the receiving water body for the plant's current operation) there were marginal exceedances to the 0.01 mg/L level (0.017 to 0.019 mg/L). Chromium is a component of laterite ores and the dissolution of chromium in hexavalent form has already been noted in some researches (M. Economou-Eliopoulos, 2016).

Marine Water Quality

The result of analysis of the water samples from the two (2) marine stations were compared to the DENR standard for Class SC (**Table 2.2.14**).

All stations showed values (within standards) for pH, dissolved oxygen, BOD, oil and grease, and total coliforms.

For all stations, all the parameters measured, except for nickel, were below the detection limits of the analytical methods used, indicating good quality for the Class SC standard.

Table 2.2.14. Results of marine water sampling analysis in Rio Tuba Nickel Mining Corp.

Parameters	Analysis Method/Instrument	DAO 2016-08 Class SC	RTN-MW1	RTN-MW2
pH	On-site	6.5 – 8.5	7.65	7.82
Temperature, °C	On-site	--	30.2	30.4
Dissolved Oxygen (DO)	On-site	5.0	7.9	6.0
Color, PCU	Visual Comparison	(c)	13	10
Biochemical Oxygen Demand (BOD)	Azide Modification (Dilution Technique)	7(10)	<1	1
Chemical Oxygen Demand	Open Reflux Method		70	90
Total Suspended Solids (TSS)	Gravimetric (dried at 103 – 105 °C)	(g)	4.5	5.0
Oil & Grease	Gravimetric (Petroleum Ether Extraction)	3	0.3	0.3
Total coliform, MPN/100ml	Multiple Tube Fermentation	5,000 (m)	1600	4.5
Fecal Coliform	Multiple Tube Fermentation		1600	4.5
E. Coli	APHA 9225		negative	negative
Arsenic (As)	SDDC Spectrophotometry	0.05	<0.01	<0.01
Cadmium (Cd)	Flame AAS	0.01	<0.006	<0.006
Hexavalent Chromium (Cr^{+6})	Diphenylcarbazide	0.05	<0.003	<0.003
Lead (Pb)	Flame AAS	0.05	<0.05	<0.05
Mercury (Hg)	Cold Vapor AAS	0.002	<0.0006	<0.0006
Nickel (Ni)	Flame AAS	0.06	0.7	0.6

Analysis of RTNMC Monitoring Data for 2011-2015 and 2016-2018

Measurements conducted by RTN and reported in its Self-Monitoring Reports (SMRs) for 2011-2015 were analysed for various parameters. Upon release of DAO 2016-08, the company was required to monitor the parameters pH, TSS, manganese, arsenic, cadmium, lead, and nickel.

Figure 2.2.39 presents the pH monitoring trend of the receiving water body (Stations 8, 9 and 10). Generally, the measured values are within the DENR standard except for a single occasion in 2011 for Station 10. Monitoring reports for 2016-18 (**Figure 2.2.39a**) show the same general trend with a few values below 6.5 occurring on two (2) of 30 sampling events.

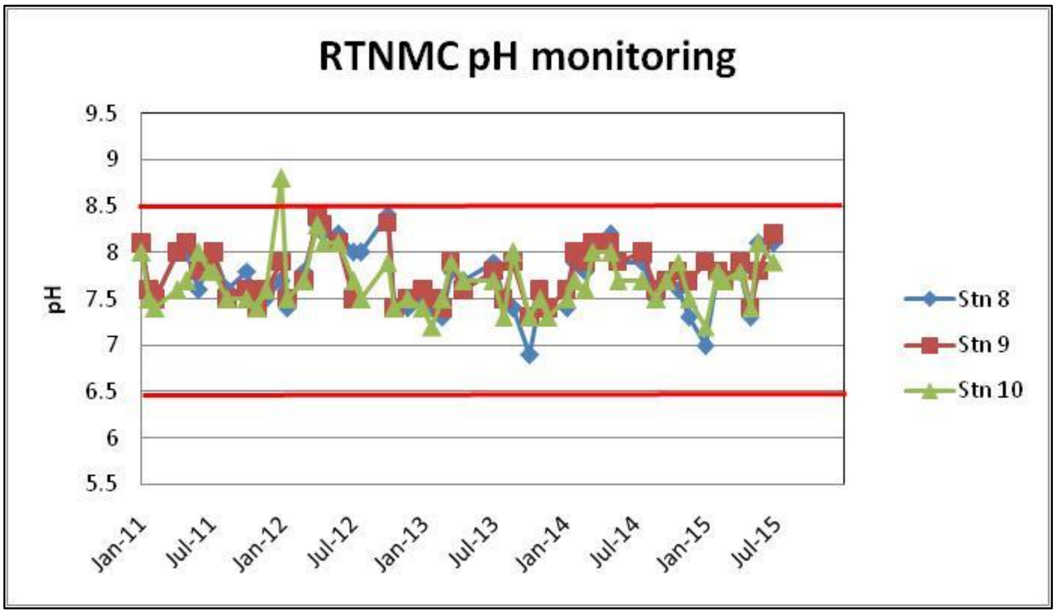


Figure 2.2.39. RTNMC pH monitoring of Rio Tuba tributaries (2011-2015)

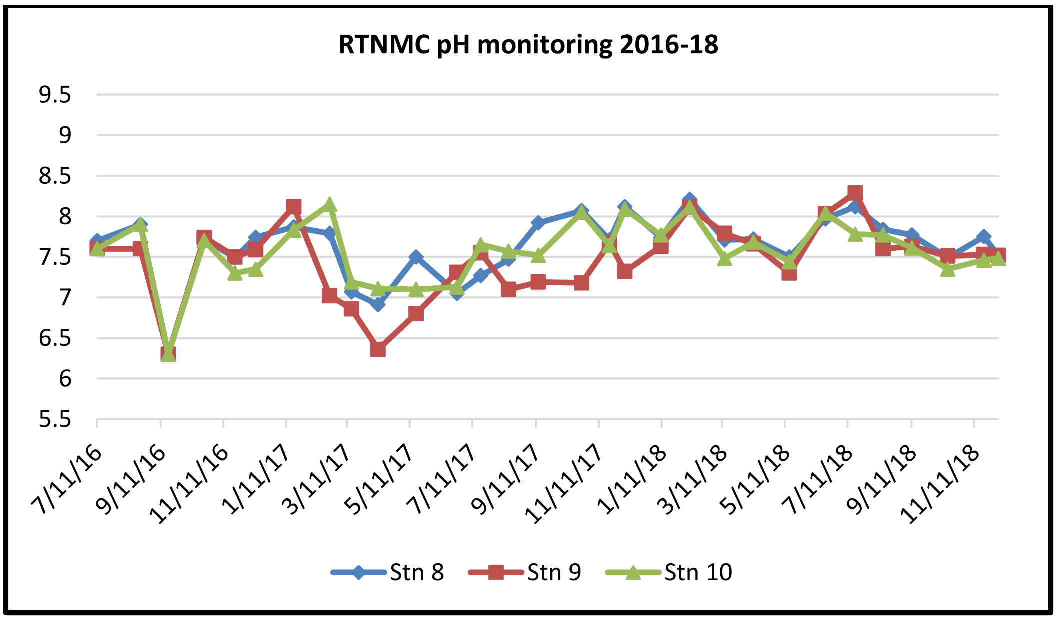


Figure 2.2.39a. RTNMC pH monitoring of Rio Tuba tributaries (2016-2018)

For TSS, the runoff water draining from the mined areas enters the siltation ponds at values that reach up to **1,000 mg/L**. At Stations 8-10, after the siltation ponds, the measured values of TSS fall below **50 mg/L** (**Figure 2.2.40**). The median value for all three (3) stations is 11 mg/L while the average is around 13.2 mg/L. For 2016-18, average is 6.3 mg/L. This would indicate the effectiveness of siltation ponds in controlling suspended solids.

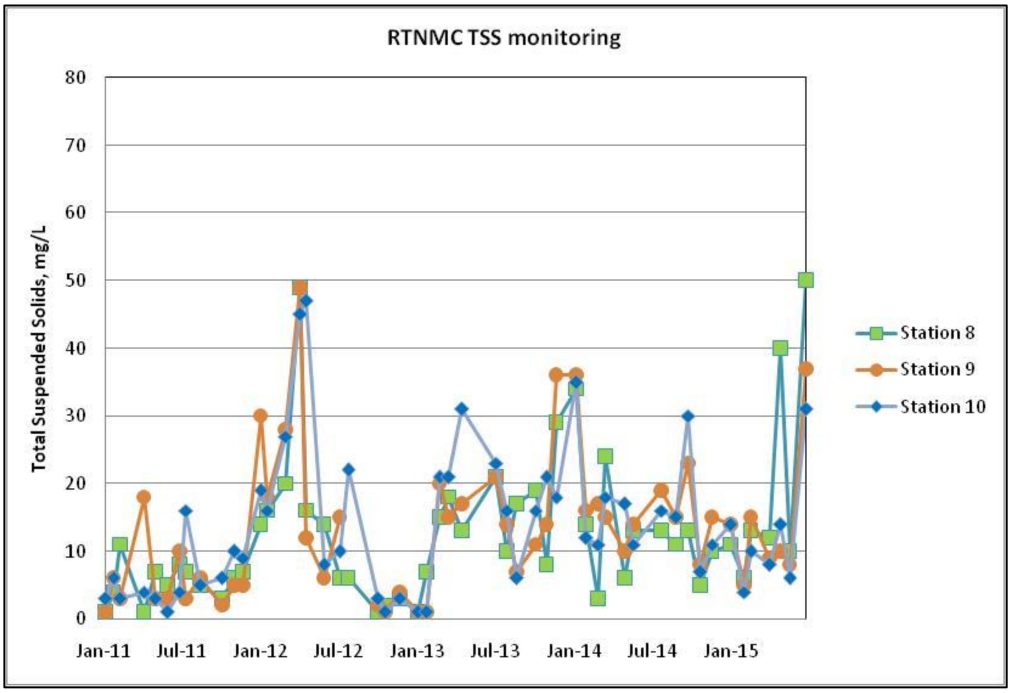


Figure 2.2.40. TSS monitoring for Rio Tuba River tributaries (2011 to 2015)

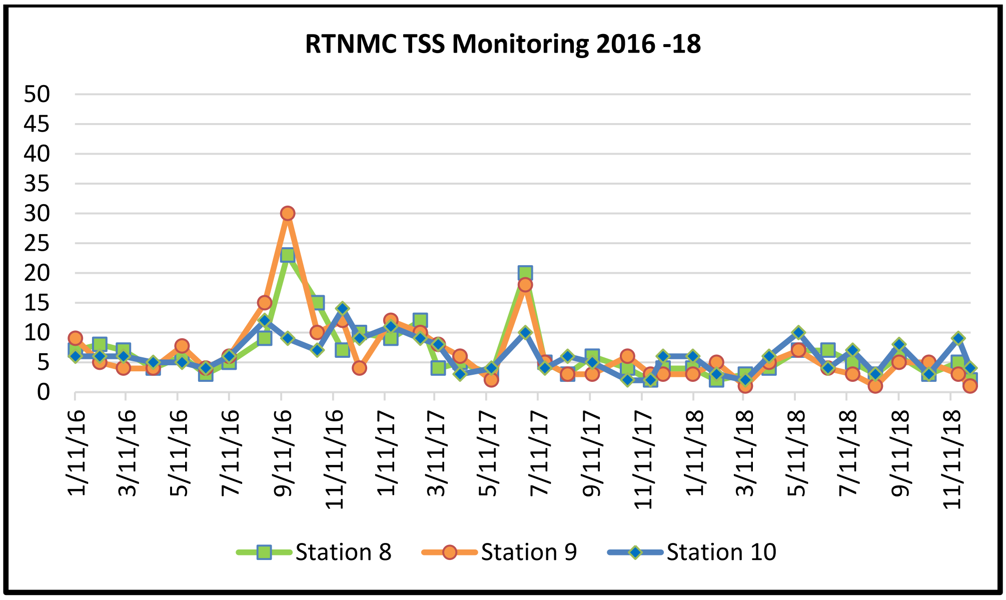


Figure 2.2.40a. TSS monitoring for Rio Tuba River tributaries (2016 to 2018)

Hexavalent chromium has been reported at times to be at levels beyond the Class C standard of 0.05 mg/L (DAO 1990-34). The current 2015 values did not show any exceedances for all the three (3) rivers. However, monitoring results showed that 5% of measured values (7 out of 151) from Stations 8-10 exceeded the prescribed limit of 0.05 mg/L (**Figure 2.2.41**).

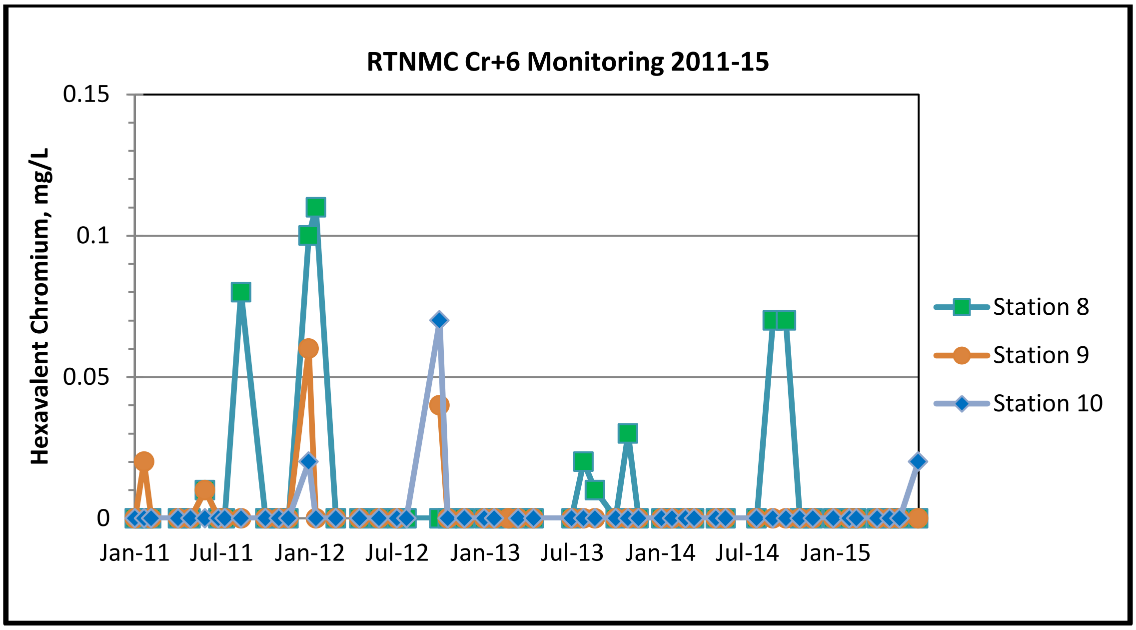


Figure 2.2.41. Hexavalent chromium monitoring for Rio Tuba River tributaries (2011 to 2015)

For new required parameters Ni, As, Pb, and Cd, the monitoring results (in **Annex 6.2.1**, 4th Quarter of 2018 SMR) showed no values above the new guide values in DAO 2016-08. Most or practically all were below the detection limits of the prescribed analytical methods.

2.2.3.3 Impact Assessment

The key impacts of the proposed project on water quality are presented in **Table 2.2.15.**

Table 2.2.15. Impacts assessment and mitigation for the water quality

List of Key Impacts	Phase Occurrence: Pre-Construction	Construction	Operation	Abandonment	Options for Prevention or Mitigation or Enhancement
• **Degradation of domestic/groundwater quality** Oil spills during construction and operation may potentially contaminate the groundwater table.		✓	✓	✓	Good construction practices will be implemented to mitigate the impacts of oil leaks from vehicles and other construction activities. Proper handling and storage of diesel, fuel oil and lubricants in covered areas with impermeable flooring and installation of proper bund walls will reduce risk from this environmental aspect. The use of oil-water separators installed at various locations in the existing operation has proven to be effective in containing oil leaks within a confined area and reducing oil in wastewater effluents. It is expected that this practice will be continued and additional oil-water separators will be installed in the new locations.
• **Degradation of surface water quality** Oil spills and leaks from fuel		✓	✓	✓	Proper storage of fuel oil and lubricants in covered areas with impermeable flooring and with concrete bunding will reduce contamination of hydrocarbon residues.

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
storage areas may potentially contaminate streams, rivers, and coastal waters. On the other hand, oil-contaminated wastewater may be generated from the operation of heavy equipment and power generation and could be carried by runoff or discharged to the nearest water body hence degrading the quality of the water body.					All oil spills should be contained, cleaned and collected in order to minimize its spread. All contaminated materials shall be stored in sealed container and temporarily stored in a secure area prior to collection and treatment of an accredited waste treater. Oily wastewater will be diverted to oil-water separators. Effluent will pass through a settling pit before final discharge to receiving water body. The design will ensure that effluent is compliant with discharge requirements of DAO-35. In addition, a monitoring system will be set up to check the effectiveness of the OWS system. The OWS will be regularly maintained and sludges will be regularly collected, stored in sealed container prior to treatment.
Increased soil erosion during construction and operation may contaminate water bodies. Furthermore, dust generated may be deposited along waterways and further increase siltation.					The new mining areas will be provided with temporary sediment control facilities until such time the surface run off are fully channeled towards the siltation ponds during construction stage. Monitoring the nearest surface water bodies will check for the effectiveness of these measures.
Increased leaching of heavy metals present in the ore-body could contaminate surface waters. Heavy metals can also be leached from the dust particles generated from the mine site.					Aside from silt, the surface runoff will carry heavy metals downstream. In the current experience, levels of Cr^{+6} at some instances, slightly exceed effluent standards. The operations should continue to intensify its mitigation measures for Cr^{+6}, including its charcoal gabion structures, constructed wetlands, and other measures to lower levels to acceptable levels. Researches on cost-effective management of this contaminant should be further supported.

2.2.4 Freshwater Biology

2.2.4.1 Methodology

There are six (6) surface water bodies that were identified as impact areas for the mining operations. These are the Sumbiling River, Gamayon Creek, Togpon Creek, Ibelnan Creek, Ocayan River and Malatgao River. These surface water bodies drain the proposed mining site.

The field sampling study was conducted on 22 and 24 August 2015. The project site has been the subject of several EIA studies. Prior to the conduct of the field sampling, maps and other secondary data were reviewed to identify the sampling points. Data from the 2001 and 2005 EIA studies are cited to compare results. The 2005 sampling were more or less at the same location or within the vicinity of the current sampling stations.

About 60 liters of river water were filtered through a 25 µm net and collected along each sampling station and stored in polyethylene bottles. Plankton samples were preserved with 10% formalin solution and were allowed to stand for one week to settle plankton for concentration and identification.

A 0.5 m x 0.5 m Surber sampler was laid along the riverbed for benthos enumeration at each sampling station. Sediment, rock and vegetation and debris within the quadrat were disturbed, and washed to dislodge clinging organisms. The benthos filtered through the net were handpicked and stored into polyethylene bottles, preserved with ethyl alcohol, and identified using a dissecting microscope. Replicates were taken for each station representing different substrate types when possible. Density counts are presented using a 1.0 m^2 area.

Fish and other riverine organisms were identified through direct observation and interviews with the field guides and residents living near the rivers. Selected residents were asked to lay down nets overnight along the river and all species were photographed for identification.

There were 11 stations sampled for this study (**Figure 2.2.42**). **Table 2.2.16** presents a detailed description of the sampling stations.

Table 2.2.16. Description of the sampling stations, RTNMC mining areas

Station No.	Location	Description
1 (6) (1*)	Ibelnan East 8˚34.243' 117˚23.568'	The station is located downstream of the water impounding dam of the HPP project within the Ibelnan Resort. The vicinity is a grassland area/residual forest area. Substrate is gravel type with sand. Depth of water is approximately 20-40 cm.
2 (7) (2*)	Ibelnan West 8˚33.735' 117˚23.436'	The station is located just downstream of the road going up to the Bulanjao mining areas. Substrate is sandy-rocky. Vegetation is composed of grasses, pitcher plants and stands of Mankono trees.
3 (4) (3*)	Ibelnan Confluence 8˚33.152' N 117˚24.90' E	The sampling station is found downstream of the confluence of the East and West Ibelnan Tributary a Gadsan Bridge along the barangay road to Barangay Sumbiling. The vicinity is a grassland area. The substrate is sandy-gravel type. Depth of water is approximately 20 – 40 cm. Collection of plankton and benthos was done previously in 2001.
4 (1)	Sumbiling upstream 8˚32.514' 117˚21.181'	The station is locate beside the Barangay Road downstream from the confluence of the east and west tributaries of Sumbiling River which drains the lower section of the RTNMC MPSA Area. The vicinity of the sampling station is mostly agricultural areas (rice fields). Vegetation found along the riverbanks includes bamboo and other grasses. The substrate is rocky-sandy and there were silty deposits along pool areas. Depth of water during sampling is approximately 15 to 40 cm.
5 (2) (12*)	Sumbiling downstream 8˚31.821' 117˚21.846'	At least 30 m downstream from the bridge along the Barangay road. Vegetation found along the riverbanks includes grasses and bamboo. Substrate is sandy-silty. Water depth ranges from 15 to 50 cm within the sampling stations.
6 (5)	Togpon downstream 8˚33.159' 117˚24.816'	The station is located beside the barangay road. The vicinity is a grassland area. The substrate on this station is gravel type with sand-silt deposits on pool areas. Depth of water is 30 to 40 cm. This station is used as a monitoring station for water quality assessment.
7	Togpon upstream 8˚34.325' 117˚24.236'	The station is near the vicinity off the Guintalunan Pit. The substrate is mainly rocky-sandy and vegetation are grasses and big trees. Depth of water is around 15 to 30 cm.
8 (3)	Gamayon Creek 8˚32.554' 117˚22.646'	The station is beside the barangay road vicinity is an agricultural area (rice fields) and grassland areas. Upstream is still forested. Substrate is gravel type. Depth of water is approximately 15 to 40 cm along the sampling areas.
9 (9)	Ocayan River (Buhoy) 8˚35.892'	The station is located upstream of Ocayan River beside the access road to Sitio Buhoy. Vegetation is mainly grass and substrate is rocky-sandy-silty. The water depth ranges from 15-35 cm at the sampling site.

Station No.	Location	Description
	117˚24.217'	
10 (8)	Ocayan Downstream 8˚35.468' 117˚25.320'	The station is located just bedside the road going to Sitio Pasi-pasi. The substrate is rocky-sandy-silty type. Vegetation is composed of grassland/residual forest type. This is also used for monitoring water quality. Water depth ranges from 10 cm to more than a meter deep.
11 (10)	Malagao River 8˚37'24"N 117˚24'97"E	Located upstream of Malatgao River on one of its tributaries. The vegetation is composed of grasses and small trees. Substrate is rocky-sandy-silty. Depth of water is estimated at 15 to 46 cm within the sampling station.

Note:
(1) - similar station in 2005 sampling
(1) - similar station in 2001 sampling*

2.2.4.2 Baseline Conditions

The surface water bodies within and around the mining areas of RTNMC are mainly used for household purposes, for irrigation and for the use of the HPP and RTNMC operations (Ibelnan and Togpon). A large area within the Sumbiling River at the foot of Mt. Bulanjao in Station 1 is mainly rice fields. Gamayon Creek is also being utilized for irrigating rice fields located near the barangay road (**Plate 2.2.10**). Malatgao River is also used for irrigation of the farmlands located downstream of the sampling stations. Residents also catch fish a these surface water bodies for food. In Sitio Bohoy, residents are raising Tilapia in ponds irrigated by the river.

Household use include bathing and washing clothes and also for drinking water. Residents also use the surface water for cleaning their vehicles (**Plate 2.2.11**).

The major factor that influences the growth of aquatic organisms in lotic environment is the unidirectional water flow (Goldman, 1983). The water movement drives the essential ecological functions including the nutrient cycle, waste cleanup and the distribution of vital gaseous elements (Molles, 1999).

The continued availability of nutrients and gaseous elements allows the survival of different plants and animal communities. However, aquatic organisms require only a certain range of physico-chemical conditions, for their survival (Bartsch, 1967). If these requirements fall beyond the prescribed range, its capacity to sustain life is undermined (Dusenbery, 1992). Thus, any environmental change may result in the shift in the community structure of aquatic organisms.

The physico-chemical properties required for the growth and survival of organisms would include water flow, substrate type, temperature, light, dissolved oxygen, dissolved salts, suspended solids, pH and other dissolved metals and chemicals, among others.

Streams have two (2) major habitats, the rapid and pool zones. Water movement influences these two (2) habitats. Fast flowing areas or the rapid zones have gravel type of bottom while slow flowing areas or pool zones have sandy-silty bottoms.

Plate 2.2.10. View of the Gamayon Creek with rock dams to irrigate farmlands.

Plate 2.2.11. Cleaning of vehicles.

Plate 2.2.12. Cleaning of motorcycles by the residents at the Gadaan Bridge.

The chemical characteristic of surface waters is also influenced by natural and anthropogenic factors. The chemistry of surface water is reflected by the geological characteristics of the area where a river/stream passes through. However, human activities within the watershed of a river play a significant influence on surface water resources. This is because the streams are the major recipients of materials that move down from the watershed areas.

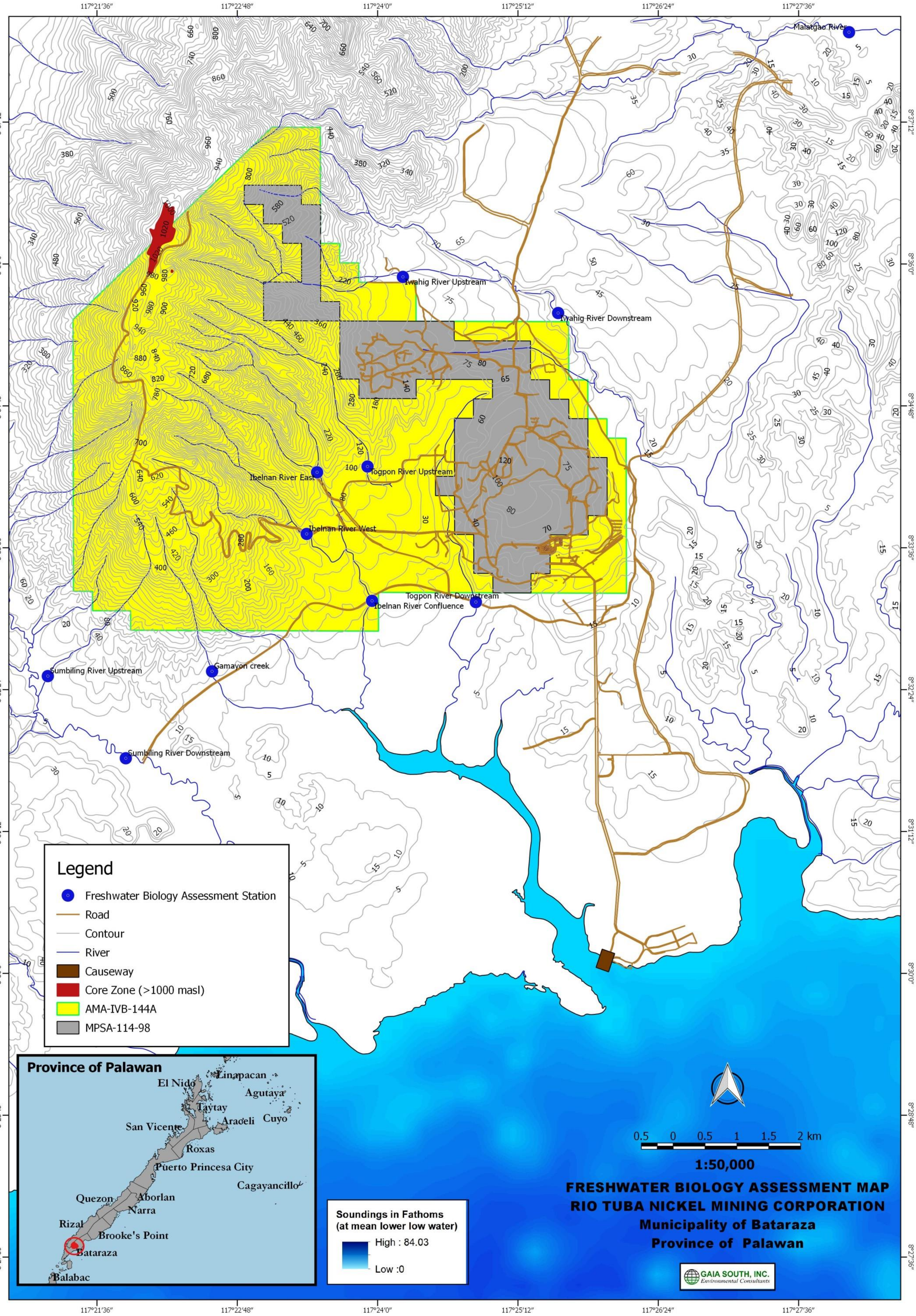


Figure 2.2.42. Freshwater ecology sampling stations

Phytoplankton

There were five (5) major groups of phytoplankton identified in the samples taken from the 11 sampling stations (**Table 2.2.17**). These are Division Chlorophyta, Division Euglenophya, Division Pyrhophyta, Division Bacillariophyta, and Division Cyanophyta with 35 species. The most number of species identified are the diatoms (Bacillariophyta) with 15 species. Station 8 in Gadsan Bridge has the most number of species (11) with diatoms represented by nine (9) species. Station 9 located in Sitio Buhoy also has more diatoms species. For the downstream stations of Sumbiling (Station 5) and Togpon (Station 6), there were more species from Division Chlorophyta.

During the 2005 Sampling, there were two (2) major groups of phytoplankton identified in the samples taken from the 10 sampling stations (**Table 2.2.18**). These were Divisions Bacillariophyta or diatoms and Cyanophyta, the blue-green algae. Of these two (2) major groups, only eight (8) species were identified; five (5) species were diatoms and three (3) were blue-green algae.

Stations 3, 5, 6 and 9 had only blue-green algae while stations 1, 2, and 4 had only diatoms. Both groups were sampled in Stations 7 and 8. No phytoplankton species were observed in Station 10. Comparing for this sampling, there are more species identified although at smaller numbers. None of the station showed similar species at both sampling.

Table 2.2.17. Phytoplankton species identified and cell densities (cells/l), RTNMC Mining Areas, 22 and 24 August, 2015

Species	1	2	3	4	5	6	7	8	9	10	11	Grand Total
Division Cyanophyta	17	3	3	2	2	2	0	7	6	5	0	28
Chroococcus	-	-	-	-	-	2	-	-	3	-	-	5
Spirulina	-	-	-	-	-	-	-	7	-	-	-	7
Oscillatoria	17	3	3	2	2	-	-	-	2	5	-	32
Division Bacillariophyta	6	18	0	7	21	5	2	97	17	23	8	198
Chaetoceros	-	-	-	-	-	-	-	4	-	-	-	4
Coscinodiscus	-	-	-	-	-	-	-	4	-	-	-	4
Cymbella	-	-	-	-	-	-	1	3	-	-	-	4
Melosira	-	-	-	-	20	4	-	4	3	-	-	30
Meuniera	-	-	-	-	-	-	-	4	-	-	-	4
Merismopedia	-	-	-	-	-	-	-	-	-	4	-	4
Nitzschia	-	-	-	-	-	-	-	-	-	3	-	3
Navicula	-	2	-	-	-	1	-	-	-	5	1	9
Odontella	1	-	-	-	-	-	-	3	-	-	-	3
Pinnularia	-	-	-	-	-	-	1	-	-	-	-	1
Pleurosigma	-	-	-	-	-	-	-	-	4	-	-	4
Pseudonitszchia	-	-	-	-	-	-	-	55	2	-	-	57
Rhizosolenia	2	-	-	-	-	-	-	15	3	-	-	20
Surirella	1	-	-	7	2	-	-	-	3	11	7	24
Thalassiosira	-	16	-	-	-	-	-	-	-	-	-	16
Thalassionema	2	-	-	-	-	-	-	7	-	-	-	10
Division Pyrhophyta	4	0	13	0	0	259	1	0	2	0	1	276
Ceratium hirudiniella	-	-	2	-	-	-	-	-	-	-	-	2
Diplopsalis	-	-	0	-	-	-	-	-	2	-	-	2
Peridinium	4	-	10	-	-	259	1	-	-	-	1	276
Division Euglenophya	0	0	0	0	3	0	0	0	1	0	0	4
Euglena	-	-	-	-	2	-	-	-	-	-	-	2
Phacus	-	-	-	-	-	-	-	-	1	-	-	1
Trachelomonas	-	-	-	-	2	-	-	-	-	-	-	2
Division Chlorophyta	4	2	3	0	18	18	6	37	7	39	36	165
Closterium	-	-	-	-	-	-	-	-	-	-	3	3
Coelastrum	-	-	-	-	2	-	-	-	-	-	-	2

Species	1	2	3	4	5	6	7	8	9	10	11	Grand Total
Cosmarium	-	-	-	-	11	-	-	-	-	-	7	18
Eudorina	-	-	-	-	2	3	-	-	-	-	-	5
Gleocapsa	-	-	-	-	-	1	-	-	-	-	4	4
Pandorina	-	-	-	-	5	=	-	-	-	-	-	5
Selenastrum	-	-	-	-	-	1	-	-	-	-	-	1
Sphaerocystis	-	-	-	-	-	9	-	-	-	-	-	9
Spirogyra	4	2	3	-	-	-	6	37	7	39	22	119
Tribonema	-	-	-	-	-	4	-	-	-	-	-	4
Grand Total	35	26	21	9	44	284	15	177	39	105	67	672
No. o species	7	4	4	2	9	9	4	11	10	6	7	35

Table 2.2.18. Phytoplankton species identified and cell densities (cells/l), RTNMC Mining Areas, 18-20 April, 2005

Species	Stations									
	1	2	3	4	5	6	7	8	9	10
Division Bacillariophyta										
Coscinodiscus sp.	-	15,500	-	-	-	-	-	-	-	-
Fragillaria sp.	-	-	-	4,000	-	-	-	-	-	-
Nitzchia sp.	94,000	114,500	-	-	-	-	-	-	-	-
Amphora sp.	-	401,042	-	-	-	-	-	-	-	-
Bacillaria sp.	-	-	-	-	-	-	4,000	3,000	-	-
Division Cyanophyta										
Oscillatoria sp.	-	-	8,000	-	74,500	-	39,000	-	-	-
Spirulina sp.	-	-	8,000	-	-	-	-	-	-	-
Trochodesmium sp.	-	-	-	-	-	102,000	-	16,000	50,500	-
TOTAL	94,000	531,042	16,000	4,000	74,500	102,000	43,000	19,000	50,500	-
No. of Species	1	3	2	1	1	1	2	2	1	0

Source: RTNMC MPSA Application Draft EIS, 2007

The sampling conducted in 2001 for the HPP EIS (**Table 2.2.19**) covered four (4) of the 11 sampling stations, eight (8) phytoplankton species were observed from three (3) major groups, diatoms, green algae and euglenophytes. The diatom group is similar to all stations however for the representative species, only *Tracheolomonas* sp. and *Navicula* sp. are common species or both 2001 and 2015 sampling.

Only the diatom group is common to all sampling periods represented by the species *Nitzschia* sp., a clean water indicator. Sampling points 3 and 6 used to have diatom population in the 2001 sampling but the count was zero for the group for the 2005 sampling. This may indicate a shift in the nutrient composition in the sampling stations.

Table 2.2.19. Phytoplankton species identified and cell densities (cells/l), RTNMC Mining Areas, January, 2001

Species	Stations			
	1	2	3	12
Division Chlorophyta				
Chlamydomonas sp.	8,000	6,000	--	3,000
Tetraedron sp.	--	6,000	--	--
Trochiscia sp.	--	3,000	--	--
Division Euglenophyta				
Trachelomonas sp.	--	12,000	7,000	6,000
Division Bacillariophyta				
Cyclotella sp.	--	--	--	6,000
Gomphonema sp.	--	--	--	6,000
Navicula sp.	--	3,000	3,500	3,000
Nitzschia sp.	4,000	--	3,000	--
Total no. of individuals	12,000	30,000	13,500	24,000
No. of species	2	5	3	5

Source: RTNMC HPP EIS, 2001

Diatoms species are thought to prefer habitat rich in calcium (Gautam, 1992) which indicates that the high calcium content (alkaline) in surface waters favors the growth of diatoms. However, this group is ubiquitously distributed occupying diverse habitats including those at extreme conditions and may be attributed to the presence of silicified cell walls, which enable them to survive under harsh conditions (Manaog, 2001).

The phytoplankton is not the dominant community of the stream ecosystem. In spite of this, they perform certain ecological functions like photosynthesis and nitrogen fixation, which contributes to the productivity of the streams in a limited manner. However, the constant water movement continually carries them downstream and inhibits their reproduction.

Zooplankton

The analysis for zooplankton species reported that there were at least five (5) groups of zooplankton species in the samples, however, similar with phytoplankton, there were limited number of individuals (**Table 2.2.20**).

In the Sumbiling downstream station, all of the four (4) types of rotifers were observed. Rotifers are indicators of high nutrient content. Although they are also observed in other stations, they have relatively higher in number of individuals that in any other stations.

Table 2.2.20. Zooplankton species identified and cell densities (individuals/m^3), RTNMC Mining Areas, 22 and 24 August, 2015

Taxa	1	2	3	4	5	6	7	8	9	10	11	Grand Total
Rotifera	-	-	-	-		-	-	-	-	-	-	12,451
Adult Bdelloid rotifer	-	-	-	-	882	-	-	-	-	-	-	882
Larval Bdelloid rotifer	-	915	-	915	1,471	-	294	-	1,373	-	-	4,967
Loricate Rotifer	-	915	-	-	2,941	-	-	-	-	2,157	-	6,013
Polyarthra (larvae)	-	-	-	-	588	-	-	-	-	-	-	588
Protozoa	-	-	-	-	-	-	-	-	-	-	-	25,010
Adult Arcellidae	-	-	-	1,471	9,706	915	588	-	-	1,078	2,157	15,915
Larval Tintinids	941	-	-	-	2,941	-	588	2,876	1,029	-	719	9,095
Bivalvia	-	-	-	-	-	-	-		-	-	-	3,595
Bivalve veliger	-	-	-	-	-	-	-	3,595	-	-	-	3,595
Crustacea	-	-	-	-	-	-	-		-	-	-	12,925
Nauplius larva	-	-	980	-	882	-	882	3,595	5,147	-	-	11,487
Cyclopoid copepod	-	-	-	-	-	-	-	1,438	-	-	-	1,438
Nematoda	-	-	-	-	-	-	-	-	-	-	-	2,549
Nematode larvae	-	-	-	-	1,471	-	-	-	-	1,078	-	2,549
Unidentified egg	-	-	-	-	-	-	-	-	686	-	-	686
Grand Total	941	1,830	980	2,386	20,882	915	2,353	11,503	8,235	4,314	2,876	57,216

A complete enumeration of zooplankton species was conducted for the 10 samples in 2001. No zooplankton species were observed. **Table 2.2.21** on the other hand presents the zooplankton species observed in the 2001 EIS. The common species are the crustacea and rotifer.

The absence of large numbers of zooplankton in the sample indicates energy relations. Phytoplanktons are the primary producers in an aquatic environment driving the energy flow and productivity of other organisms. Low population of phytoplankton limits available energy source for the secondary producers like the zooplankters which also limits their probability of being included in the sample.

Table 2.2.21. Zooplankton species identified and cell densities (cells/l),RTNMC Mining areas, January 2001

Species	Stations*			
	1 (6) (1*)	2 (7) (2*)	3 (4) (3)	12 (2) (5*)
Crustacea				
Crustacean nauplii	50	100	-	-
Cladocera				
Diaphanosoma sp.	-	100	-	-
Copepoda				
Eucyclops sp.	-	-	-	-
Rotatoria				
Trichocerca sp.	-	100	-	-
Lecane sp.	-	100	50	300
Brachionus sp.	-	50	-	150
Lecane bulla	-	-	-	100
Total no. of individuals	50	450	50	550

Source: RTNMC HPP EIS, 2001
Note: (1) – similar station in 2005
(1) – similar station in 2015*

Benthic Macroinvertebrates

The sampling identified three (3) major groups of benthic macroinvertebrates from the crustaceans, gastropods and insect groups. During the sampling, there were two (2) freshwater crab species observed (**Plate 2.2.13**) and two (2) gastropods (**Plate 2.2.14** and **Table 2.2.22**). For the insects, there were five (5) orders observed. Station 2 (Ibelnan W) has the most species observed (7) with Sumbiling River upstream with the highest number of individuals (43) followed by Malatgao River (28) and next is Ocayan River in Bohoy (24). Majority of Individual are mayflies from Family Heptageniidae (Order Ephemeroptera). These species is adapted to both fast flowing to still waters. The stations have both rocky-sandy substrates characterized by fast flowing section and pool zones. All insects are found in all stations.

Table 2.2.22. Benthic macroinvertebrates species identified (m^2), RTNMC Mining Areas, 22 and 24 August, 2015

Taxa	1	2	3	4	5	6	7	8	9	10	11	Grand Total
Crustaceans												
Order Decapoda										-	-	-
Infraorder Brachyura	-	1	-	-	2	-	-	2	*	-	*	5
Infraorder Caridea												
Family Palymonidae	-	1	-	-	9	1	-	-	*	-	2	13
Class Insecta												
Order Plecopera												
Family Perlidae	1	-	-	-	-	-	-	-	-	-	-	1
Family Peltoperlidae		-	4	2	-	-	-	1	2	2	-	12
Order Ephemeroptera												
Family Heptageniidae	-	6	-	36	1	-	2	3	19	6	21	94
Order Trichoptera												
Family Hydropsichidae	-	2	2	4	-	2	-	-	2	2	2	16
Order Odonata	-	-	-	-	-	-	-	-	-	-	-	-
Family Coenagrionidae	-	-	-	1	-	-	-	-	-	-	-	1
Order Diptera												
Family Chironomedae	2	2	2	-	-	-	1		1	-	-	8
Order Coloeptera												
Family Psephenidae	1	5	-	-	-	-	-	-	-	-	-	6

Taxa	1	2	3	4	5	6	7	8	9	10	11	Grand Total
Family Staphylinidae	-	1	-	-	-	-	-	-	-	-	-	1
Class Gastropoda												
Family Thiaridae	-	-	-	-	-	-	-	-	-	-	1	1
Family Neritidae	-	-	-	-	-	-	-	-	-	-	2	2
Total individuals	4	18	8	43	12	3	3	6	24	10	28	159
Total Species	4	7	4	4	3	2	2	3	4	3	5	11

*Notes: * with observed species and not collected in situ*

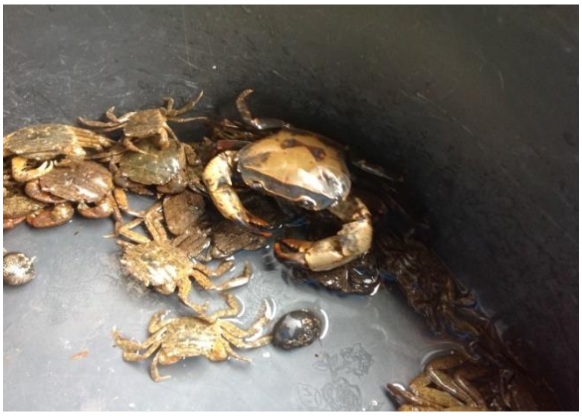


Plate 2.2.13. Freshwater crabs caught in Malatgao River and are utilized as food.

Plate 2.2.14. Gastropods caught in Malatgao River.

Plate 2.2.15. Freshwater shrimps caught in Malatgao River and utilized as food sources.

In 2005, the same major groups of benthic macroinvetebrates were also observed from the different surface water bodies with seven (7) orders from Class Insecta 21 families (**Table 2.2.23**). Stations in Ocayan River, Station 8 have the most number of species while Station 9 has the highest density of benthos. Insect larvae are found in all sampling stations. Members of the Family Hydropsychidae are the only common benthos in all 10 stations in 2005 and are also common in the 2015 sampling. Hydropsychids are mainly composed of carnivore larvae inhabiting swift flowing waters that characteristically build cases, which are found attached to the surface of rocks. Mayflies are also commonly found in both 2015 and 2005 sampling.

Table 2.2.23. Benthic species identified at the different sampling stations (organisms/m^2), RTNMC Mining Areas, 18-20 April, 2005

Species	Stations									
	1	2	3	4	5	6	7	8	9	10
Class Gastropoda										
Order Megastropoda										
Viviparus sp.	-	8	-	-	-	-	-	-	-	-
Order Neritinacea										
Family Neritinea	2	-	-	-	-	-	-	-	-	-
Class Insecta	-	-	-	-	-	-	-	-	-	-
Order Coleoptera	-	-	-	-	-	-	-	-	-	-
Family Elmidae	-	-	-	2	-	-	-	4	-	-
Family Gyrinidae	-	-	-	-	-	-	-	6	-	-
Family Hydraenidae	-	10	-	-	-	-	-	4	-	-
Family Psephenidae	-	-	-	-	-	2	2	8	-	16
Order Diptera	-	-	-	-	-	-	-	-	-	-
Family Athericidae	2	-	-	-	-	-	-	-	-	-
Family Ceratopogonidae	58	-	-	26	-	2	-	-	-	-
Family Chironomidae	-	-	-	-	-	-	2	-	-	-
Family Tipulidae	-	-	2	2	-	2	-	2	4	2
Order Ephemeroptera										
Family Beatidae	2	2	14	2	-	2	-	-	-	2
Family Caeridae	-	-	-	-	-	2	-	-	-	6
Family Ephemerallidae	16	-	8	6	2		16	2	16	66
Family Siphionuridae	-	-	-	4	-	-	-	-	-	-
Order Hemiptera										
Family Naucoridae	-	-	-	-	-	-	-	2	-	-
Family Veliidae	-	-	-	-	-	2	-	-	-	-
Family Belastomatidae	-	4	-	-	-	-	-	-	-	-
Order Odonata										
Family Calopterygidae	-	-	-	-	2	-	-	-	-	-
Family Lilellulidae	8	-	2	2	-	4	-	-	6	-
Family Amphipterygidae	-	-	-	-	-	2	2	-	-	-
Order Plecoptera										
Family Perlidae	2		4	-	-	4	4	32	12	4
Order Trichoptera										
Family Hydropsychidae	32	2	20	24	2	6	30	60	134	66
Family Ryacophilidae	-	-	-	-	-	-	-	2	-	-
Class Crustacea										
Macrobrachium sp.	-	16	-	2	4	-	-	8	-	2
Crab	-	-	16	2	-	-	2	4	-	-
No. of individuals	122	42	66	72	10	28	58	134	172	164
No. of species	8	6	7	10	4	10	7	12	5	8

Source: RTNMC MPSA Application Draft EIS, 2007

Compared to data collected in 2001 with the 2005 sampling (**Table 2.2.24**), the insect groups are present in the three (3) stations with the East Ibelnan Station with the most number of individuals and species. Ephemeropterans, mostly composed of clean water insects was only present in Station 7 (Ibelnan W) in 2001 but were found on all four in 2005 and most stations in 2015.

Benthic data in 2002 and 2003 from Stations 5 and 8 (**Table 2.2.25**) indicate the presence of more benthos species. Generally, species count in Stations 8 and 5 decreased significantly in 2015 and 2005 from the 2003 level. However, regular sampling was conducted every two (2) months starting in June 2002 to January 2003. This may account for the more species observed from these two (2) orders.

Table 2.2.24. Benthic species identified at the different sampling stations (organisms/0.5m^2), RTNMC Mining Areas, January, 2001

Species	Stations			
	1 (6)	2 (7)	3 (4)	12 (2)
Phylum Arthropoda				
Class Insecta				
Coleoptera	-	-	-	-
Psephinidae (water penny)	4	1	-	-
Gerridae (water strider)	2		-	-
Plecoptera (stonefly)	6	1	-	-
Nepthyid	-	-	-	-
Ephemeroptera	-	2	-	-
Ephemerellidae (mayfly)	10	-	10	-
Hemiptera	1	-	-	-
Veliidae	4	-	1	-
Trichoptera (caddishflies)	1	-	-	-
Diptera	-	-	-	-
Chironomidae	1	-	-	-
Odonata	1	-	-	-
Class Crustacea	-	-	-	-
Shrimp	-	1	-	1
Crab	-	2	1	2
Total no. of individuals	32	9	13	3
No. of species	10	6	4	2

Source: RTNMC HPP EIS, 2001.
Note: (1) – similar staion in 2005

Table 2.2.25. Benthic macroinvertebrate families observed at the Ocayan and Togpon Creeks, Brgy. Rio Tuba, Bataraza, Palawan, June 2002 to January 2003

Families	Ocayan Down (8)	Togpon Down (5)
CLASS GASTROPODA		
Order Neritinacea		
F. Neritidae	-	+
Order Megastropoda		
F. Thiaridae	+	
CLASS INSECTA		
Order Coleoptera		
F. Dryopidae	-	+
F. Dysticidae	+	+
F. Elmidae	+	+
F. Gyrinidae	+	+
F. Helodidae	+	+
F. Hydrophilidae	-	+
F. Psephenidae	+	-
Order Diptera		
F. Athericidae	-	+
F. Chironomidae	+	+
F. Sarcophagidae	-	+
F. Tipulidae	+	+
Order Ephemeroptera		
F. Baetidae	+	+
F. Caenidae	+	+
F. Ephemerallidae	+	-
F. Heptageniidae	+	+
F. Leptophlebiidae	+	+
F. Siphlonuridae	+	+
Order Hemiptera		
F. Hydrometridae	+	-
F. Naucoridae	+	-
F. Pleidea	+	-
F. Veliidae	-	+
Order Lepidoptera		

Families	Ocayan Down (8)	Togpon Down (5)
F. Noctuidae	+	-
F. Pyralidae	-	+
Order Odonata		
F. Calopterygidae	+	+
F. Libellulidae	+	+
Order Plecoptera		
F. Perlidae	+	+
Order Trichoptera		
F. Hydropsychidae	+	+
F. Ryacophilidae	+	+
Total families per station	23	23

Source: Manaog, M.D. 2003.
Note:
(+) present (-) absent

Insects are the most diverse group of organisms on earth however, only 3% of insect species are found living in the aquatic ecosystem. In the aquatic environment, insect species comprises almost 95% of the benthic macroinvertebrates community. This is because they are able to evolve various physical, morphological and behavioral adaptations.

Alternating sequence of riffle and pool zones throughout the stream provides different habitat for benthic organisms. Majority of aquatic insects are restricted to running waters since they require the continuous water flow for respiration and nutrition. Insect macroinvertebrates are important in cycling organic materials. Plecopterans, Ephemeropterans, Trichopterans and Coleopterans (Dyropoidea) are known shredders breaking down organic materials into smaller particles which are carried downstream. Filter feeders, collectors, and scrapers, mostly from the Gastropod Family and some orders of insects, in turn consume the resulting fine particulate materials.

Changes in the benthic macroinvertebrate community structure signify variations in the existing environmental conditions. With their limited mobility and relatively long life, benthos integrates environmental impacts and could be used to monitor water quality.

Generally, the presence of Ephemeropterans, Plecoperans and Tricopterans in the sample is an indicator of a healthy water body.

Fish and Other Aquatic Organisms

In the aquatic ecosystems, fishes are the top consumers and often the most visible indicator of the general health of an aquatic ecosystem. Fishes depend on both the benthos and the plankton as energy source and therefore are reliable measure of the economic productivity of a body of water.

There are around [1]358 freshwater fish species reported in the country which are classified as endemic, native, introduced, reintroduced. These fish species are inhabitants of estuaries, rivers, streams, lakes, reservoirs, rice paddies and ponds though some marine fishes are able to tolerate reduced salt content and are able to inhabit estuarine/brackish areas. Limited fish species were observed to be present in the surface water. The most common is paet but all species are found in all sampling areas. The resident have also reported the presence of eel however, were not caught.

[1] http://www.fishbase.org/

Plate 2.2.16. Dalag (*Channa striata*)

Plate 2.2.17. Goby or Biya (*Gobius criniger*)

Plate 2.2.18. Cyprinids (Cyprinidae)

Plate 2.2.19. *Dermogenys* sp.

Plate 2.2.20. Tilapia (*Oreochromis niloticus*)

Plate 2.2.21. Pantat or hito (*Clarias batrachus*)

Plate 2.2.22. Martiniko (*Anabas testudineus*)

Plate 2.2.23. Paet or *Barbodes* sp.

Fishing in rivers is not a major source of livelihood for the community. Only subsistence fishing is done through the use of fishnets and fishing rods as well as electric rods. Eels are commonly caught using electricity.

Heavy Metals Analysis of Freshwater Fish Species

In 2004, fish heavy metals analysis was conducted to comply with Conditionality No. 29 of ECC No. 0201-021-313 issued for the HPP. Freshwater fish samples were caught in the Lower Kinurong Siltation Pond within the RTNMC Mining Areas. However, the mineral analyses were made using both the flesh and viscera of each fish species due to their small sizes.

The minerals or heavy metals or elements are natural components of the environment. In whatever form they are called, their existence affects life. The mineral elements are important for the proper functioning of body processes. Some mineral elements are classified as macroelements because they are required in large quantities, whereas some mineral elements required in very low quantities are called micronuttrients. Some elements, however, have no known physiological function yet and are considered hazardous to health.

The classification of these elements as macro and micronutrients stresses the amount of mineral intake. This indicates that a minimum amount is required for growth and development and that low levels in the diet may actually cause deficiencies whereas excess intake may just be excreted. However, for some of the elements, a thin borderline separates the dose that may cause a deficiency or may cause toxicity. It is such elements, when available in excess that causes a concern.

In general, the elements zinc, chromium, manganese, nickel, arsenic, aluminum, and silicon are considered as essential in humans, presenting health problems whenever deficient. For most of these elements, evidence has shown the occurrence of nutritional problems in humans with abnormally low or high dietary intakes. On the other hand, there are several reports associating high intake of cadmium, lead and mercury to some physiological disorders.

Based on the results of the freshwater fish heavy metals analysis in 2004, Pb concentration in fish flesh is high and may be toxic to humans if ingested (**Table 2.2.26**) and also observed in 2015 (**Table 2.2.27**). It must be noted however that analysis of the fish samples utilized both the muscle and visceral parts of the fish due to its limited size but for the large fishes, mainly the flesh. Normally, heavy metals have higher concentration in the viscera especially the liver and visceral parts, which are often removed before fish is cooked for food. Likewise, the samples have been frozen for some time and the process of unfreezing the sample for sample preparation may have contaminated the fish flesh of heavy metals from the visceral parts.

Table 2.2.26. Mineral content (mg/kg) of the flesh of some representative fish caught inside the Lower Kinurong Siltation Pond

Mineral	RDA	13 May 2004			4 November 2004		
		Karpa	Biya	Dalag	Karpa	Biya	Tilapia
Macro element							
Magnesium	300-350a	547.000	336.000	300.000	793.870	1922.960	855.570
Trace elements							
Aluminum	2-8b	195.000	42.000	24.000	33.000	<1.000	33.490
Arsenic	Trace	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Chromium	0.05-0.2a	<0.200	<0.200	<0.200	<0.200	3.730	18.660
Cobalt	0.003-0.005a	<0.200	0.000	0.000	<0.200	0.890	2.430
Iron	18-50a	67.000	139.000	44.000	102.000	116.990	826.090
Manganese	2.5-5a	28.000	30.000	37.000	52.000	15.740	22.540
Nickel	0.3 - 0.7a	<0.200	2.000	1.000	<0.200	7.490	65.330
Silicon	20-50a	68.000	103.000	65.000	<10.000	157.460	79.340
Zinc	15a	12.000	16.000	13.000	8.000	4.600	5.420
Toxic Elements							
Lead	0.5c	<0.100	3.380	3.560	3.420	2.760	0.530
Mercury	40c	0.139	<0.004	<0.004	<0.004	<0.004	<0.004
Cadmium	0.5c	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030

Source: Gaia South, Inc, 2005
Note:
RDA – Required Daily Allowance
[a] *- mg/day*
[b] *- mg/Kg*
[c] *- WHO Allowable Limit only*
[d] *- FAO Allowable Limit only*

Table 2.2.27. Mineral content (mg/kg) of the flesh of some representative fish caught in the surface water bodies draining the RTNMC Mining Areas, August 2015

Species	As	Cr	Ni	Pb	Hg	Cd
Biya (Malatgao River)	<0.010	<0.020	<0.200	2.480	0.050	<0.030
Dalag (Malagao River)	<0.010	<0.020	<0.200	2.260	0.022	<0.030
Tilapia (Malatgao River)	<0.010	<0.020	<0.200	3.850	0.004	<0.030
Pantat (Ocayan River)	<0.010	<0.020	<0.200	3.430	0.020	<0.030
Paet (Ocayan River)	<0.010	<0.020	<0.200	4.520	0.004	<0.030
Tilapia (Ocayan River)	<0.010	<0.020	<0.200	5.390	0.004	<0.030
Martiniko (Ocayan River)	<0.010	<0.020	<0.200	5.500	0.004	<0.030
RDA	Trace	0.05-0.2a	0.3 - 0.7a	0.5c	40c	0.5c

Note:
RDA – Required Daily Allowance
[a] *- mg/day*
[b] *- mg/Kg*
[c] *- WHO Allowable Limit only*
[d] *- FAO Allowable Limit only*

2.2.4.3 Impact Assessment

The key impacts of the proposed project on freshwater ecology are presented in **Table 2.2.28.**

Table 2.2.28. Impacts assessment and mitigation for freshwater ecology

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
• **Threat to Existence or Loss of Local Species/threat to abaundance and distribution of species** The upstream sections of the surface water bodies draining the mining site are generally clean due to the periodic flushing of the River during wet season. However, for the downstream sections where there are residential areas (Sumbiling and Malatgao), there are evidences of organic pollution. The main impact to the aquatic fauna will be the overloading of silt. During the rainy season, surface runoff will carry silt downstream and will smother aquatic fauna. Habitat alteration due to silt results in the disappearance of intolerant species, e.g., from Orders Trichoptera and Ephemeroptera and Plecoptera. Benthic community structure is also expected to change. Since oligochaetes and chironomids are tolerant of silt, it is possible that only these species will eventually remain. In spite of the long term mining activities, only Togpon Creek is affected most with siltation however, long term data collected in 2002 and 2003 indicated that benthos species are present even with periodic impact of siltation. Studies have also shown that silt causes blockage of fish gills causing physiological damage on them. Aside from fish, filter feeders like mollusks are also physiologically affected by silt through clogging of gills and abrasion.		✓	✓		Measures to contain silt will be most beneficial to the aquatic organisms. As a practice, RTNMC maintains siltation ponds which are designed to accommodate surface run off from the mining areas. The siltation ponds are proven effective to contain silt based in the monitoring results for TSS. During the cosnstruction and oeprations phase, RTNMC will continuously maintain these ponds as well as construct new facilities as neccesary. The stormwater management plan of the new mine site will be engineered to ensure that all surface run off from the new mining area will be directed towards the silt ponds. The silt ponds are regularly maintained. It is also provided with including its charcoal gabion structures which can help minimize heavy metals especially Cr^{6+}. Grass species that are also able to filter sediments are maintained at the mouth of spillway of the silt ponds.

2.2.5 Marine Biology

2.2.5.1. Methodology

For the fish and coral surveys, 50-m transects were laid in six (6) different reefs near Rio Tuba (**Table 2.2.29, Figure 2.2.43**) while five (5) transects were done for the seagrass survey, on three (3) different sites (**Table 2.2.29, Figure 2.2.44**). Water quality and plankton surveys were done in seven (7) different sites across the waters adjacent to Rio Tuba (**Table 2.2.29, Figure 2.2.45**).

Table 2.2.29. Site coordinates of sampling sites for fish, coral, and seagrass surveys

Site Code		Latitude	Longitude
Fish and Coral			
PBRT1R0815	Nagoya Beach	8.50428	117.45327
PBRT2R0815	Sumbiling River	8.48942	117.41200
PBRT3R0815	Sandbar Big	8.47898	117.44255
PBRT4R0815	Sandbar Parola	8.47723	117.42265
PBRT5R0815	Ameril ST2	8.44620	117.45147
PBRT6R0815	Ameril ST3	8.43357	117.43836
Seagrass			
SSSG1	Sandbar Small SG1	8.48901	117.44108
SBSG1	Sandbar Big SG1	8.47842	117.44092
SBSG2	Sandbar Big SG2	8.47886	117.44072
ASG1	Ameril SG1	8.43387	117.45700
ASG2	Ameril SG2	8.43349	117.45771
Plankton and Water Quality			
PWQ1	Site 1	8.48646	117.48621
PWQ2	Site 2	8.50551	117.46074
PWQ3	Site 3	8.48771	117.44102
PWQ4	Site 4	8.48797	117.41355
PWQ5	Site 5	8.43965	117.41926
PWQ6	Site 6	8.45237	117.43481
PWQ7	Site 7	8.44234	117.46087

Benthic surveys were done using the line intercept transect method (LIT) from English et al., (1997). The LIT method involves measuring the cover of the benthic attribute intercepted by the transect by recording the transition length on the transect tape in situ. The percent cover of each benthic component was computed using the following formula:

$$\%\ cover\ of\ benthos_a = \frac{length\ intercepted\ by\ benthos_a}{total\ length\ of\ transect} \times 100\%$$

Other important invertebrates such as urchins, molluscs etc. found near the transects were noted.

Fish Visual Census (FVC) technique (English, et al., 1997) was used to determine the species diversity, abundance and biomass in different survey sites. Each transect covers an area of 500 m^2 (50 m long x 10 m width). All fish sizes of major, indicator and target species were estimated to the nearest centimeter using the total length (TL). Fish density and biomass were then computed using ReefSum (Uychiaoco, 2000). Fish biomass was based from the relationship, $W=aL^b$, where W is the weight in grams; *a* and *b* are the growth coefficient values taken from published length-weight data; and L is the length of the fish in cm (English, et al., 1997).

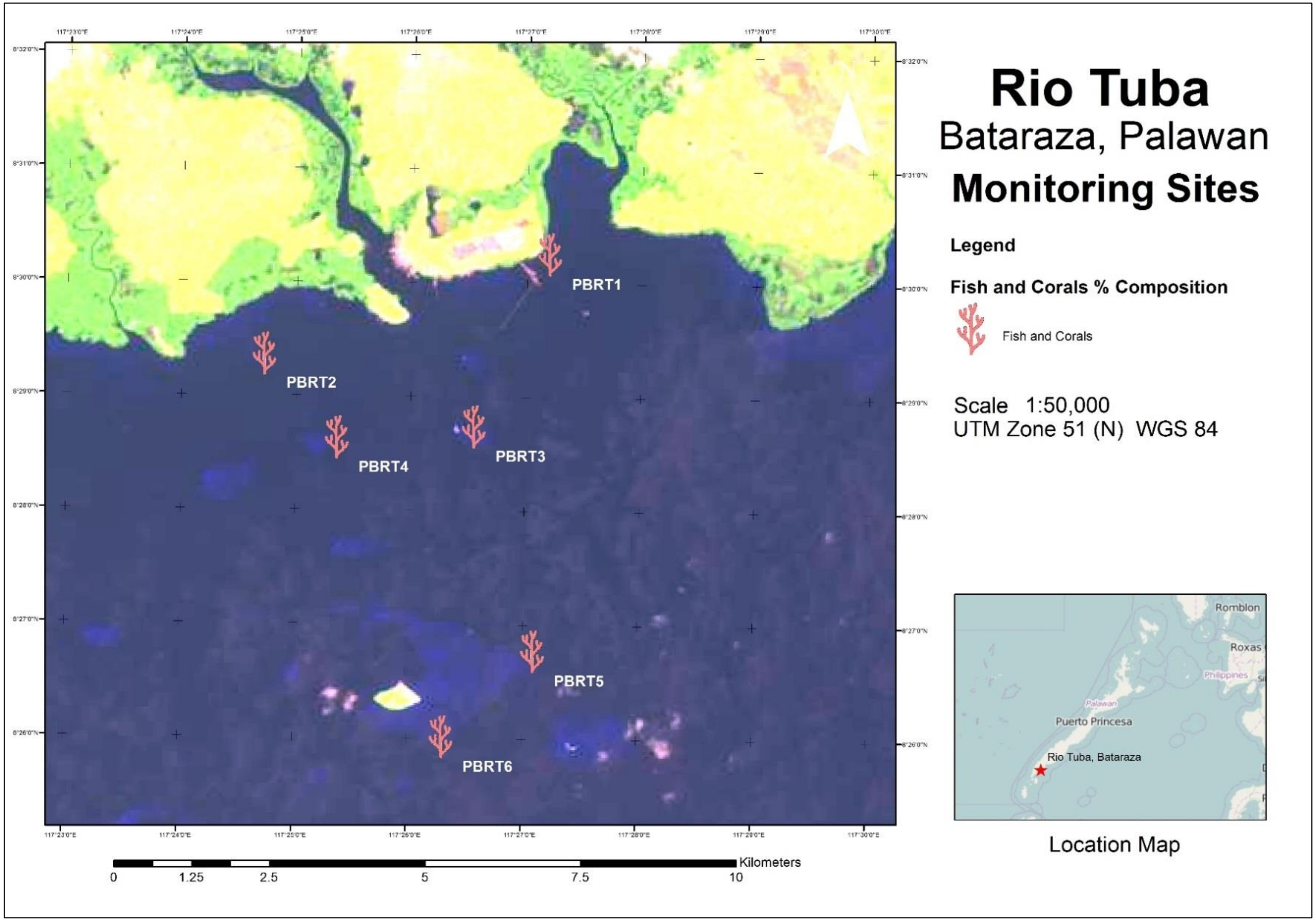


Figure 2.2.43. Sampling sites for fish and coral surveys.

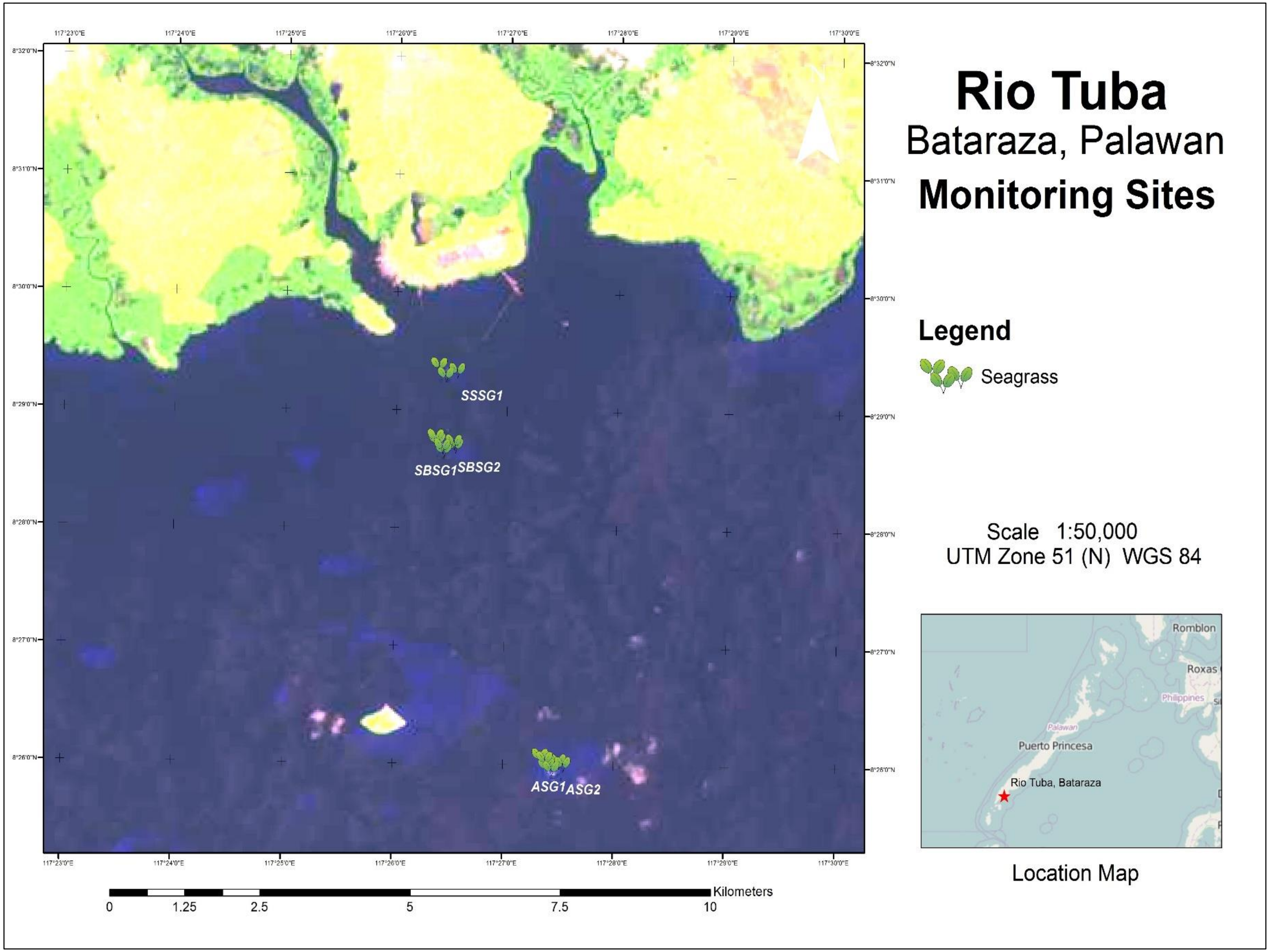


Figure 2.2.44. Sampling sites for seagrass surveys.

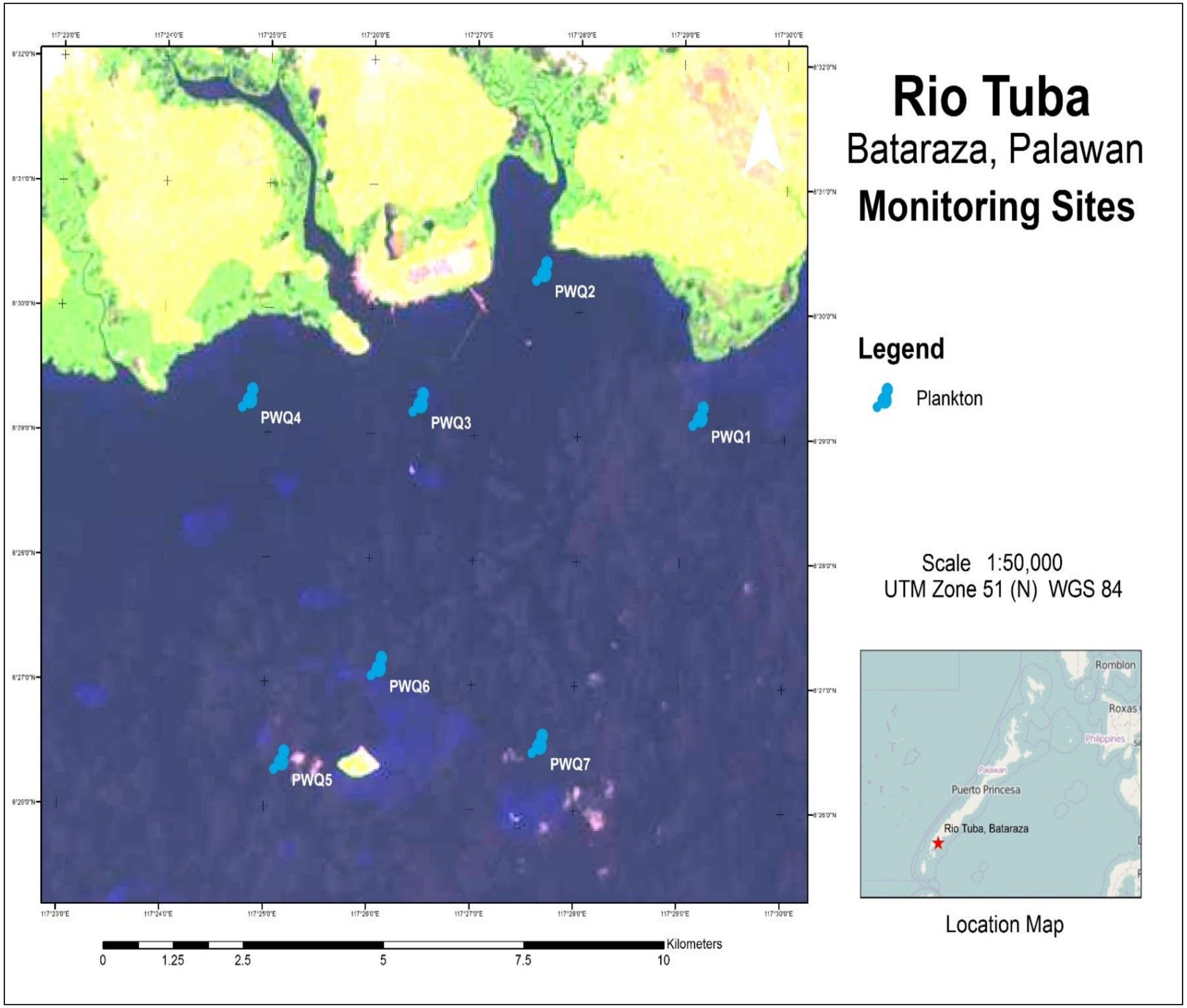


Figure 2.2.45. Sampling sites for water quality and plankton surveys.

For the seagrass monitoring, a modified Seagrass Net method (Short, et al., 2006) was adopted. 1 m x 50 m transect was laid perpendicular to the shore and a 0.5 m x 0.5 m quadrat was placed every 5 m in every station. For shoot density per species, *Enhalus acoroides*, a large seagrass species was read using the 0.5 m x 0.5 m quadrat, while the smaller species (e.g. *Thalassia hemprichii*, *Halophila* spp., and *Halodule* spp.) were sub-sampled using 0.25 m x 0.25 m quadrat, following the methodology described by Duarte and Kirkman (2001) and Short et al (2006). In this monitoring period, percentage seagrass cover being the easiest measure of abundance (McKenzie, 2003) was used as the alternative parameter instead of the visual estimate of seagrass biomass.

Surface water quality data namely surface water temperature, pH, and dissolved oxygen, were measured *in situ* using Lutron WA-2017SD. Turbidity was also measured using a Secchi disc. In each of the sites, plankton samples were collected by filtering 50 L of seawater through a 20 µm net. Filtered water was stored in 500 ml polyethylene bottles and the samples fixed with a 5% formalin solution.

Specimen samples of Black-barred halfbeaks (*Hemiramphus far*) caught by fishermen near Sandbar Malaki were sent to Ostrea Mineral Laboratories for heavy metal analysis of arsenic (As), chromium (Cr), nickel (Ni), lead (Pb), mercury (Hg), and cadmium (Cd).

2.2.5.2. Baseline Conditions

<u>Corals and other Reef Benthos</u>

The coral reefs in Rio Tuba are in Good to Excellent Condition, with coral covers ranging from more than 50% to more than 75% (**Figure 2.2.46**). The highest coral cover was observed in the Sandbar Parola site (76.2% - within the *excellent* category), while the lowest coral cover was observed in the reefs near the mouth of the Sumbiling River (53.9% - still within the *good* category). Taken together, the average coral cover in all six sampling sites 62.7%. This figure is almost twice that of the national hard coral cover average of 36% (Magdaong, et al., 2013), and the regional average of 33% for the Indo-Pacific (Bruno, et al., 2009).

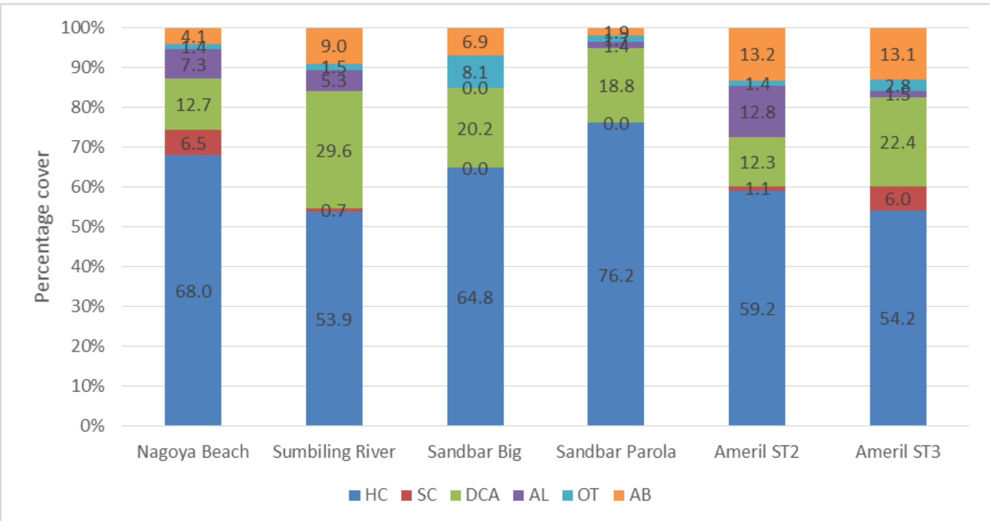


Figure 2.2.46. Benthic cover in the different coral reef sampling sites in Rio Tuba. HC – Hard coral; SC – Soft coral; DCA – Dead coral with algae; AL – Algae; OT – Other organisms; AB – Abiotic components.

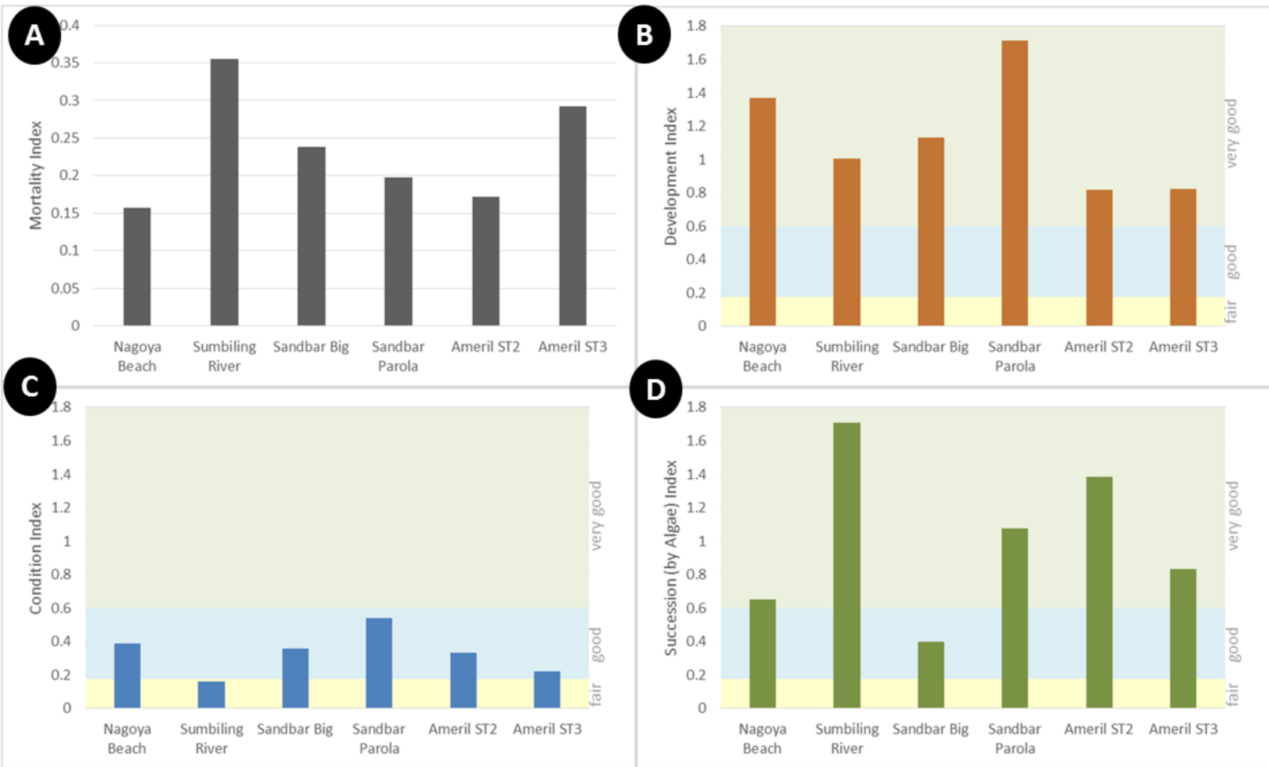


Figure 2.2.47. Reef health indices: A – Mortality index; B – Development index; C – Condition Index; D – Succession Index.

Table 2.2.30. Detailed benthic cover in the different sampling sites in Rio Tuba, Bataraza, Palawan

Benthos	Code	Palawan							
		Rio Tuba – Bataraza							
		Nagoya Beach	Sumbiling River	Sandbar Big	Sandbar Parola	Ameril ST2	Ameril ST3	Mean	Sterr
		PBRT 1R0815	PBRT 2R0815	PBRT 3R0815	PBRT 4R0815	PBRT 5R0815	PBRT 6R0815		
HARD CORAL	**HC**	**68.0**	**53.9**	**64.8**	**76.2**	**59.2**	**54.2**	**62.7**	**3.5**
ACROPORA	**ACR**	**0.2**	**13.4**	**1.5**	**0.2**	**3.0**	**41.9**	**10.0**	**6.7**
Acropora branching	ACB	0.2	1.0	0.8	0.0	2.1	41.0	7.5	6.7
Acropora digitate	ACD	0	0.0	0.0	0.2	0.6	0.0	0.1	0.1
Acropora encrusting	ACE	0	0.0	0.0	0.0	0.0	0.0	0	0
Acropora submassive	ACS	0	12.4	0.7	0.0	0.3	0.9	2.4	2.0
Acropora tabulate	ACT	0	0	0	0.0	0.0	0.0	0	0
NON-ACROPORA	**Non-ACR**	**67.8**	**40.5**	**63.3**	**76.0**	**56.2**	**12.3**	**52.7**	**9.4**
Coral Branching	CB	1.5	21.5	47.0	19.6	10.1	7.4	17.9	6.6
Coral Encrusting	CE	8.8	2.4	1.6	5.8	6.7	0.2	4.3	1.4
Coral Foliose	CF	0.8	0	0.3	49.3	0.1	0.0	8.4	8.2
Heliopora	CHL	0	0	0.8	0.0	0.7	0.9	0.4	0.2
Coral Massive	CM	25.1	13.8	12.2	0.0	8.2	3.0	10.4	3.6
Milepora	CME	0	0	0.0	0.0	0.6	0.0	0.1	0.1
Mushroom Coral	CMR	0	2.4	0.8	0.1	0.0	0.8	0.7	0.4
Coral	CS	31.6	0.4	0.6	1.2	29.8	0.0	10.6	6.4

Benthos	Code	Palawan							
		Rio Tuba – Bataraza							
		Nagoya Beach	Sumbiling River	Sandbar Big	Sandbar Parola	Ameril ST2	Ameril ST3	Mean	Sterr
		PBRT 1R0815	PBRT 2R0815	PBRT 3R0815	PBRT 4R0815	PBRT 5R0815	PBRT 6R0815		
Submassive									
Tubipora	CTU	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SOFT CORAL	**SC**	**6.5**	**0.7**	**0.0**	**0.0**	**1.1**	**6.0**	**2.4**	**1.2**
DEAD CORAL/WITH ALGAE	**DCA**	**12.7**	**29.6**	**20.2**	**18.8**	**12.3**	**22.4**	**19.3**	**2.6**
Dead Coral	DC	0	0.0	0	0.0	0.0	0.0	0.0	0.0
Dead Coral with Algae	DCA	12.7	29.6	20.0	18.8	12.3	22.4	19.3	2.6
ALGAE	**AL**	**7.3**	**5.3**	**0**	**1.4**	**12.8**	**1.5**	**4.7**	**2.0**
Algal Assemblage	AA	5.9	3.9	0	0.0	1.2	0.0	1.8	1.0
Coraline Algae	CA	0	0.0	0	0.0	0.0	0.5	0.1	0.1
Halimeda	HA	0.8	1.4	0	1.4	11.6	1.0	2.7	1.8
Macroalgae	MA	0.6	0.0	0	0.0	0.0	0.0	0.1	0.1
Turf Algae	TA	0	0.0	0	0.0	0.0	0.0	0.0	0.0
OTHER FAUNA	**OT**	**1.4**	**1.5**	**8.1**	**1.7**	**1.4**	**2.8**	**2.8**	**1.1**
Other animals	OT	0	0.3	7.7	0.6	0.2	1.2	1.7	1.2
Sponges	SP	1.4	1.2	0.4	1.1	1.2	1.6	1.2	0.2
Zoanthids	ZO	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ABIOTIC COMPONENT	**AB**	**4.1**	**9.0**	**6.9**	**1.9**	**13.2**	**13.1**	**8.0**	**1.9**
Rubble	R	1.6	6.4	1.1	1.9	9.0	7.7	4.6	1.4
Rock	RCK	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sand	S	0.4	0.0	3.0	0.0	4.2	5.4	2.2	1.0
Silt	SI	2.1	2.6	2.8	0.0	0.0	0.0	1.3	0.6
Water	WA	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MARINE PLANT	**SG**	**0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Total		100.0	10 0.0	100.0	100.0	100.0	100.0	100.0	

Reef Fish

A total of 155 reef fish species belonging 34 families were recorded in the six selected sites in Coral Bay (**Table 2.2.31**). Over 90% fishes in the bay are composed of non-target species or fishes that are not commercially valuable. The most abundant species come from the families Pomacentridae (damselfishes) and Apogonidae (cardinalfishes). The most abundant damselfishes include Smith's damsel (*Pomacentrus smithi*), Staghorn damsel (*Amblyglyphidodon curacao*), Lemon damsel (*Pomacentrus moluccensis*), and Brown damsel (*Pomacentrus opisthostigma*). For the cardinalfishes, there is the Twinspot cardinalfish (*Archaemia biguttata*) and the Five-lined cardinalfish (*Cheilodipterus quinquelineatus*).

Table 2.2.31. Reef fish richness, abundance, and biomass in coral reef sampling sites in Rio Tuba, Bataraza, Palawan

Parameters	Nagoya Beach	Sumbiling	Sandbar Big	Sandbar Parola	Ameril ST2	Ameril ST3
RICHNESS (total encountered)						
Species	28	49	59	49	67	58
Families	12	19	19	18	20	19
ABUNDANCE (individuals/500m^2)						
Major species	397	224	304	474	491	357
Coral indicator	4	6	22	13	5	20

Parameters	Nagoya Beach	Sumbiling	Sandbar Big	Sandbar Parola	Ameril ST2	Ameril ST3
species						
Target species	9	13	29	36	50	69
Total	**410**	**243**	**355**	**523**	**546**	**446**
BIOMASS (g/m^2)						
Major species	0.8	2.1	2.4	3.6	12.1	6.7
Coral indicator species	0.2	0.1	1.7	1.0	0.2	0.7
Target species	8.9	11.1	9.4	18.8	9.8	8.6
Major species	0.8	2.1	2.4	3.6	12.1	6.7

Most of the target or commercially valuable species encountered were either parrotfishes or large wrasses. The parrotfish family include Rivulated parrotfish (*Scarus rivulatus*), Bullethead parrotfish (*Chlorurus sordidus*), Yellowtail parrotfish (*Scarus hypselopterus*), and Bleeker's parrotfish (*Chlorurus bleekeri*). The large wrasses include the Cigar wrasse (*Cheilio inermis*), Floral wrasse (*Cheilinus chlorourus*), Red-breasted wrasse (*Cheilinus fasciatus*), and Black-eye thicklip (*Hemigymnus melapterus*).

Among the selected stations, the Ameril Station 2 had the highest species richness with 67. This was followed by Big Sandbar and Ameril Station 3 with 59 and 58 species, respectively. With 28 species, Nagoya Beach has the least number among the stations. There appears to be a gradient of species richness that increases the further the site is from the river mouth. This is due to larger reef extent in areas away from the river, particularly in Ameril Island where there is a wide expanse of fringing reefs. The larger the reef, the more habitats available to support a diverse array of species.

Abundance was highest at Ameril Station 2 with 546 individuals/500m^2 (**Figure 2.2.49**). This was followed by Sandbar Parola with 523 individuals/500m^2. With 243 individuals/500m^2, the station in Sumbiling River had the least number of fishes recorded.

Biomass values showed a similar pattern. Sandbar Parola yielded the highest biomass with 23.3 g/m^2, followed by Ameril Station 2 with 22.1 g/m^2 (**Figure 2.2.50**). At the lower end of the spectrum is Nagoya Beach with approximately 9.9 g/m^2. Target species account for more than 80% of the biomass for most of the sites except for the Ameril sites where target species comprise is 50% or less of the of the overall biomass composition.

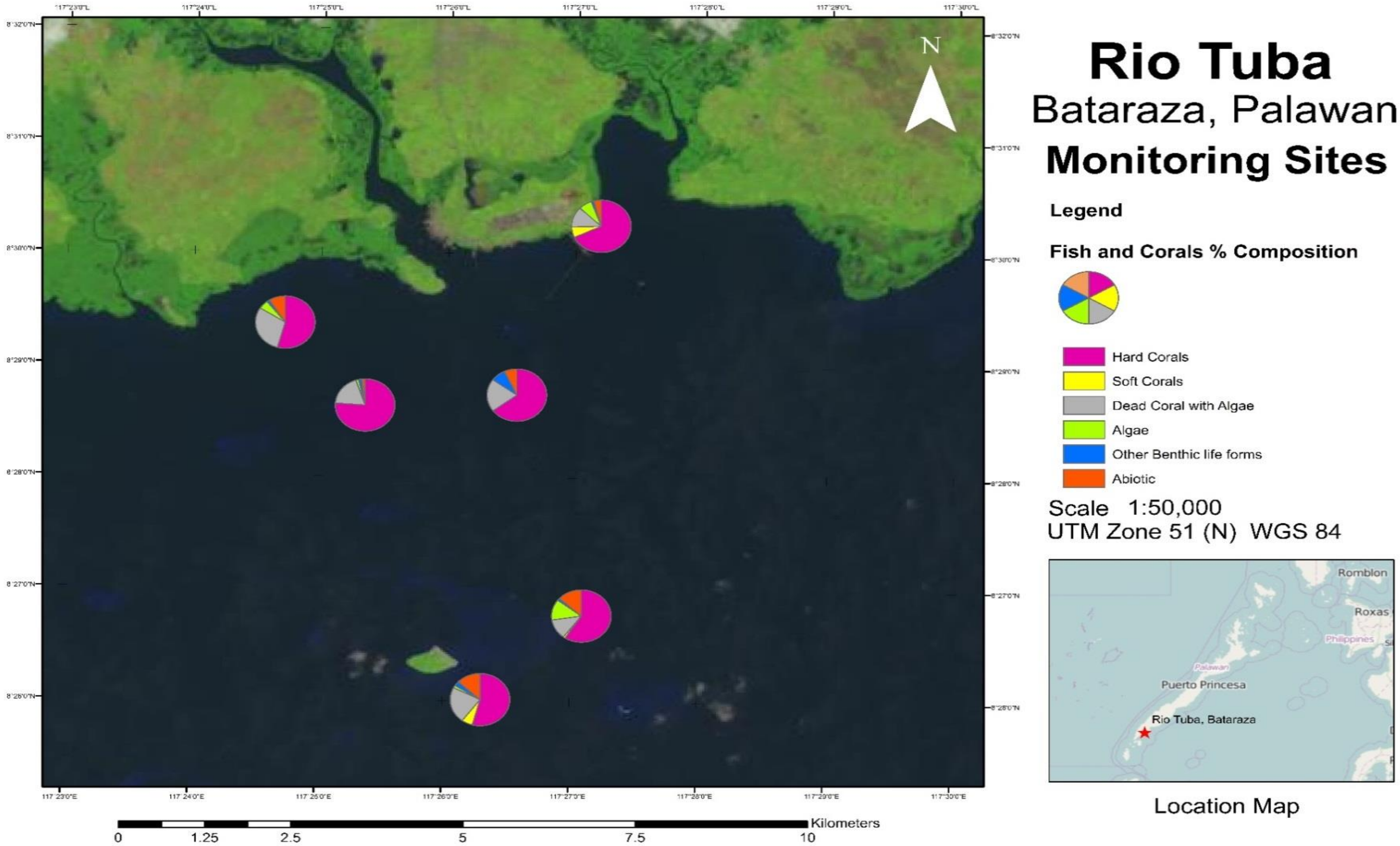


Figure 2.2.48. Map of coral cover in the different sampling sites in Rio Tuba, Bataraza, Palawan.

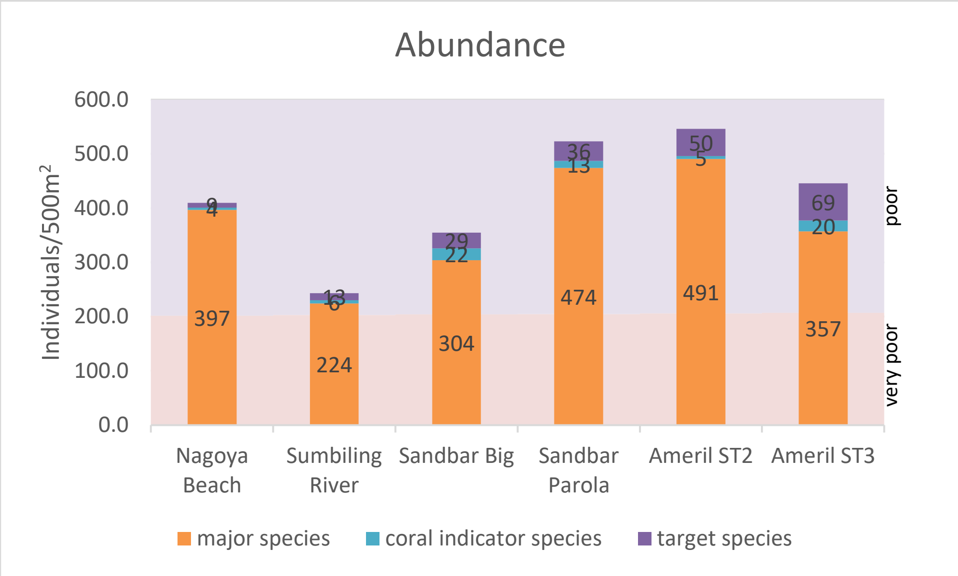


Figure 2.2.49. Reef fish abundance in the coral reef sampling sites in Rio Tuba, Bataraza, Palawan.

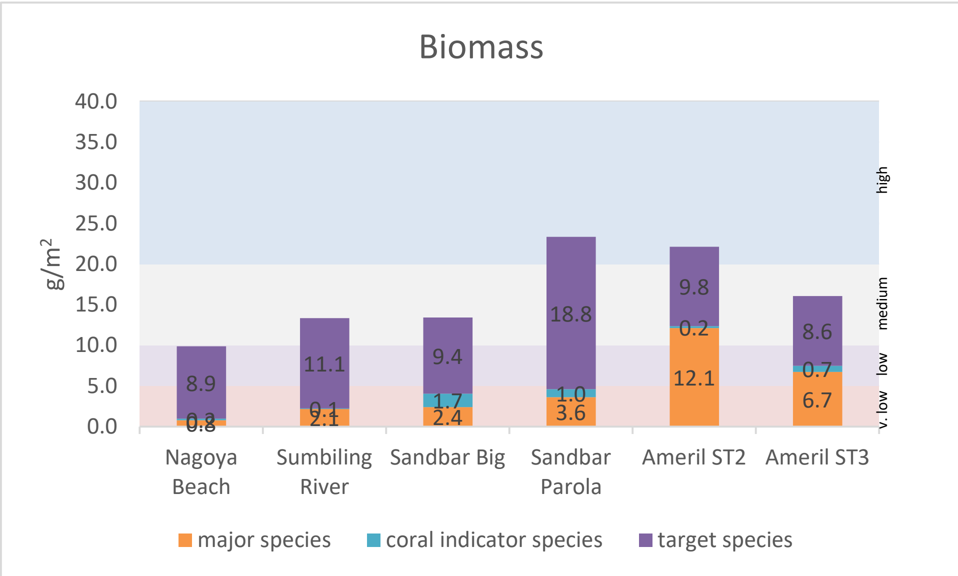


Figure 2.2.50. Reef fish biomass in the coral reef sampling sites in Rio Tuba, Bataraza, Palawan.

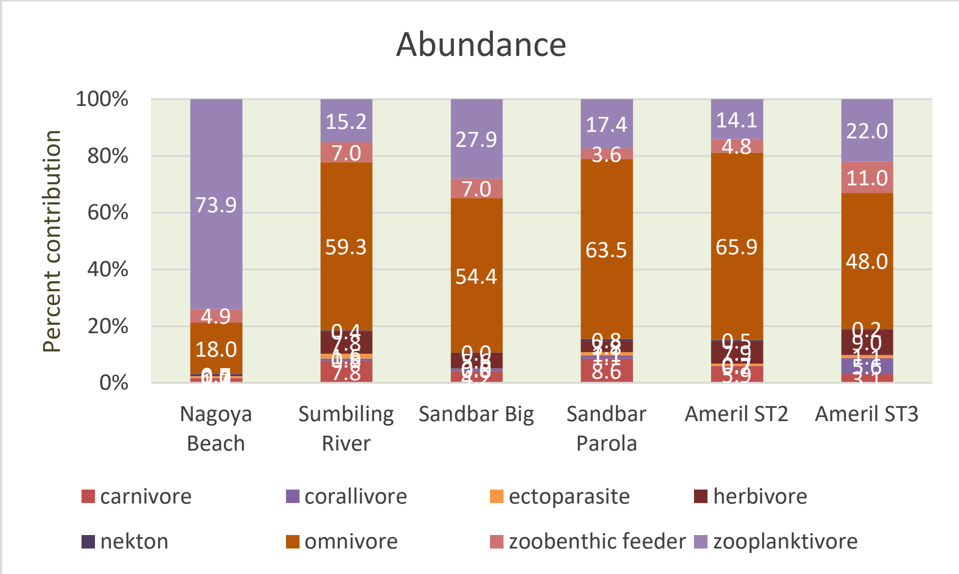


Figure 2.2.51. Percent contribution of reef fish trophic groups in terms of abundance.

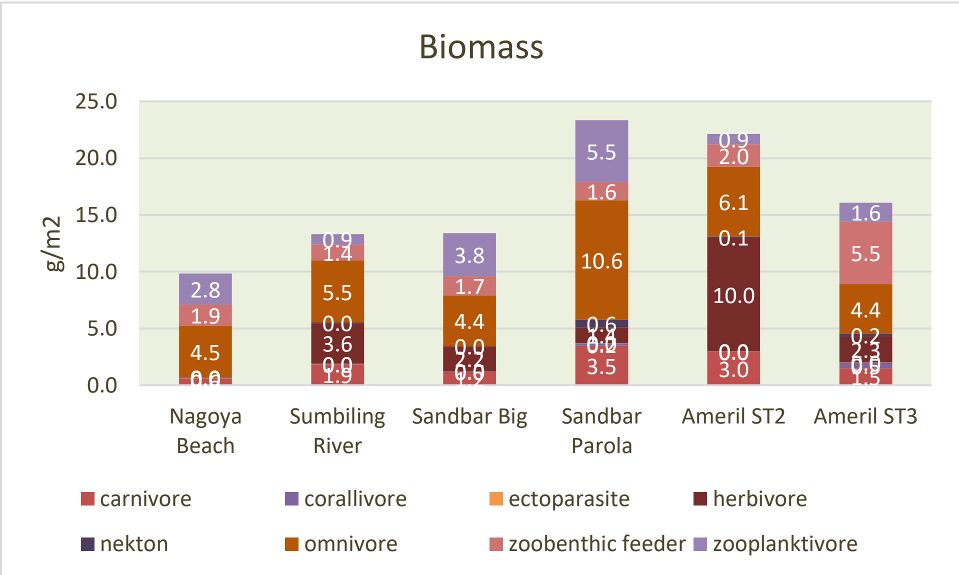


Figure 2.2.52. Reef fish biomass according to trophic groups.

Seagrass

A total of seven (7) species were recorded in five (5) stations (**Table 2.2.32**) indicating a high diverse mixed seagrass bed in the area. *C. rotundata, H. ovalis and T. hemprichii* were present in all stations, while *E. acoroides* was only recorded in one (1) station. Sandbar Big 1 (SBSG1) had seven (7) seagrass species recorded with the presence of the 'pioneer species (smaller, short-lived and fast-growing species), while Ameril 2 (ASG2) had only three (3) seagrass species recorded. The mixed meadow at Sandbar Big 1 (SBSG1) with the presence of the tiny *H. ovalis* to the largest seagrass species, *E. acoroides* was found to be significant. Located in the middle of the bay, distribution of flowers and seeds of seagrasses from the mainland may play a role and this may practically explains the high species richness of the area. The presence of *C. serrulata, S. isoetifolium, H. uninervis* indicate a relatively favorable environment since these species are known to be resistant to clearer, less silted waters. The low diverse community was Ameril 2 (ASG2). It was evident of a less clear water compared to the other stations but it should be noted that this station is more exposed to wave action and muddier substrates.

Table 2.2.32. Total number of species present and species frequency in five (5) stations. X-marks indicate presence of species in a station.

Species	SBSG1	SBSG2	ASG1	ASG2	SSSG
Cymodocea rotundata	X	X	X	X	X
Cymodocea serrulata	X		X		
Halodule uninervis	X	X	X		X
Halophila ovalis	X	X	X	X	X
Syringodium isoetifoium	X	X	X		X
Thalassia hemprichii	X	X	X	X	X
Enhalus acoroides	X				

Seagrass Cover and Density

Cymodocea rotundata was recorded in all stations. In terms of (%) cover, it was found to be highest in Ameril 2 (ASG2; **Figure 2.2.53**). The low species diversity in Ameril could explain its dominance and high percent cover (**Figure 2.2.54**). It was also found to be the densest with 470 shoots /m2, followed by *T. hemprichii* (243 shoots /m2), and lastly, 32 shoots/m^2 from *H. ovalis* (**Figure 2.2.56**).

In contrast to Ameril 2 with only three (3) seagrass species found, Ameril 1 had six (6) seagrass species. The high species richness in the area showed an absence of dominant species. *H. uninervis, C. rotundata* and *C serrulata* were the three (3) most abundant species in terms of cover with 24%, 23%, and 20% respectively. What is striking in this station is the relatively high cover and density of *C. serrulata*, a species known to be sensitive to turbid water. This station however had clear waters, thus a healthy *C. serrulata* bed was observed.

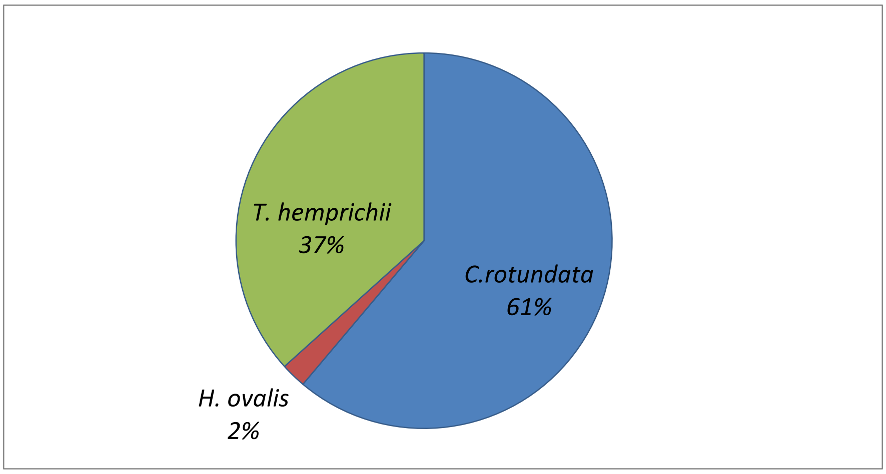


Figure 2.2.53. Seagrass percent cover in Ameril 2.

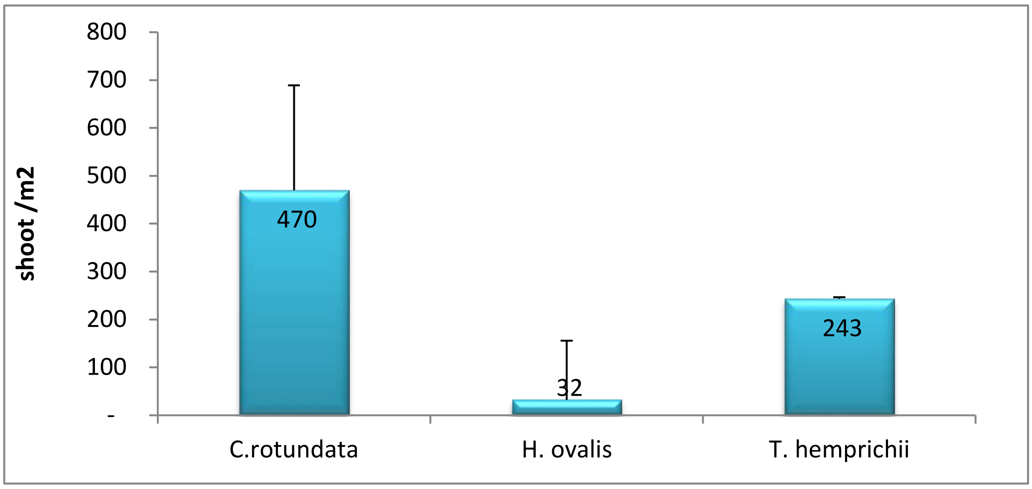


Figure 2.2.54. Seagrass density (shoots /m2) in Ameril 2.

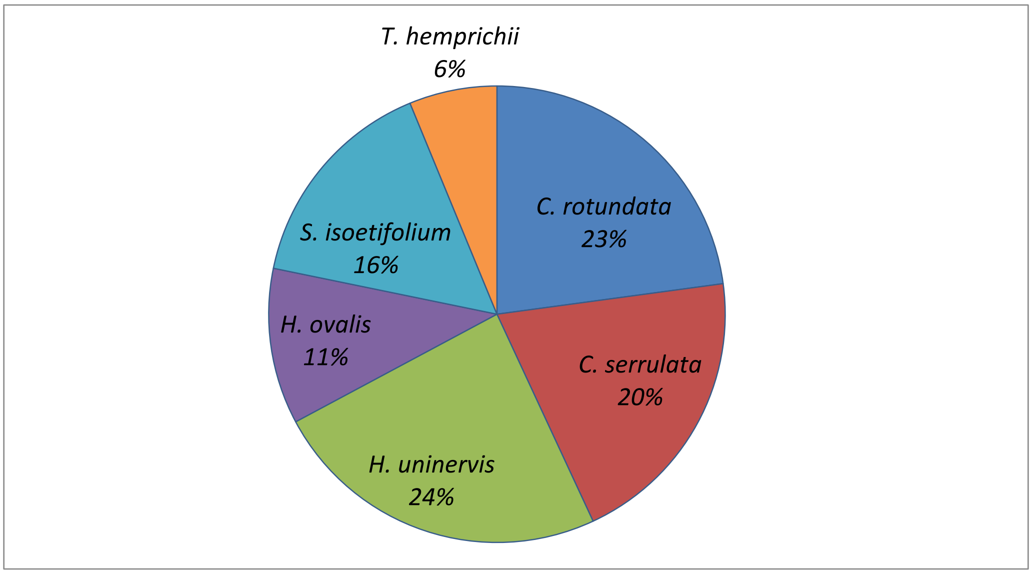


Figure 2.2.55. Seagrass cover in Ameril 1.

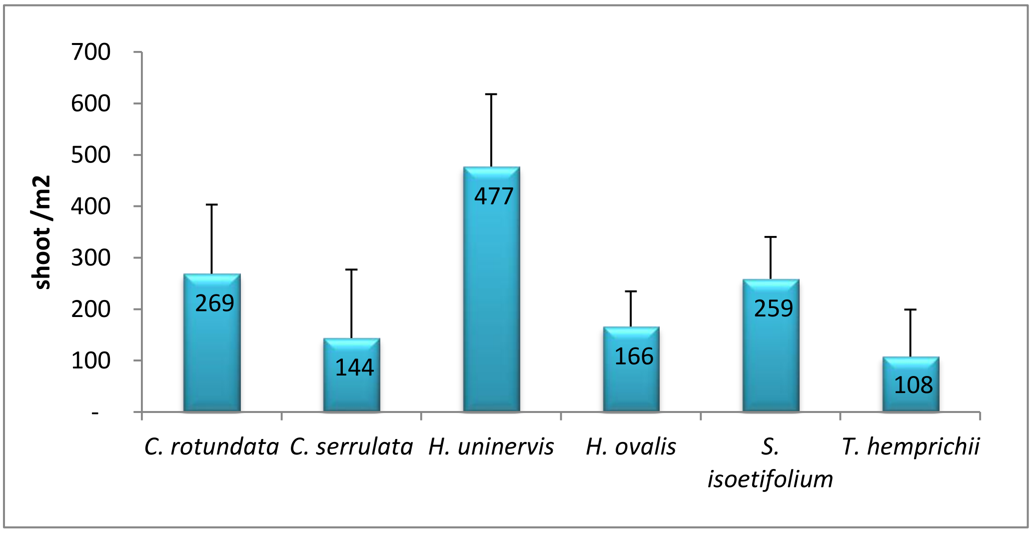


Figure 2.2.56. Seagrass density (shoot /m2) in Ameril 1.

Cymodocea rotundata also showed the highest cover in Sandbar Big 1 (SBSG1) with 37% cover, followed by the *T. hemprichii* with 17%. *C. serrulata* had the lowest cover with only 1% (**Figure 2.2.57**). Seven seagrass species were found in this station. *E acoroides* which has larger shoots could allow them to occupy space more permanently, accumulate and retain resources. However, its low (%) cover made way for the small, opportunistic, fast-growing species to expand and occupy more space. *C. rotundata* was the densest (284 shoots/m^2) followed by *S. isoetifolium* (183 shoots/m^2). *C. serrulata* was the least dense (9 shoots/m^2).

Big Sandbar 2 had lower species richness than Big Sandbar 1. Spatial analysis of the data indicates that low seagrass composition in this station could be due to site conditions. Species in this site may have limited distribution as this station is more exposed to waves/surf compared to the more protected site, SBSG1. Substrate type may also play a role. *C. rotundata* still topped to be highest in terms of cover and density with 45% and 426 shoots /m2 respectively. Although *T. hemprichii* followed to be highest in cover (31%), *H. uninervis* was abundant in density than *T. hemprichii* with 246 shoots/m^2 and 196 shoots/m^2, respectively. The smallest species, *S. isoetifolium* and the sand occluded *H. ovalis* were the least abundant (**Figure 2.2.58**).

Station in Small Sandbar (SSSG) had five (5) species of seagrass with *C. rotundata* (32%) as the most abundant, followed by T. hemprichii (21%), then by H. uninervis and S. isoetifolium with 20% and 18% respectively and finally H. ovalis (9%) (**Figure 2.2.59**). *C. rotundata, H. uninervis* and *S. isoetifolium* dominated the area in terms of density.

In summary, a total of seven (7) species were recorded in five (5) stations in Rio Tuba indicating a high diverse mixed seagrass bed. These species include *Cymodocea. rotundata, C. serrulata, Thalassia hemprichii, Syrimgodium isoetifolium, Halodule uninervis, Halophila ovalis,* and *Enhalus acoroides.* The highly diverse mixed seagrass communities found is indicative of clear, less silted waters. The species showed distribution patterns that appeared to be dictated both by site conditions and periods of the year. Across transects, Sandbar Big 1 (SBSG1) had the highest observed seagrass diversity. *C. serrulata* was found only in stations with clearer, less turbid water. *C. rotundata* and *T. hemprichii* were found in all stations even at the more exposed, coralline sites in the bay with consistently high abundance and dominance. *Halodule uninervis* was present in shallower portions of the bay. In terms of frequency and abundance, *Enhalus acoroides* showed the least. The low seagrass diversity in Ameril 2 may be due to its location being frequently exposed to wave actions and with coarser substrates.

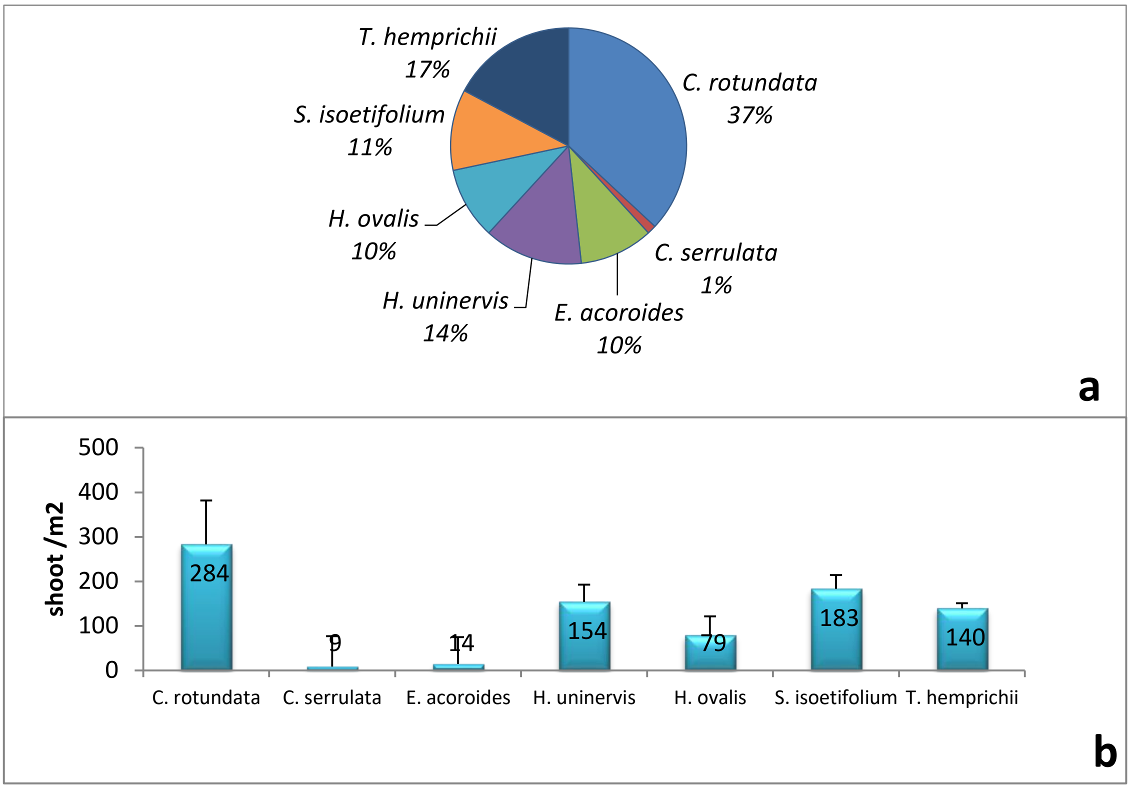


Figure 2.2.57. Seagrass (%) cover (a) and density (b) (shoot /m2) in Sandbar Big 1.

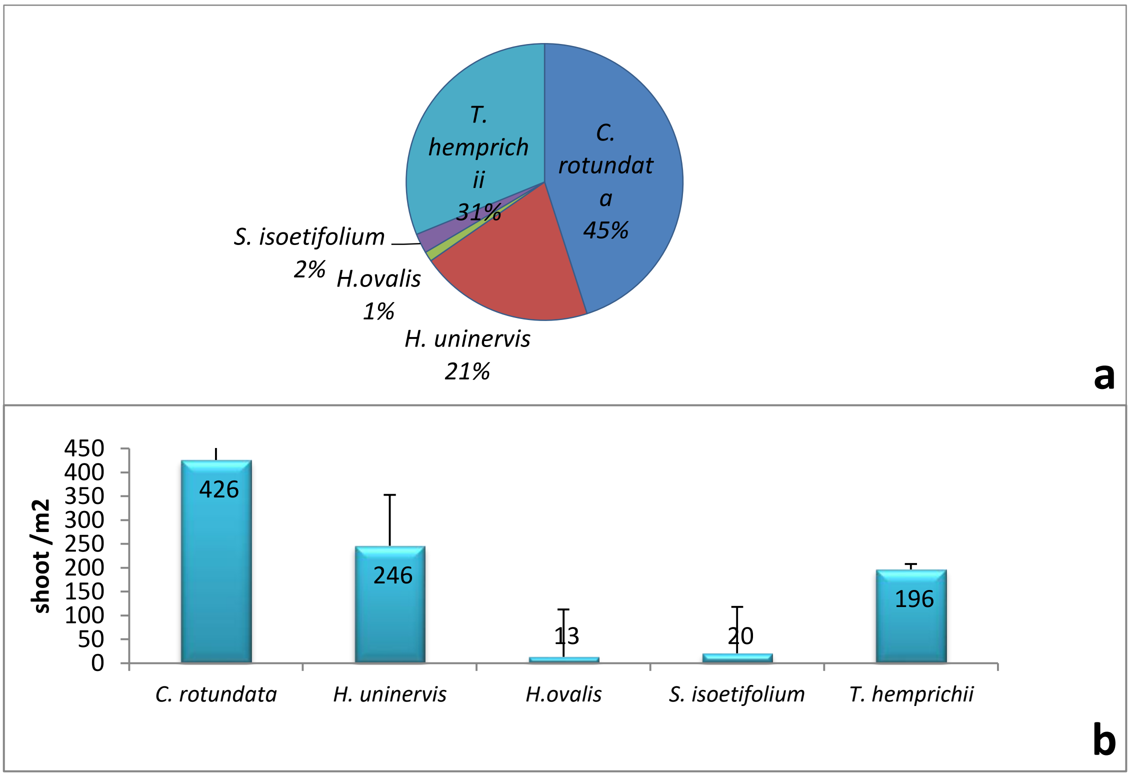


Figure 2.2.58. Seagrass (%) cover (a) and density (b) (shoot /m2) in Sandbar Big 2.

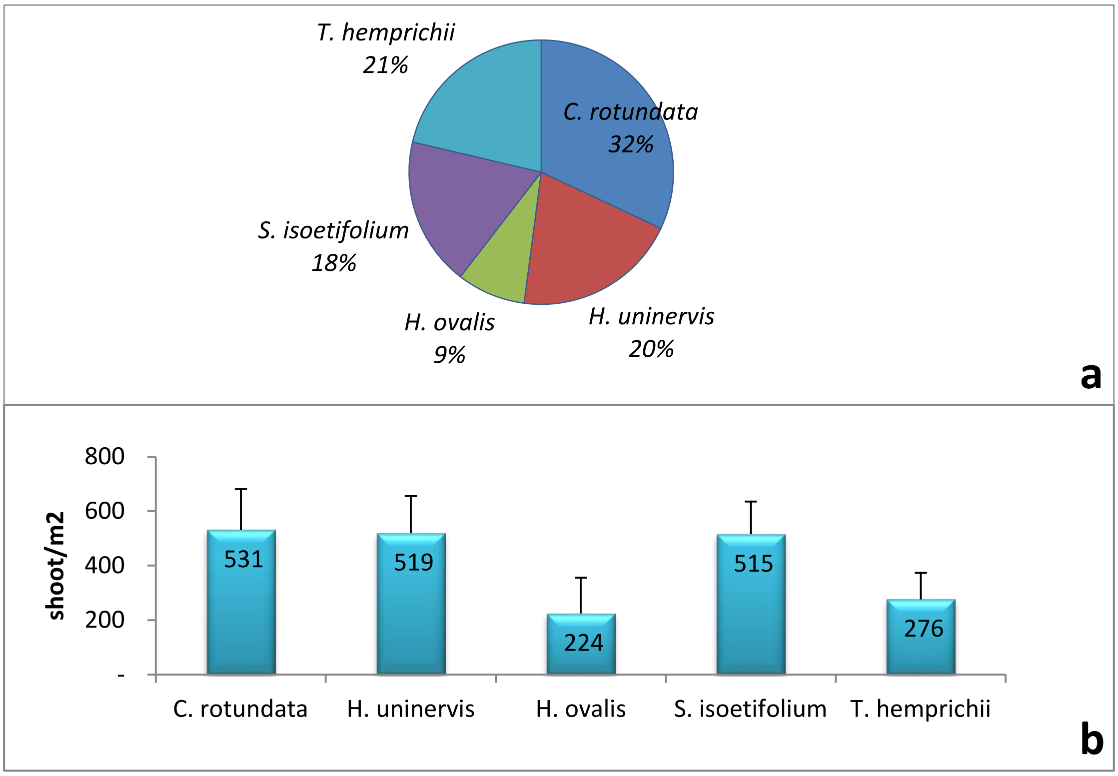


Figure 2.2.59. Seagrass (%) cover (a) and density (b) (shoot /m2) in Sandbar Small.

Seaweeds and Macro-invertebrates

All stations are home to several species of invertebrates such as sea urchin *Diadema setosum,* and some species of seastars such as *Linkia laevigata* and *Protoreaster nodosus*. Presence of mollusks was also observed.

Closely associated with seagrass and corals are seaweed communities. Seaweeds were found and recorded along transects in all stationss. A total of 20 species were recorded in all stations. There were 10 species found from Chlorophyceae (green algae), six (6) species from Phaeophyceae (brown algae) and four (4) species from Rhodophyceae (red algae) (**Table 2.2.33**). Seaweed species were observed to be abundant in Ameril.

It should be noted that record of the seaweeds might not have been complete as seaweeds have different habitat requirements and they were observed/surveyed at sites dominated by seagrasses.

Table 2.2.33. List of seaweed species recorded in all stations in Rio Tuba

Species	Division
Neomeris vanbosseae	Chlorophyta
Laurencia papillosa	Rhodophyta
Sargassum polycystum	Phaeophyta
Acanthophora sp.	Rhodophyta
Halimeda opuntia	Chlorophyta
Boergesenia forbesii	Chlorophyta
Eucheuma sp.	Rhodophyta
Gracilaria cervicornis	Rhodophyta
Amphiroa fragillissima	Chlorophyta
Sargassum cristaefolium	Phaeophyta
Padina sp. 1	Phaeophyta

Species	Division
Padina minor	Phaeophyta
Padina australis	Phaeophyta
Dictyota cervicornis	Phaeophyta
Udotea orientalis	Chlorophyta

Water Quality

Some water quality parameters have been measured: the dissolved oxygen, temperature, pH, and secchi depth (**Table 2.2.34**). Temperature and pH in the different sites are similar and are within normal range. Dissolved oxygen was lowest in Station 7 (east of Ameril), and highest at Station 1 (Iglesia Point). Turbidity is highest at Station 2 (Ocayan Point) and lowest at Station 7.

Table 2.2.34. Dissolved oxygen, temperature, ph, and secchi depth in plankton sampling sites in Rio Tuba, Bataraza, Palawan

Sampling stations	DO (mg/L)	Temp. (°C)	pH	Secchi Depth (m)
Station 1	7.4	29.4	8.1	6.0
Station 2	6.8	29.9	8.0	2.9
Station 3	7.0	29.3	8.1	9.1
Station 4	7.0	29.3	8.1	8.6
Station 5	6.9	29.1	8.1	10.3
Station 6	7.3	29.3	8.1	9.5
Station 7	6.6	28.9	8.1	13.1
AVE.± SE	7.0 ± 0.1	29.3 ± 0.1	8.1	8.5 ± 1.1

Phytoplankton

The abundance and composition of the phytoplankton community are shown in **Figure 2.2.60** and **Table 2.2.35**. A total of 39 phytoplankton species belonging to three (3) major groups (Cyanobacteria: one (1) species, Diatoms: 17 species, and Dinoflagellates: 21 species) were identified in the selected stations. The highest phytoplankton abundance was recorded in Station 2 (Ocayan Point) with 952 cells/L. This is the only station where the phytoplankton community is dominated by dinoflagellates with 628 cells/L. There is no cause for concern as these values are very low to be classified as an algal bloom. This site also has the highest turbidity (lowest Secchi depth; **Table 2.2.34**), which usually will negatively affect proliferation of phytoplankton since these minute organisms are dependent on light for proliferation. However, being very close to land, there might be high nitrogen and phosphorous input which may act as fertilizers and affect the abundance of the phytoplankton.

Table 2.2.35. Phytoplankton composition and abundance (cells/L)

Taxa	Stations							Grand Total
	Stn 1	Stn 2	Stn 3	Stn 4	Stn 5	Stn 6	Stn 7	
Cyanobacteria					5			5
Trichodemsium	-	-	-	-	5	-	-	5
Diatoms	333	324	240	403	405	102	144	1,951
Asterionella	-	-	-	-	-	4	-	4
Asterumphalus	-	4	-	-	-	-	-	4
Campylodiscus	-	-	-	-	-	4	-	4
Chaetoceros	85	53	81	59	58	13	17	366
Coscinodiscus	11	16	14	5	43	19	5	113
Ephemera	3	-	-	2	4	-	1	9
Guinardia	48	41	30	72	-	-	2	193
Hemaiulus	2	11	-	-	-	4	2	19

Taxa	Stations							Grand Total
	Stn 1	Stn 2	Stn 3	Stn 4	Stn 5	Stn 6	Stn 7	
Leptocylindrus	-	-	-	-	-	2	-	2
Odontella	2	-	-	-	4	-	-	6
Pleurosigma	26	2	-	8	9	11	-	56
Pseudonitzschia	-	-	-	21	122	-	5	148
Rhizosolenia	75	82	94	139	65	38	55	548
Stephanophysis	20	4	4	8	-	-	-	36
Thalassionema	52	102	13	85	101	4	58	414
Thalassiosira	9	11	4	-	-	4	-	27
Surirella	-	-	-	5	-	-	-	5
Dinoflagellates	208	628	42	93	38	38	25	1,072
Ceratium candelabarum	-	-	8	-	-	-	-	8
Ceratium furca	96	438	13	35	7	10	5	604
Ceratium fusus	8	2	-	5	5	-	4	24
Ceratium macroceros	2	6	2	-	-	-	-	10
Ceratium teres	-	5	4	-	-	-	1	10
Ceratium trichoceros	4	-	-	-	-	-	-	4
Ceratium tripos	5	6	6	6	-	2	-	26
Dinophysis caudata	4	8	-	-	-	-	-	12
Dinophysis tripos	5	-	-	-	-	-	-	5
Dipopsalis	75	34	2	18	18	24	4	174
Goniodoma	-	-	-	5	-	-	-	5
Gonyaulax	3	37	2	-	-	-	-	42
Ornithocercus	-	-	-	-	-	-	2	2
Phalacroma	-	-	-	10	4	-	-	13
Podolompas	-	-	-	-	-	-	5	5
Protoperdinium depressum	-	-	-	-	-	-	2	2
Protoperdinium pallidum	2	10	-	-	-	-	-	12
Protoperidnium conicum	2	64	2	2	-	2	2	73
Protoperidnium oblongum	-	17	3	-	-	-	-	20
Protoperdinium oceanicum	2	1	-	13	-	-	-	16
Protoperdinium divergens	-	-	-	-	4	-	-	4
Grand Total	**541**	**952**	**282**	**496**	**448**	**140**	**169**	**3,028**

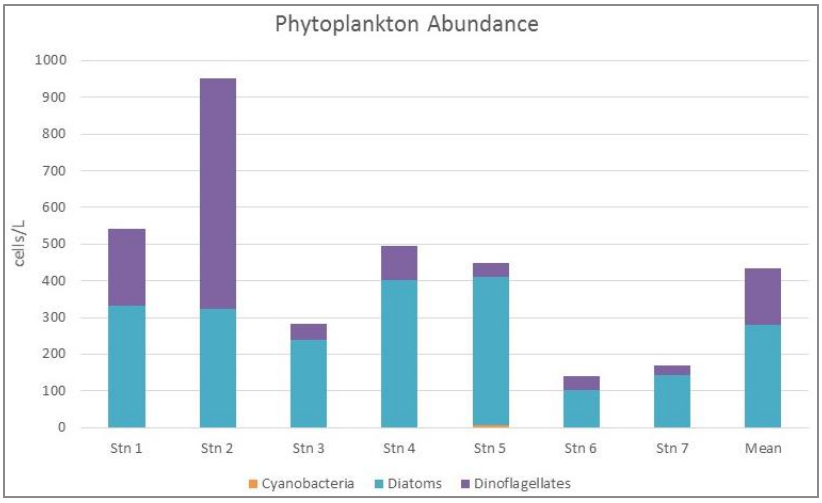


Figure 2.2.60. Phytoplankton abundance in the sampling sites in Rio Tuba, Bataraza, Palawan.

Station 1 (Iglesia Point) has the next highest abundance of phytoplankton with 541 cells/L. This pattern is consistent with the previous surveys in the area. The rest of the stations have phytoplankton density below 500 cells/L.

Interestingly, Station 3 (Tuba Rivermouth) has lower phytoplankton abundance compared to Station 4 (Deception Point) and Station 5 (West Ameril Island). Station 6 (North Ameril Island) and Station 7 (East Ameril Island) have the lowest abundance values. The mean phytoplankton abundance for all the stations is 433 cells/L.

The only species of cyanobacteria observed is *Trichodesmium* which is found in oligotrophic waters such as those in Station 5. The diatoms were represented by 17 species of which *Rhizosloenia* sp., *Thalassionema* sp., and *Chaetocereos* sp. were the most abundant. Among the dinoflagellates, with 21 species, the most dominant is *Ceratium furca* which comprises half of the dinoflagellate abundance and a fifth of the overall abundance.

Zooplankton

The zooplankton composition and abundance are shown in **Figure 2.2.61** and **Table 2.2.36**. A total of 12 major groups were identified that can be classified as either adult forms (6 groups) or larval forms (6 groups). Zooplankton abundance is similar to the phytoplankton. Station 2 (Ocayan) still has the highest abundance with 42,720 individuals/m^3. Not far behind is Station 1 (Iglesia) with 40,000 individuals/m^3. This is followed by Station 4 (Deception Point; 31,680 individuals/m^3) and Station 3 (Tuba Rivermouth; individuals/m^3). The Ameril Island sites have values below 15,000 individuals/m^3. Station 7 (East Ameril Island) has the lowest abundance at 4,980 individuals/m^3.

Table 2.2.36. Zooplankton composition and abundance (ind/m3).

Taxa	Stations							Total
	Stn 1	Stn 2	Stn 3	Stn 4	Stn 5	Stn 6	Stn 7	
Adult forms	14,400	8,400	300	8,000	900	2,280	360	34,640
Adult polychaete	500	-	100	-	-	-	-	600
Arrow worm	900	-	-	-	-	240	-	1,140
Calanoid	6,100	6,600	200	3,680	900	1,440	120	19,040
Cyclopoid	4,800	1,320	-	3,520	-	360	240	10,240
Harpacticoid	1,100	-	-	800	-	240	-	2,140
Larvacean	1,000	480	-	-	-	-	-	1,480
Larval forms	25,600	34,320	16,000	23,680	11,340	12,240	4,620	127,800
Bivalve veliger	1,600	480	-	2,080	1,260	-	-	5,420
Foraminiferans	-	240	-	320	180	360	60	1,160
Gastropod veliger	600	-	200	640	180	480	-	2,100
Polychaete trocophore	400	-	100	-	-	360	-	860
Barnacle nauplius	500	720	200	-	-	-	120	1,540
Nauplius and copepodite	22,500	32,880	15,500	20,640	9,720	11,040	4,440	116,720
Grand Total	**40,000**	**42,720**	**16,300**	**31,680**	**12,240**	**14,520**	**4,980**	**162,440**

Adults are the dominant forms found in the zooplankton with a total of 34,640 individuals/m^3. Among the adult forms, the most dominant are the copepods (Calaonoid, Cylopoid, and Harpacticoid groups) which comprise 90% of the overall zooplankton abundance. They are major food organisms for small fish and other crustaceans.

The larval forms have a total of 127,800 individuals/m^3. Once again they are dominated by larval crustaceans (nauplius) and copepodites with 116,720 individuals/m^3. These were present in all the sampling stations. This was followed by bivalve veliger at 5,420 individuals/m^3 and present only at Station 1, 2, 4, and 5.

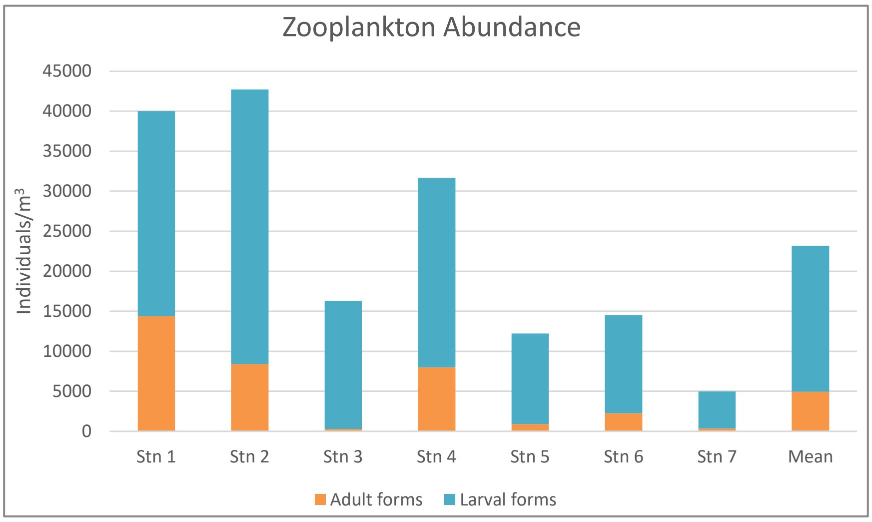


Figure 2.2.61. Zooplankton abundance in the sampling sites in Rio Tuba, Bataraza, Palawan.

Heavy Metal Analysis

The term heavy metals is a general collective term which applies to group of metals and metalloids with atomic density greater than 4g/cm^3 or 5 times or more greater than water (Duruibe, et al., 2007), they are also known as trace elements because they occur in minute concentrations in biological systems.

Depending upon their concentration they may exert beneficial or harmful effects on plant, animal and human life (Forstner, et al., 1981). Some of these metals are toxic to living organisms even at low concentrations, whereas others are biologically essential and become toxic at relatively high concentrations. When ingested in excess amounts heavy metals combine with body's biomolecules, like proteins and enzymes to form stable biotoxic compounds, thereby mutilating their structures and hindering them from preforming their functions.

Plate 2.2.24. Black-barred halfbreaks (*Hemiramphus far*) were used for heavy metal analysis.

Specimen samples of Black-barred halfbeaks (*Hemiramphus far*) caught by fishermen near Sandbar Malaki were taken for heavy metal analysis. Black-barred halfbeaks breeds in estuaries. They are typically pelagic schooling forage fish, forming schools on surface over sandy areas with seagrass and reefs. Marine halfbeaks are omnivores feeding on algae, marine plants such as seagrasses and plankton, and smaller fishes. They are in turn eaten by many ecologically and commercially important fish, such as marlin, mackerel, and sharks, and so are key links between trophic levels. They are used for human consumption and marketed fresh and dried.

The results of the analysis done by Ostrea Mineral Laboratories, Inc. are shown in **Table 2.2.37**. Chromium, nickel, lead, and cadmium were analyzed using flame atomic absorption spectroscopy. Arsenic was analyzed using hydride generation and mercury with cold vapor atomic absorption spectroscopy. **Annex 2.2.4** shows the certificate of analysis of the fish sample.

Table 2.2.37. Results of heavy metal analysis.

Parameters	Results	Units	Method
Arsenic (As)	<0.01	mg/kg	Hydride Generation
Chromium (Cr)	<0.02	mg/kg	Flame AAS
Nickel (Ni)	<0.20	mg/kg	Flame AAS
Lead (Pb)	2.49	mg/kg	Flame AAS
Mercury (Hg)	<0.004	mg/kg	Cold Vapor AAS
Cadmium (Cd)	<0.03	mg/kg	Flame AAS

Arsenic

Arsenic is a widely distributed metalloid, occurring in rock, soil, water and air. Exposure to arsenic is mainly via intake of food and drinking water. Only a few percent of the total arsenic in fish is present in inorganic form. Chronic exposure to inorganic arsenic may cause serious impact on peripheral and central nervous system. Results obtained (<0.01) were less than the maximum acceptable levels of the Philippine Food and Drug Administration of 0.05 mg/kg.

Chromium

Chromium compounds are found in the environment due to erosion of chromium-containing rocks and can be distributed by volcanic eruptions. The World Health Organization (WHO) has proposed that chromium is a human carcinogen. Several studies have shown that chromium compounds can increase in risk of lung cancer (Ishikawa, et al., 1994). The chromium levels in the samples were much less than the limits prescribed by the FDA of 12-13 mg/kg.

Nickel

Nickel is a silvery white, hard and malleable metal. It is very abundant element, found in all soils and is emitted from volcanoes. At very trace levels, Ni is considered as an essential trace element. It acts as an activator of some enzyme systems but its toxicity at higher levels is more prominent. High level of nickel can cause respiratory problems and it is carcinogenic (Sivaperumal, et al., 2007). Nickel concentrations were less than the limits set by the WHO of 0.5-1.0 mg/kg.

Lead

Lead is found in small amount in the Earth's crust. It is ubiquitous and most of it came from human activities, like mining, manufacturing and the burning of fossil fuels. The principal source of Pb in the marine environment appears to be the exhaust of vehicles run with leaded fuels that reaches the sea water by a way of rain and wind blown dust (Castro, et al., 1997). Lead is found at high concentration in muscles and organs of fish. The WHO maximum acceptable limit for lead is 2 mg/kg. The results from the analysis slightly exceeded the World Health Oragization (WHO) recommendation by approximately 0.5 mg/kg.

Mercury

Mercury is an extremely rare element in Earth's crust. Mercury is used primarily for the manufacture of industrial chemicals or for electrical and electronic applications. Mercury is a known human toxicant and the primary source of mercury contamination in people is through eating fish. Mercury pollution in aquatic ecosystems has received great attention since the discovery of mercury as the cause of Minamata disease in Japan in the 1950s. The mercury values were well below the value of 0.5-1.0 mg/kg recommended by the European Community.

Cadmium

Cadmium is a natural element in the Earth's crust. It is usually found as a mineral with other elements. All soils and rocks, including coal and mineral fertilizer, have some cadmium in them. Cd enters air from mining, industry, and burning coal and household wastes. Its particles can travel long distance in air before falling to ground or water. Cadmium is widely distributed at low levels in the environment and is not an essential element for humans, animals and plants. The obtained concentration is below the WHO maximum acceptable limit permitted in fish of 1.00 mg/kg.

Health-Risk Assessment for Fish Consumption (Consumption Safety)

The average fish consumption in the Philippines is 28.5 kg per capita per year (Barut, et al., 2004). This translates to approximately 78 g per capita per day. Multiplying this value by the average concentration of each metal (As, Cr, Ni, Pb, Hg, and Cd) in the analyzed fish, the average daily intake (consumption) of metals from fish can be estimated. The estimated daily consumption of As, Cr, Ni, Pb, Hg, and Cd are shown in **Table 2.2.38**. The tolerable daily intake are gathered from the values established by the WHO and were computed for a 70 kg person.

Table 2.2.38. Estimated daily consumption of selected and heavy metal and tolerable daily intake (WHO, 1996)

Heavy Metal	Estimated Intake (µg/day)	Tolerable Daily Intake (µg/day)
Arsenic (As)	0.78	150
Chromium (Cr)	1.56	250
Nickel (Ni)	15.6	300
Lead (Pb)	194.22	210
Mercury (Hg)	0.312	140
Cadmium (Cd)	2.34	60

The current estimated intake values for the various heavy metals are well below the tolerable daily intake suggested by the World Health Organization (WHO) except for lead. The estimated intake value for lead is 92% of the TDI. People in the area consuming more than 78 g of fish per day are likely to exceed the limit. When lead accumulates in the human body, it replaces the calcium in bones. Lead exposure has been mainly related to retardation of neurobehavioral development (Lidsky, et al., 2003).

2.2.5.3. Impact Assessment

The key impacts of the proposed project on the marine environment are presented in **Table 2.2.39**.

Table 2.2.39. Impacts assessment and mitigation for marine ecology

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
• **Threat to existence and/or loss of important local species** • **Threat to abundance, frequency and distribution** Possible increase in siltation may further affect corals near the mouth of the river. The corals there are mostly resistant to siltation effects, although the community might still be affected if siltation levels become higher or stay high for prolonged periods of time. The continued siltation will contribute to the progressive deterioration of coastal water quality through increasing turbidity and TSS and subsequent long term impact to the coral reefs and seagrass beds.		✓	✓		• An effective Stormwater Management Plan is currently being implemented in the mine site and will be continued for the new operations. The plan includes slope stabilization measures, installation of drainage system and diversion anals and maintenance of silt ponds. The stormwater management plan will minimize siltation from the mining areas. The silt ponds are proven effective in limiting siltation of rivers however, RTNMC can opt to install silt curtains along the outfall area of the siltponds to further minimize siltation. • Moreover, the selective clearing and progressive rehabilitation will assist in minimizing siltation from the mining operations. • RTNMC should support fisheries management programs prescribed in the overall Municipal Coastal Resources Management Plan to ensure fish stock reproduction and habitat restoration in the SDMP. • RTNMC should also support income-generating livelihood projects involving women in fisheries and strengthening organized fisher groups including the conduct of regular advocacy and IEC activities for responsible fishing practices. • RTNMC further should include mangrove rehabilitation programs along the different river systems in their gevetation enhancement programs. A healhty mangrove ecosystem would be able to sustain the habitat of marine organisms and provide shelter for fish fingerlings and other marine organisms. • RTNMC shall conduct regular monitoring of coastal water quality and marine ecosystem including monitoring of HAB-causing phytoplankton.

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
Oil and grease contamination in coastal waters especially in dock area and from the spillages from the mining areas and from gouding of sea vessels that can result to fuel leaks. Hydrocarbon containing compoudds can also threaten coral, fish, and seagrass communities Disposal of solid wastes and waste water from the cargo ships and barges will also threaten coral, fish, seagrass communities and other marine organisms			✓		• All sea vessels used by the company should be strictly forbidened to dispose bilge water. • Oil water separators (OWS) should be installed in the repavehicle and equipment shops and motorpool. The OWS should be regularly maintained with sludeges regularly collected, stored in leak proof container prior to transport and treatment by an accredited transporter and treater. • Implementation of clean practices for all sea vessels. Solid waste should not be disposed directly to the sea. • All latrines are efficiently fitted with wastewater filtering system • Emergency response for oil spill in coastal areas shall be included in the Emergency Response and Preparedness Program (ERPP).

2.3 The Air

2.3.1 Meteorology

2.3.1.1 Methodology

Climatological data were obtained from PAGASA. The closest synoptic station of PAGASA relative to the proposed project site is the Puerto Princesa Synoptic Station in Palawan. This station has available record since 1981. Climatologic indicators for the area include mean temperature, rainfall, relative humidity, wind speed and direction.

Site data from rainfall and temperature were obtained from Rainfall Monitoring stations established by RTNMC and the automated weather station established by CBNC in 2004.

Other relevant information gathered from PAGASA is the climate and typhoon frequency maps and the 2020 and 2050 climate projection (Climate Change in the Philippines, 2011).

2.3.1.2 Baseline Conditions

Climate

The province of Palawan has two (2) types of climate. The first, which occurs in the northern and southern extremities and the entire western coast, has two (2) distinct seasons – six (6) months dry and six (6) months wet. The other, which prevails in the eastern coast, has a short dry season of one (1) to three (3) months and no pronounced rainy period during the rest of the year. The southern part of the province is virtually free from tropical depressions but northern Palawan experiences torrential rains during the months of July and August. Summer months serve as peak season for Palawan.

Rainfall characteristics indicate that the climate in the project area is of Type III under the Modified Corona Classification of Philippine Climate (**Figure 2.3.1**). This type of climate is relatively dry from January to April and wet throughout the year. The main atmospheric systems controlling rainfall in the area are the southwest monsoon from June to September, northeast monsoon from December to February, and Easterly Waves from March to April. The Intertropical Convergence Zone (ITCZ) also contributes significantly to the rainfall in the area especially during summer.

Tables 2.3.1 and **2.3.2** present the climatological normals and extremes from the Puerto Princesa Synoptic Station.

Table 2.3.1.Climatological Normals at Puerto Princesa Synoptic Station (1981-2010)

Month	Rainfall		Temperature						Vapor Pressure (mbs)[9]	Rel. Hum. (%)[10]	MSLP (MBS)[11]	Wind		Cloud Amount (okta)[13]	No. of Days with	
	Amount[1] (mm)	No. of RD[2]	Max (°C)[3]	Min (°C)[4]	Mean (°C)[5]	Dry Bulb (°C)[6]	Wet Bulb (°C)[7]	Dew Point (°C)[8]				DIR (16pt)[12]	Speed (mps)[12]		TSTM[14]	LTNG[15]
JAN	36.4	5	30.8	23.2	27.0	26.7	24.0	23.0	28.0	80	1,010.9	E	3	5	1	2
FEB	23.7	3	31	23.1	27.0	26.8	24.0	23.0	27.9	79	1,011.1	E	3	4	1	1
MAR	37.3	4	31.7	23.7	27.7	27.5	24.5	23.4	28.7	78	1,010.7	E	3	4	2	3
APR	54.2	7	32.7	24.5	28.6	28.4	25.3	24.2	30.1	78	1,009.7	E	2	4	7	8
MAY	118.4	12	32.7	24.8	28.8	28.4	25.7	24.8	31.1	81	1,008.9	W	2	5	15	18
JUN	171.1	17	31.8	24.2	28.0	27.5	25.3	24.5	30.7	84	1,008.8	S	2	6	13	17
JUL	153.5	18	31.4	23.8	27.6	27.1	25.0	24.3	30.2	84	1,008.7	W	2	6	11	13
AUG	185.4	18	31.3	23.8	27.5	27.0	25.0	24.3	30.3	85	1,008.6	S	2	6	11	12
SEP	170.1	17	31.5	23.7	27.6	27.0	24.9	24.1	30.0	84	1,009.1	W	2	6	12	13
OCT	216.1	19	31.4	23.7	27.5	27.0	25.0	24.3	30.3	85	1,009.2	W	2	6	13	15
NOV	211	15	31.1	23.7	27.4	27.1	25.0	24.3	30.2	84	1,009.3	E	2	5	11	13
DEC	150.1	11	30.7	23.5	27.1	26.9	24.5	23.6	29.1	82	1,010.1	E	3	5	4	8
ANNUAL	1,527.30	146	31.5	23.8	27.7	27.3	24.8	24.0	29.7	82	1,009.6	E	2	5	101	123

Source: PAGASA

Notes: [1]The amount of precipitation (rain, hail etc.) expresses in millimeters depth, of the layer of the water which has fallen.
[2]A rainy day is defined as a period of 24 hours beginning at 8AM to 8AM of the next day during which 0.1 mmm of rain is recorded.
[3]The maximum temperature in °C recorded for the day, usually occurring in the early afternoon.
[4]The minimum temperature in °C recorded for the day, usually occurring during early hours of the morning (before sunrise).
[5]Mean Temperature =(Maximum + Minimum) /2
[6]It gives thee air temperature in °C at the time of observation.
[7] It gives the temperature in °C that an air parcel would have if cooled adiabatically to saturation at constant pressure by evaporating water in it.
[8]The temperature in °C that an air parcel would have cooled to become saturated. It is the temperature when atmospheric moisture begins to condense to liquid forming "dew" upon obejects.
[9]Denotes the partial pressure of water in atmosphere. As the water evaporates, additional water vapor is introduced into spaceabove and pressure increases slightly as the new vapor is added. The increasing pressure is due to an increase in the partial pressure of water vapor.
[10]The ratio of the amount of water vapor actually in the air to the maximum amount the air can hold at that temperature.
[11]The force exerted by the weight of the atmosphere on a unit area at the mean sea level. It is also the atmospheric pressure at mean sea level.
[12] The prevailing wind direction most frequently observed during a given period while the average wind speed in meters per second is the arithmetic average of the observed wind speed.
[13]The amount of cloud present in the sky, expressed in oktas of the sky cover. (Okta is the functionused in denoting cloud amount and is equal to 1/8 of the whole sky.
[14]A thunderstorm day is defined as an observational day during which thunder is at station.
[15] A day with lightning is reported whenever lightning is observed.

Table 2.3.2. Climatological Extremes at Puerto Princesa Synoptic Station (as of 2014)

Month	Temperature (°C)				Greatest Daily Rainfall (mm)		Highest Wind (mps)			Sea Level Pressures (MBS)			
	High	Date	Low	Date	Amount	Date	Speed	Dir.	Date	High	Date	Low	Date
JAN	34.4	1/16/1988	18.3	1/20/1961	120.4	1/19/1985	19	E	1/19/1985	1,019.4	1/9/2004	1,002.2	1/1/1950
FEB	34.6	2/16/2010	18.5	2/2/2002	140.8	2/26/1982	18	E	2/26/1982	1,018.8	2/1/1962	1,003.8	2/7/1985
MAR	36.4	3/17/2005	19.2	3/15/1967	116.3	3/5/1954	18	SE	3/21/1982	1,019.8	3/5/2005	989.1	3/24/1949
APR	36.3	4/3/1996	20.9	4/16/1971	92.7	4/25/1971	16	E	4/4/2005	1,017.2	4/8/1969	989.8	4/4/1949
MAY	36.0	5/22/1987	21.3	5/24/1961	121.7	5/8/1954	15	SSE	5/12/2006	1,015.8	5/16/1958	1,002.7	5/17/1989
JUN	35.6	6/4/1998	16.2	6/17/1988	194.1	6/29/1980	18	SW	6/22/1990	1,015.8	6/9/1971	1,001.3	6/30/1964
JUL	35.2	7/13/1975	20.6	7/11/1961	106.3	7/28/2012	20	SW	7/4/2001	1,014.8	7/7/1953	1,001.4	7/4/2001
AUG	35.2	8/30/1996	20.5	8/31/1987	137.5	8/21/1982	18	WSW	8/7/2005	1,017.8	8/25/1979	1,000.5	8/17/1990
SEP	34.7	9/5/2000	20.6	9/8/1967	226.0	9/30/1983	18	ESE	9/4/1993	1,015.4	9/20/1965	1,001.8	9/11/1996
OCT	36.0	10/16/1977	20.9	10/2/1967	134.1	10/2/1949	23	WSW	10/6/1988	1,016.4	10/27/1977	999.6	10/14/1970
NOV	34.2	11/20/2004	19.2	11/19/1984	202.4	11/28/1955	49	NW	11/25/1968	1,017.5	11/24/1957	989.2	11/25/1968
DEC	34.0	12/4/2002	19.2	12/30/1986	269.3	12/29/1975	31	ENE	12/31/1998	1,018.3	12/12/2002	999.2	12/12/1998
ANNUAL	36.4	3/17/2005	16.2	6/17/1988	269.3	12/29/1975	49	NW	11/25/1968	1,019.8	3/5/2005	989.1	3/24/1949
Period of Record	1951 - 2014				1949 - 2014		1950 - 2014			1949 - 2014			

Source: PAGASA

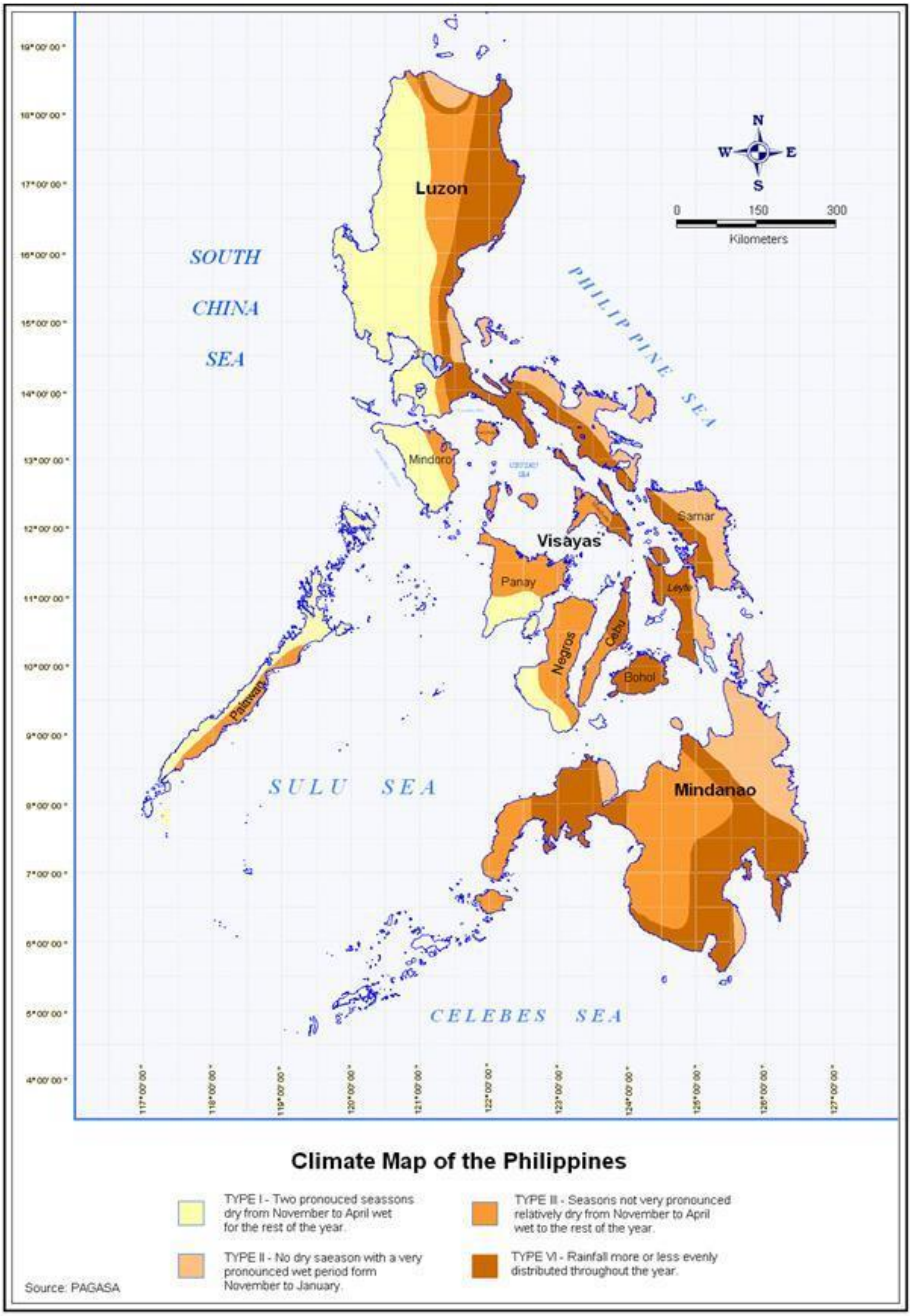


Figure 2.3.1 Climate map of the Philippines

Rainfall

Rainfall has been measured in Palawan as early as 1949 by PAGASA. Several rainfall stations are operating and the station in Brooke's Point is the newest since it only started operation in 1971. Monthly minimum rainfall ranges from zero (as observed in all stations) to 188 mm (as observed in Cuyo), while monthly maximum ranges from 22 (as observed in Coron) to 4,623 mm (as observed in Brooke's Point). On the other hand, mean monthly values vary from 3 mm to 613 mm as recorded in Cuyo and Brooke's Point, respectively. There is abundant rainfall during the months of June to October.

Table 2.3.3. Climatic variables at Puerto Princesa City

Months	Rainfall (mm)	No. of rainy days	Temperature (°C)	Relative Humidity	Evaporation (mm)
January	3.2	1	26.3	78	19.82
February	2.6	2	26.7	78	21.06
March	9.5	3	26.2	82	22.37
April	19.8	3	27.9	79	23.75
May	116.4	16	28.2	82	22.37
June	148.8	12	27.3	82	22.37
July	147.6	16	26.6	87	22.37
August	143.5	17	26.8	86	22.37
September	83.0	12	27.0	84	22.37
October	145.9	15	26.5	86	22.37
November	118.1	14	26.4	85	22.37
December	52.7	5	26.6	89	22.75
Total	991.1	116	26.9	83	266.34

RTNMC maintains three (3) rainfall stations in the vicinity of its mining claims. These stations are located at the Guintalunan, Mangingidong and Piersite areas of Brgy. Rio Tuba and have been operating since the early eighties. Based on the Thiessen Polygon Method, the rainfall record of Mangingidong Station represents the rainfall on approximately 88% of the coverage of AMA-IVB-144A, while that of the Guintalunan Station represents the rainfall on the rest of the mining claim application. **Table 2.3.4** lists the average monthly and annual rainfall over the said mining claim as derived from the weighted averages of these two (2) rainfall stations in the last 21 years while **Figure 2.3.2** illustrates the monthly rainfall trend.

Table 2.3.4 and **Figure 2.3.2** reveal that AMA-IVB-144A receives an average rainfall of 2,611 mm per year. The rainy season apparently begins at April and lasts up to January where the monthly rainfall exceeds 160 mm and peaks at 362 mm in October. February and March constitute the dry season with the monthly rainfall averaging 75 mm.

Table 2.3.4. Average Monthly and Annual Rainfall

Period	Rainfall (mm)
January	194
February	69
March	81
April	171
May	189
June	329
July	260
August	260
September	313
October	362
November	213
December	170
Annual	2,611

Source: 1994-2014 Record of Mangingidong and Guintalunan Rainfall Stations

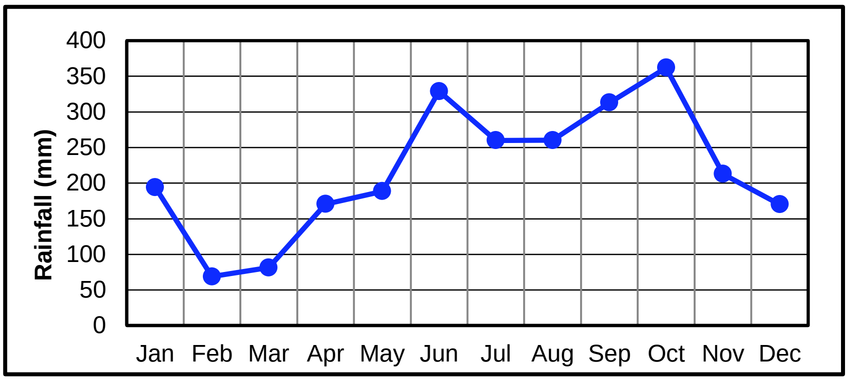


Figure 2.3.2. Monthly Rainfall Trend
Source: 1994-2014 Record of Mangingidong and Guinatalunan Rainfall Stations

Temperature

RTNMC also monitored other weather parameters including daily minimum and maximum temperature from 1980 to 1999. More recently, Coral Bay Nickel Corporation (CBNC) on the other hand, installed an automatic weather station in their HPAL plant in Brgy. Rio Tuba in 2004 that likewise monitored maximum, minimum and mean temperature, among other parameters.

Table 2.3.5 enumerates the minimum, maximum and mean monthly temperature culled from the weather data of RTNMC and CBNC in the last 20 years. The table indicates that the area is generally warm, having an average annual temperature of 27.1 ^{0}C. The hottest period occurs on April and May where the average monthly temperature reached 28.1^{0}C. The coldest month is January, which has an average temperature of 26.4^{0}C.

Table 2.3.5. Minimum, Maximum and Mean Temperature

Month	Temperature (^{0}C)		
	Minimum	Maximum	Mean
January	22.5	29.0	26.4
February	22.5	30.3	27.0
March	23.2	30.8	27.6
April	24.0	31.9	28.3
May	24.3	31.4	28.2
June	23.5	31.0	27.2
July	23.1	30.5	26.8
August	23.3	30.0	27.0
September	23.0	29.9	26.8
October	23.1	29.9	26.8
November	23.2	30.4	27.0
December	23.0	29.5	26.7
Annual	23.2	30.4	27.1

Source: 1994-2013 temperature data of RTNMC and CBNC

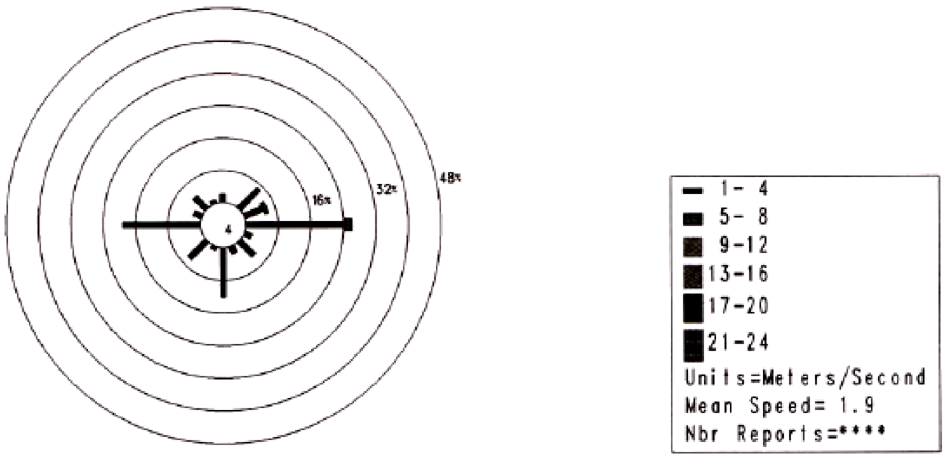
Wind Pattern

There are several types of wind systems that affect the province. Wind speed range from 1.0 m/s during the months of July and August to a maximum of 2.3 m/s in January. Mean annual wind speed is 1.9 m/s on general E direction. The annual wind rose diagram is shown in **Figure 2.3.3**.

WIND ROSE DIAGRAM, 1971-2000

PUERTO PRINCESA,PALAWAN

Annual



FREQUENCY TABLE
PUERTO PRINCESA, PALAWAN
Wind Speed and Direction
Annual (1971-2000)

Direction / Speed (mps)	N	NNE	NE	ENE	E	ESE	SE	SSE
CALM								
1 – 4	2.1	0.2	6.6	5.1	24.1	2.0	5.4	2.0
5 - 8	0.1	0.0	0.2	1.1	1.9	0.0	0.0	0.0
>8	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
TOTAL	2.2	0.2	6.8	6.3	26.0	2.0	5.4	2.0

Direction / Speed (mps)	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM									4.3
1 - 4	11.8	0.6	6.2	0.5	18.6	2.3	3.6	0.9	92.0
5 - 8	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.0	3.6
>8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
TOTAL	11.8	0.6	6.3	0.5	18.7	2.3	3.7	0.9	100.0

Figure 2.3.3. Annual Windrose Diagram (1971-2000)

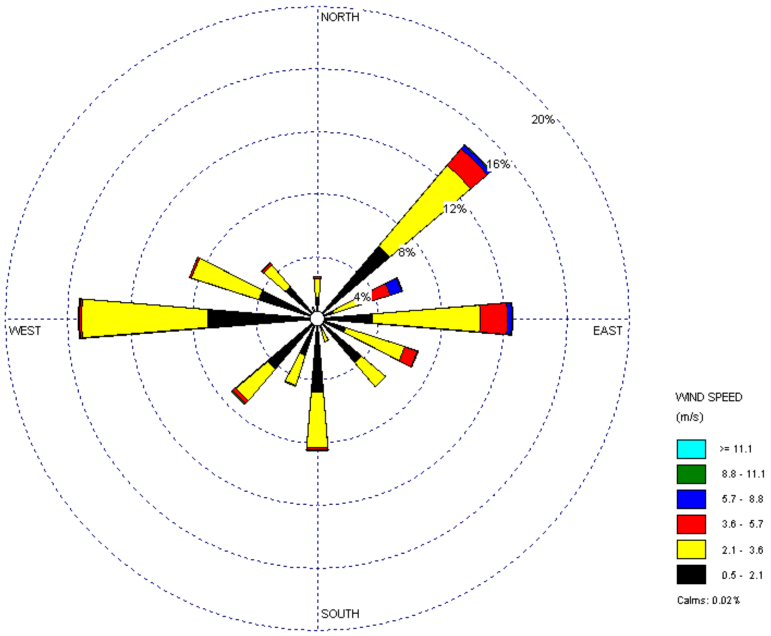


Figure 2.3.4. Annual windrose diagram, Puerto Princesa (Station 618)

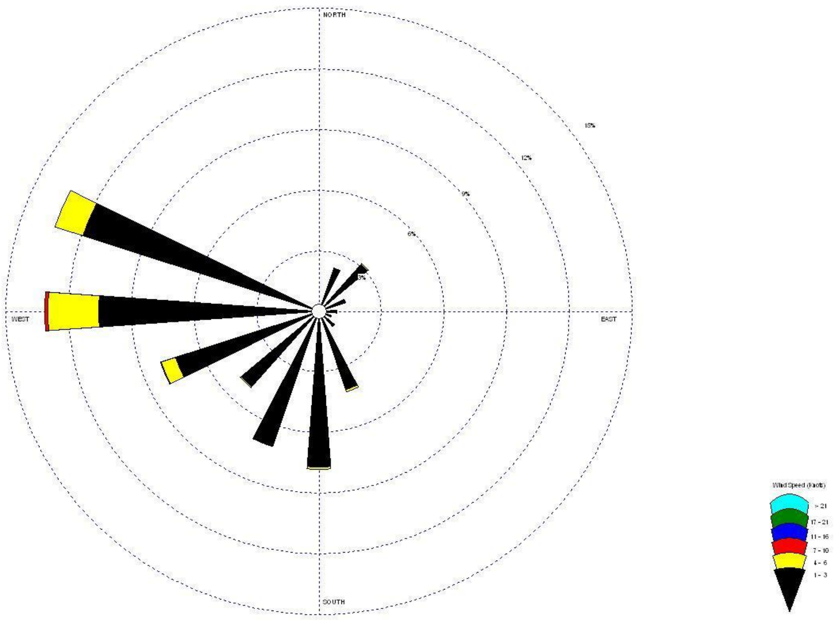


Figure 2.3.5. Annual windrose diagram, CBNC HPP,
Brgy. Rio Tuba, Bataraza, Palawan

Typhoons

The mean frequency of typhoon passage inside the Philippine Area of Responsibility (PAR) is about 20 typhoons per year. In the Palawan area, the typhoon passage frequency is one (1) cyclone per year mostly in Northern Palawan. This occurs during the last quarter of the year when the tail end of the cold front moves towards the southern part of the country. It is very rare for typhoons to pass in the project area which is located at the southern tip of mainland Palawan. **Figure 2.3.6** presents the cyclone map of the Philippines.

Cloudiness

Cloudiness is measured in terms of the fraction of the sky covered with clouds. One okta is one-eight sky cover. Cloud observation records in Puerto Princesa show that the mean monthly cloud cover ranges from 4 to 6 oktas. Mean cloud cover is 4 oktas in the dry months of January to April and 5 to 6 oktas in the wet months from May to December. The mean annual cloud cover is 5 oktas.

Mean Sea Level Pressure

The mean sea level pressure in Palawan is 1009.6 mbs. The extremes recorded over the 1949-2014 period were 1019.8 and 989.

Greenhouse Gas (GHG) Emission

The estimated GHG emission for the project's current operation is derived through the GHG emissions calculation tool ***Transport Tool*** (version 2.6 formulated by the Greenhouse Gas Protocol Initiative (World Resource Institute, World Business Council for Sustainable Development). GHG estimation for the project is limited to the Scope 1 (all direct emissions) category of Greenhouse Gas Protocol.

The degree of difficulty in calculating transportation emissions depends largely on which gases are included in the analysis. In most cases, CO_2 emissions are relatively straightforward to estimate, since they are primarily dependent on only two factors: the type and quantity of fuel burned. N_2O and CH_4 emissions, on the other hand, depend largely on the emissions control equipment used (e.g., type of catalytic converter). Since N_2O and CH_4 emissions comprise a relatively small proportion of overall transportation emissions, only CO_2 emissions estimates are included in this tool.

Default emission factors were provided by the tool and they are actually 2.68 kg $CO_{2\text{-}e}$/L of diesel and 2.27 kg $CO_{2\text{-}e}$/L gasoline. For all mobile sources, one may apply either a fuel-based or distance-based methodology to calculate CO_2 emissions. In the fuel-based approach, fuel consumption is multiplied by the CO_2 emission factor for each fuel, where emission factor is in terms of liters of fuel.

$$\textbf{\textit{CO}}_{\textbf{\textit{2}}}\ \textbf{\textit{Emissions = Fuel Used x Emission factor}}$$

The fuel data of the vehicles and heavy equipment involved in ore extraction and transport were provided by RTNMC (**Annex 2.3.1**). Two sets of data were obtained: the existing operation was based on the 2016 fuel budget while a breakdown of the fuel budget under the proposed mining project was also provided.

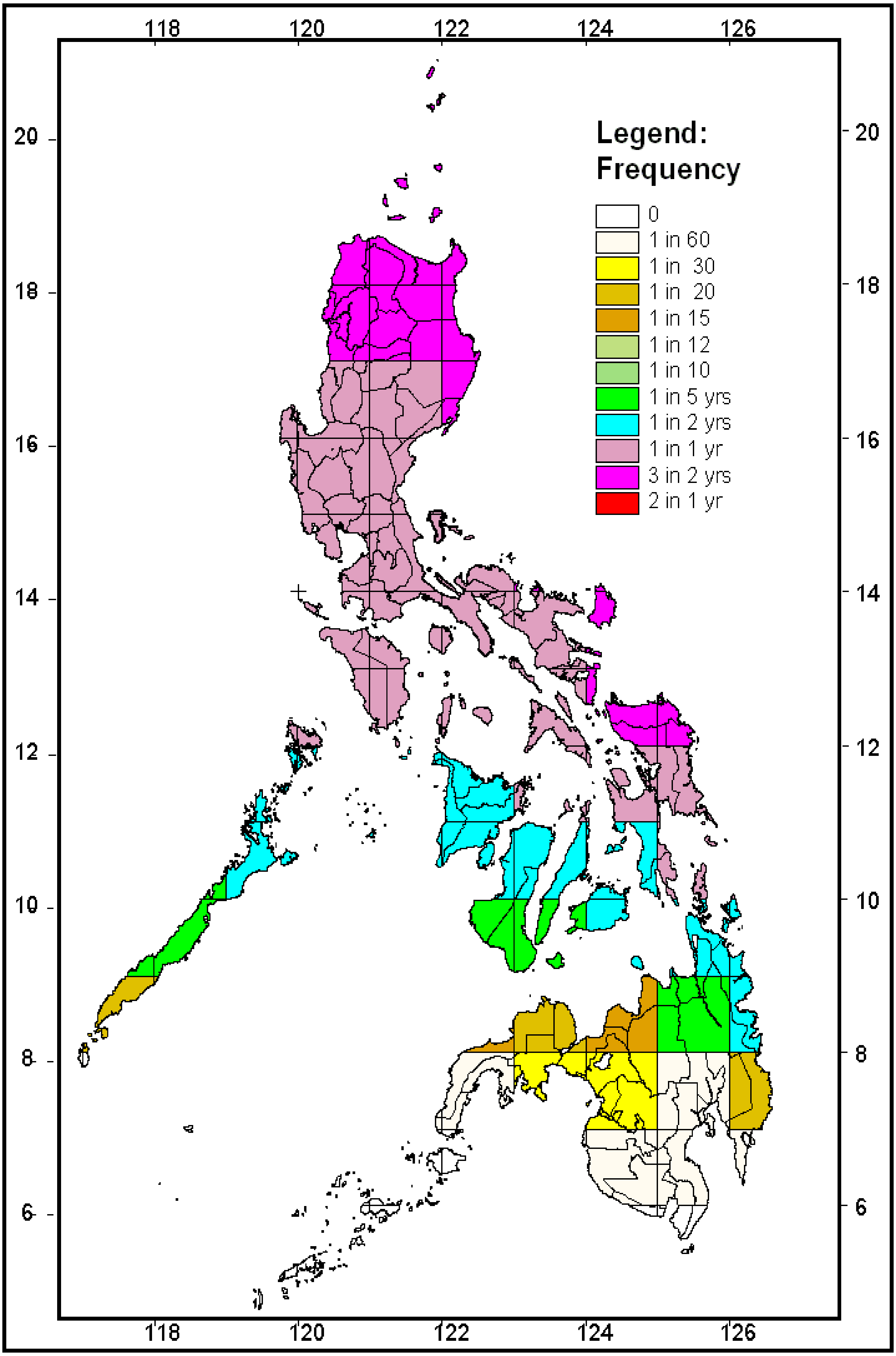


Figure 2.3.6. Cyclone frequency map of the Philippines

Using the aforementioned emission calculation tool or the above formula, it is estimated that the potential CO_2 emission ($CO_{2\text{-}e}$) of the proposed operation within the AMA-IVB-144A per year is **36,272** metric tonnes. This is 6,171 tons higher than the 2016 $CO_{2\text{-}e}$ emission. **Table 2.3.6** shows the estimated $CO_{2\text{-}e}$ for Scope 1 GHG emission of RTNMC while the **Annex 2.3.2** presents the emission calculation tool worksheet.

Table 2.3.6. RTNMC estimates of GHG Emissions (CO_2-e)

Annual Fuel Requirement	Annual Fuel use (L)	CO_2 Emission Factor (kg/L)	CO_2 Emissions, Tons
Existing operation within MPSA (114-98-IV)			
Diesel Fuel Budget	11,110,928	2.6763	29,736
Gasoline Fuel Budget	160,580	2.2715	365
Total for Exsiting operation	11,271,508		30,101
Proposed Fuel Requirement (AMA-IVB-144A)	13,552,796	2.6763	36,272

2.3.1.3 Impact Assessment

The key impacts of the proposed project on the meteorology are presented in **Table 2.3.7.**

Table 2.3.7. Impacts assessment and mitigation for meteorology

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
• **Change in the local climate** The data on climate change projections study for 2020 and 2050 (PAGASA, 2011) are presented in **Tables 2.3.8** to **2.3.10**. The study shows that mean temperature rise by 2020 would be 0.98°C and for 2050 it would be 1.9°C, both compared to baseline of 27.4°C. The proposed project will have no impact on the local climate as the amount of emission from the proposed mining would be insignificant compared to the current greenhouse gas inventory.					• Reforestation programs and progressive rehabilitation of mined out areas will be undertaken in order to offset GHG emissions and alleviate projected increase in ambient temperature. • Monitoring of local weather is already being undertaken and will be improved in order to contribute to the country's overall data on monitoring climate change.
• **Contribution in term of greenhouse gas emissions** The current fuel consumption of the existing operations is at 11,271,508 liters (mostly diesel). The equivalent CO2emissions for this is 30,101 tons CO2-e. The estimated fuel consumption of the proposed project is 13,552,796 liters		✓	✓		• Greenhouse gas emissions, although small, will be monitored in accordance with the GHG Protocol developed by the WRI-WBCSD. • Progressive rehabilitation of mined out areas and enhancement planting of adjacent areas is being undertaken in order to offset GHG emissions arising from the operations of the project. • Included in the enhancement program are areas in the designated buffer zones along the peripheries of roads and mine pits.

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
of diesel per year. With this, the estimated greenhouse gases annually would be around 36,272 tons CO_2-e. Hence, the proposed project would result to minimal change in existing CO_2 emission.					

Table 2.3.8. Seasonal temperature change for 2020 and 2050 in Palawan

Months	OBS (1971-2000)	2020 (2006-2035)		2050 (2036-2065)	
		Change	Projected Value	Change	Projected Value
December-January-February (DJF)	26.9	0.9	27.8	1.8	28.7
March-April-May (MAM)	28.1	1.1	29.2	2.1	30.2
June-July-August (JJA)	27.3	1.0	28.3	2.0	29.3
September-October-November (SON)	27.4	0.9	28.3	1.8	29.2

Table 2.3.9. Seasonal rainfall change for 2020 and 2050 in Palawan

Months	OBS (1971-2000)	2020 (2006-2035)		2050 (2036-2065)	
		Change	Projected Value	Change	Projected Value
December-January-February (DJF)	101.8	15.7	117.78	7.3	109.23
March-April-May (MAM)	189.3	-7.2	175.67	-9.0	172.26
June-July-August (JJA)	781.7	-2.6	761.38	1.0	789.52
September-October-November (SON)	640.6	19.6	766.16	6.9	684.80

Table 2.3.10. Seasonal extreme events for 2020 and 2050 in PP, Palawan

Parameters	OBS (1971-2000)	2020	2050
No. of days with Temp. max >35°C	29	23	297
No. of Dry Days	8348	6457	6455
No. of days with Rainfall >300 mm	2	7	7

2.3.2 Air and Noise

2.3.2.1 Methodology

<u>Ambient Air Quality Sampling</u>

The ambient air quality at the project site was assessed following the DENR Administrative Order (DAO) 2000-81 (Implementing Rules and Regulations of the Philippine Clean Air Act of 1999). The sampling procedures were based on USEPA, 40 CFR Part 50, (*Appendix A, B, and* J) and EMB Air Pollution Monitoring Manual (1994). A 24-hour ambient sampling for analysis of particulate matter (PM10) and gaseous pollutants (NO_2, and SO_2) was done for each sampling station.

The 24-hour ambient air quality sampling was conducted from August 13 to 21, 2015 covering seven (7) sampling stations. **Annex 2.3.3** shows the sampling report. The locations and descriptions of the selected sampling sites are provided in **Table 2.3.11** and **Figure 2.3.7.** Photo-documentation of the sampling is provided in **Annex 2.1.5**.

Table 2.3.11. Air quality sampling stations, August 13 to 21, 2015

Station ID	Geographical Coordinates	Site Description	Conditions during sampling
RTN AQ1	08º 32' 3.02" N 117º 26' 7.88" E	Townsite - Monitoring equipment were set-up in the center of the oval, about 100 meters south of hospital and chapel, about 150 meters east of main gate and north of LSVMS high school, about 100 meters, about 160 meters west of the nearest residential houses.	Fair weather condition with 50 to 75 percent cloud cover and light southeasterly wind. During sampling, there were people playing on the oval ground with grass cover. Pollutants would mostly come from passing vehicles.
RTN AQ2	08º 30' 07.48" N 117º 26' 16.35" E	Pier Stockyard A - Monitoring equipment were set-up inside the compound of fuel depot, about 400 meters northeast of loading area, about 20 meters northwest of diesel depots and about 200 meters from Philippine Navy naval station.	Fair to cloudy weather condition with light southwesterly wind. The possible sources of dust would be the hauling operation from mine site and stockpile to the loading area which is about 500 meters from the sampling point.
RTN AQ3	08º 36' 0.4" N 117º 24' 12.4" E	Sitio Bohoy - Monitoring equipment were set-up in a concrete basketball court about 20 meters east of Bohoy Community Learning Center and about 50 meters from the nearest residential houses.	Fair weather condition. with light easterly wind was prevailing This station is located near the national road and it was in a downwind position during sampling. The possible source of pollutants was from the hauling operation
RTN AQ4	08º 33' 47.3" N 117º 26' 19.5" E	Sitio Tagpisa - Monitoring equipment were set-up in an open area about 50 meters east of national highway and about 50 meters from the nearest residential house.	Station AQ4 was located in a vacant lot. There was no notable activity near the area during sampling. Possible sources of pollutants are from passing vehicles along the national road and from the residential area.
RTN AQ5	08º 33' 15.93" N 117º 25' 26.17" E	Upper Kinurong - Monitoring equipment were set-up in a vacant area, about 5 meters southeast of explosive depot, about 250 meters south of CBNC facility and about 7 kilometers southeast of mine site.	Cloudy weather condition with light to moderate southwesterly wind and with occasional moderated to heavy rain shower; rain usually lasted only 5 minutes or less. The sampling station was upwind of the mine site and CBNC facility during the time of sampling. Possible sources of pollutant would be road dust and company vehicles passing along the sampling station.
RTN AQ6	08º 31' 28.9" N 117º 23' 36.6" E	Barangay Taratak - Monitoring equipment were set-up in an open area east of Taratak Elementary School and covered basketball court, about 75 meters east; about 50 meters south of barangay hall and about 50 meters from the nearest residential house.	Weather was cloudy with light southwesterly wind. Since the location was very far from mining activities, most of the pollutants can be attributed to passing vehicles and residential activities.
RTN AQ7	08º 30' 35.8" N 117º 21' 30.0" E	Barangay Sumbiling - Monitoring equipment were set-up in a concrete parking lot, about 20 meters east of covered basketball court and about 50 meters southwest of Sumbiling Elementary School, the nearest residential houses was about 50 meters.	At Station AQ7, sampling was conducted near the school during fair weather with light southwesterly wind. This station is also far from mining activities thus, most of the pollutants can be attributed to passing vehicles and residential community.

Noise Level Monitoring

A Digital EXTECH 407764 sound meter that meets the American National Standard Institute (ANSI) standard was used in measuring noise level in the air quality sampling points. The arithmetic median of the readings was taken and compared with the National Pollution Control Commission (NPCC-1981) noise standards.

2.3.2.2 Baseline Conditions

Ambient Air Quality

Particulate Matter (Micron 10) and Total Suspended Particulates

The results for the seven (7) sampling stations showed conformity to DAO 2000-81 ambient air quality guideline values for both PM10 and TSP, which are 150 µg/Ncm and 230 µg/NCM, respectively. PM10 values were below the standard and ranged between 0.02-0.06 ug/Ncm. TSP values were also below the limit and ranged from 2.3-10.8 ug/Ncm.

The monitoring results based on the Self-Monitoring Reports (SMR) of RTNMC for the period 2011-2017 for TSP show no exceedance from the 300 ug/Ncm guide value (**Figure 2.3.8**). The highest values were mostly in Station 4, located at the Admin Building facing the crushing plant and occurred between the periods March to June 2011 and October 2012 to June 2013[2]. Succeeding periods after June 2013 however, exhibited lower TSP values in Station 4. **Table 2.3.12** shows the air quality monitoring stations of RTNMC.

Starting 2018, PM10 was required for the monitoring activities of the company. Results are shown in **Table 2.3.13**. For all stations, average was only 0.00055 ug/NCM.

[2] *The Admin Building station (near crushing plant) was a monitoring station of RTNMC for its nickel operation. In July 2013, RTNMC commissioned a third party consultant to conduct Air Quality Dispersion Modeling for the operation of the Crushing Plant and Sun Drying Area. Included in the said report are the recommended locations forAmbient Air stations. The EMB MIMAROPA after their visit advised RTNMC and MMT to adopt the suggested stations as stated in the Air Quality Modeling Report. The Admin site is still within the Plantsite area of RTNMC and with the advent of operation of the UMPI Lime Plant which has crushing operation, transport of materials for CBNC operation, and with the access roads squaring the Admin location; dust dispersed in the area cannot be associated from the operation of the Crushing Plant alone. There are many other contributory factors, activities, and facilities for dust emanation affecting the Admin Area and other locations. Hence, the transfer of monitoring station was adopted. Station 4 which was located at the Admin Building (near crushing plant) was relocated to the Magazine Area.*

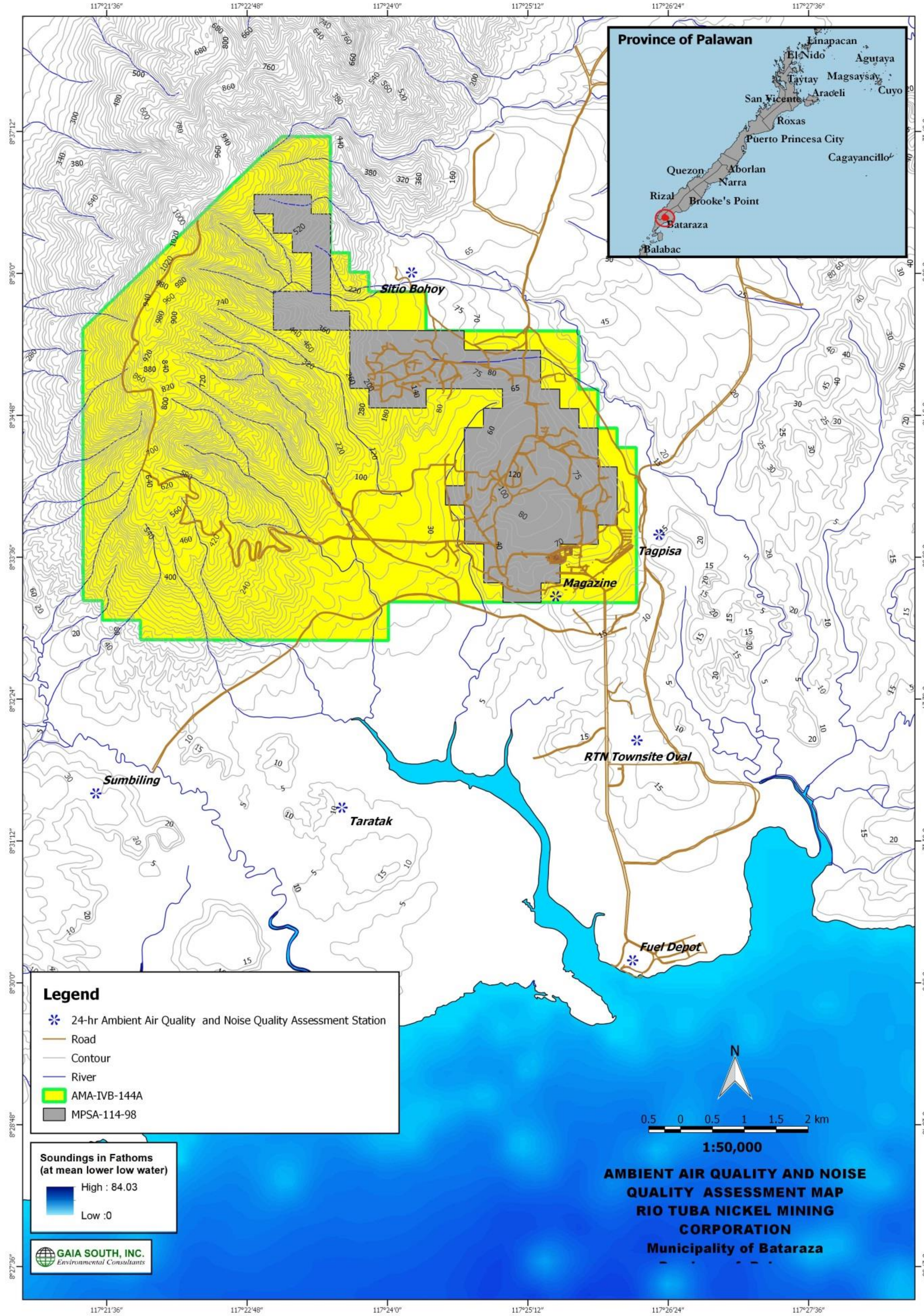


Figure 2.3.7 Ambient air quality and noise level sampling station for the proposed Rio Tuba Nickel Mining Project

Table 2.3.12. Air quality monitoring stations of RTNMC

Station No.	Location 2011- 1Q 2014	Location 2Q 2014-2015
Station 1	Pier Stockyard A	Pier Stockyard A
Station 2	Macadam Road	RTN Townsite Oval
Station 3	Minesite Gate	(removed)
Station 4	Admin Building Facing Crushing Plant	Magazine Area
Station 5	RTN Townsite Oval	Tagpisa

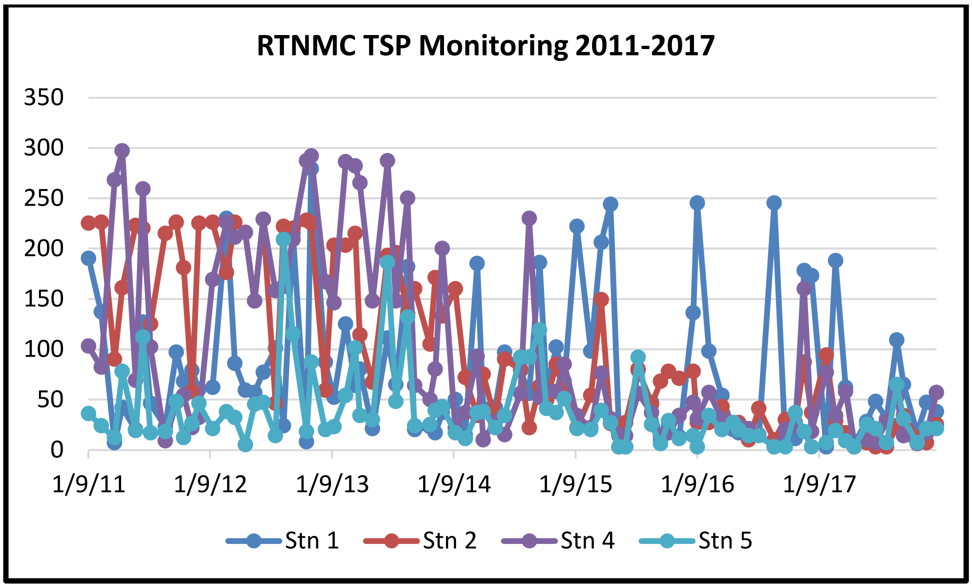


Figure 2.3.8 Monitoring trend of TSP from 2011 to 2017

Table 2.3.13. PM-10 monitoring of RTNMC for 2018

Date	Stn 1	Stn 2	Stn 4	Stn 5
1/31/18	0.0001	0.0001	0.0001	0.00016
2/19/18	0.0001	0.0001	0.00031	0.00016
3/20/18	0.00041	0.0001	0.001	0.00016
4/27/18	0.0001	0.0001	0.00021	0.00097
5/18/18	0.00042	0.00021	0.0001	0.00146
6/25/18	0.00021	0.0001	0.00021	0.00065
7/30/18	0.00021	0.0001	0.00021	0.00065
8/25/18	0.0001	0.00011	0.00031	0.0097
9/28/18	0.00031	0.0001	0.00021	0.00081
10/16/18	0.0004	0.0002	0.0003	0.0006

Sulfur Dioxide and Nitrogen Dioxide

Baseline SO_2 results for all sites were below the DENR standard for ambient air of 180 ug/Ncm (**Table 2.3.14**). The values ranged from 0.49 to 4.74 ug/Ncm. Similarly, NO_2 values were all below the ambient air quality guide value of 150 ug/Ncm, ranging from 3.14 to 5.53 µg/Ncm. These are comparable to the 2010 ambient air quality sampling (**Table 2.3.15**).

Table 2.3.14 shows the results of the ambient air quality sampling.

Table 2.3.14. Result of ambient air quality sampling Rio Tuba

Station	Location	Date of Sampling	PM_{10}, µg/Ncm	TSP ug/Ncm	SO_2 µg/Ncm	NO_2, µg/Ncm
RTN AQ-1	Town Site	August 15, 2015	0.04	10.8	4.74	5.53
RTN AQ-2	Pier Stockyard A	August 13, 2015	0.06	6.0	4.20	4.26
RTN AQ-3	Sitio Bohoy	August 17, 2015	0.02	4.1	4.23	3.70
RTN AQ-4	Sitio Tagpisa	August 16, 2015	0.04	2.3	0.49	3.14

Station	Location	Date of Sampling	PM_{10}, μg/Ncm	TSP ug/Ncm	SO_2 μg/Ncm	NO_2, μg/Ncm
RTN AQ-5	Upper Kinurong	August 20, 2015	0.05	6.9	3.86	3.70
RTN AQ-6	Barangay Taratak	August 18, 2015	0.04	2.3	3.52	3.44
RTN AQ-7	Barangay Sumbiling	August 19, 2015	0.04	1.8	3.41	3.39
DENR National Ambient Air Quality Guideline Value (NAAQGV)			150	230	180	150

Table 2.3.15. Result of 2010 ambient air quality sampling Rio Tuba

Station	Time of Sampling	Wind Direction	NO_2 (μg/Ncm)	SO_2 (μg/Ncm)	TSP (μg/Ncm)	Noise (dBa) (residential)
A	9:40 – 10:40	SW	4.0	3.6	90.9	45 - 85
B	13:05 – 14:05	NW	1.5	<3	99.4	43 – 83
C	15:00 – 16:00	NW	1.8	<3	25.2	40 – 63
D	09:25 – 10:25	W	1.5	<3	30.3	38 – 85
DENR Standard			260	340	300	45 - 55

Source: Rio Tuba Nickel Mining Project, EIS 2010.

Noise Level

Twenty-four hour noise readings were measured for these sites. Results were compared with the DENR standard for Class C areas. Class C is primarily zoned or used as a light industrial area.

The noise levels are presented in **Table 2.3.16**. The Philippine Ambient Noise Standard for the different DENR class is shown in **Table 2.3.17.**

The data shows that average morning values for all sites would be 60.8, daytime would be 60, evening at 62.6, and nighttime at 60.6. This would indicate that the area generally falls under Class C noise category which is designated for light industrial area. Even for this category, though, sites such as AQ2 (pier), AQ3 and 4 which are roadside areas, exceed the nighttime noise standards.

Table 2.3.16. Ambient Noise Levels, dBA

Station ID		Morning (db)	Daytime (dB)	Evening (dB)	Nighttime (dB)
RTN AQ1	Min	57.7	58.4	57.3	51.6
	Max	64.1	63.9	67.4	59.5
	Ave	60.9	61.1	62.2	55.6
RTN AQ2	Min	58.7	55.9	58.2	58.3
	Max	62.5	63.1	66.6	64.2
	Ave	60.6	59.5	62.4	61.3
RTN AQ3	Min	64.5	62.2	63.4	65.2
	Max	68.9	66.0	69.3	68.3
	Ave	66.7	64.1	66.3	66.8
RTN AQ4	Min	62.0	55.3	61.1	59.3
	Max	65.3	57.0	65.9	70.9
	Ave	63.7	56.1	63.5	65.1
RTN AQ5	Min	57.7	58.6	59.1	58.4
	Max	60.4	60.6	61.9	59.6
	Ave	59.1	59.6	60.5	59
RTN AQ6	Min	52.7	54.4	63.6	52.9
	Max	56.0	60.5	66.1	65.2
	Ave	54.4	57.4	64.9	59.1
RTN AQ7	Min	57.2	56.6	55.5	57.6
	Max	64.2	66.9	61.6	57.3
	Ave	60.7	61.8	58.6	57.5
Average for all sites		60.8	59.9	62.6	60.6

Station ID	Morning (db)	Daytime (dB)	Evening (dB)	Nighttime (dB)
DENR Standard (Class C)	70	75	70	60

Table 2.3.17. Philippine Ambient Noise Standards

Category[1]	Maximum Allowable Noise (dBA) by Time Periods[2]		
	Daytime	Morning/Evening	Nighttime
AA	50	45	40
A	55	50	45
B	65	60	55
C	70	65	60
D	75	70	65

*Note: [1]**Class AA** - a section of contiguous area, which requires quietness, such as areas within 100 meters from school sites, nursery schools, hospitals and special houses for the aged; **Class A**- a section of contiguous area, which is primarily used for residential areas; **Class B** – a section or contiguous area, which is primarily a commercial area; **Class C** – a section primarily zoned or used as a light industrial area and **Class D** – a section, which is primarily reserved, zoned or used as a heavy industrial area. [2]**Morning** - 5:00 A.M. to 9:00 AM; **Daytime** - 9:00 A.M. to 6:00 P.M; **Evening** - 6:00 P.M. to 10:00 P.M.; **Nighttime** - 10:00 P.M. to 5:00 A.M.*

The monitoring stations of RTNMC for noise level are as follows:

Station 1 – Front of Omar Residence
Station 2 – Front of Valdeztamon Residence
Station 3 – Front of Sto. Nino Chapel (Near Hulguin Residence)
Station 4 – Oval (Near Townsite Gate 2)
Station 5 – Pier Jetty Area

Background noise readings ranged from a minimum of 54 dB to a maximum of 87 dB. Average noise level in the areas sampled is 75.4. These readings were above the daytime DENR standard of 70 dB for Class C areas. Of the 276 measurements reported, 210 exceeded 70 dB (76%). Noise in the area was mainly contributed by working people, playing children, domestic activities, RTNMC and CBNC operations and noise from vehicular engines. While the levels are not high enough to cause permanent damage, residents living near busy thoroughfares may need to install sound barriers or walls to reduce noise as it is virtually impossible to totally eliminate it.

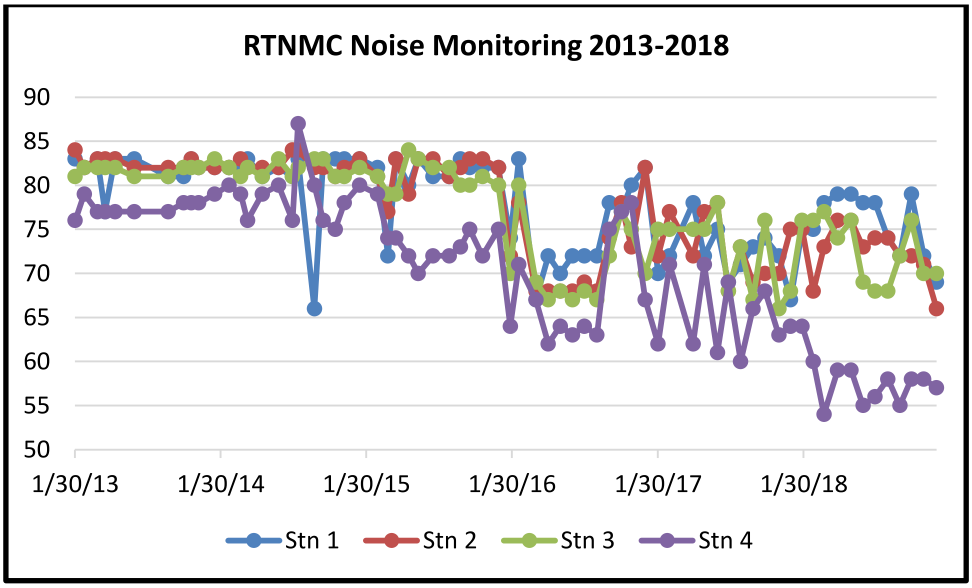


Figure 2.3.9. Noise level monitoring from 2013 to 2018

Table 2.3.18. Statistical calculations of the noise level monitoring data

Parameter	Value
Count	276
Average	75.4
Standard deviation	7.0
Minimum value	54
Maximum value	87
Mode	82
Median	77
Count>70	210

2.3.2.3 Impact Assessment

The key impacts of the proposed project on the air quality are presented in **Table 2.3.19**.

Table 2.3.19. Impacts assessment and mitigation for air and noise

<table>
<tr><th rowspan="2">List of Key Impacts</th><th colspan="4">Phase Occurrence</th><th rowspan="2">Options for Prevention or Mitigation or Enhancement</th></tr>
<tr><th>Pre-Construction</th><th>Construction</th><th>Operation</th><th>Abandonment</th></tr>
<tr><td>• Degradation of air quality

The project's impact on air quality will be mainly dust generation and to a lesser extent, an increase in SO_x and NO_x concentrations resulting from genset operations and increased vehicular activity during the construction and operations phase.

Loss of vegetation in newly opened sites will contribute to increased dust emission.

The mining operation, stockpiling of soil materials and ores, and hauling of these materials will also generate dust.</td><td></td><td>✓</td><td>✓</td><td></td><td>The following measures are currently being implemented and will be maintained to reduce dust generation:
• Regular water sprinkling along haul roads and more frequent during dry and windy days;
• Maintenance of the concreted Macadam Road including regular removal of deposited soil materials;
• Imposing speed limit of vehicles, hauling trucks and other heavy equipment;
• Installation of tire-washing platform at entrance of Macadam Road;
• Use of tarpaulin covers on hauling trucks;
• Installation of chutes, wind breaker and dust collector boxes for the mining operations; and
• Covering the ore stockpiles also helps minimize dust generation.

RTNMC has installed accordion chutes in the screening and crushing plant to contain dust particles. Windbreakers and dust collector boxes are also installed at strategic locations around the crushing plant.

Progressive rehabilitation will be implemented to bring back the natural vegetation of mined out pits as the mining operations progress to new locations. Through progressive rehabilitation, soil erosion and siltation is diminished which can contribute in reducing dust generation.

Increased vehicle movement may also generate additional SO_x, NO_x, and VOCs from vehicle emissions. Construction activities use a wide range of mobile equipment, such as bulldozers, graders, dump trucks, pavers, excavators, and bobcats. The engine exhaust from these vehicles, especially from those operating on diesel fuel, represent a source of particulate and other emissions (e.g., SO_2, NO_x, VOC, CO) from the construction site.</td></tr>
</table>

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
					Regular maintenance of the engines of vehicle and equipment engines should be conducted to reduce exhaust emissions of CO, VOCs, and PM. Equipment and vehicle that is in good condition will also reduce fuel consumption. • During operation of the gensets, the potential emissions are NO_x, SO_x and particulate matter. The gensets shall use low sulfur and non-lead containing fuel. The regular emissions monitoring of the gensets indicate compliance with NESSAP guidelines.
• **Increase in ambient noise level** As a result of vehicle movement and mining operations, ambient noise levels are expected to increase. To date, the noise levels are already that of Class C (light industry).		✓	✓		This impact can be minimized by using properly maintained heavy equipment with installed mufflers. Maintaining the vegetation (i.e., 'buffer zones') near the mining areas and along access/haul roads will serve as a noise barrier. Workers exposed to increased noise levels shall use appropriate PPEs while at work.

2.4 The People

2.4.1 Socio Economics

2.4.1.1 Methodology

The baseline data were sourced from the barangay profiles provided by each barangay and the profile of Bataraza was provided by the Municipal Planning and Development Office (MPDO).

A perception survey (**Annex 2.4.1**), Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs) were conducted for the direct impact barangays - Rio Tuba, Ocayan, Taratak and the indirect impact barangays - Sumbiling, Igang-igang, Sarong, Culandanum, Tarusan, Sandoval and Iwahig (**Annex 2.4.2 Spot Maps of the Direct Impact Areas and Indirect Impact Areas**). A total of 370 respondents for the perception survey were randomly selected from the DIA while 171 respondents were derived from the IIA (**Table 2.4.1**)

Table 2.4.1. Sample size used in the household survey conducted for the direct and indirect impact barangays

	Direct Impact	Indirect Impact	Combined Areas
sample size	370	171	541

The sample sizes for the household survey were determined with consideration of the household population size, the level of confidence of 95% and margin of error of + or – 5% - 7.5%. A total combined sample size of five hundred forty-one (541) respondents was surveyed.

Using the 2010 NSO population data and 2.66% annual growth rate of Palawan a projected population for 2015 was derived. The derived figure was then divided by 4.6 persons per HH which is the average household size per household in Palawan. The derived figure corresponds to the population used in the computation of the sample size. Sample size was computed with a 95% confidence level plus or minus 5% margin of error (MOE) for direct impact barangays and 7.5% MOE for indirect impact barangays.
The formula used was: $n= N/(1+Ne^2)$

where :
n=sample size
N= number of households
e=margin for error at + or - 5% margin of error for DIA, 7.5% for IIA
confidence level, 95%

2.4.1.2 Baseline Conditions

History of Bataraza

Sultan Haron Narrazid, the great negotiator and one of the signatories of the Treaty of 1878 pledging peace and loyalty of the Sultanate of Sulu to Spain, left Sulu and settled in Palawan, where the Spanish Government entrusted him the rule of the Muslim population of Balabac, and the neighboring southern islands. This Sultan established the main settlement at Bono-Bono. Several settlements were put up from Abo-Abo, the first barangay of Brooke's Point (now Municipality of Española) from the north, to the west coast up to Alfonso Hill (Quezon). Sultan Haron brought with him his family, his favorite sons, Datu Bataraza and Datu Jolkiple, who were in their teens when they settled in Bono-Bono. Because of his kindness, understanding and sympathy over the welfare of the native Palawanos, his rule in a nutshell was very successful one. He died and was buried in Bono-Bono where his tomb serves as a landmark in the said place.

Datu Bataraza Narrazid being the eldest ruled over the area. Like his father, he ruled with prudence and tact and continued the program of government of his great father. When the Americans took over the country, Datu Bataraza's authority over his subjects was fully recognized and respected by the American Government. He became a good and trusted friend of Governor Edward Miller. Because of the great trust and confidence of the Governor, Datu Bataraza was appointed Deputy Governor and given the title Superior Datu of the Muslim population. The Governor set the boundary of his territory from Barangay Salogon, Brookes Point down south. A monument was erected in Barangay Salogon to serve as landmark of the decree signed by the Governor himself.

Datu Bataraza married Diumatria and was blessed with three sons, Sapiodin, Tahang and Anzaruddin. Datu Sapiodin grew to be the most outstanding among the three brothers. Leadership runs in their blood. Datu Sapiodin Narrazid was elected as Mayor of Brooke's Point and served for three consecutive terms.

Until January 1, 1964, by virtue of Republic Act No. 3425 authored by then Congressman Gaudencio Abordo mandating the division of Brooke's Point into two distinct municipalities, the northern portion remained the municipality of Brooke's Point and the southern part was named the Municipality of Bataraza, in honor of the late Datu Bataraza Narrazid. By popular mandate, Datu Sapiodin became the first mayor of Bataraza.

The seat of government was put up in Tarusan, which was at that time strategically located in relation to the center of population, had proved very accessible to the greater bulk of the population. Datu Sapiodin strongly endorsed a resolution that all barangays south of Malis River will comprise the Municipality of Bataraza and that the seat of government shall be at Barangay Tarusan.

In 1967, Datu Jolkiple, the younger brother of Datu Bataraza and Uncle of Mayor Sapiodin was given also the authority to rule the Municipality of Bataraza. Under the administration of Datu Jolkiple, a massive socio-economic program was launched. Education was endorsed and he encouraged all parents to send their children to school.

The 1971 election ended the rule of the Narrazid in Bataraza and Hadjes P. Asgali, Sr. reigned. The major changes that the new mayor instituted was the return of the seat of government to Marangas, which until the present time remain in the Poblacion. He was also remembered for his decisive action in rejecting the Cojuangco estate to occupy Bataraza and for his fearless crusade against military abuses.

Demography

In the 2010 Census of Population and Housing released by NSO, the total population of Bataraza was 63,644. The barangay with the highest population based on the 2008 CBMS survey, results show that the municipality of Bataraza registered a total population of 41,479 and with a total household population of 7,561. Female population dominated the area with 22,568 while the male population totaled only 18,479. The average family size was 5.4 persons per household.

The barangays with the lowest population size were Barangays Tagnato and Tagolango with 522 and 538, respectively.

Table 2.4.2. Total Population by Barangay, 2010

Barangay	Total Population
Bono-bono	2,673
Bulalacao	1,809
Buliluyan	1,388
Culandanum	3,839
Igang-igang	1,404
Inogbong	3,111
Iwahig	1,787
Malihud	1,966
Malitub	622
Marangas(pob)	7,613
Ocayan	2,016
Puring	1,143
Rio tuba	16,577
Sandoval	3,044
Sapa	1,454
Sarong	1,461
Sumbiling	2,670
Tabud	962
Tagnato	893
Tagolango	940

Barangay	Total Population
Taratak	1,501
Tausan	4,731
Total	63,644

Source: NSO Census of Population and Housing, 2010

Table 2.4.3. Number of Households, Total Population by Barangay, 2008

Barangay	No. of Households	Total Population	Male	Female
Bono-bono	508	2,312	1,164	1,148
Bulalacao	270	1,165	586	579
Buliluyan	241	1,067	531	536
Culandanum	651	2,855	1,448	1,407
Igang-igang	258	1,143	590	553
Inogbong	435	1,966	1,027	939
Iwahig	330	1,542	789	753
Malihud	212	1,352	724	628
Malitub	130	544	286	258
Marangas(pob)	1,086	5,299	2,660	2,639
Ocayan	294	1,252	646	606
Puring	218	1,015	549	466
Rio tuba	826	8,461	1,832	6,629
Sandoval	238	1,183	606	577
Sapa	134	611	309	302
Sarong	416	1,868	979	889
Sumbiling	300	1,361	704	657
Tabud	170	761	372	389
Tagnato	126	522	264	258
Tagolango	124	538	277	261
Taratak	373	1,759	916	843
Tausan	268	2,471	1,220	1,251
Total	**7,561**	**41,047**	**18,479**	**22,568**

Income

Households with Income Below Poverty Level

Out of the 7,561 total households, 3,940 or 52.11% were categorized as with income below poverty threshold. This 2008 proportion rate was significantly lower than the 2006 proportion rate of 69.41%.

Households with Income Below Food Threshold

The total number of households with income below food threshold decreased to 39.21% in year 2008 as compared to the 2006 result of 53.34%.

Based on the CBMS survey results, Barangay Malihud posted the biggest number of households below food threshold with 89.15% followed by Barangay Tarusan with 89.04%. With only 1.93%, Barangay Rio Tuba had the lowest proportion rate of households with income below food threshold.

Water and Sanitation

Households with Access to Safe Water

Based on the data gathered during the 2008 CBMS survey 55.92% of the total households in Bataraza have access to safe water supply. This is slightly higher as compared to the 2006 CBMS result of 55.38%.

Households using safe water supply are predominant in Barangays Tarusan and Sumbiling with both recorded a 100% proportion rate. Households using unsafe water can be found in the Barangays of Puring and Malitub.

Households with Access to Sanitary Toilets

The data gathered during the 2008 CBMS survey showed that the proportion of households equipped with sanitary toilets decreased to 35.16% as compared to the 2006 rate of 51.54%. The highest numbers of households utilizing sanitary toilets were found in Barangay of Rio Tuba with 73.55% followed by Barangay Marangas with 62.25%, while on the other hand all households in Barangays Buliluyan and Malitub had no access to sanitary toilets.

Education

The 2008 CBMS results showed that the basic literacy rate of persons with ages 10 years old and above in the municipality was 79.34%. This 2008 result was slightly lower than the 2006 basic literacy rate of 82.24%.

At the barangay level, Barangay Marangas recorded the highest number of persons with ages 10 years old and above who were able to read and write with a proportion rate of 94.18% followed by Barangay Buliluyan with 93.77% while Barangay Inogbong posted the lowest literacy rate of 30.57%.

Elementary Education

At the elementary level enrollment participation rate of children with ages 6-12 years old during the 2008-2009 school year was 70.46%. This 2008 participation rate decreased by 3.4% as compared to the 2006 elementary participation rate of 73.50%.

Secondary Education

Out of 3,210 children with ages ranging from 13-16 years old, only 1,767 were enrolled during the school year 2008-2009. This figure (1,767) only constitutes 55.05% secondary school participation rate.

Employment

Employment rate in the municipality stood at 91.69% or 8,419 employed individuals from its labor force population of 9,182. This 2008 proportion rate was slightly lower as compared to the 2006 employment rate of 92.38%.

Infrastructure and Utilities

Roads and Bridges

A national highway connects the Municipality of Bataraza to the Provincial Capital. An all-weather gravel road stretches from Buligay Bridge (Brooke's Point) to Barangay Tagnato, Bataraza. Presently, the improvement of the pilot road is being undertaken. If completed, this will connect Barangay Puring and Buliluyan to the all-weather road leaving two more barangays to be connected by a road network -Barangay Tabud and Barangay Tagolango. However, these two (2) remaining barangays are accessible by trail from Barangay Puring and Malitub or by pump boat from Barangay Rio Tuba or other barangay.

Transportation

Public utility vehicle (jeeps, buses and shuttle vans) ply the routes of Rio Tuba-Bataraza – Puerto Princesa City and vice-versa daily. Tricycles also serve some barangays while other barangays use pump boats and motor boats as means of transportation.

Power

The Palawan Electric Cooperative (PALECO), operating 24 hours is the major distributor of energy in the area. It serves 1,055 households in three (3) barangays.

Communication Services

Two telecommunication companies provide communication network in Bataraza: the SMART Communication and GLOBE Communication companies.

Households in Makeshift Housing

Based on the 2008 CBMS survey results, out of the total 7,561 households only 103 or 35.15% were living in makeshift housing condition.

Tourism

Malihud Falls

Malihud falls is made up of a series of falls emanating from the very source of the Bulalacao River. The main falls is located at the very source of the river that it could not be reached by foot due to some impassable steep ravines and fully forested area.

The most frequented area is the KAPANGYAN FALLS, which could be reached by foot from the national highway traversing Barangay Malihud to Barangay Rio Tuba. It will take at least one and a half hours to reach the Kapangyan Falls through a winding trail of greenery and forest trees.

Gangub Cave

Gangub Cave is located at Barangay Sandoval, 20 km from the Poblacion. It could be reached by bus or jeep. It is accessible by foot from the provincial road traversing Sandoval to Barangay Iwahig for about 15 minutes at a slow pace.

From a distance, the cave resembles a ten–story building with an imposing height of more or less 100 ft. from the base. The base is firmly anchored on a rock having an estimated area of at least 50,000 m^2. The main entrance has an elevation of at least 39 ft., which requires one climber to ascend with greater effort and stamina. Upon reaching the entrance, one will be awed by its wonderfully and architecturally designed facade resembling that of a stately cathedral in the city. As you enter, you are welcomed by enticing sounds emanating from the multi-colored dome of the cave created by millions of bats that inhabit the cave. One will notice that the floor of the cave is carpeted with guano that from time to time is being utilized/excavated for agricultural purposes.

Ursula Island Game Refuge and Bird Sanctuary

Ursula Island was declared as Palawan's Game Refuge and Bird Sanctuary through Presidential Proclamation No. 14 on July 30, 1960. This 17-hectare oval-shaped island is located southwest of Sulu Sea. It is 10 nautical miles southeast of Rio Tuba. On the southern side of the island lies a wide coral reef covering an even larger area than the island itself.

The island is haven to over 1,500 birds that cluster two hours before sunset as they roost back to their places among the island trees. The scenery is a delightful sight for tourists and sports divers enjoying the beautiful coral line and marine vegetation surrounding the island.

A. Barangay Profiles – Direct Impact Barangays

1. Barangay Rio Tuba

The data provided in this section were sourced from the State of Barangay Governance Report of 2014.

General information

Barangay Rio Tuba is around 39.7 km way from the Central Poblacion of Bataraza. Rio Tuba has a total land area of 16,635.887 hectares.

The barangay is basically industrial. Of the total land area, 5000 ha were classified as industrial of which 100 hectares were planted with coconut trees, 80 hectares of forest area and 50 hectares were considered as idle land based 2014 barangay profile.

Its development thrusts had been in recreation, communication, legal, medical, tailoring and dress shop, beauty parlor, barber shops, gasoline stations, restaurants, lodging, etc. Manufacturing establishments found in the barangay like bakeries, hollow block-making and furniture were found to be thriving.

Demography

Population

The population of Rio Tuba in 2004 was shown to be at 8,695, while 2014 data show that it increased to 20,071. This is higher than the 2013 survey of 17,689. The average percentage increase in household population for 2013 and 2014 is 10.9% and 10.93% while if this is divided for two (2) years, the average yearly percentage is 4.25% and 5.76%, respectively.

Household accounts show that out of 4,544 households in 2013 Household Actual Survey (HHAS) it has increased by 372 with a total of 4,196 in this year 2014 survey. This represents 7.21% increase for one (1) year after census was previously conducted.

Age distribution

Based on the 2003 CBMS data, the broad age distribution of the population showed that 53.33% of the population was within the working age range.

Dependency ratio was approximately 1 worker: 2.01 dependents with about 80% of the labor force being male and 63% of the dependents being female.

Sex Distribution

There were more males than females and the ratio was 51:49.

Marital Status

The population was a healthy mix of people with various marital statuses. The population was predominantly classified as single being composed of young people still in school age.

Religion

The predominant religion was Roman Catholic closely followed by Islam. This is due to the ethnic background of the settlers in the area from Luzon and from the Sulu group of islands. Records showed that 45% of the population in Rio Tuba was Roman Catholic, 23% Islam, 17% Protestants, 10% Iglesia ni Cristo and 5% practicing beliefs of indigenous tribes.

Ethnicity

The predominant ethnicity and dialect spoken by the people in the area was Tagalog with more than half of the population being Tagalog speakers.

Education

Educational facilities for pre-school, elementary and high school were present in the barangay. Tertiary and vocational schools did not exist. The nearest tertiary level school is in Brooke's Point about 70 km away from the barangay.

Preference for enrolment is more for public schools due to the affordability and accessibility of the public schools. This was true for the educational levels for pre-school to age 24.

Non-formal education was also provided to indigenous communities through the Indigenous Learning System (ILS) by the two (2) companies. There was also an Alternative Learning System in Barangay Rio Tuba that catered to the out of school youth sponsored by the two (2) mining companies.

Housing

Housing was relatively stable in the barangay with about 84% having their own house and lot or having their own house on a free lot with the consent of the owner. The RTNMC has also provided housing for their employees complete with utilities and facilities.

Infrastructure and Utilities

Access to potable water

Water sources tapped was mostly artesian and deep well which produced reasonably potable water. The level of technology being applied has improved in the recent years which came with the introduction of commercial water refilling stations and provision of the RTNMC of potable water.

Water services to some sitios of the barangay come from the water services of RTNMC and CBNC, while in the other sitios, the source of water are from deep wells.

Barangay Rio Tuba has relied mainly on surface water (river and lakes) and ground water pumped from wells for drinking water. Drinking water was obtained through Pilipinas Water Resources Incorporated (PWRI).

Source of lighting

The Power Source Philippines through the Barangay Power Association (BAPA) primarily supplies the power needs of Barangay Rio Tuba. The total number of households served by BAPA gradually increased from 2013 to 2014 due to the increase in population according to the latest survey. Households without access to electricity utilized kerosene for lighting and cooking.

Sports and recreational facilities

The barangay has a basketball court with a stage used for various purposes. Other sports facilities present are the privately owned billiards hall and the public plaza in front of the barangay hall where games can be played.

Roads and bridges

There is a concrete road 500 meters long in fair condition while there is an earth surface road maintained by RTNMC.

Means of transportation

Barangay Rio Tuba is accessible to all kinds of land and sea transportation. There are 14 buses, 25 vans plying to Puerto Princesa City and vice versa. There are also 12 jeepneys and five (5) buses plying everyday from Rio Tuba to Brookes Point and vice versa.

The sea port in the barangay accommodates cargo vessels from Japan and other countries.

Means of communication

The barangay has cellular services from Globe Telecom and Smart Telecom. Both companies have a cell site in the barangay since November 2003. Aside from these, the barangay also operates a post office and has radio communications technology.

The headway Cable station has been the popular source of information and entertainment for the people of Rio Tuba.

The Brigada News FM 94.5 is the radio station in the barangay. It serves as the source of information and news coming from the main radio station in Puerto Princesa City.

Private courier services such as JRS and 2GO with offices deliver domestic and overseas letters, cargoes and packages.

Smart Bro/ Globe Tattoo also make internet services possible.

Peace and order

The peace and order in the barangay is uncontrollable even if there is a Police Station present in the barangay. There still exist criminal cases that remain unsolved.

Cultural data

Barangay Rio Tuba is said to be a melting pot of different tribes and cultures. Many people coming from other provinces migrate and look for a job in the barangay. The two (2) companies present in the barangay are the reasons why different people tended to congregate in the place.

The ethnicity is diverse in the barangay. The different ethnic groups found to be present in the barangay were Tagalogs, Cebuano, Tausug, Manaranao, Mapun, Ilonggo, Cuyunun, Ilocano, Pangutaran, Bicolano, Palaw'an, and Boholano.

Economic data

State of Income

Income per capita is high. Poverty incidence is low. Magnitude of families living below poverty threshold is low.

Labor force/employment

Age range analysis showed that about 60% of the population was within the working age range of 15 to 64 years old denoting a high level of potential labor force.

Nature of Occupation

The profile of occupation showed a high percentage of permanent employment in the private sector. Owning a business can also be interpreted as self-employed which is applicable to farm owners and other occupations.

The good economic condition in the barangay paved the way for better or improved standard of living in the area. Establishment of livelihood programs created opportunities for economic development. Other forms of business also contributed to the economic growth in the barangay.

Rio Tuba is known for its nickel mineral reserves. Nickel mining is a very important industry in the locality. The RTNMC mine site is located within its jurisdiction. In addition to the mine site, a $180 million mineral processing plant is being operated by CBNC within the barangay. The plant was designed to extract nickel from low grade ore previously considered as waste.

Commercial enterprises are thriving. There are many medium sized stores, mostly located in barangay proper. The service sector is also growing with the rise of many commercial establishments. The barangay produces good quality nickel and cobalt.

Commerce and Industry

Trade and commerce has been gradually escalating around Rio Tuba and the barangay is being considered as an important hub of commercial and other socio-economic activities. Several agricultural trading establishments, financing institutions and motorcycle outlets have been put up in the barangay which has encouraged the growth of small and medium enterprises from a small store beside the house to a mobile food stall installed on a bicycle sidecar.

In the same way, the barangay has become the drop-off point of various fruits and vegetables, livestock, household goods, local handicraft and native delicacies coming from the neighboring barangays during “Tabuan” which is every Saturday in sitio Marabahay and barangay proper on Sunday. Traders would come to the barangay to buy goods and sell these to their barangays. Business is usual during week days. The presence of the different panels loaded by groceries and other products give trading industry more productive to the barangay. The sea port is accessible to all kinds of sea transportation to ship products from Balabac and Mangsee.

The public market is located at Sitio Kayasyasan which is the center of commercial activities in the barangay. Business establishments inside the public market are of different categories like grocery stores, rice stores, and others.

Major establishments

Residents are engaged in agriculture, fishing and livestock raising. At least six (6) financing institutions were present in the area in 2003. The barangay also has an airport and a sea port. The wharf has a capability to accommodate cargo ships.

Through RTNMC, Rio Tuba is known for its pro-responsible mining advocacy and as one of Palawan’s major contributors in propelling the national economy. The municipality also hosts the HPP project operated by CBNC. The plant was constructed in 2003 and was commissioned in the middle of 2005.

2. Barangay Ocayan

The data provided in this section were based on the 2007 Barangay Profile of Barangay Ocayan.

General information

Barangay Ocayan is considered a rural barangay with a total land area of 1,803.5 hectares. Its land use is generally agricultural with negligible portions of residential, forest and idle land.

Demography

Population distribution

Based on the 2007 NSO Census of Population declared in the Barangay Profile of Barangay Ocayan, the total population was 1,780 with 846 males and 936 females. Around 26.23% of the population was classified as adults (ages 18-35 years) followed by children (18.65%) belonging to age class 6-12 years old. A considerable portion, 17.47% accounted for children 0-5 years old while children 13-17 years old made up 11.40% of the populace. Adults 36-50 years old comprised 15.73% of the population while only 6.23% were adults classified under 51-65 years old. Only 3.70% made up the more than 66 years old age group.

In 2007, there were 308 households with an average of 6 persons per household.

Religious affiliation

Majority of the residents in barangay Ocayan were Roman Catholics (52.92%) while 32.47% practiced the Palaw'an religion. Islam was the religion 10.5% believed in. The other religious affiliations for the rest of the members of the community were Iglesia ni Cristo, Seventh Day Adventist, and Christian Fellowship.

Language/dialects predominantly spoken

The prevalent dialect spoken in the barangay as declared in the Barangay Profile was Ilonggo at 38.31%, followed by Palaw'an, 32.46%. There was also 17.21% of the resident who spoke Tagalog while 9.09% communicated in Mapun. Cebuano was spoken by 2.92% of the community.

Education

Number of school buildings

The barangay has five (5) pre-school/day care centers, five (5) public elementary schools and one (1) private preschool facility.

Educational background of residents

The residents of Barangay Ocayan generally were able to attend primary or elementary level. There were also 238 who had pre-school education. There were eight (8) who reached and graduated from college while two (2) were able to pursue post graduate studies.

Housing materials

Very few of Barangay Ocayan residents occupied houses made of permanent structures (4.87%). On the other hand, majority of its members dwell in temporary abodes made of bamboo, sawali and nipa/cogon (82.14%) while 12.98% reside in semi-permanent structures made of wood and GI sheets.

Infrastructure, Transport Facilities and Services

Roads

Roads in the barangay were reported to be either gravel or earth filled. The most common means of transportation was through public utility bus, jeeps, tricycle and skylab.

Access to potable water

Potable water from pipes and tubes were limited to only 7.07% of its residents having access. There was 26% that had deep wells as the source of water and 69.77% abstracted from surface waters such as rivers and springs.

Source of lighting

Lighting source of the barangay came in the form of kerosene for 86.98% of the population. There were 12 residents or 4.04% that used solar power while 10, 78% utilized generator sets.

Toilet facilities

Most of the residents (40.44%) had pit type toilets while 24.26% utilized water sealed facilities. It is noteworthy to mention that 39.10% had no toilet facilities.

Sports and recreational facilities

There were four (4) basketball courts existing in the barangay where residents could hold their sports and recreational facilities.

Peace and order situation

The situation in the barangay has been described as generally peaceful.

Presence of indigenous/ethnic groups

There were two (2) ethnic groups – the Cuyunen and Palaw'an - noted in the barangay. The members of these groups, their capacity as chieftains are involved in the settlement of disputes. The chieftain is likewise involved in the celebration of their traditional wedding practices and burial rites.

Economic Data

Employment

There were a total of 616 employed residents. Of this number, four (4) were employed locally while 612 were self-employed. There were four (4) residents employed as teachers while 28 as skilled workers.

Major sources of livelihood

Farming has been ranked as number one major source of income while fishing was ranked number two. Business was ranked third as their major source of livelihood.

Establishments found in the barangay

There was one poultry/livestock farm reported in the barangay, together with 21 backyard gardens. There were 21 *sari-sari* stores and one rice flour/corn/saw mill. Three mining/quarrying firms had also been indicated.

3. Barangay Taratak

The data provided in this section were based on the perception survey conducted in 2015 by the team.

Demographic information

Population, Gender and Age

Barangay Taratak in 2015 had 815 or 50.09% male residents compared to 809 or 49.72% females. The total population was 1,627.

The barangay was generally composed of a young population. There were 643 or 39.52% of the dwellers who belonged to the 0-14 year- old age group while 12.05% consisted of 15 -19 year-olds. There was 10.02% that belonged to the 20-24 years old group classification and

6.52% to the 25-29 years old category. These figures corresponded to 68.11% of the total barangay population. The rest of the inhabitants consisted of the 30 to more than 65 years old. The barangay had 52.92% of its population belonging to the working age of 15-64 years old. On the other hand, the dependent population of the young (1-14) and old (65 and over) comprised 43.21%.

Household size

In 2015, 16.71% of the population reported that their households have five (5) members. The second highest number of members per household was four (4) at 16.43% followed by three (3) members at 16.43%. There were six (6) households or 1.67% who reported to have more than 10 members in their homes.

Marital status

There were 1,196 members of the community who were over 10 years old. From this group, 504 or 42.14% were married while 39.72% or 475 were single. The other reported marital statuses were widow/widower, (3.09%), separated (0.84%) and live-in arrangements (0.17%).

Birthplace

Most of the residents in Barangay Taratak were born in the barangay (45.36%) while 2.95% were born in other barangays in Bataraza, Palawan, Region IVB. The Mindoro, Marinduque, Romblon, Palawan (MIMAROPA) region was the birthplace for 6.95% of the residents in the barangay.

Highest educational attainment

Very few of the residents of Taratak had reached college level, 37 or 4.15% or graduated from college, 1.12%. Most of the residents reached elementary level (25.34%) while 5.83% graduated from elementary. There was also 12.89% who reached high school level while 9.53% graduated from high school. A relatively low percentage of 2.02% had no formal education.

Dialects spoken

There were several dialects spoken in the barangay. Foremost of this was the Mapun 18.92%, Netibo 13.27%, Bisaya, 8.45%, Tagalog, 5.35%, Ilonggo, 3.15%. The less spoken dialects were Palaw'an, Karay-a. Waray, Cebuano, Cuyunin, Ilocano, Bicolano, to name a few.

Religious affiliation

The most predominant religion practiced in the barangay was Islam (32.58%), Catholicism (12.17%), and Pentecostal (2.40%). The other religious affiliations were Panun, Gospel, Baptist, Iglesia Ni cristo, Back to Christ and others.

Economic Data

Around 244 or 32.97% of the residents were farmers. The other sources of income were barangay workers/employment, fishing, employment as teachers, company staff or retail, self-employment. It is interesting to note that there was 54.59% or more than one half of the working force in the barangay who were unemployed.

B. Barangay Profiles – Indirect Impact Barangays

1. Barangay Culandanum

The data provided in this section were based on the 2007 Barangay Profile of Barangay Culandanum. Note that no updated profile is available at the barangay and municipal level.

General information

Barangay Culandanum is classified as a rural barangay with a land area of 3,117 hectares. Its land use is basically agricultural in nature and a small portion is allotted to residential and forest land.

Demography

Population distribution by age and gender

In the 2007 Census data, Barangay Culandanum, had the highest number of residents who belonged to age range 18-35 years old. The data showed that the barangay seemingly has an older population profile. The percentage of residents 0-17 years old was only 21.35% compared to the population who we had ages from 18-65 years old which had a proportion of 62.29% to the total population. There were more females (2,592) compared to males (1,865).

There were a total of 1,230 households, with an average of five (5) persons per household.

Religious groups

Majority of the barangay households belonged to the Roman Catholic Church (71%) while more than one fifth or 22% claimed to be pagans. The other religious affiliations were Iglesia Ni Cristo (3.2%), Seventh Day Adventist (6.8%), Islam (0.4%) and Methodist (1.8%).

Language/ dialects predominantly spoken

The predominant dialect spoken in the barangay was Palaw'an at 31.30%. The next dialect largely spoken was Ilonggo at 25.60% followed by Cebuano, 10%. The other less spoken dialects were Tagalog, 6.7%, Bicolano, 2.27%, Ilocano, 3.42% and Waray, 2.60%.

Education

There are 17 schools existing in the area composed of public preschool/day care center, four (4) public primary/elementary schools, and 6 other public schools found in the barangay.

From the total population, 1,364 were reported to have some form of educational background. Majority or 68.69% went through elementary education while 17.37% had secondary or high school education, 10.70% attended pre-school education while a small number has gone through vocational (0.44%), college (1.61%) and post graduate courses (1.17%).

Housing

Most of the residents of Barangay Culandanum live in semi-permanent structures (43.25%) while more than one third of the households (37.39%) had temporary dwelling places made of bamboo, sawali, nipa/cogon. Residents who dwell in permanent abodes comprised 19.35% of the household population.

Infrastructure and Utilities

Sources of potable water

A relatively large (42.43%), portion of the population sourced their potable water from surface waters such as lakes, rivers and springs. There was 36.26% who obtained water from open wells while 11.78% used pipes and tubes to abstract water. Deep wells are sources of water for 9.1% of the population.

Toilet facilities

As far as toilet facilities are concerned for Barangay Culandanum, 56.34% have the open pit type, while 31.38% have water sealed type. Only 8.29% acquired the modern type or flush type toilets. There were 3.98% of the households that had no toilet at all.

Means of Transportation

The means of transportation prevalent in the barangay were skylab, public utility bus, jeepney and tricycles.

Sports and recreational facilities

It has been reported that the barangay has one (1) gymnasium and three parks/plazas where they hold their sports and recreational activities. Other than these, no other facilities are present.

Cultural data

There were 335 Palaw'ans residing in the barangay in 2007 and no other ethnic groups have been reported to have settled in the area.

Economic data

Employment data

As of 2007, there were 2,384 residents who were self- employed while 2,417 were unemployed. There were also reports that two (2) of the residents were employed overseas.

Major sources of livelihood

The number one source of livelihood was farming, followed by employment and lastly, business endeavors.

Major establishments

There were 18 reported vegetable farms in the barangay. On the other hand, commercial establishments such as 26 *sari-sari* stores and five (5) buy and sell stations have also been noted. There were two (2) mining/quarrying firms stated to exist in the barangay.

Barangay development projects

The barangay has engaged in various projects such as the waterline distribution system, irrigation projects, and farm to market roads.

2. Barangay Igang-igang

The data provided in this section were based on the 2013 Barangay Profile of Barangay Igang-igang.

Barangay Igang-igang has a land area of 3,136.431 ha and is considered a rural barangay. It has an Internal Revenue Allotment (IRA) of PhP 1,126,344.00 and a RPT share of PhP 21,734.17 for a total of PhP 1,148,078.17.

Demography

Population

Its population has 852 females and 619 males for a total of 1,471 with 618 families and 551 households. The number of people in the labor force is 539 while 932 of the population were unemployed.

Education and culture

The barangay has three (3) day care centers and two (2) reading centers. The barangay day care program has 39 enrollees and the barangay provided access to Alternative Learning System to qualified students. Cultural activities were also conducted.

Women and children

The barangay council for the protection of children was organized or reconstituted through a barangay resolution ordinance. The barangay also formulated and implemented plans and allotted budget for women and children programs with quarterly council meetings held.

Utilities and Services

The residents of the barangay (538 families) have access to electric supply from the Palawan Electric Cooperative.

Water supply is classified at level II with 538 families given access to potable water supply.

The basic means of transportation in the area were the jeep and motorcycle while communication was done through mobile phones serviced by Smart and Globe.

Waste management and pollution control has still a long way to go with the barangay. Among the activities lined up to manage waste and pollution, only the maintenance of sewerage and drainage canals has been implemented.

The barangay has formulated and implemented a barangay public safety plan. An executive order creating the Barangay Disaster Risk Reduction and Management committee has been put in place together with a BDRRM Plan.

The barangay has also an inventory of disaster equipment such as transistor radio, television, mobile phones, generator, banca/ raft, flashlight, first aid kit and a rescue vehicle. The barangay has also organized the Barangay Anti-Drug Abuse Council (BADAC). However, a council meeting touching on this matter has not been conducted. Furthermore, formulation and implementation of policies to counter drug abuse has yet to be pursued.

The Lupong Tagapamayapa has been constituted to act on and settle disputes that had been filed. In addition, barangay tanods conduct regular foot patrol around the barangay.

Economic development

Agriculture and fisheries development

The barangay has provided agriculture support services as far as threshers/ post-harvest facilities and multi-purpose pavements are concerned. Livestock and poultry dispersal was conducted and the barangay fisheries development program has been formulated/ implemented.

Entrepreneurship, business and industry promotion

The presence of cooperatives and the community participation is an indication that the barangay is determined to further their economic status. The officials are serious in building entrepreneurship and economic development.

Environmental Governance

The barangay is unwavering in keeping the environment stable. The officers and residents have pursued clean and green activities, organized the green brigade and conducted tree planting and preservation activities. Mangrove planting and preservation program has also been implemented.

3. Barangay Iwahig

The data provided in this section were based on the 2013 Barangay Profile of Barangay Iwahig.

Barangay Iwahig has been classified as a rural barangay. It is bounded in the north by barangays Culandanum and Tarusan, in the east by Igang-igang, in the west by Sandoval and in the south by Ocayan. Its land area is 2,375.59 hectares.

Demography

Population distribution by age and gender (2007 Census)

The total population of Barangay Iwahig in 2007 was 2,030 with 999 males and 1,031 females. The residents in barangay are relatively young. The residents 0-35 years old comprised about 79.98% of the total population while the 36 to above 66 years old group only totaled to 19.99% of the population.

There were 518 households with an average of seven (7) members per household.

Religious affiliation

The predominant religion in the barangay is Roman Catholicism at 43.44%, Assembly of God, 27.79% came in second and the practice of Islam came third at 20.27%. There was 1.15% of the households that were with the Iglesia ni Cristo. Both the Seventh Day Adventist and the Methodist religious affiliation had 0.19% of the household population as members.

Language/Dialects predominantly spoken

Tagalog was the main dialect spoken by 43.43% of the barangay population. On the other hand, Arabic was the dialect spoken by 20.27% of the barangay residents while Ilocano by 10.42% of the household population. There were also Bicolano (9.65%), Ilonggo (7.72%), Waray (0.96%) and Cebuano (0.96%) as dialects spoken.

Education

There were a number of basic school facilities in the barangay ranging from pre-school/day care (2), primary/elementary schools (4) and Indigenous Learning Center (2).

Educational background of residents

Among the residents in Barangay Iwahig who were schooled, 550 were able to attend pre-school, 120 primary, 100 secondary, and 10 college level.

Housing materials

Majority of the houses in Barangay Iwahig (60.23%) were made up of temporary materials such as bamboo, sawali, nipa/cogon. There were also houses made up of semi-permanent materials like wood and galvanized iron sheets (19.30%) while 11.58% resided in permanent structures made of concrete, wood and GI sheets.

Infrastructure, Utilities and Services

Access to Potable water

As far as access to potable water is concerned, only 200 or 38.61% of the population were reported to draw water from open or dug wells.

Sources of lighting

Source of lighting for majority of the households (57.91%) was from kerosene and solar (19.30%) was also included as well as generator sets (13.89%). There were 8.88% of the households that did not provide an answer.

Toilet facilities

Toilet facilities for 100% of residents were the pit type.

Sports and Recreational facilities

The only place where the members of the community hold their sports and recreational activities is the barangay park or plaza.

Presence of Indigenous/ethnic groups

The only indigenous group reported to be present in the barangay was the Palaw'an ethnic group.

Transport facilities and services

There was one wooden bridge built in the barangay. The road network system in the barangay was classified as made of gravel.

The means of transportation was through public utility jeepney and tricycle. Communication was through mobile phones serviced by Smart and Globe.

Peace and order situation

The peace and order situation in the barangay was described as peaceful.

Indigenous practices

The tribal chieftain or those who are members of the *Lupon Tagapamayapa* were given the task of settling disputes.

Economic data

Employment

Total number of employed residents reached 470 with 320 employed locally while 50 gained employment from overseas. There were 100 residents who were self-employed.

Major sources of Livelihood

The major sources of income were fishing for 70% of the population, farming for 25% and business endeavors for 15%.

Establishments present in the barangay

It was reported that there were 20 vegetable/agricultural farms present in the barangay. Furthermore, six (6) *sari-sari* stores, three (3) buy and sell stations and one mining/quarrying firm are present.

Barangay income

The total income of the barangay in 2013 was PhP 1,150,956.70 compared to only PhP 1,032,511.00 in 2009. The income came from revenue from taxes (PhP 1,266,384.20) and real property tax (RPT) share of PhP 10,948.88.

4. Barangay Sandoval

The data provided in this section were based on the 2011 Barangay Profile of Barangay Sandoval.

General information

Sandoval is classified as a rural barangay. It is bound in the north by Barangays Tarusan and Culandanum, in the east by Iwahig, in the west by the mountain range and in the south by Barangay Ocayan. Its total area is 182.25 hectares. Fifty percent of the barangay is plain while 25% is mountainous.

Demography

Population

Based on the 2007 Census, Barangay Sandoval had a population of 2,717 people with 1,376 male and 1,341 female. As far as percentage distribution is concerned, children 0-5 years old comprised 19.32% of the population while 23.19% belonged to the 6-12 years old. Residents 13-17 years old made up 16.85% and adults 18-35 years old composed 15.27% of the total population. Adding these figures, the residents 35 years and below comprised a considerable proportion of the population at 75.29%.

Religion

Several religions or religious groups had been reported to exist in the barangay. Fifty- five percent of the households were Roman Catholics, 20% belonged to the Iglesia ni Cristo while the remaining were practicing Islam, Seventh Day Adventist, Methodist and others religious groups.

Dialects predominantly spoken

Twenty percent (20%) of the households spoke Tagalog, 10% Bicolano, 5% Ilocano, 19% Ilonggo, 3% Cebuano and 1% Waray. There was a considerable proportion of the population (40%) who spoke Palaw'an.

Education

There were three (3) pre-school/day care centers reported to be in the barangay in addition to three (3) primary/elementary schools.

Housing materials

Twenty-five percent or 165 households in the barangay have houses made of permanent structures (concrete, wood and galvanized iron sheets for roofing materials). On the other hand, another 25% lived under semi-permanent shelters made of wood and GI sheets. Fifty percent of the households built their houses with temporary materials such as bamboo, sawali and nipa/cogon.

Infrastructure, Utilities and services

Sources of potable water

Potable water is important to have a healthy community. Thirty percent or 198 households draw water from piped water sources while 329 households (50%) sourced their supply from surface waters such as rivers and spring.

Source of lighting

One hundred percent of the residents of the barangay used kerosene to provide light in their houses.

Toilet facilities

The barangay profile stated that 30% of the population used modern type commercial bowls for their toilet facilities while 50% had water-sealed types. Furthermore, there were 20% of the households that did not have any toilet.

Roads and Bridges

There was one (1) steel bridge reported to be functioning in Barangay Sandoval while gravel and earth filled roads under the administrative jurisdiction of the provincial and barangay units were found to be operational.

Transportation and Communication

The main means of transportation in the barangay are public utility jeepneys and tricycles. Cell/mobile phones were the means of communication which was generally serviced by Globe and Smart.

Peace and order condition

The peace and order condition in the barangay has been classified as peaceful.

Sports and recreational facilities

The barangay had four (4) parks and plaza that the residents used for sports and recreational purposes. They did not have any of the other types.

Cultural data

Among the various tribes, there were only five (5) ethnic groups present in the community. There were the Palaw'an (50%), Ilonggo (30%), Ilocano (10%), Bicolano (5%) and Muslims (5%).

The various practices that the Indigenous residents who were members of *the Lupon Tagapamayapa* included the settlement of disputes. The chieftains performed traditional wedding rites.

Economic data

Employment

It was reported that there were 22 qualified people in the barangay to be in the labor force. Out of this number, only two (2) were unemployed while the rest (20) were gainfully employed.

Major sources of livelihood

The major source of livelihood in the barangay was farming. Other residents have business endeavors while others were employed.

Number of establishments in the barangay

There was one (1) vegetable farm found to exist in the barangay while one (1) grocery/ dry goods store was noted. There were 70 sari-sari stores, two (2) furniture shops and one (1) buy and sell station thriving in the barangay. As far as industrial/manufacturing establishments are concerned, one (1) handicraft, one (1) mining/quarrying and one (1) rice/flour, corn, sawmill were reported to exist in the barangay.

5. Barangay Sarong

The data provided in this section were based on the Barangay Profile of Barangay Sarong.

General information

Barangay Sarong is classified as rural barangay. It has a total land area of 2,270 hectares. It is bound in the north by Barangay Igang-igang, in the east by the Sulu seas, in the west by Barangay Iwahig and in the south by Barangay Rio Tuba. Its land forms are categorized as plain and hilly while the general land use is agricultural.

Demography

Population

Barangay Sarong has a population of 1,948 where 948 were males and 1,000 were females. Almost one fourth of the population (23.10%) belonged to the adult group 18-35 years old while 17.96% comprised of children 5-12 years old. Adults 66 years old and above consisted only 2.56% of the total barangay population.

In 2007, there were 510 households with an average of 3.5 persons per household.

Religious affiliation

There were two (2) major religions existing in the barangay. Islam was practiced by 45.09% while Palaw'an was the belief for 45.49%. The other non-major religious groups were Roman Catholic, Assembly of God, and Jesus is King.

Dialects predominantly spoken

The predominant dialect spoken was Palaw'an at 45.49% followed by Mulbog (32.94%). There were 17.45% Waray and the other less spoken dialects were Tagalog, Bicolano, Ilocano and Ilonggo.

Education

The barangay has one (1) pre-school/ day care center, five (5) elementary school buildings and one (1) high school all classified as public.

Housing materials

Ninety-seven percent of the barangay households have dwelling places classified as temporary as these are made of light materials. Only 0.39% lives in permanent structures and 2.55% in semi-permanent structures.

Infrastructure, Transport Facilities and Services

Roads

No bridge was reported to exist in the barangay while the road system consists of gravel and earth-filled roads.

Transportation

The most common means of transportation are public utility jeepneys, calesas and tricycle. No service providers of mobile phones were reported to be operational in the area.

The barangay was generally described as peaceful.

Sources of potable water

There were only two (2) sources of potable water for the barangay residents. The main source was open or dug wells at 80.39% and the other 19.60% used deep wells at 19.60%.

Sources of lighting

Like the other barangays, kerosene was the major (84.96%) lighting source for the barangay dwellers. The other sources used to illuminate their houses were generator sets (11.17%) and solar power (2.12%).

Toilet facilities

The pit type was predominantly the kind of toilet for 74% of the barangay residents while 26% did not have any toilet facility.

Sports and recreational facilities

A covered court and a park/plaza were present in the barangay where the constituents can hold their sports and recreational activities.

Presence of indigenous/ethnic groups

The two (2) major tribes existing in the community were the Palaw'an and the Molbog. The other reported tribe but with fewer numbers was the Tausug.

The indigenous practices undertaken by the members of the ethnic group were settlement of disputes, wedding ceremonies, baptism and burial according to their customs and traditions.

Economic data

Employment

There were 310 residents of Barangay Sarong who were employed in 2007, 10 locally and 300 were self-employed. Of those who were employed, two (2) were engineers, four (4) teachers, and four (4) skilled workers.

Major sources of livelihood

Farming was the main source of livelihood for the residents of Sarong. The other sources included fishing and business endeavors.

Number of establishments

There were 10 vegetable and 20 coconut farms reported to thrive in Barangay Sarong. Furthermore, 10 sari-sari stores were located in the area. There were two (2) rice/flour/corn/saw mills established in the barangay.

6. Barangay Sumbiling

The data provided in this section were based on the 2013 Barangay Profile of Barangay Sumbiling.

Barangay Sumbiling is classified as a rural barangay. It is bounded in the north by Barangay Taratak, in the south by Sapa, in the east by the Sulu Sea and in the west by barangay Canipaan. Its land area is comprised of 5715.36 hectares. The land uses present in the barangay are agricultural, upland, lowland, coastal and commercial.

Education and culture

The barangay has established education and information facilities such as day care centers (3) and one (1) information and reading center. A barangay day care program had been put in place with two day care workers and 103 enrollees. The barangay had also regularly conducted the *Linggo ng Wika* and cultural activities.

Basic utilities/services

Power supply

The source of power in the barangay was kerosene and generator sets.

Water supply

There were 740 families that have access to potable water coming from the first level water system.

Means of transportation

The means of transportation consisted of bus, jeep, shuttle vans, tricycle and motorcycle.

Means of communication

The means of communication was through mobile phones serviced by Smart or Globe.

Economic development

Of the 2,963 total populations, 1,455 were in the labor force. Twenty-one were unemployed.

There were agriculture and fisheries development projects conducted as well as entrepreneurship, business and industry promotion.

Financial information

The total income for 2013 amounted to PhP 1,394,805.38 broken down as Internal Revenue Allotment (PhP 1,371,104.00) RPT share (PhP 13,701.38), others (PhP 10,000.00).

Environmental management

Natural resource management and waste management and pollution control activities had been fairly conducted.

7. Barangay Tarusan

The data provided in this section were based on the 2008 Barangay Profile of Barangay Tarusan.

Barangay Tarusan, which is classified as a rural barangay, has a total land area of 4,531.97 hectares. It is bounded in the north by Barangay Bulalacao, in the east by Barangay Culandanum, in the west by Barangay Sandoval and in the south by Barangay Iwahig.

Its landforms are considered as mountainous, plain, valley, plateau and hilly. The biggest area in the barangay was designated for residential use followed by agricultural use. The other land uses consisted of commercial, industrial and aquatic.

Demography

Population distribution

In 2007, Barangay Tarusan had a population of 2,952. Of this, 1,970 were males and 1,982 were females. About one fourth of the population, 25.84% were adults 18-35 years old while one fifth or 20.02% were children 13-17 years old. The distribution of population did not very much differ by age group. Children 0-5 years old comprised 17.75% of the population, children 6-12 years old made up 19.82%. Adults 51-65 years old constituted 16.59% while adults above 65 years old covered 15.72% of the population.

The number of households was 785 and the average household size was five (5) persons per household.

Religious affiliation

The predominant religion practiced in the barangay was Islam at 50% Roman Catholics comprised 20% of the population. The other religions the residents were affiliated to were Iglesia ni Cristo (10%), Seventh Day Adventist (10%), and Methodist (10%).

Languages/ dialects predominantly spoken

The dialect prevalent in the barangay was the native Palaw'an spoken by 50% of the residents. On the other hand, there was 20% of the population that spoke Ilonggo, Ilocano, (10%), Waray (10%) and Bicolano (5%).

Education

Barangay Tarusan had four (4) pre-school/day care facilities and 10 primary/elementary schools. There was no other type of school facilities found in the area.

Housing materials

It is worthy to note that 73% of the residents of the barangay had temporary dwellings made of bamboo, sawali and nipa/cogon while 22% lived in semi-permanent houses made of wood and GI sheets. Only 5% was reported to reside in permanent structures of concrete, wood and GI sheets.

Infrastructure, Utilities and Services

Transport facilities

Five concrete bridges were reported to be functional in the barangay in addition to the roads which are laden with gravel. The main means of transportation was through public utility buses, jeepneys, tricycles and shuttle vans.

The means of communication were via cell phones and internet with Globe as the service provider.

Access to potable water

There were several ways by which the residents sourced water. Fifty percent obtained their potable water from deep wells, while 30% got water through piped sources. There were 157 residents who depended on rivers for their domestic water needs.

Sources of lighting

Lighting sources came in different forms for the residents of Tarusan. Majority or 65% utilized kerosene while 20% depended on solar energy. Only 15% tapped from electricity provided by PALECO.

Toilet facilities

Water sealed toilet facilities were used by 30% of the populace while 25% utilized the pit type. It is disturbing to note that 45% of the households in barangay Tarusan have no toilets facilities at all.

Recreational/sports facilities

The barangay park/plaza is the only recreational facility existing in the barangay for the residents to enjoy.

Peace and order situation

The barangay was classified as peaceful.

Presence of indigenous/ethnic groups

There were three (3) ethnic groups reported to be present in Barangay Tarusan. These are the Maranao (30%), Tausug (30%) and the Palaw'an (40%). The indigenous practice done by the ethnic folks who belonged to the *Lupon ng Tagapamayapa* consisted of the settlement of disputes.

Economic data

Employment data

There were 670 residents in Barangay Tarusan who were in the workforce. This number includes one (1) nurse, 11 teachers and skilled workers.

Major sources of livelihood

The number one source of livelihood was farming with fishing coming in second and employment/business as third.

Establishments present in the barangay

Among the agricultural establishments present in the barangay, five (5) were identified as fishponds/fishpens and 120 coconut farms. Twenty- six *sari-sari* stores also exist in the area in addition to two (2) rice/flour/corn/saw mills.

Barangay income

The total income derived by the barangay in 2006 was PhP 1,045,362.96 broken down as revenue from tax (PhP 1,038,018.18), real property tax share (PhP 6,629.78) and barangay fees (PhP 715.00).

Results of the Household Survey

Annex 2.4.3 shows the result of the perception survey in tabular form.

Respondent's Profile

Position of respondents in the family

Majority of the respondents for the socio-economic survey in the direct impact areas were the spouses of the head of family at 195 or 52.70%. There were 163 or 44.05% heads of families in the direct impact areas who were interviewed. The other members of the family who had been respondents were either the son/daughter (6 or 1.62%). For the indirect impact areas. Majority of the respondents were the heads of the family with 93 persons or 54.39%. The other 45% of the respondents were the spouses. When the two results were combined, it turned out that one half or 50.28% of those surveyed were the spouses while the other 47.32% were the heads of the households (**Annex 2.4.3**, **Table 2.4.4**).

Gender of Respondents

Females dominated the respondents in the direct impact areas at 55.68% compared to males at 44.32%. This substantiates the previous results that majority of the respondents in the direct impact areas were the spouses when the husbands were out earning a living. The same trend was observed for the indirect impact areas which had more male respondents identified as heads of families (**Annex 2.4.3**, **Table 2.4.5**).

Age bracket of respondents

Table 2.4.6 (Annex 2.4.3) shows that the age range of the respondents was fairly distributed among all brackets. However, it is worthy to note that 76.22% of the respondents in the direct impact barangays belonged to the 20-49 age range. As far as the indirect barangays are concerned, 61.99% belonged to the aforementioned age group. When results had been combined, there were 75.96% of the respondents that belonged to the 20-49 age group.

Marital status of respondents

Majority of the respondents in the direct impact areas were married at 84.59% while the rest were in live-in arrangements, 5.95%, widowed, 3.78%, single, 4.05%, separated, 1.35%. A completely different picture is presented in the indirect impact barangays where 91.81% were in a live – in situation. Only 1.17% was married, 2.92%, widowed, 1.75% single and 2.34% separated (**Annex 2.4.3, Table 2.4.7**).

Religion

Most of the respondents in both the direct (48.11%) and indirect (35.67%) impact barangays were Catholics. There was however other religious affiliations of the respondents as reported. The second predominant one for the direct impact barangays was Islam (27.57%). The second prevalent religions in the indirect impact barangays were Islam (18.71%) and Born Again (18.71%). The third highest reported religion in the DIA was Iglesia Ni Cristo at 10% compared to the third highest reported religion in the IIA which was Protestantism (8.77%). Only a couple of persons reported to have no religious affiliations (**Annex 2.4.3**, **Table 2.4.8**).

Ethnicity

There were 56 or 15% of the respondents from the DIA who reported they were members of an ethnic group while 96 or 56.14% of the respondents in the IIA belonged to an indigenous group. The majority of the respondents in both the DIA (60.71%) and IIA (77.08%) belonged to the Palaw'an ethnic group. The other indigenous groups reported were Molbog, Mapun, Cuyunen, Cagayano, to name a few (**Annex 2.4.3, Table 2.4.9**).

Years residing in the area

The respondents from the DIA seemed to be more mobile than their counterparts from the IIA. Almost thirty percent has been residing in the DIA since birth, 37.84% for more than 10 years, and 20.81% from 6-10 years. On the other hand, 52.05% of the respondents from the IIA had been residing in their respective barangays since birth. There was also a considerable number, 35.09% who has lived in the area for more than 10 years. The other responses consisted of living in the area for 1-5 years, 4.68%, and 5.85% for those who resided in the area from 6-10 years. (**Annex 2.4.3, Table 2.4.10**).

The same table shows that for those who reported not being born in the area, the birthplaces identified were other barangays in Bataraza, Palawan, the MIMAROPA Region, Western Visayas, Bicol Region, National Capital Region, and from other regions in the Philippines.

The most prevalent reason given by both the DIA (45.83%) and the IIA (50.57%) respondents for migrating to their place of residence was the opportunity for employment. It is interesting to note that the second most dominant answer given by the respondents from the IIA (35.63%) was for marriage/family reasons compared to the (30.30%) response by the DIA respondents which were for livelihood. Only 1.15% of the respondents from the IIA gave livelihood as a reason for migration. This implies that there are more livelihood opportunities in the DIA to warrant more people migrating to the area.

Highest educational attainment of respondents

Table 2.4.11 (**Annex 2.4.3**) shows that 28.11% of the respondents from the DIA were high school graduates, 29.19% got to the high school level, 9.46% reached college level and 6.22% were college graduates. The trend was not the same for the IIA as they seemed to have a lower educational level compared to the DIA. In the IIA, 32.75% was able to get to elementary level, 12.87% were elementary graduates, 20.47% high school level, and 12.87% were high school graduates. There was only 8.77% who reached college and 1.75% graduated from college. On the whole, when results were combined, only 23.29% were high school graduates and only 4.81% were able to graduate from college.

Employment

Of the 370 respondents interviewed from the DIA, 263 or 71.08% were gainfully employed while almost a third or 28.92% were not. The same trend was observed for the respondents from the IIA where 73.68% enjoyed obtaining income from their respective sources while 26.32% struggled to even be employed (**Annex 2.4.3, Table 2.4.12**).

There were different sources of livelihood as reported by the respondents. The biggest source of income for the DIA respondents was from self-employment or business endeavors at 18.63%. There were also skilled workers (14.07%) who worked as carpenter, crane operator, forklift operator, technician, foreman, etc., local government (barangay) workers, 13.69%, employed as teachers, revenue collector, sales agent, etc.), (9.51%), farmers (8.75%), fisherman (7.22%), among others.

The distribution of respondents as to sources of income differed in the IIA. The highest number reported was farming at 40.77%, followed by barangay workers, 15.38%, self-employment, 14.62%, fishing, 10%. The other sources of income include working as skilled labor, as driver and employment as teacher, sales agent, clerk, engineer, security officer, etc.

Household information

Household size

Table 2.4.13 (**Annex 2.4.3**) shows that the number of persons in a household ranged from 1 to more than 10. For the DIA, the larger percentage (22.97%) mentioned 4 persons, 3 persons (19.73%) and 5 persons (19.46%). The results from the IIA were leaning to the same trend. The highest percentage reported was for 4 household members (22.22%), five (5) (18.71%), and three (3) (13.45%). The derived results somehow parallel the average household size for Palawan of 4.6 persons per household.

Household income

Based on the survey, the average monthly household income from primary sources was Php 12,646.65 for the DIA residents compared to the PhP5,611.71 of the households in the IIA (**Annex 2.4.3**, **Table 2.4.14**). These figures were based on a minimum of PhP650 to a maximum of PhP80,000 monthly incomes of respondents from the DIA and a minimum of PhP 300 to a maximum of PhP25,000 in the IIA.

The monthly income from secondary sources was considerably less compared to the income from primary sources. The average monthly household income in the DIA was PhP5,276.29 compared to only PhP2,808.07 in the IIA.

The combined monthly average household income from primary and secondary sources amounted to PhP 13981.46 in the DIA as compared to PhP6,876.24 in the IIA.

Dialects Spoken

Because of the diversity of the origin of the residents in both the DIA and IIA, there were several dialects reported to be spoken in the respective households. It can be seen from (**Annex 2.4.3, Table 2.4.15**) that majority of the households in the DIA spoke Tagalog (54.25%), with Jama Mapun coming second at 11.72% followed by Bicolano at 10.11%. The IIA households also generally spoke Tagalog, 46.05%. The second most spoken dialect, at 34.42% was Palaw'an, and coming a far third was Molbog at 3.72%. The other less spoken dialects were Bisaya, Ilonggo, Cuyunen, Ilocano, Cebuano, Tausug, etc.

Other sources of Income

When asked whether there were other sources of income aside from the ones discussed earlier, 25.95% of the respondents in the DIA responded in the affirmative (**Annex 2.4.3**, **Table 2.4.16**). There were also 30.99% of the respondents in the IIA who responded positively.

The other sources of income ranged from agriculture based endeavors, buy and sell, moonlighting with other entities/institutions, gathering of crabs and shellfish and others.

Availability of skills for potential additional income

There were more respondents from the DIA (32.16%) than from the IIA (15.20%) who responded that they possess other skills to potentially contribute to additional income (**Annex 2.4.3**, **Table 2.4. 17**). The most common skills mentioned were related to business, cooking and vending sweets and rice cakes, carpentry, sari-sari store management, agriculture based, among others.

Household Expenses

The expenses that the household members had to deal with every month included costs for food, clothing, transportation, appliances/furniture, education, health, utilities, vices/hobbies and other toiletries.

As seen in **Annex 2.4.3**, **Table 2.4. 18**, the biggest expense incurred was for food followed by educational expenditures. Transportation also ate up a big chunk of the allotted budget for both the direct and indirect impact areas.

Marketplace

There were various places from which the residents in the different barangays obtained their household supplies and needs. The residents from the DIA generally sourced their needs from Rio Tuba (91.44%) while 5.35% purchased their essentials from the Bataraza municipal market. There were also small stalls in the barangays where necessities were obtained. Only 0.53% derived their basic needs from the Tabuan.

The residents of the IIA sourced their essentials from the municipal market of Bataraza (46.34%) while 26.83% went to Rio Tuba for marketing. The other 19.92% made use of the informal market stalls within the barangays (**Annex 2.4.3**, **Table 2.4.19**).

Household members working outside the barangay

Both the respondents from the DIA and IIA were one in saying that majority of their household members do not work outside their barangays (84.32%, DIA and 84.80%, IIA).

For those household members who work outside the respective barangays, on the whole, the occupation they pursued included employment, 25.53%, as safety officer, teacher, security guard, cashier, secretary, among others. They were also employed as drivers, welder, carpenter, foreman, etc. (21.28%). There were 17.02% who were employed overseas while 12.77% had agriculture based businesses. There were about 10% of the household members who worked as house help, baby sitters, caretakers and house assistants (**Annex 2.4.3**, **Table 2.4.20**).

Housing information

Home ownership

Seventy percent of the respondents in the direct impact areas owned their homes with 92.40% giving the same response for respondents from the IIA (**Annex 2.4.3**, **Table 2.4.21**). For those who did not own their houses, they stayed with the owner of the house (50%), rented (45.90%) or took care of someone else's house (3.28%).

Residential land ownership

Majority of the respondents from the combined results of the direct and indirect impact barangays revealed that they did not own the land (59.52%). It was reported that 50% was owned by a private owner, 15.53% by parents/family, 19.25% owned by relatives, 10.56% by government, 2.48% by Gawad Kalinga and 2.17%, no idea of who the owner was (**Annex 2.4.3**, **Table 2.4.22**).

Fuel for lighting

There were multiple responses given by the respondents as to the type of fuel/ source for lighting (**Annex 2.4.3**, **Table 2.4. 23**). There were different percentage distributions between the DIA and IIA. For the DIA, 70.91% of the respondents reported to use generators while another 10.13% was reported to have been supplied by RTNMC. Almost ten percent of the respondents used kerosene lamps while 5.45% of the residents surveyed got their electricity needs from PALECO. Solar energy for 2.60% of the respondents was also an option for them. A mere 1.30% used candles to provide light to their houses at night.

On the other hand, the barangays in the indirect impact area used generators (39.90%), kerosene lamps (30.77%), and solar power (12.50%). Only 7.21% obtained power from Paleco and 1 person reported to use a car battery as a power source. It should be noted that a bigger percentage of the respondents from the IIA adopted solar power as a source of lighting.

For those households that derived power from PALECO, 77.78% owned their own meter connection while 22.22% did not. The average monthly bill from PALECO ranged from PhP50 to more than PhP1,600 although majority or 61.11% paid from a range of PhP50 to PhP400.

For those who reported to derive power from generator sets, 91.01% of the respondents did not own these while 6.18% claimed ownership. The monthly expenses from operating the generator sets as a source of lighting ranged from PhP50 to more than PhP1,600, which was basically the same as when electricity was sourced from PALECO. There was 59.55% of the respondents who reported that their expense incurred was between PhP50 and PhP400 per month. Twenty-three percent however spent from PhP401 to PhP800 per month while 7.87% incurred an expenditure of PhP 801 to PhP1,200 per month.

Fuel used for cooking

The residents of the DIA and IIA reported multiple responses for their cooking fuel. Majority or 63.05% of the respondents, used charcoal to cook their food while 17.545 used fuelwood. There was also a considerable number of 67 households or 13.99% who reported to have used liquefied petroleum gas for cooking purposes. There were 23 households or 4.80% that used electricity. A minimal 0.63% used kerosene.

For the IIA, the fuel used by the majority was electricity, 52.74%, followed by charcoal at 44.76%. The other fuel used were LPG (1%) and firewood (0.50%) (**Annex 2.4.3**, **Table 2.4.24**).

Sources of water

Again the respondents gave multiple answers as far as sources of water is concerned. For the DIA respondents, they generally got their water supply provided by the barangay (43.06%). Twenty-five percent of the respondents obtained water from the RTNMC. A considerable portion (17.22%) of the respondents derived water from water pumps. Thirty-five or 8.37% sourced water from the Pilipinas Water Resources Inc. (PWRI) and four (4) respondents or 0.96% got water from the Dela Chica water source (**Annex 2.4.3, Table 2.4.25**).

About 43% of the respondents from the IIA source water from the barangay water supply while about 15% abstracted from deep wells. More than 35% owned water pumps while 1.55% utilized surface water from rivers and streams.

Majority (82.19%) of the respondents from the DIA incurred from PhP50 to PhP1,000 per month for their water usage. There were five (5) households or about 2% who spent from PhP1,001 to more than PhP4,000 for their water bill every month.

House appliances

The respondents from both the DIA and IIA reported to own a variety of house appliances. The most commonly owned was a television set at 26.42% of the total respondents. Another appliance which was owned by most of the surveyed households was an electric fan (17.23%). It seems doing laundry by hand was getting to be less practiced as 12.31% owned washing machines, with more reported in the DIA. VCD/DVD players were reported to be owned by more of the respondents from the IIA at 23.04% compared to the 9.62% from the DIA. Refrigerators were reported to be in the possession of the families in the DIA (11.81%) compared to the 1.57% families in the IIA. An item that the families in the IIA have more of than the DIA was the transistor radios. There had been 11.52% in the IIA who reported that they owned transistor radio while only 2.38% of the DIA respondents had one. The other appliances owned by the respondents were electric iron, stereo, electric stove, VHS player, rice cooker. A few of the respondents also owned air conditioning units, personal computers, blender, hair blower, videoke machines, among others (**Annex 2.4.3**, **Table 2.4.26**).

Housing materials

Annex 2.4.3 and **Table 2.4.27** show that for the roofing materials of the respondents, galvanized iron or G.I sheets (69.92%) dominated the responses of the DIA respondents. On the other hand, nipa/cogon/anahaw (53.51%) was the response given by majority of the interviewees in the IIA. For materials of their walls, majority of the respondents, 50.59% from the DIA and 61.64% from the IIA mentioned bamboo/sawali as material for the walls of their houses. There were also wood and cement raw materials used.

Community information

Leading sources of livelihood/income in the barangay

For residents from the DIA, fishing was the leading source of income for 40.12% of the respondents while business endeavors (33.54%) such as sari-sari store management, vending, buy and sell, among others was the second main source of livelihood. The third leading source of livelihood is farming (24.90%).

In the IIA, farming was the main source of income for majority of the residents (58.61%) while fishing came in second at 30.46%. It seems that there were very few small business prospects in the IIA as 8.94% reported it to be their leading source of livelihood or income. When the responses for the two areas have been combined, the ranking was farming (37.82%), fishing (36.42%) and business endeavors (24.11%) (**Annex 2.4.3**, **Table 2.4.28**).

Other possible sources of income in the barangay

The other potential sources of income for all the respondents which gained 40.11% of the responses was vending or selling either food, fresh and dried fish, homemade food products, gasoline or vegetables. Another possible income source was farming (11.60%). The other potential livelihood options less mentioned were poultry and livestock raising (7.13%), commercial business like canteen operation, grocery management, parlor operation (6.84%), fishing (5.23%), handicraft-making (4.28%) and others like tailoring, employment, transport services, bamboo weaving, and other skilled labor (**Annex 2.4.3**, **Table 2.4.29**).

Membership in local organizations

Annex 2.4.3 and **Table 2.4.30** show that 20.00% of the respondents from the DIA were members of local organizations while 73.785 were not. The same trend was observed with the responses from the IIA with 27.49% of the respondents stating their membership while 63.74% were not.

For those who cited membership to organizations, 67.31% belonged to civic organizations as members and 32.69% as officers. There was also 30% who belonged to religious organizations as a member (83.33%) and 16.66% as officer. Economic organizations were not new to 27.86% of the respondents who belonged to organizations. They were either a member (74.36%) or an officer (25.64%). There was minimal participation of the respondents to political organizations (2.86%) with 50% stating just being a member and 50% as an officer.

Name of Local Organizations

The organizations the respondents belonged to came in different forms. The civic organizations included women's and senior citizen's groups, Gawad Kalinga, Marabahay organization, Guardians, RTN Worker's Union, Protected Area Management for Ursula Island Bird's Sanctuary, Barangay Water System Association.

The religious groups consisted of Catholic Association, San Vicente Ferrer group, Samahan ng INC, Catholic Pastoral Association to name a few.

Economic organizations included 4Ps, Healthy Pinoy Program, cooperatives, farmers and fishermen association, World Vision, and others.

Political organizations consisted of purok organizations, barangay human rights action groups, etc (**Annex 2.4.3, Table 2.4.31**).

Development projects of local organizations

There were various projects implemented by the different organizations to contribute to the development of the barangays. For the civic organizations, the most prevalent was the provision of financial assistance and livelihood to its members like poultry and livestock production, tailoring business and handicraft manufacturing. There were also activities such as community cleaning, seminars on livelihood, financial management, sports activities, environmental management and housing projects, to name a few.

Religious organizations focused on the spiritual and values formation of its members and the barangay residents as well. Community service such as feeding programs, clean up drives and even educational assistance to the children of its members were implemented.

Economic organizations provided financial assistance for livelihood endeavors including capital cost for other businesses (e.g. seedling loan with interest). These organizations likewise extended livelihood assistance to members for fish cages, farming materials, seedlings and fertilizers, livelihood for women, seminars and trainings. Information, Education, and Communication (IEC) on the improvement and proper farming system which included seedling dispersal, fertilizer application, cropping system and medicine distribution (**Annex 2.4.3, Table 2.4.32**).

Community problems

The most pressing community problem faced by the respondents from both the DIA and IIA was the lack of employment opportunities in their barangays (26.09%). Another worth mentioning problem was on illegal drug pushing/use which was reported by 18.73% of the respondents. The lack of educational background (13.36%), health problems (absence of accessible health facilities, lack of sanitary toilet facilities, lack of safe drinking water, malnourished children), bad smelling air coming from the company (8.73%), prostitution, mainly reported by DIA respondents (8.73%), peace and order (theft/burglary), (5.09%), child labor (3.18%) were also some of the community problems raised by the respondents (**Annex 2.4.3, Table 2.4.33**).

The most mentioned possible solutions to address the community problems included the provision of the local government units' assistance in giving employment opportunities to the residents (29.78%), participation of the lgu and community in programs against drug addiction (13.78%), improvement of government services (12.22%), promotion or participation in health and nutrition programs (8.45%) and provision of programs for the youth that will contribute to community development (7.93%).

Positive attributes of the barangay

The respondents thought that there were good features existing in the barangay (**Annex 2.4.3, Table 2.4.34**).They mentioned that there were honest and good performing barangay officials (28.85%), higher rate of educated community members (23.14%) and clean environment (13.67%), among others.

Source of help regarding problems in the barangay

It was reported that in times of problems, the number one "go to" person were the respective barangay captains. Both types of responses were obtained from the DIA (60.41%) and IIA (62.05%) respondents. The other parties approached for help for were the barangay councilors (10.75%), other barangay officials such as the treasurer, secretary, purok president (7.59%), tribal chieftain (6.49%) and barangay health workers (3.01%). The other entities included the Lupon Tagapamayapa, barangay tanods, Vice mayor of Bataraza, DSWD, parents and relatives, RTNMC, and church officials (**Annex 2.4.3, Table 2.4.35**).

Participation of women in family decision making

Women were considered vital in family decision making. They participated in financial decisions (18.35%), education of children (18.04%), caring and strategies in raising the children (18.00%), daily household activities (16.52%), purchase of properties for the family (16.48%) and social and wedding preparation of children's weddings (12.61%) (**Annex 2.4.3, Table 2.4.36**).

Current income sources of women in the barangay

Women in the respective barangays predominantly sourced their income from selling fresh and dried fish, vegetables and home cooked delicacies (72.17%). A considerable percentage of 13.10% provided tailoring/sewing services to the community. The other income sources reported were farming, laundry services, working in the barangay, farm laborer and other commercial and agricultural business like beauty parlor activities, poultry and livestock production, to name a few (**Annex 2.4.3, Table 2.4.37**).

Problems experienced by women in the barangay and possible solutions

Majority of the women in the barangays experienced some problems (60.07%) while 38.63% responded in the negative as shown in (**Annex 2.4.3**, **Table 2.4.38**).

The problems besetting the women include the lack of employment opportunities or income sources (76.49%), wife battery and abuse (12.75%), inadequate skills and capital for business and livelihood endeavors (3.12%), spousal issues (1.98%), insufficient family income (1.98%), and lack of education/knowledge on women's rights (1.70%).

The possible approaches or activities to address these problems would be a more active pursuit of potential jobs or income opportunities (28.94%), participation in community activities (28.25%), form or join an organized women's group in the barangay, participate in different trainings and seminars about livelihood, women's right, personality improvement and educational programs (7.45%)

Youth activities in the barangay

The youth in the barangay participated in various activities (**Annex 2.4.3**, **Table 2.4. 39**). The endeavor that was widely participated in were sports activities (81.56%), as indicated by the answers of both the DIA and IIA respondents. About 5.32% of the respondents reported that participation in organizations such as the Gawad Kalinga and school organizations occupy some of the youth's time while 4.32% of the minors utilized their time with friends and playing computer games. The more studious ones (2.49%) spent their time studying and the other 2.33% participated in community, church and other livelihood activities.

Youth Development activities

There was an overwhelming 75.60% positive response as to whether there can be youth development activities that can be pursued in the barangay (**Annex 2.4.3, Table 2.4.40**). Some of these included the participation in different community programs and activities (37.55%), focusing on their studies and doing well on this (21.26%), formation of a youth group (8.24%), provision of livelihood projects and other income generating activities for the youth (6.70%), participation in programs against drug addiction (5.56%) and sports development (4.98%).

Environmental Change

Perceived environmental changes

Annex 2.4.3 and **Table 2.4.41** show that in the last five years there were changes observed by the respondents from both the DIA and IIA (91.68%). It was observed by 18.64% of the respondents that populations as well as migration of people into their barangays have increased. There was also an increase in the coming in of industries and factories (16.36%), rise in the incidence of air, noise and water pollution as well as traffic congestion. The conversion of lands to subdivisions was also seen to have increased while flooding in low lands has also proliferated. There was also an increase in road development and solid waste generation in the barangays. Those that have been observed to decrease were forest cover and farm harvest.

As far as the factories/ power plants/ industries are concerned, 46.58% reported that these have increased while it is interesting to note that 51.57% gave no response. The entities named responsible for the increase in factories/power plants/industries were the private companies themselves such as RTNMC, CBNC, and Unichamp (28.40%). The church (21.40%), provincial government (15.18%), national government agencies (12.84%), local government, and private organizations were likewise held responsible.

For lands converted to subdivisions, the barangay officials and private organizations were held accountable for the changes. The decrease in farm harvest was mostly blamed on the barangay officials (41.61%) and the municipal (12.42%) and private organizations (12.42%). The flooding in low lying areas was mostly made answerable to the barangay and municipal officials. The decrease in forest cover and increase in migration/population was generally blamed on the barangay and municipal officials together with private organizations (**Annex 2.4.3, Table 2.4.42**).

Environmental change that affected households most

Based on the responses of all the respondents from the DIA and IIA, the presence of the factories/power plant/industries affected them most in a negative way at 23.04%. The change in forest cover came in second at 10.71% while the increase in population and migration rate (8.93%) was the third environmental change that made a mark on them. The decrease in farm harvest (8.57%), increased noise/air pollution (8.04%), flooding in low lands (7.50%) conversion of lands into subdivisions (4.46%), water pollution (2.32%) and traffic congestion (1.61%) likewise affected their lives (**Annex 2.4.3, Table 2.4.43**).

Calamities

The calamities experienced by the residents of the different barangays came in different forms. The most predominating calamity was the occurrence of typhoons as reported by 44.74% of the respondents surveyed. As a result of the typhoons, flooding was encountered by 26.53%. The incidence of fire was experienced in the direct impact barangays (10.52%) as well as drought (3.61%). The other calamities that were minimally experienced consisted of landslides, air pollution, high tide, and lightning strike (**Annex 2.4.3, Table 2.4.44**).

Awareness of the Project

Awareness of RTNMC as a private company

Both the respondents from the direct impact and indirect impact barangays overwhelmingly responded to the positive (95.38%) when queried if they knew RTNMC as a private company. There was 44.92% who was aware of the proposed project of RTNMC to expand mining operations while more than half (54.34%) did not know anything about it. It should be noted that there are more residents from the direct impact areas who expressed ignorance of the proposed project.

For those who were aware, they came to know about the project through the government/ barangay officials/tribal chieftains (23.77%), sitio meetings/ barangay meetings/consultations (22.95%), surveys and other data gathering activities (18.85%), employees of RTNMC (17.49%), relatives/neighbors (10.66%) and from multi-media sources (6.01%) (**Annex 2.4.3, Table 2.4.45**).

Knowledge of RTNMC's positive contribution to the barangay

The positive effects brought about by the presence of RTNMC in the area according to the respondents, came in the form of health and sanitation programs (26.11%), education programs (23.61%), infrastructure (15.05%), provision of employment and livelihood opportunities (9.56%), benefits extended to the indigenous peoples/tribes in the form of medical, educational, housing, service vehicles and financial assistance, (7.77%). The other benefits obtained by the residents included provision of housing, electrification, construction/repair of churches/mosques, community development assistance, environmental projects, transportation service and capability/training programs (**Annex 2.4.3, Table 2.4.46).**

Perception towards the Project

Presence of perceived positive effects of the RTNMC option for mineral conversion

It was reported by 91.13% that the RTNMC project on its option for mineral conversion will bring positive benefits to the community.

The number one perceived positive effect is the provision of employment to local residents (21.04%). In addition, it was perceived by 19.27% that more community projects, infrastructure, and livelihood development will be implemented in the area. An increase in livelihood and business was also projected to happen by 15.46% while the same percentage (15.46%) expected that there will be an increase in tax collection and revenue in the barangay and municipality. Ten percent of the respondents saw an increase in land values. Community solidarity was also expected by 9.11% of the respondents (**Annex 2.4.3, Table 2.4.47**).

Perceived negative effects of the RTNMC Option for mineral conversion

While there were reported perceived positive effects of the proposed RTNMC project, there were likewise corresponding anticipated negative effects. These negative effects consisted of the danger and risk the project might bring to the community in terms of pollution, sickness or environmental degradation (17.94%). The respondents were also wary of possible traffic accidents (14.76%), possible flooding and landslides (13.44%), peace and order hazards (12.24%), decrease in livelihood (11.76%), in-migration (11.34%), displacement of families (10.38%) and potential changes in lifestyle and culture (8.16%) (**Annex 2.4.3, Table 2.4.48**).

Opinion about the proposed project

Both the respondents in the DIA and IIA (70.98%) were one in saying that the proposed project will help the community and local residents. However, there were a proportion of the respondents who thought that the proposed project will be able to help the community but not much (20.89%). There was a small portion (1.11%) who felt that the project will not help the community at all. A small group of 2.59% opined that the project will even be slightly detrimental to the community while 1.66% thought that there will be a large damage brought about by the proposed project (**Annex 2.4.3, Table 2.4.49**).

Expectations

About 50% of the respondents stated that that they agree to the statement that the proposed project will bring additional employment to the community. Only 27.36% strongly agreed while one fifth or 20.15% had no opinion. There were only a couple of respondents or 0.37% that strongly disagreed to the statement (**Annex 2.4.3, Table 2.4.50**).

Willingness to be employed with RTNMC

There was a big majority of the respondents (89.28%) who if qualified, were willing to be employed by RTNMC. Their reasons for their willingness consisted of reasons such as the additional income to be derived will provide the needs of their family (40.17%), regularity or stability of the job (29.81%), provision of assistance to family (18.01%) and community development (3.73%).

The reasons for their unwillingness to work for the company ranged from being dangerous to community health and environment (38.46%), family displacement out of the barangay (23.08%), incapability (7.69%) and unavailability due to the need to care for small children (7.79%).

There were also reasons forwarded for unwillingness for their family members to work for RTNMC. There is a perceived notion that there is subjectivity in the company (21.74%) when hiring people. Furthermore, they believed their family members are not qualified to work for certain positions (**Annex 2.4.3, Table 2.4.51**).

Attitude towards the project

Table 2.4.52 and **Annex 2.4.3** show that majority of the respondents have a positive attitude towards the proposed project with 33.09% strongly in agreement and 43.99% with just agreeing. There was 19.59% who had no opinion or were neutral towards the project. Very few, 1.66% were in disagreement and 1.48% was strongly in disagreement towards the proposed project.

Acceptance of the Project

On an overall perception about the project and once perceived negative effects are abated, 70.06% of the total respondents will approve/endorse it while 12.94% will not. There was 16.64% who cannot yet make up their minds while 0.37% did not provide an answer (**Annex 2.4.3, Table 2.4.53**).

The reasons forwarded for approving the project was the anticipation for more employment opportunities and additional income (47.15%), development assistance for the barangay (16.06%), appropriate management measures to prevent negative effects and enhance positive results (14.25%), assurance of community and environment safety (7.77%), community and economic development (7.25%), no perceived negative effects (2.59%) and educational assistance (1.04%). Other reasons given were lifestyle improvement, for the benefit of future generations and nothing can be done since majority has already endorsed it.

There was 32.86% of the respondent who said that the reason for disapproving the proposed project was because they saw the project bringing negative impacts on the health, welfare and livelihood of the residents of the community. There was 15.71% who thought that the project will bring harmful effects on the environment while 14.29% were skeptical that the mitigating measures that will be put in place may fail. There were also 8.57% of the respondents who thought that the project should not push through to avoid accidents in the project site. Some of the respondents expressed the perceived subjectivity of the company in the hiring of employees (4.29%), not interested in the project at all (1.43%) and 1.43%

saw no benefit to be derived from the project. There was also some apprehension in 1.43% of the respondents that the proposed project will affect negatively the peace and order situation in the community.

Those who were indecisive about the project also forwarded their reasons. The lack of appropriate knowledge about the project was a justification given by 33.70% of the respondents. On the other hand, possible mismanagement in providing pollution control and adopting the employment process was expressed by 11.96% while 9.78% stated that the project may be harmful to the environment, health and source of income of the people the indirect assurance from the company of them being employed was also a reason given by 11.96% of the respondents surveyed.

Willingness to participate in monitoring activities related to the RTNMC proposed project

There was a positive response given as to the willingness of the respondents to participate in monitoring activities of the RTNMC proposed project. There was 41.96% who strongly agreed and 42.70% in agreement. A portion of 13.31% expressed no opinion while 0.37% disagreed and 0.55% strongly disagreed. There was 1.11% who provided no answer (**Annex 2.4.3**, **Table 2.4.54**).

Willingness to attend meetings organized by RTNMC related to the project

Table 2.4.55 and **Annex 2.4.3** show that 97.04% responded positively in attending meetings organized by RTNMC regarding the project. Only 1.66% did not want to attend these meetings and 1.29% did not provide an answer.

2.4.1.3 Impact Assessment

The key impacts of the proposed project on the socio-economic environment are presented in **Table 2.4.56**.

Table 2.4.56. Impacts assessment and mitigation for socio-economics

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
• **Displacement/ disturbance of properties** No family will be displaced at all phases of the project. RTNMC shall ensure that no property shall be disturbed.					
• **Change/conflict in landownership** • **Conflict in right of way** This ECC application is for the purpose of applying for a Mineral Product Shared Agreement (MPSA) which will give RTNMC an authority over the project area in Bulanjao.					

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
• **Impact on public access** RTNMC shall open and maintain access roads from mine site to plant site which can also be used by the public provided that they will follow the traffic rules and regulations.					RTNMC shall open and maintain access roads from mine site to the port facilities which are being used by the resident provided that they will follow the traffic rules and regulations RTNMC shall provide road signages and implement speed limits for the safety of the public.
• **In migration** With the project, migration of people from nearby and far places for work, educational and other economic opportunities have increased through the years with the presence of the company. However, with an increase in migration some problems come into light. There were reports of prostitution, incidences of sexually transmitted diseases and illegal drug related problems.		✓	✓		The company is cognizant of the problems brought by the in migration and has continuously coordinated and worked together with the Philippine National Police, the barangay peace keeping officers and their privately employed security guards. RTNMC provides assistance to the surrounding barangays in terms of water supply, road system as well as the health facility (RTNMC Hospital). These utilities and facilities shall be maintained for the residents and possibly the migrants.
• **Cultural lifestyle change** The company has greatly impacted the lives of not only the non-IPs but the IPs as well through the SDMP, CSRs and other community projects. The respect for the IP communities increased due to the different assistance provided by the company. Some IPs can now read and write as a result of the implementation of the Indigenous Learning System (ILS), scholarship grants and other educational programs. Some of the IPs are also gainfully employed within the company. Due to the different benefits provided to them, most of the IPs have their own mobile devices like cellular phones. Motorcycles and four-wheel drive vehicles are used as a means for their transportation. Furthermore, several benefits were acquired through the housing program, employment, health assistance. Some of the IPs prefers the traditional way of farming but to augment their income, other livelihood sources were introduced in addition to the conduct of seminars and trainings along this line. Assistance for the improvement of agricultural production in the form of fertilizers, seedlings, and other	✓	✓	✓	✓	With the proposed mining project, provision and conduct of social development projects shall continue. To ensure the delivery of these social benefits, RTNMC should strengthen the monitoring of the implementation of the projects. In addition, RTNMC shall provide regular spiritual and/or values orientation/development seminars within the company and in surrounding communities. This has to be incorporated in the IEC program of the company.

List of Key Impacts	Phase Occurrence: Pre-Construction	Phase Occurrence: Construction	Phase Occurrence: Operation	Phase Occurrence: Abandonment	Options for Prevention or Mitigation or Enhancement
materials needed for their livelihood activities were likewise extended. While some of the ways of life were positively affected, some erosion in the values of those who were given access to more money had been observed. Exposure to vices such as gambling and drinking alcohol was also reported. For the non IPs, the availability of jobs and business opportunities allowed many individuals access to better goods that were previously not readily available in the project site. Communication facilities including mobile services allowed faster communications, however, have encourage people to be more materialistic and wanting to have the opportunity to own electronic gadgets. Entertainment facilities such as videoke, bars have promoted vices.					
• **Impacts on physical/cultural resources** There are no known burial grounds of tribal ancestors that will be affected as a result of the project. Improved roads, construction of enhanced barangay facilities, increased access to educational facilities and better medical assistance, increased water quality, sources and distribution were some of the positive impacts experienced by the communities surrounding the RTNMC. Without the proposed project, maintenance and sustainable management of these physical resources may not be prolonged.	✓	✓	✓		
• **Threat to delivery of basic services** With the project, there are no identified threats to the delivery of basic services or competition in the use of resources.					The Operations of RTNMC provides for the employees its own housing, water and power supply, solid waste disposal, health, and other facilities and does not compete with the other residents. RTNMC provides water supply to the residents of surrounding barangays and will continue to maintain these facilities to provide for safe water supply.
• **Generation of local benefits** • **Increased revenue of LGUs** The existence of the RTNMC and consequently its community projects through	✓	✓	✓		

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
the CSR and SDMP carried out various benefits to the intended beneficiaries. These include the following to name a few: - Improved commercial activities due to the construction of the Macadam road. - Farmers and fishermen benefitted as they are able to transport their produce and catch directly to the market. Higher income was obtained as the middlemen were eliminated. - Previously, IPs were dependent on their hunting and fishing activities for subsistence. With RTNMC, they were able to avail of free housing, free medical assistance and hospitalization and improved their skills to carry out livelihood activities. - Through Community Relations Assistance (CRA), IPs were able to obtain proper education through scholarship programs. Some graduated and became licensed engineers and professionals. - The RTNMC promptly pays taxes to the municipal treasurer's office of Bataraza. Coral Bay Nickel Mining Corporation (CBNC), promptly paid Real Property taxes (RPT) from 2005-2013. However, the taxes paid by the company decreased in 2014 due to the official recognition of the company as under the Philippine Economic Zone Authority (PEZA), which exempted them from paying the RPT. Presently, the taxes paid by RTNMC and CBNC were based on the market value of minerals. Without the proposed project, the expected additional taxes paid to the government and the royalty payments from the percentage of the direct mining and production costs will not be realized and forwarded to the SDMP budget. Eventually, when the projects do not push through, the communities will be left at the mercy of the local government funds. With this scenario, RTNMC must come up with phase out plans to prepare the communities to manage themselves and resources as well. The people must be informed that the assistance provided to them is finite and has an end. They should ultimately be empowered to be able to fend for their own needs and existence. They should take to heart and practice the learnings and theories from the various trainings and seminars provided to them.					

List of Key Impacts	Phase Occurrence				Options for Prevention or Mitigation or Enhancement
	Pre-Construction	Construction	Operation	Abandonment	
Traffic congestion The continued operations of RTNMC and the construction of the CBNC plant has increased the buying capacity of the residents for them to apply for a loan or directly pay in cash for their own vehicles, be it a motorcycle, car or van. It is also worthy to note that the companies have issued company cars/pick-up trucks as service vehicles for its employees. The increase in the number of vehicles plying the roads of Rio Tuba and the surrounding barangays has caused the roads to be congested at certain times of the day along Macadam Road. The proposed project will contribute to more vehicles using the local roads. The RTNMC and CBNC must coordinate with the local traffic officials to come up with plans and traffic rules and regulations to be implemented and adopted by the public address the traffic problems.	✓	✓	✓		To manage traffic and minimize occurrence of accidents, RTNMC shall implement vehicle speed limit, install safety signages and employ traffic aides. RTNMC shall also ensure that all drivers shall attend training on road safety.

2.4.2 Public health

2.4.2.1 Methodology

The methodology adopted for the study is primarily based on the review of secondary data from the 10 barangays identified as impact areas of the project.

Focused group discussions were also conducted in these barangays. Participants included the Barangay Chairman, councilors, health workers, *tanod,* and sanitation officers.

2.4.2.2 Baseline Conditions

Municipal Health Profile

The Municipal Health Statistics prepared by the Rural Health Unit (RHU) of the municipality is presented in **Table 2.4.57.**

Table 2.4.57. Health Statistic of the Municipality of Bataraza (2011-2015)

Statistics	2011	2012	2013	2014	2015
Morbidity Rate	152.44	24.28	145.98	75.67	94.96
Infant Mortality Rate	8.96	5.00	11.72	2.40	5.74
Mortality Rate	1.13	1.62	1.29	0.90	1.73
Maternal Mortality Rate	0.00	0.70	2.06	1.20	1.04

As seen in **Figures 2.4.1** and **2.4.2**, the trend for morbidity rate, mortality rate and infant mortality rate is fluctuating. Highest infant mortality rate (11.72%) for the past five years was experienced in 2013 when there was also high rate of maternal mortality. There was no specific reason or findings cited in the RHU report on the sudden increase in infant mortality rate, morbidity rate and maternal mortality rate in 2013.

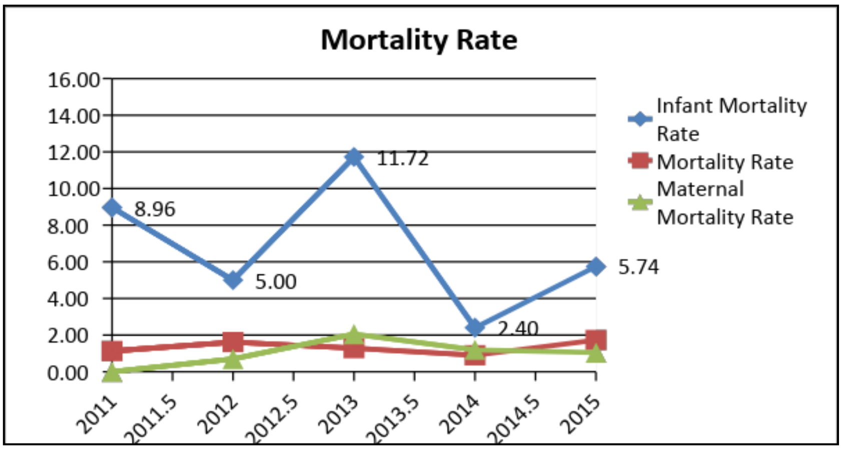


Figure 2.4.1. Trend in mortality rate from 2011 to 2015 *(Source: Bataraza Rural Health Unit, 2016)*

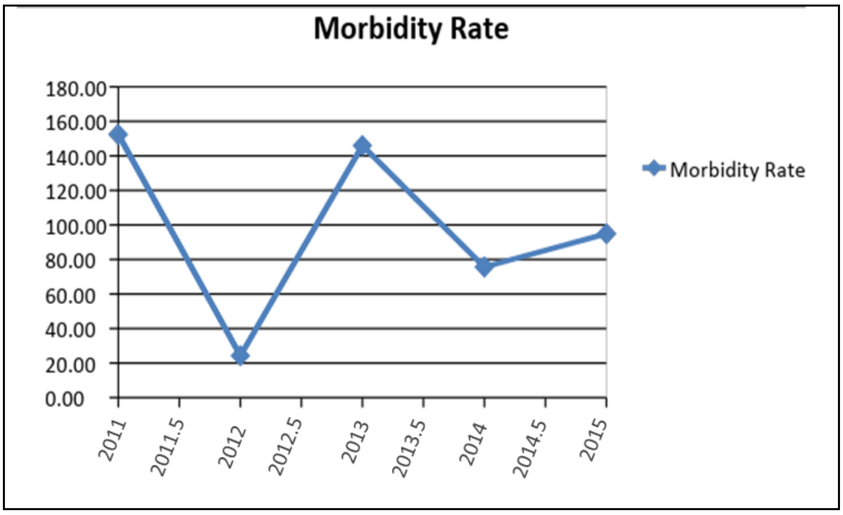


Figure 2.4.2. Trend in morbidity rate from 2011 to 2015 (Source: Bataraza Rural Health Unit, 2016)

The leading cause of diseases in Bataraza, Palawan is upper respiratory tract infection (URTI) which consistently ranked first from 2010 to 2014. Listed among the leading causes of infectious diseases from 2010 to 2014 are influenza, urinary tract infection (UTI), diarrhea, dermatitis, malaria, and infectious wound (**Table 2.4.58).** Among the leading causes of non-infectious diseases are hypertension, bronchial asthma, anemia, arthritis, and gastritis (**Table 2.4.58**).

Table 2.4.58. Leading causes of diseases by year, Bataraza Palawan

Causes	2010	2011	2012	2013	2014
Upper Respiratory Tract Infection (URTI)	2,059	1,007	1,789	3,228	1,615
Hypertension (HPN)	416	195	185	218	145
Influenza	334	70	0	22	0

Causes	2010	2011	2012	2013	2014
Diarrhea	256	238	306	250	57
Skin Disease/Dermatitis	215	12	13	26	0
Urinary Tract Infection (UTI)	197	254	192	234	149
Bronchial Asthma	107	35	41	32	21
Malaria	87	70	8	46	40
Anemia	46	77	39	30	14
Arthritis	8	31	11	1	9
Infectious wound	0	19	24	0	4
Gastritis	45	11	10	3	1

Source : Barangay Health Statistic Bataraza, Palawan 2010 -2014

All of the leading causes of infection showed a fluctuating trend from 2010 to 2014 with URTI being the leading cause of diseases in Bataraza Palawan during the mentioned period (**Figure 2.4.3**). Based on the information released by the Department of Health in 2010, Acute Respiratory Infection appeared to be the highest number of cases in the country with a total of 1,289,168[3]. URTI represents the most common acute illness evaluated in the outpatient setting which ranges from common cold to life threatening illnesses such as epiglottitis[4]. Thus, such illness is present not only in the Bataraza but in the global range.

Hypertension was the leading cause of non-infectious disease in 2010 but the number of cases dropped in 2011 and was then replaced by UTI as the leading cause non-infectious diseases until 2014 (**Figure 2.4.4**).

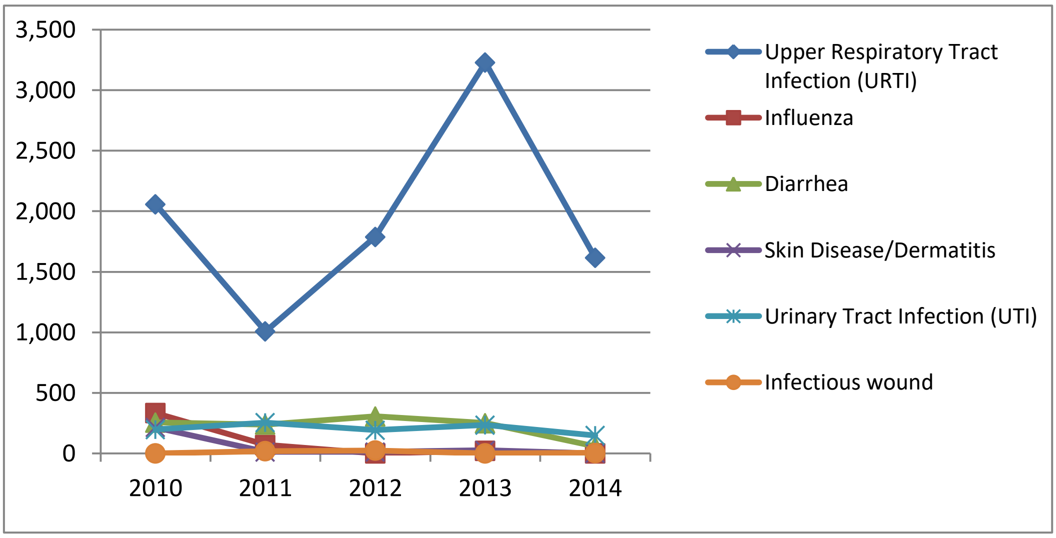


Figure 2.4.3. Leading Causes of Infectious Diseases by Year, Bataraza, Palawan

3 https://www.doh.gov.ph/Statistics/Leading-Causes-of-Morbidity
4 https://emedicine.medscape.com/article/302460-overview

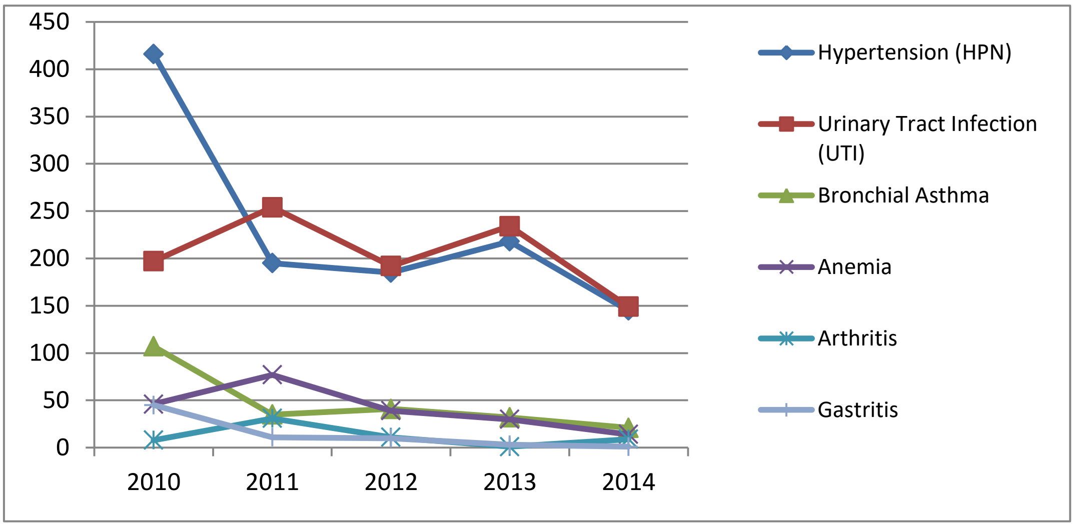


Figure 2.4.4. Leading Causes of Non-infectious Diseases by Year, Bataraza, Palawan

The leading cause of deaths in Bataraza, Palawan from the years 2010 to 2014 is hypertension (HPN). Most of the leading causes of death for the covered period are not related to communicable diseases with the exception of pulmonary tuberculosis (PTB) and pneumonia (**Table 2.4.59**) and classified as degenerative (senility), lifestyle (cardiac arrest, HPN, and cancer), Obgyne-related (still birth and post-partum hemorrhage), and others.

Table 2.4.59. Leading causes of death by year, Bataraza Palawan

Causes	2010	2011	2012	2013	2014
Hypertension	12	12	4	9	6
Still Birth	7	3	2	6	2
Senility	6	4	2	8	7
Pulmonary Tuberculosis (PTB)	7	3	0	2	1
Pneumonia	4	3	2	1	1
Accident	2	3	4	5	0
Cancer	0	5	4	4	3
Asthma	0	5	2	0	3
Suicide	1	4	0	2	3
Post-partum hemorrhage	2	0	4	0	1
Cardiac Arrest	1	0	2	1	2

Source: Barangay Health Statistic Bataraza, Palawan 2010 -2014

Figure 2.4.5 shows a decreasing trend in death caused by pneumonia from 2010 to 2014. During the same period, PTB showed a fluctuating trend as a leading cause of death.

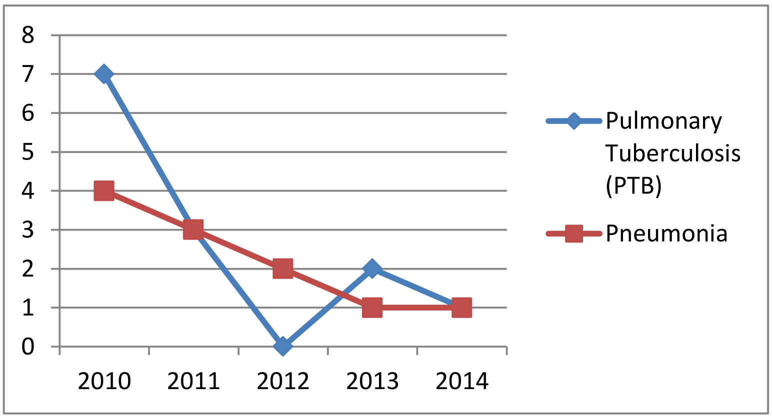


Figure 2.4.5. Leading Causes of Death by Infectious Diseases by Year, Bataraza, Palawan

Figure 2.4.6 shows that hypertension dropped in 2012 as a leading cause of death but it remains to be leading cause of death until 2014.

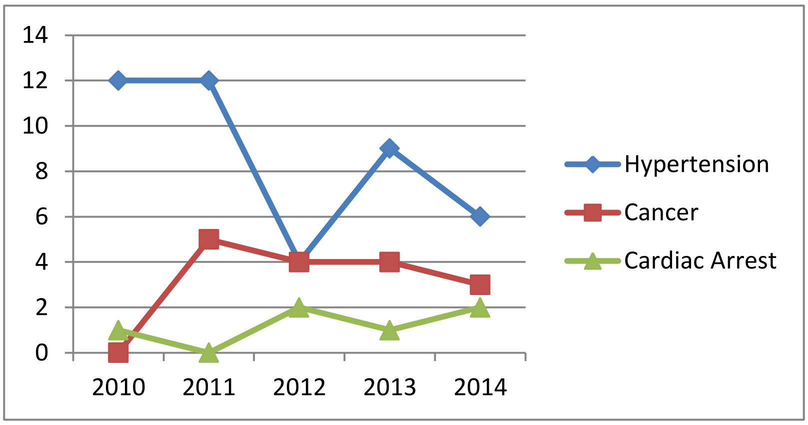


Figure 2.4.6. Leading Causes of Death by Lifestyle Diseases by Year, Bataraza, Palawan

Table 2.4.60. Health workers in Bataraza, Palawan, 2011

Health Worker	Number	Ratio of No. to Population
Doctor	1	1:63,644
Nurse	3	1: 21,215
Dentist	1	1:63,644
Midwives	14	1:4,546
Medtech	1	1:63,644
Sanitary inspectors	1	1:63,644
Active Barangay Health Workers	182	1:350

Source: PPDO-Research, Statistics & Evaluation Division | As of December 2013

In 2011, a doctor, a dentist, a medical technologist, and a sanitary inspector take care of the 63,644 population of Bataraza, Palawan. There is one (1) nurse for every 21,215 resident in the municipality; one (1) midwife for every 4,546 resident; and one (1) active barangay health worker for every 350 resident in the municipality (**Table 2.4.60**).

Table 2.4.61 shows that 78% of residents have access to safe water and 45% of the households keep sanitary toilet facilities.

Table 2.4.61. Environmental sanitation program of Bataraza, Palawan, 2011

Activities	Number	Percentage (%)
No. of Households (HH)	12,729	
No. of HH with access to safe water	9,922	78
HH with Sanitary Toilet Facilities	5668	45

Source: PPDO-Research, Statistics & Evaluation Division | As of December 2013

Municipal Health System and Facilities

Bataraza Palawan has one Municipal Health Unit. The only existing hospital in the municipality is owned and operated by the RTNMC, a Level 1 Hospital.

Barangay Rio Tuba listed 19 health related facilities, which included three (3) private medical clinics, one (1) hospital, two (2) maternal and child clinics, a Barangay Health Center, a Family Planning Center, six (6) Day Care Centers, and five (5) drug stores. There is the South Palawan Provincial Hospital located in Brooke's Point, about 32 km from the

Poblacion area of Bataraza. Available services include diagnostic, therapeutic and rehabilitative.

Table 2.4.62. Health workers in Bataraza, Palawan, 2011

Health Worker	Number	Ratio of No. to Population
Doctor	1	1:63,644
Nurse	3	1: 21,215
Dentist	1	1:63,6455
Midwives	14	1:4,546
Medtech	1	1:63,644
Sanitary inspectors	1	1:63,644
Active Barangay Health Workers	182	1:350

Source: PPDO-Research, Statistics & Evaluation Division, as of December 2013

RTNFI hospital

Complementing the role of the Municipal RHU in health service delivery is the RTNFI Hospital, which is located within the RTN Townsite about 35 km from the town proper. It has 30 beds and five (5) bassinets. It is a primary hospital with capability for emergency operations. It also provides outpatient services including clinical laboratory, radiological, pharmacy, dietary, dental, and pastoral services. There are nine (9) doctors, 21 nurses and 32 staff that provide medical services to employees of RTNMC and CBNC as well as residents of the nearby barangays. Since 1984, indigent patients particularly members of the indigenous community are treated free. For the period 1990 to 1996, 53% of patients admitted in the hospital and 18% of outpatients are non-employees and dependents. The Community Relations Assistance (CRA) program includes free-hospitalization and medical services for indigent folks at the RTNFI hospital. To date, the hospital serves about 50,000 patients every year. Half of them are the workers and their dependents while the rest are indigenous people (IPs) and poor non IPs. Quarterly medical outreach activities to all impact areas are being conducted and a total of PhP 322 M in 12 years (2004 -2015) has been spent on medical assistance programs.

Environmental Health and Sanitation

A little more than half of the households had access to sanitary toilet facilities. Based on the 2013 records of the Municipal Health Office, only 58% of households had sanitary toilet facilities. 850 households have sanitary solid waste disposal and complete basic sanitation facilities which is only about 7% of the total households. Most households practice open burning or composting to manage their solid wastes. About 7,816 households or 68% of residents have access to safe water (**Table 2.4.63**).

Table 2.4.63. Environmental sanitation program of Bataraza, Palawan, 2013

Activities	Number	Percentage (%)
No. of Households (HH)	11,479	
No. of HH with access to safe water	7,816	68
HH with Sanitary Toilet Facilities	6,615	58

Source: *Municipal Health Office of Bataraza, Palawan*

2.4.2.3 *Impact Assessment*

The key impacts of the proposed project on public health and safety are presented in **Table 2.4.64.**

Table 2.4.64. Impacts assessment and mitigation for public health

List of Key Impacts	Phase Occurrence: Pre-Construction	Phase Occurrence: Construction	Phase Occurrence: Operation	Phase Occurrence: Abandonment	Discussion
Threat to public health and safety The construction of access roads and subsequent mining operations will generate dust and other particulates in the air. The size of respirable dust is between 0.5 to 5.0 µm. Dust particles less than 0.1 µm remain in suspension and are not deposited in the lungs. Dust particles greater than 10 µm tend to settle out in the upper respiratory tract, those 3-10 µm settle mainly in the airways and those less than 3 µm deposit mainly in the lung parenchyma and small airways. Excessive inhalation of dust particles may irritate the respiratory system. However, the primary concern is the presence of soil microbes (mold, yeast and bacteria) in the soil dust particles inhaled by the workers. While most healthy individuals are able to remove these microbes from the respiratory system, individuals that are either immunocompromised or are exposed to large doses on a continuing basis are at risk of developing either a cutaneous or respiratory infection due to soil microbes. These infections are usually caused by opportunistic molds. The heavy metals associated with nickel mining are enumerated and the following hazards are identified : <u>Iron (Fe)</u> The possible health effects of iron are irritation cause by mechanical stimulation of solid particles by contact with the skin. It may also cause lethality through the ingestion of a large dose of soluble ferrous or ferric ions. <u>Nickel (Ni)</u> When present in water, it may cause contact dermatitis or "nickel itch" resulting to simple and chronic eczema. Nickel dust may enter the body via the respiratory system and may cause cancer. The primary manifestations of nickel toxicity caused by inhalation are paranasal sinus cancer and/or asthma. The presence of nickel dust has been correlated with an increased crude death rate as well as an increase in the incidence of pneumonia, tuberculosis and accidental deaths. Nickel compounds are carcinogens where the insoluble ones are more potent than the soluble compounds. The toxic levels of exposure to nickel dust are 25 µg per cubic		✓	✓	✓	RTNMC shall ensure implementation of the mitigating measures for dust provided in **Table 2.3.18**. Also PPEs for the workers such as eye protector and dust masks shall be provided.

List of Key Impacts	Phase Occurrence: Pre-Construction	Construction	Operation	Abandonment	Discussion
meter or 8.14 µg per kilogram per day for a 70 kg adult. <u>Silica Dioxide</u> Silica dioxide dust has been suspended to be associated with scleroderma-like changes of the skin with prolonged contact. When inhaled, it may cause silicosis. The deposition of silica dioxide in the lung parenchyma and airways causes an intense cellular reaction, with infiltration of macrophages, neutrophils and lymphocytes. With time, a lesion may be formed that is referred to a silicotic nodule that are prominent in chest x-rays. The aggregation of several of these nodules may result to conglomerate silicosis that causes an impairment of lung function that may be followed by functional deterioration. Other pulmonary effects include inflammation, thickening of the pleura, a definite increase risk of pulmonary tuberculosis and possibly an increased risk of lung cancer. <u>Manganese</u> This element may enter the human body either by ingestion or inhalation. During the later route, the organ systems affected are the respiratory systems and central nervous system causing metal toxicity and neurotoxicity, respectively. The primary manifestations of this illness are fever, headaches, restlessness, insomnia, mental confusion, irritability, extra pyramidal symptoms and speech/hearing impairment. It has been identified to cause neurotoxic Parkinsonism that exhibit acute behavioral manifestations. The use of Positron emission tomography (PET) scan can differentiate Parkinsonism caused by manganese exposure and the idiopathic Parkinson's disease. Furthermore, the climatic variations due to climate change, may render the resident vulnerable to diseases. The El Niňo phenomenon increases the risk of diseases transmitted by mosquitoes, such as malaria and dengue and other arboviruses. Malaria transmission is particularly sensitive to climate variations. The health consequences of drought brought about by El Niňo include diseases resulting from lack of water. Studies have shown that in times of shortage, water is used for cooking rather than hygiene. In particular, this increases the risk of fecal–oral (primarily diarrheal) diseases and water-washed diseases (such as trachoma, scabies). Malnutrition also increases susceptibility to infection.					
Exposure to Occupational Health and Safety Hazards Workers in the mine site are exposed to occupational hazards including prolonged exposure to intense		✓	✓		RTNMC shall provide necessary PPEs for the workers and shall ensure that regular Safety and Health training shall be conducted.

List of Key Impacts	Phase Occurrence				Discussion
	Pre-Construction	Construction	Operation	Abandonment	
heat, dust, fumes, repetitive stress injury (RSI), intense noise, manual handling (e.g. lifting) of heavy machinery and biological and chemical hazards. Workers are vulnerable to airborne particulates including fine dust particles with heavy metals. Prolonged exposure may lead to systemic toxic effects due to the absorption of these substances in the respiratory tract. Noise can cause hearing impairment and/or disrupt body functions like blood circulation and hormone imbalance. Deafness and hearing loss can become irreversible and other non-auditory effects are increased blood pressure and peptic ulcer due to increased gastrointestinal motility. Manual lifting of materials can cause injuries including back pains, broken bones and others in case accidents happen.					Aside from health training, regular discussions regarding safety protocols should be conducted to constantly remind workers work safety practices. Workers should also be required to undergo annual physical examinations to determine their fitness to work.

Environmental Management Plan

Rio Tuba Nickel Mining Corporation

3

This chapter presents the Environmental Management Plan (EMP) of the Rio Tuba Nickel Mining Corporation (RTNMC). The discussion shall focus on the measures being implemented by RTNMC in addressing the potential impacts of the proposed mining project as stated in *Chapter 2*.

3.1 ENVIRONMENTAL MANAGEMENT PROGRAM

RTNMC is planning to operate within the mineable areas covered by AMA-IVB-144A. Summarized in **Table 3.1.1** are the proposed management measures to be implemented by RTNMC to address the impacts of the project to the environment and the people. Most of these measures are currently being implemented by RTNMC for its operation within the MPSA 114-98-IV.

Table 3.1.1 Impacts Management Plan

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
PRE-CONSTRUCTION AND CONSTRUCTION PHASE						
➢ Contour Planning and surveying ➢ Site Clearing ➢ and overburden removal ➢ Field office and motor pool construction ➢ Access road construction ➢ Drainage canal and Settling pond construction	LAND	• Vegetation removal and loss of habitat • Threat to existence and loss of important species • Threat to abundance, frequency and distribution of important species • Impairment of visual aesthetics	Prior to any physical development on the site (e.g. road access development and construction for mining operations), RTNMC shall prepare and implement a comprehensive Biodiversity Conservation Action Plan.	RTNMC Engg RTNMC MEPEO Contract or	Part of project cost	Include in the TOR of the contractor; Include in the EPEP, FMR/DP and ECC Conditionality.
			Representative specimens of the 15 species of plants endemic to Palawan (**Table 2.1.8**), including those listed as threatened, should be protected, and where necessary, transplanted to a secure area in the nursery and provided with proper maintenance for their growth, survival and propagation.			
			Areas for clearing shall be delineated carefully based on the approved mining plan. Markers shall be placed around the edges of the mine areas, road networks			

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
			and areas delineated for other mine facilities.			
			Clearing shall be done by phase to allow movement/migration of faunal species based on the approved mining plan.			
			Reforestation/enhancement planting of other open areas within or outside of the mining claims shall be done to compensate for the vegetation loss using endemic and native species.			
			RTNMC will confine its mining operations along the areas defined in their mining plan and approved by the MGB. A 50-m buffer zone will be maintained at the peripheries of the mining areas. The buffer zones shall be maintained and enhanced.			
		• Soil erosion • Loss of topsoil /overburden • Change in soil quality/fertility	Clearing and excavations works should be done during the drier months or days of the year (January -May), if possible.	RTNMC Eng'g. RTNMC MEPEO Contractor	Part of project cost	Include in the EPEP and FMR/DP, ECC Conditionality
			Only areas needed to construct mine facilities and the mining areas needed for the first year of operations should be cleared. Subsequent clearing for the next mine area should be done once all ores are exhausted. This will minimize exposure of large areas of soil to erosion.			
			Clearing of vegetation cover especially trees shall not be done within the required legal easements such as rivers, creeks, riparian zones, and other identified restricted areas and will be confined within the approved mining areas.			
			Topsoil and other spoils should be stored in run-off controlled storage and disposal area.			

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
			Appropriate biological or mechanical erosion control measures such as coco mats or retaining walls should be installed along the slopes of the access roads to prepare the site for the operations phase and at the topsoil storage areas to protect topsoil.			
			Install diversion channel before the construction areas to divert storm water run- off from draining through the open areas.			
		Change in surface landform/ topography/ terrain/ slope	Minimize ground disturbance through proper delineation of areas to be mined, areas allotted as access road, office, motorpool, drainage canal and settling pond and other mine facilities.	RTNMC Eng'g. RTNMC MEPEO Contractor	No cost	Include in the TOR of the contractor; Include in the EPEP,
			Maintain vegetation cover in the designated buffer zones and in the peripheries of roads and mine areas			
			Clearing for new mine areas shall be done after excavating all ores at the active areas. The clearing shall be limited to only 50 ha at a time.			
		Inducement of subsidence, liquefaction, landslides, mud/ debris flow	Geotechnical site investigation should be conducted prior to any major earthwork. Access roads will be designed and constructed with stable slopes and shall be installed with slope protection measures to prevent collapse. Vegetation clearing will be selective and will be confined on areas needed for the current mining operations to maintain vegetation cover in surrounding areas. The Stormwater Plan will be designed to	RTNMC Eng'g. and Geotechnical Consultant	Part of EPEP cost	Include in the EPEP, ECC Conditionality

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
			divert stormwater away from the active mining areas and access roads will be provided with drainage system with stable slopes to allow unimpeded flow and directed towards the siltation ponds.			
		Soil contamination with oil and grease	Regular maintenance of vehicles and heavy equipment to check for leaks. Maintenance activities should be conducted in the motorpool to contain fuel leaks. The motorpool shall be installed with Oil and Water Separator (OWS) to capture spillages. The OWS should be maintained monthly and oil residues removed, stored in airtight container prior to transport and treatment of accredited transporter and treater. Fuel oil storage areas should be provided with concrete bund to protect from spillages. Waste materials contaminated with hydrocarbon residues should be stored in leak proof containers and collected and treated by accredited contractors.	RTNMC Mechanical	Part of project cost	Include in the EPEP, ECC Conditionality
		Devaluation of land value as a result of improper solid waste management and other impacts	Continuous implementation of solid waste management program within the mine facilities	RTNMC MEPEO	Part of EPEP cost	Include in the EPEP
			Proper storage and disposal of hazardous wastes			
	WATER	Change in stream depth	Prior to the construction of drainage canals temporary sediment control measures should be installed at the downstream side of the construction area or sand bags can be used to line	RTNMC Eng'g. RTNMC MEPEO Contractor	No cost	Include in the TOR of the contractor; Include in the EPEP, ECC Conditionality

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
			construction site.			
			Installation of silt fences to prevent loose excavated soil and weathered rock from moving downslope and silt traps along gullies and creeks that will be intersected by the canals. Vegetation cover especially trees within the required legal easements for rivers, creeks, riparian zones, buffer zones of mining areas and other identified restricted areas shall not be cleared.			
		• Degradation of surface water bodies • Threat to existence or loss of local marine and freshwater species • Threat to abundance and distribution of marine and freshwater species • Change in bathymetry	Construction of drainage canals will be at the same time as the road construction. Temporary sediment control measures should be installed at the downstream side of the construction.	RTNMC Engg Contractor	Part of project cost	Include in the TOR of the contractor
			All oil spills should be cleaned and contained and contaminated materials are collected. Oil contaminated materials shall be stored in secure storage areas in leak proof container and transported and treated by an accredited transporter and treater.	RTNMC Mechanical	Part of project cost	Include in the EPEP
			Support fisheries management programs prescribed in the overall Municipal Coastal Resources Management Plan to ensure fish stock reproduction and habitat restoration.			
	AIR	Contribution in terms of greenhouse gas emissions	Greenhouse gas emissions, although small, will be monitored in accordance with the GHG Protocol developed by the WRI-WBCSD.	RTNMC Eng'g. RTNMC MEPEO Contractor	Part of project cost	Include in the TOR of the contractor; Include in the EPEP
			Clearing will be contained within the approved mining areas and RTNMC will continue to implement its progressive rehabilitation programs in their current			

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
			operations as well as areas outside of their MPSA.			
		Degradation of air quality	Construction and haul roads shall be sprinkled with water at least 2x per day or 4x per day during dry and windy days to prevent generation of dust particles.			
		Increase in ambient noise level	Heavy equipment will be installed with mufflers and maintained regularly to minimize noise			
			Vegetation cover along access roads shall be maintained to serve as noise barrier			
			All workers shall be provided with PPEs. No worker shall be admitted on site without the proper PPEs including ear muffs			
	PEOPLE	In migration	Coordination with the Philippine National Police, barangay peace keeping officers and RTNMC privately employed security guards at all times	RTNMC ComRel	No cost	
		Generation of jobs	Prioritization of local residents in employment	RTNMC HR and ComRel	No cost	Include in the CSR
		Traffic congestion	Implementation of vehicle speed limit, installation of safety signages and employment of traffic aides	RTNMC Safety and ComRel	Part of construction cost	Include in TOR of Contractor
			Conduct of regular road safety training for drivers and traffic aides			
		• Threat to public health and safety • Exposure to Occupational Health and Safety hazards	Provision of necessary PPEs for the workers and conduct of regular Safety and Health training	RTNMC Safety and ComRel Contractor	Part of construction cost	Include in TOR of Contractor
			Implementation of the mitigating measures for the generation of dust			
OPERATIONS PHASE						
➢ Development drilling ➢ Clearing and overburden	LAND	• Change in land form • Change in sub-surface/ underground geomorphology	RTNMC will confine its mining operations along the areas defined in their mining plan and approved by the MGB. A 50-m buffer zone will be maintained at the	RTNMC MEPEO RTNMC Eng'g. Contractor	Part of EPEP cost	Include in TOR of Contractor; EPEP, ECC Conditionality

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
removal ➢ Limonite mining and stockpiling ➢ Soft saprolite ore mining ➢ Hard saprolite ore mining ➢ Waste material handling ➢ Saprolite ore beneficiation involving solar drying of raw soft ore, reclamation of solar dried ore, screening and crushing, transfer of marginal ore to stockpiles ➢ Ore hauling and stockpiling of beneficiated saprolite ore ➢ Direct limonite ore hauling to HPAL Plant ➢ Limonite ore stockpile retrieval and delivery to HPAL plant		• Inducement of subsidence, liquefaction, landslides, mud/debris flow etc.	peripheries of the mining areas. The buffer zones shall be maintained and enhanced.			
			RTNMC will implement progressive rehabilitation, selective clearing, maintenance of nursery and clonal laboratory, surface run-off management, water quality management and drainage plans to manage the impacts of mining.			
			Regular inspection and maintenance of erosion control structures, drainage channels, culverts			
		• Soil erosion • Loss of topsoil /overburden • Change in soil quality/fertility	RTNMC shall ensure that new mine areas shall not be opened as long as an active mine area is being mined. If possible, active mining areas shall be confined to 50 ha at a time. Appropriate erosion control, such as vegetation cover or retaining walls shall be established. Erosion control structures shall be regularly inspected and maintenance should be conducted if necessary.	RTNMC MEPEO RTNMC Engg Contractor	Part of operating; EPEP cost	Include in the TOR of the Contractor Part of the EPEP, ECC Conditionality
			Sediment ponds/traps, check dams and gabions will be constructed on the creeks/rivers to reduce sedimentation in rivers and other bodies of water.			
			After mining activity the area will be rehabilitated by backfilling with waste materials followed by slope stabilization. The overburden with topsoil will be returned and the stabilized areas will be replanted with suitable seedlings.			
			Keeping stockpiles with moderate slopes to minimize high erosion rate			

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
		• Vegetation removal and loss of habitat • Threat to existence and loss of important species • Threat to abundance, frequency and distribution of important species • Impairment of visual aesthetics	The Biodiversity Conservation Action Plan shall be implemented which includes: • A full inventory and mapping of all the important plants species in the area; • The RTNMC nursery shall be provided with complete facilities and staff where all representative specimens of rescued (balled and transplanted) plants and propagules from the project site will be grown and cared for to ensure supply of good planting materials for the progressive rehabilitation program. • No exotic or non-native species of plants should be introduced into the area; • During mining operations, the protection of all the surrounding native vegetation from physical damage by movement of machineries and vehicles, soil transport, and by chemical pollution should be guaranteed by the company. • Clearing shall be done by phase to allow migration and movement of faunal species • Opening of new mining block shall be considered only when all ores are recovered from an active mining area. • Enhancement planting in other open areas within and outside the mining claims to compensate the vegetation loss during the mining operations and provide alternative habitat for faunal species.	RTNMC MEPEO RTNMC Eng'g Contractor	Part of EPEP cost	Include in TOR of Contractor; EPEP, ECC Conditionality

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
		Devaluation of land value as a result of improper solid waste management and other impacts	Continuous implementation of Solid waste management program	RTNMC MEPEO RTNMC HR & ComRel LGU	Part of EPEP cost; CSR cost	Part of the EPEP; Part of the CSR Program
			Proper storage and disposal of hazardous wastes			
		Change in stream depth	Installation of silt fences to prevent loose excavated soil and weathered rock from moving downslope and silt traps along gullies and creeks that will be intersected by the canals.			
		Inducement of flooding	Regularly desilting and deepening of the downstream river channels and regularly removing debris and water plants that would impede the flow of water to increase transporting capacity			
		Depletion of water resources	Keeping bare or exposed areas to a minimum through progressive rehabilitation to allow more water to infiltrate into the ground			
			Impounded water from the siltation ponds can be re-used for spraying water.			
			RTNMC shall consider installing a sewage treatment facility within the townsite and re-using treated wastewater for flushing toilets, for dust suppression and for cleaning.			
			Constructing recharge trenches and pits at the lowlands near the base of Mount Bulanjao and directing surface runoff to these structures to increase the amount of groundwater recharge to the shallow aquifers in these areas			
		Degradation of domestic/ groundwater quality	Proper handling and storage of diesel, fuel oil and lubricants in covered areas with impermeable flooring and installation of bund walls to reduce risk of spillage.			
			Continuous use of oil-water separators and installation of additional units			

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
			RTNMC shall continuously monitor the groundwater resources for contamination (coliforms, and chemical pollutants).			
		• Degradation of surface water bodies • Threat to existence or loss of local marine and freshwater species • Threat to abundance and distribution of marine and freshwater species • Change in Bathymetry	Repair and maintenance of all company vehicles shall be done at designated areas. All oily wastewater shall be treated prior to discharge. Regular maintenance of vehicles shall be conducted to check for leaks. All company drivers shall perform weekly checks for leaks. The weekly checks should be recorded. In addition, all discharge for all OWS shall be monitored to ensure compliance to standards.	RTNMC Eng'g Contractor	Part of project cost	Include in the TOR of the contractor, ECC Conditionality
			All oil contaminated materials should be contained, cleaned, collected and stored in leak proof containers in order to minimize its spread and perform regular maintenance of vehicles and heavy equipment	RTNMC Mechanical	Part of project cost	Include in the EPEP, ECC Conditionality
			Monitoring the nearest surface water bodies will check for the effectiveness of these measures.			
			The stormwater management plan of the new mine site will be engineered to ensure that all surface run off from the new mining area will be directed towards the silt ponds			
			RTNMC shall conduct a monthly inspection of erosion control structures, drainage channels and culverts. Maintenance shall be conducted as necessary.			
			Consider measures to mitigate Cr^{+6} such			

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
			as installation of charcoal gabion and constructed wetlands and planting of grass species to filter sediments at the mouth of spillway of the silt ponds.			
			RTNMC shall further support fisheries management programs of the Municipality of Bataraza to ensure fish stock reproduction and habitat restoration.			
			Installation and adoption of coastal water quality and habitat condition monitoring system using marine baseline information which will include periodic monitoring of Harmful Algal Bloom (HAB)-causing phytoplankton			
	AIR	Contribution in terms of greenhouse gas emissions	Greenhouse gas emissions, although small, will be monitored in accordance with the GHG Protocol developed by the WRI-WBCSD.	RTNMC Eng'g RTNMC MEPEO Contractor	Part of project cost	Include in the TOR of the contractor; Include in the EPEP
			Progressive rehabilitation shall be conducted according to the approved EPEP and enrichment planting of degraded areas outside of the MPSA area will be supported to offset GHG emissions arising from the operations of the project.			
			Maintain vegetation cover in the designated buffer zones and in the peripheries of roads and mine area. Clearing and opening of new mine block shall be done only when all ores from an active mine area are excavated.			
		Degradation of air quality	Regular water sprinkling along haul roads shall be done at least twice per day and up to 4 times per day during dry and windy days.	RTNMC Eng'g RTNMC MEPEO Contractor	Part of project cost	Include in the TOR of the contractor; Include in the EPEP, ECC Conditionality
			Currently, the main haul road to the pier			

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
			is concreted. There are assigned sweepers that regularly clean Macadam Road from spilled ore. The clean-up of spilled ore shall be done daily.			
			Speed limits shall be imposed at Macadam Highway to minimize suspension of dust as well as for safety purposes.	RTNMC Contractor	Part of project cost	Include in the TOR of the contractor;
			Hauling trucks to the pier site shall be covered with tarpaulin. Stockpiled ores at the pier site shall be covered to minimize dust generation of dried out ores.	RTNMC Engg RTNMC MEPEO Contractor	Part of project cost	Include in the TOR of the contractor; Include in the EPEP, ECC Conditionality
			Tire-washing platform at entrance of Macadam Road shall be installed to minimize contamination of loose soil particles along the main haul roads.			
			Chutes, wind breaker and dust collector boxes is installed at the crushing site. These will be properly maintained to minimize dust generation that can affect the health of mine personnel.			
			Proper maintenance of vehicle and equipment shall be conducted at least 2x per year to reduce exhaust emissions of CO, VOCs, and PM.			
			Annual emission testing for gensets shall be conducted including maintenance to ensure emissions are within standards.			
		Increase in ambient noise level	All heavy equipment shall be installed with mufflers and regularly maintained to minimize noise generation.			
			Vegetation cover along the access roads will be maintained to serve as noise barrier.			
			Workers exposed to increased noise levels shall use appropriate PPEs while			

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
			at work.			
	PEOPLE	In migration	RTNMC shall regularly coordinate with the Philippine National Police, barangay peace keeping officers to discuss safety issue within the surrounding communities.	RTNMC HR and ComRel	No cost	Include in the CSR
		Generation of jobs	Employment of local residents shall be prioritized. Training programs shall be provided through the SDMP to improve the skills of residents to be gainfully employed.	RTNMC HR and ComRel	No cost	Include in the CSR
		Traffic congestion	Speed limit for the hauling trucks shall be implemented. Safety signages shall be installed.	RTNMC Eng'g. RTNMC MEPEO Contractor	Part of project cost	Include in the TOR of the contractor; Include in the EPEP
			Regular road safety training for drivers and traffic aides shall be conducted. Traffic personnel shall be stationed along intersections at Macadam Road to manage traffic and ensure safety of all motorists.	RTNMC Safety and Health		
		• Threat to public health and safety • Exposure to Occupational Health and Safety hazards	All mine workers shall be provided with PPEs. During work hours, all mine personnel shall strictly wear PPEs and supervisors shall issue warning to non-complying personnel. At least an annual Safety and Health training shall be conducted for all mine personnel. Annual health check-up shall also be required including contractual personnel. A weekly safety reminder shall be done by all department supervisors.	RTNMC Safety and Health	Part of operating costs	Include in the Health and Safety Program of the Proponent

Project Phase/ Environmental Aspect	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost	Guarantee/ Financial Arrangements
ABANDONMENT PHASE						
Project Abandonment	LAND	Soil erosion of open and bare areas	The EPEP shall outline extensive Rehabilitation Program to rehabilitate mined out areas.	RTNMC MEPEO	Part of FMR/DP cost	Part of the FMR/DP
	PEOPLE	Displacement of workers	Consultation with workers and concerned stakeholders prior to abandonment	RTNMC ComRel	Part of FMR/DP cost	Part of the FMR/DP
		Loss of revenue	Legal and formal discussions with LGU prior to abandonment to turn over the site	RTNMC LGU	Part of FMR/DP cost; SDMP cost	Part of the FMR/DP
		Hazards on the existing mine during abandonment	Provision of proper signages/notices for deep excavations	RTNMC	Part of FMR/DP cost	Part of the FMR/DP

3.2 COST ESTIMATE FOR MANAGEMENT PLANS

Table 3.2.1 presents the estimated environmental protection expenses of RTNMC from 2019 to 2026.

Table 3.2.1. RTNMC Environmental Expenses (2019-2026)

No.	Project	2019	2020	2021	2022	2023	2024	2025	2026	2016-2026
1	Tree Planting/ Reforestation Projects	5,836	5,836	5,836	5,836	5,836	5,836	5,836	5,836	64,196
2	Mine Rehabilitation	51,538	53,752	61,263	53,544	58,823	61,263	64,328	61,263	622,109
3	Silt Control Project	10,068	15,753	10,068	12,819	10,068	10,068	10,068	10,068	133,263
4	Dust Emission Control Project	11,234	11,234	11,234	11,234	11,234	11,234	11,234	11,234	123,574
5	Heavy Metal Control Projects	705	705	705	705	705	705	705	705	7,755
6	Waste Water Treatment Control Project	1,806	1,806	1,806	1,806	1,806	1,806	1,806	1,806	11,946
7	Solid Waste Disposal Project	1,585	1,585	1,585	1,585	1,585	1,585	1,585	1,585	17,435
8	IEC and Monitoring	2,570	2,570	2,570	2,570	2,570	2,570	2,570	2,570	28,270
9	Others	11,581	11,581	14,482	11,581	11,581	13,420	11,581	11,581	137,156
Total		**96,203**	**104,102**	**108,829**	**100,960**	**103,488**	**107,767**	**108,993**	**105,928**	**1,145,704**

Source: A Feasibility Study on Mt. Bulanjao Mining Project (AMA-IVB-144A) MPSA Acquisition, 2015

Environmental Risk Assessment & Emergency Response Policy and Guidelines

Rio Tuba Nickel Mining Corporation

4

This Environmental Risk Assessment (ERA) and Emergency Response Policy and Guidelines were prepared for the proposed Rio Tuba Nickel Mining Project (AMA-IVB-144A) of the Rio Tuba Nickel Mining Corporation (RTNMC). The content of this chapter is in compliance with the scoping agreement between the Environmental Management Bureau (EMB), Gaia South, and RTNMC. The details used in this assessment are based on the components discussed in *Chapter 1*. The following discussion presents the methodology, scope and limitations, hazards identification, worst-case accident scenario, and risk management. A summary of the existing Emergency Response Plan (ERP) and Guidelines of RTNMC is presented in this chapter. The ERP document was revised and submitted to the Mines and Geosciences Bureau (MGB) on December 2008. A copy of the 2019 Annual Safety & Health Program and Emergency Response and Preparedness Program (ERPP) received by MGB on March 08, 2019 is provided as **Annex 4.1.1**.

4.1 OBJECTIVES OF THE STUDY

The objective of this ERA is to analyze the hazards associated with the proposed nickel mining project of RTNMC in Barangay Rio Tuba, Bataraza, Palawan (AMA-IVB-144A). Significant hazards associated with the project were identified and their associated risks characterized and described. This ERA also aims to come up with recommendations on risk mitigation and management based on the results of the risk assessment.

4.2 SCOPE AND LIMITATIONS

Risk characterization focused on safety as well as physical hazards. Safety hazards refer to fire, explosion and release of toxic substances. Physical hazards, on the other hand, refer to possible failure of structures that could pose threat to life, property and/or the environment. Accident consequences were described in terms of loss of human lives or injuries, property losses, and damage to the environment. The technical scoping document for the proposed project and the guideline in *Annex 2-7e, Revised Procedural Manual for DAO 2003-30* indicated that the required ERA is qualitative and descriptive in nature. Assessment of hazardous substances focused on liquid fuel (diesel), which is stored in bulk in conjunction with project operations. Occupational safety risks were also addressed. The assessment likewise covered possible accident scenarios in the projected extreme climate events associated with global climate change in the years 2020 and 2050. The study does not focus on geological, geo-technical and engineering risks as these issues are tackled in *Chapter 2*.

Since none of the substances for use in the project exceed the Level 1 Threshold Inventory limit (*Annex 2-7e*, Procedural Manual for DAO 2003-30), risk assessment on hazardous substances was mainly descriptive.

4.3 ERA CONCEPTUAL FRAMEWORK

4.3.1 The ERA Process

The Procedural Manual for DAO 2003-30 defines environmental risk assessment as "the use of universally accepted and scientific methods to assess the risks associated with a project. It focuses on determining the probability of occurrence of accidents and their magnitude. Risk is defined as a measure of potential human injury/death, economic loss, or environmental damage in terms of the probability of the loss, injury/death or damage occurring and the magnitude of the loss, injury/death or damage if it occurs. Risk involves two (2) measurable parameters: consequence and probability. In the context of this study, risk refers to qualitative or quantitative measure of hazards associated with the proposed project in Brgy. Rio Tuba, Bataraza, which is within the boundaries of AMA-IVB-144A.

4.3.2 The ERA Framework

The general framework of this ERA is illustrated in **Figure 4.3.1**.

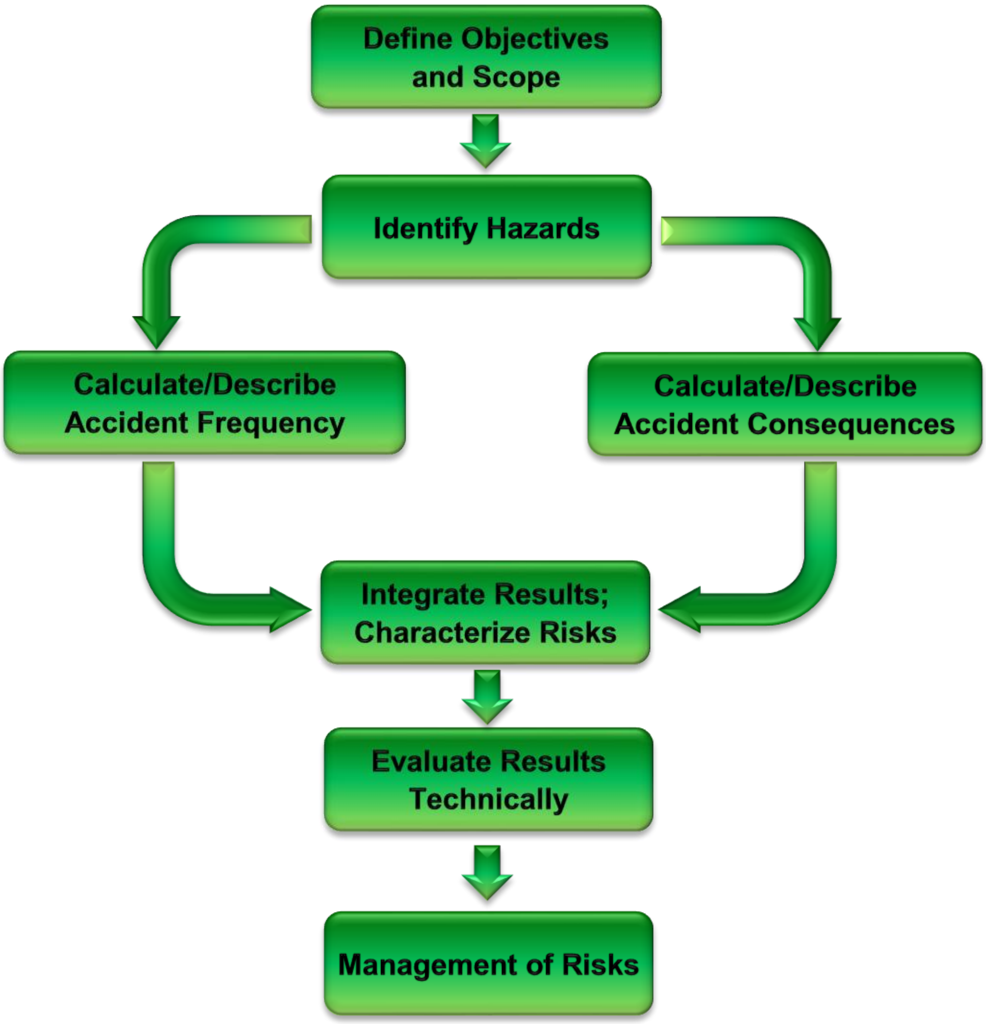


Figure 4.3.1 The risk assessment procedure

4.3.3 Hazard Identification

The various hazardous processes, activities and substances associated with the Rio Tuba Nickel Mining project in Mt. Bulanjao (AMA-IVB-144A) were identified at this stage. Hazardous activities and processes with potential to cause onsite and offsite injuries and fatalities to people were determined. The potential of substances to be explosive, flammable, and/or toxic was analyzed. The most likely initiating events and causes of failures leading to the occurrence of hazardous incidents were analyzed vis-à-vis the operation of the nickel mining project.

4.3.4 Consequence Analysis

Consequence analysis involved the estimation of unwanted consequences, effects, impacts or outcomes of projected major hazard incidents involving specific activities and substances in the facility. Major hazard incidents mean accidents involving hazardous activities or substances that have an impact in terms of death, injury or evacuation of people, damage to property or lasting harm to the environment.

The consequence analysis focused on accident scenarios that involve the release of flammable, explosive and/or toxic substances, especially on substances with quantities beyond the Level 1 Threshold Inventory limits set by DENR. Estimated was the consequence of worst-case accident scenario involving liquid fuel in storage (diesel).

Calculation of consequences was undertaken in two (2) steps. First, distance to specified endpoint of accident impacts was calculated. Secondly, the number of potential fatalities and injured people from the accident was determined. Earlier derived calculation was used to generate a map of the fatality zone. Then the number of potential fatalities was calculated. For fire/explosion accidents involving diesel, the fatality radius and fatality zones were estimated using the methodology described in IAEA-TECDOC-727 Manual (IAEA, 1996). The following assumptions were applied in the estimation of fatality radius and zone:

- The intensity of the source is the maximum possible.
- Fatality criterion for fires: 100% fatalities of the persons exposed within the fire area. The heat flux is not taken into account.
- Fatality criteria for explosions: For a vapour cloud explosion, 100% fatalities among persons engulfed in the volume of the burning cloud; lower flammability limit ignition criterion assumed (i.e. ignition occurs for vapour concentration >LFL). The overpressure is not taken into account.

4.3.5 Frequency Analysis

Frequency analysis was conducted using the methodology as described in IAEA-TECDOC-727 Manual or the "Manual for the Classification and Prioritization of Risks Due to Major Accidents in Process and Related Industries" by the International Atomic Energy Agency (IAEA, 1996). Calculating the frequency ($P_{i,s}$, number of accidents per year) of accidents involving a hazardous substance (subscript s) for a certain hazardous fixed installation (subscript i), which causes definite consequences, necessitates the calculation of the so-called probability number ($N_{i,s}$). Equation 2 in the Manual can be used to calculate $N_{i,s}$.

The formula for Eq. 2 is as follows:

$$\mathbf{N_{i,s} = N^*_{i,s} + n_1 + n_f + n_o + n_p}$$

Where:

$N^*_{i,s}$	=	the average probability number for the installation and the substance;
n_1	=	probability number correction parameter for the frequency of loading/unloading operations;
n_f	=	probability number correction parameter for the safety systems associated with flammable substances;
n_o	=	probability number correction parameter for organizational and management safety;
n_p	=	probability correction parameter for wind direction towards the populated area.

The "probability number" N has an associated equivalent frequency value P. The relationship of N to P is defined as:

$$\mathbf{N = / \log_{10} P /}$$

4.3.6 Risk Characterization

Due to the qualitative nature of this ERA, risk characterization focused on description of the risks associated with the various hazards inherent to activities, substances and conditions at the mining site. This included natural hazards arising from extreme climate events such as tropical cyclones, flooding, landslides and storm surges; as well as from earthquakes. For the fire/explosion hazards, risks were characterized using the ERA Guidelines in DAO 2003-30. In particular, it looked into the Location Specific Individual Fatality Risks (LSIFR).

Risk characterization involved the integration of the results of the consequence analysis and frequency analysis. Associated risks were characterized through the use indicative Location-Specific Individual Fatality Risk (LSIFR). The ERA Guidelines in DAO 2003-30 has set 10^{-6} fatalities per year as the maximum acceptable individual fatality risk criterion, subject to "supplemental guidelines that may be issued by the DENR Secretary". LSIFR is defined by DAO 2003-30 as "the risk of death to an individual person, if present 24 hours per day (in the open) at a particular location for a whole year". Its value can be interpreted as the probability for an individual to die in a year. The Dutch Ministry of Housing, Spatial Planning and Environment (VROM) defined individual risk (IR) as the "probability that an average unprotected person, permanently present at a certain location, is killed due to an accident resulting from a hazardous activity" (Jonkman, 2003). With the assumption that the probability of failure (P_f) approximates the frequency of accident occurrence, values of LSIFR were computed using the equation used by VROM for Individual Risk (IR), which is as follows:

$$\mathbf{IR = P_f * P_{d/f}}$$

Where:

P_f	=	the average probability number for the installation and the substance;
$P_{d/f}$	=	the probability of an individual dying in the case of failure, assuming the permanent unprotected presence of the individual

4.4 HAZARDS IDENTIFICATION

Hazards associated with the proposed project include mass movement of soil and rocks, release of contaminated sediments from settling ponds, flooding, occupational safety hazards, and fire due to storage/utilization of liquid fuel. Exposure to heavy metals and minerals from mining activities and wastes may likewise exert toxicity impacts to people, animals and plants in the affected area.

Fire hazard is chiefly attributable to storage of diesel. Occupational safety hazards may occur at the various project phases and processes from ground clearing to ore feeding and shipment. Outcomes from occupational safety hazards include deaths and injuries resulting from ground/structure failure, fall from heights, being struck or crushed by equipment parts or falling rocks/debris, vehicular/equipment accidents, and others. Mass movement of soil/rocks/sediments may result from breach of containing walls of impoundment and berms, overburden storage facilities and settling ponds. It may also arise as a direct result of ore extraction activities. Such incidents may be triggered by natural events such as inclement weather conditions (heavy and sustained rains, typhoons, storm surges, etc.), earthquakes and subsidence; faulty engineering design; inadequate maintenance of structures; and sabotage. Water contamination could result from the release of heavy metal-laden sediments, mining overburden and wastes to water bodies, particularly the streams and surrounding coastline. The water bodies could also become heavily silted with sediments.

4.4.1 Hazard Analysis Matrix

The hazards and risks associated with the various mining activities, processes and conditions are listed in the Hazard Analysis Matrix (**Table 4.4.1**).

Table 4.4.1. Hazards Analysis Matrix

Hazard Classification/ Unit Operation	Major Hazards	Initiating/ Contributing Factors	At Risk Sector
A. Fire and Explosion			
1. Storage of Diesel (maximum of 3,208,198 liters – total capacity of 3 fuel depots/storage)	Fire and explosion following major releases/ spills	• Presence of ignition sources; breach of containment; mechanical impacts; exposure to fires and high heat; corrosion; defective or substandard tank materials; breach of bund walls; vandalism	• Persons, equipment and structures within the hazard area.
B. Mass Movement of Rocks and Soil			
1. Waste overburden dumps and stock yards	• land and rock slides; • siltation of surface water bodies; and • runoffs from overburden may contain toxic heavy metals and minerals which may contaminate surface water bodies • land and rock slides; • siltation of surface water bodies; and • runoffs from overburden may contain toxic heavy metals and minerals which may contaminate surface water bodies.	• heavy rains, typhoons, earthquakes, defective engineering design.	• surrounding communities, personnel and workers • ecological entities

Hazard Classification/ Unit Operation	Major Hazards	Initiating/ Contributing Factors	At Risk Sector
2. Settling and Wastewater Ponds	• Breach of containment of ponds and drainage system could cause flooding of low-lying areas; release of heavy-metal contaminated sediments; siltation; and contamination of surface water bodies and possibly ground water with toxic heavy metals and substances.	• natural disasters (earthquakes, extreme weather); engineering problems; sabotage	• surface waters • aquatic ecological entities • surrounding communities
C. Occupational Safety Hazards			
1. Site Preparation			
a. Surveying	• fall from heights; and • vehicular accidents.	• inherent geological formations; adverse weather conditions; human error; vehicular failure	• surveying team
b. Clearing and Grubbing	• being struck by felling trees, debris and equipment part; • vibration and noise from power saws and other equipment; and • vehicular and equipment accidents (overturning, fall from heights, etc.).	• human error; equipment failure; adverse weather conditions	• clearing team
c. Laying Out	• fall from heights; being struck by vehicles and earth moving equipment; • vehicular and earth moving equipment accidents; and • electrocution.	• human error, equipment/ vehicular failure • breach of protocols	• workers, drivers and operators at site
2. Contour Mining Processes			
a. Drilling and Excavation	• fall from the edge of a bench; • being struck by falling rocks/debris at the foot of a face; • inhalation of and contact with dusts which predisposes to respiratory and skin diseases and possibly cancer; • Harmful noise levels; and • Being struck by a moving part of the drilling equipment.	• Human error • breach of protocols • equipment failure • face instability • •	• Drilling operators and assistants
b. Nickel Ore Extraction	• inhalation of and contact with dusts, nickel and other toxic heavy metals which could predispose to respiratory and skin diseases and heavy metal-induced diseases.	• lack of or inappropriate protective equipment	• Mining area operators and workers, neighboring communities
c. Ore Loading	• Being struck by falling rocks from loading arm • falls while gaining access to operator's cabin • vehicular accidents	• breach of protocols • human error • failure of hydraulic system and other equipment • uneven ground	• driver, operator, assistants, trespassers
3. Hauling and Transport of Ores and Overburden	• Vehicular accidents (fall from edge of bench, collision with other vehicles or structures, overturning, etc.); • inhalation of and/or contact with dusts; and • high level noise.	• incompetent driving • heavy rains and flooding • trespassing • breach of protocols • brake failure	• driver, pedestrians, driver of smaller vehicles,

Hazard Classification/ Unit Operation	Major Hazards	Initiating/ Contributing Factors	At Risk Sector
4. Ore Stockpiling	• Inhalation of and contact with dusts and heavy metals could predispose to respiratory/skin/eye diseases and heavy metal-induced diseases.	• airborne dusts especially with strong winds	• workers, nearby communities
D. Natural calamities due to extreme climate events (as predicted in years 2020 and 2050)			
1. Increased frequency and intensity of tropical cyclones	• flooding of low lying areas; rock and land slides; storm surges and tidal flooding.	• poor engineering design and zoning, poor maintenance of structures, defective warning systems; infrastructures along coastlines, riverbanks and flood plains	• personnel and workers of the project; contractors, nearby communities esp. along coastlines and in river banks
2. Increased intensity and frequency of rains during rainy season	• flooding of low lying areas; rock/ land slides; tidal flooding; increased soil erosion and loss of fertility.	• same as above	• same as above • farmers
3. Sea level rise	• submersion and damage of coastal infrastructures like loading/unloading piers and facilities.	• location of infrastructures near coastlines	• same as above
4. Drier dry seasons and increased ambient temperatures	• fire incidents; increased airborne dusts; drying of water reservoirs and sources	• presence of ignition sources, especially near storage of fuel and chemicals; indiscriminate disposal of live cigarette butts • inadequate dust suppression system; forest/ vegetation denudation	• personnel, workers, contractors, nearby communities
E. Natural Calamities due to Earthquakes			
1. Natural calamities due to earthquake	• collapse of infrastructues and buildings; spillage of fuel and chemicals predisposing to fires and toxic events; land slides; tsunami	• poor engineering design and zoning; poor maintenance of structures and equipment; location of buildings and other infrastructures along coastlines	• same as above

4.4.2 Risk Screening of Hazardous Substances at the Facility

A risk screening procedure was undertaken to determine the type of environmental risk assessment to be undertaken and to prioritize the environmental risks presented by the various hazardous substances and activities. The criteria and process used in risk screening was primarily based on *Annex 2-7e* (*Guidelines for the Conduct of Environmental Risk Assessment)* of the Revised Procedural Manual of DAO 2003-30. The screening criteria for hazardous substances are (1) inherent hazardous characteristics of the substance; and (2) maximum quantity involved. After classifying the substances according to defined categories (i.e. flammable, oxidizing, toxic, etc.), their respective maximum inventories were compared to DENR's threshold inventory levels (Levels 1 and 2), which are defined in the Revised DAO 2003-30 guideline. A facility that will manufacture, process or store any hazardous substance in excess of DENR's Threshold Inventory Level 2 is required to undertake a quantitative risk assessment. Those with any hazardous substance exceeding Level 1 threshold inventory but below Level 2 threshold inventory is required to undertake Hazard Analysis Study, and Emergency/Contingency Plan based on the study and worst-case scenario. For substances with maximum inventory below Level 1, a risk screening and emergency plan based on hazard analysis is required.

As far as hazardous substances are concerned, only liquid fuel (diesel) will be stored in bulk for the project. Diesel will be used as fuel for vehicles, generator sets and equipment at the mine site. No new fuel storage tanks will be installed. The project will make use of the existing two (2) storage tanks of RTNMC located at the pier site of RTNMC. Diesel requirement of the project is estimated at 1,033,292 Li per month. Maximum capacities of the two (2) existing vertical, atmospheric storage tanks are 1,077,147 Li (around 905.8 tons) and 1,711,018 (1,439 tons) Li or a total maximum capacity of 2,344.8 tons (assuming that the diesel has specific gravity of 0.841), an amount that is way below DENR's Level 1 Threshold Inventory of 5,000 tons for diesel. As such, risk screening is required for this substance. Preparation of an emergency plan based on hazard analysis is likewise required.

4.4.3 Hazardous Characteristics of Diesel

Diesel is a moderately flammable liquid fuel. The National Fire Protection Agency (NFPA) of the U.S.A. assigns to diesel a Flammability Rating 2 (ignites when moderately heated). Distillation temperature of diesel at 90% point is between 282-338°C. Its minimum flash point temperature is 52°C. Its other physico-chemical and toxicological properties are listed in **Table 4.4.2**. Fuel oil is less flammable than diesel.

Table 4.4.2. Physico-chemical and toxicological properties of diesel

Property	Value/ Description
CAS RN No(s).	68334-30-5; 68476-30-2;68476-31-3
UN Number	1993
Maximum Inventory at the Site	50 m^3
Flammability Designation/Code	Moderately Flammable
Flash Point, °C	52
Lower flammability limits in air (%)	1.3
Upper flammability limits in Air (%)	6
Autoignition Temperature, °C	254-285
Boiling/Condensation point (°C) at 1 atm	282-338
Specific gravity (liquid)	0.841 at 16°C
Vapor pressure	0.0028 bar at 21°C

4.4.3.1 Fire and Explosion Hazards of Diesel

The potential of diesel storage to pose hazards of fire and/or explosion was assessed. Vapor cloud explosions and vapor cloud fires are not significant hazards to this particular substance and activity due to the low vapour pressure of the liquid (0.042 psia at 21°C). The more probable accident scenario for this type of substance is a pool or tank-top fire.

Hazards from fires are associated with their direct heating effect, by convection within the fire itself, and thermal radiation from the fire. In case of fire engulfment, the effects of fire on humans are usually on the skin and on the lungs. Smoke rather than the fire itself is the most common cause of death indoors. Fires emit radiation, which can produce considerable impact on nearby equipment and may cause harm to people. Thermal radiation levels and their damaging effects on equipment and people are described in **Table 4.4.3** (CCPS-AIChE, 1994).

Table 4.4.3. Effects of radiation from fire

Incident Flux (KW/m^2)	Type of Damage Caused	
	Equipment	**People**
37.5	Damage to process equipment (steel structure, piping, vessels, etc,) after several minutes of exposure.	100% fatality in 1 min.; 1% fatality in 10 sec.
25.0	Minimum energey level to ignite wood at indefinitely long exposure without flame	100% fatality in 1 min.; Significant injury in 10 sec.
12.5	Minimum energy to ignite wood with a flame; melts or degrades plastic materials	30% fatality in 1 min.; 1st degree burns in 10 sec.
10.0	-	People will feel pain after 5 seconds and receive second-degree burns after 14 seconds. Usually used to define the fatality zone, as this level is expected to quickly cause third degree burns leading to potential fatalities
5.0	-	People will feel pain after 13 seconds and receive second-degree burns after 40 seconds. Usually used to define the injury zone.
4.0	-	Causes pain is duration is longer than 20 sec.; blistering is unlikely
1.6	-	Causes no discomfort even for long exposures

Sources: Taylor, 1994; USEPA, et al., 1990; World Bank Technical Paper No. 55.

4.4.3.2 Health Hazards of diesel

The NFPA Health Hazard Rating of Diesel is 1 (slightly hazardous). This slight health hazard is mainly attributable to its volatile organic compound components (VOCs), which comprise about 1.5% of its total weight. These VOCs are benzene, toluene, ethylbenzene, xylene and other alkylbenzenes. The acute effects of exposure to high level concentration of various solvents are generally very similar. High level exposure usually results to disorientation, euphoria, giddiness and confusion, progressing to unconsciousness, paralysis, convulsion, and death from respiratory or cardiovascular arrest. Chronic exposure to levels above the threshold level values may result to specific organ toxicity. The hazardous VOC components of diesel, which may exert deleterious health impacts, are benzene, toluene, ethylbenzene, and xylene.

Benzene is a proven human carcinogen. It is classified as a very hazardous substance. Toxicity to benzene frequently results from inhalation of its vapors with some undefined contribution from skin absorption. Acute exposure to high levels of benzene vapors may result to depression of the central nervous system, leading to unconsciousness and death, or death through cardiac arrythmias. The major toxic effect of benzene, however, is its hematopoietic toxicity resulting from chronic exposure to benzene vapors. Among the simple aromatic hydrocarbons, hematopoietic toxicity is unique to benzene. Chronic exposure to benzene leads to bone marrow damage, which may show initially as anemia, leukopenia, or thrombocytopenia. Continued exposure may result in pancytopenia, which may eventually lead to bone marrow aplasia, a usually fatal condition. Bone marrow depression induced by benzene appears to be dose- and time-dependent. Leukemia induced by exposure to benzene has been noted in humans. In mice and rats, chronic benzene exposure through inhalation and per oral has been shown to produce solid tumors in nonhematopoietic organs.

Alkylbenzenes. Alkylbenzenes like toluene, ethylbenzene, isopropylbenzene, trimethylbenzene and xylene are relatively non-toxic except during acute exposure to high concentrations. This could be because their major metabolic pathway is toward metabolites that have low toxicity and are readily excreted. Unlike benzene, they have not been demonstrated to be carcinogenic. Acute exposure to very high levels of these substances could result to acute toxicity manifested by central nervous system (CNS) depression, symptoms typical of acute solvent toxicity. Long term exposure could lead to CNS function impairment (Cragg et. al. 1989; Bardodej and Cirek 1988).

4.4.4 Mass Movement of Rocks and Soil from Waste Dumps and Mine Sites

Waste rocks and soil materials generated from mining and beneficiation/ sizing activities are built into a series of waste dump stockpiles or used as backfill. Major hazards associated with mine waste dumps are mass movement of rocks and soil (e.g. landslides and rockslides), soil erosion and runoffs. Such events could be initiated by natural hazards such as earthquakes, heavy rains and typhoons, and breaching of berms. Rock slides and landslides can result to loss of lives and injuries, siltation and contamination surface waters, and damage to terrestrial and aquatic environments. The waste dumps may contain high concentration of heavy metals such as nickel (Ni), chromite (Cr), cobalt (Co), cadmium (Cd), iron (Fe), lead (Pb), mercury (Hg), arsenic (As), and copper (Cu). Many of these metals have the potential to exert toxic impacts on people, flora and fauna. The disturbed condition of soil and rocks at mine sites also predisposes to mass movement of rocks and soil at the site, especially during inclement weather conditions and earthquakes. Such events could put to risk the workers at the site, as well as the mining equipment.

4.4.5 Flooding and Mass Release of Sediments from Settling Ponds

The project has several existing settling ponds and plan to construct additional ones to receive surface run-offs. Major hazards associated with the settling ponds are flooding and mass release of sediments that may be heavily tainted with heavy metals and minerals. Such events may result from breaching of walls/containment of the settling ponds. Factors that may contribute to such accidents are natural hazards like strong earthquakes, long duration heavy rains, strong typhoons, faulty engineering design, and sabotage.

Mass release of sediments and flooding can result to fatalities, injuries, heavy siltation of affected surface water systems, and destruction and contamination (with heavy metals and minerals) of affected terrestrial and aquatic environments.

4.4.6 Occupational Safety Hazards

Occupational safety issues involving the project are listed in the Hazard Analysis Matrix (**Table 4.4.1**). Occupational safety issues in mining activities include fall from heights; rock falls and soil movement accidents; vehicular/equipment accidents; being struck by equipment parts, debris, etc.; respiratory, eye and skin ailments; and hearing impairment due to high level noise.

4.4.7 Exposure to Toxic Heavy Metals and Minerals

Mining activities are expected to increase the loads of heavy metals and other toxic substances in the vicinity and at the site. Mining wastes are expected to contain high concentration of toxic heavy metals and minerals such as nickel, chromium, cadmium, cobalt, iron, manganese, mercury, lead, copper, zinc, aluminum, selenium, and arsenic. Heavy metals may be washed off from the ores and mining wastes as a result of runoff. Workers who are involved in the extraction and processing of nickel ores are likely to get exposed to these toxic substances, especially to nickel, through skin contact and inhalation of dusts. The toxicological hazards of these substances are summarized in **Table 4.4.4**. The toxicological character of the identified heavy metals and minerals are subsequently discussed.

Table 4.4.4. Heavy metals and other hazardous substances in nickel mining

Substance	Effects and Significance
Nickel	Carcinogenic; may induce contact dermatitis; may affect male and female reproductive capacity
Iron	Essential nutrient; damages fixtures by staining; partly responsible for acid mine drainage
Chromium	Essential as Cr(III), toxic as Cr(VI)
Cobalt	Toxic effects on vascular system and male and female reproductive organs
Arsenic	Toxic, possibly carcinogenic
Copper	Essential trace element; toxic to humans, plants and algae at higher levels
Lead	Toxic, harmful to humans and animals, carcinogenic
Manganese	Toxic to plants, damages fixtures by staining
Mercury	Toxic, mobilized as methyl mercury compounds by anaerobic bacteria
Zinc	Essential element, toxic to plants at higher levels

4.4.7.1 Nickel (Ni)

Nickel may be an essential trace metal in mammals, as it is involved in glucose metabolism. Excess nickel, however is toxic to life forms. Nickel is a respiratory tract carcinogen, the incidence of which is significantly higher among workers in the nickel refining industry. Severe acute and sometimes fatal toxicity may follow nickel carbonyl exposure. Nickel may also induce contact dermatitis (Goyer, 1996).

Nickel is slightly absorbed through the gastrointestinal tract. It is transported in the plasma bound to serum albumin and a host of other small organic ligands, amino acids or polypeptides. Excretion in the urine is complete in 4 to 5 days. Environmental nickel or nickel concentration in ambient air influences serum nickel concentration. A study of people living near a large nickel mine in Ontario revealed serum nickel levels of 4.6±1.4 ug/L, with range of 2.0 to 7.3 mg/L, and urinary concentrations of 7.9 ± 3.7 ug/day (range 2.3 to 15.7 ug/day). Fecal nickel is generally 100 times the concentration in urine (Goyer, 1996).

Occupational exposure to nickel predisposes humans to lung and nasal cancer. There are also evidence of increased risks from laryngeal cancer in nickel refinery workers in Norway and gastric carcinoma and soft tissue sarcomas from the Soviet Union. Increased risks from renal cancer had also been reported among nickel refinery workers in Norway and Canada. Increased risks from respiratory tract cancer had also been detected among nickel refining workers. Studies indicate that the increased risk of cancer among the nickel refining workers could be attributable to nickel subsulfide (Ni_3S_2) and nickel sulphate ($NiSO_4$), substances which are present in the nickel molten ore (Goyer, 1996). Nickel carbonyl [$Ni(CO)_4$], an extremely toxic intermediate product of nickel refining, accounts for many cases of acute toxicity among nickel refining workers.

Nickel dermatitis is one of the most common forms of allergic contact dermatitis. Increased ingestion of nickel-containing food increases the probability of external sensitization to nickel and eventually the episodes of acute nickel dermatitis (Goyer, 1996). Nickel is also reported as affecting male and female reproductive capacity (Thomas, 1996).

4.4.7.2 Iron (Fe)

Elemental and iron compounds are usual components of mining wastes. In fact, limonite type of lateritic nickel is highly enriched in Fe. Iron is an essential element to human and animal metabolism in trace amounts. In excess, it can exert toxic effects and environmental impacts. The iron compound pyrite (FeS_2) is partly to blame for acid mine drainage, one of the most common and damaging problems in the aquatic environment. Acid mine water is a consequence of the presence of sulfuric acid produced by the oxidation of pyrite, a process that occurs very slowly at low pH conditions. Below pH 3.5, the iron oxidation is catalyzed by the iron bacterium *Thiobacillus ferrooxidans*, and in the pH range 3.5-4.5 it may be catalyzed by a variety of *Metallogenium*, a filamentous iron bacteria. The beds of streams afflicted with acid mine drainage are usually covered with “yellowboy”, an unsightly deposit of amorphous, semigelatinous $Fe(OH)_3$. The product sulfuric acid is however the most damaging component of acid mine water. It is directly toxic to organisms and plants (Manahan, 1994).

4.4.7.3 Chromium (Cr)

The process of nickel mining may facilitate the release of chromium to the environment. Chromium is extracted from chromite ore, the molecular formula of which is [(Fe, Mg)O(Cr, Al, $Fe)_2O_3$]. The largest deposits of chromite are located in the Philippines, South Africa, the former USSR, southern Zimbabwe and Turkey (Losi et al., 1994). Chromium in trace amounts is an essential element of human and animal nutrition. It is important in glucose and fat metabolism. Trivalent Cr is the nutritionally useful form while the hexavalent form is toxic and mutagenic. The biotoxicity of chromate is mostly a function of its ability to cross biological membranes and its powerful oxidizing capabilities. Cr(VI) compounds can be absorbed by humans through inhalation, dermal contact, and ingestion. Excessive Cr exposure can result to ulceration and perforation of the nasal septum, respiratory cancer, skin ulceration, contact dermatitis, and in the event of ingestion, kidney damage. It can also cause damage to various proteins and nucleic acids, which can lead to mutation and carcinogenesis (Lewis and Bianchi, 1982).

4.4.7.4 Cobalt (Co)

Like the other heavy metals selenium, chromium, copper, zinc, cadmium, lead and mercury, cobalt is known to exert toxic effect on the vascular system through blocking of the calcium channels and through reactions with the sulfhydryl, carbonyl, or phosphate groups (Ramos et al., 1996). It is also known to be toxic to the male and female reproductive capacity like the heavy metals aluminium, boranes, boron, cadmium, lead, mercury and nickel. Excess of cobalt has been demonstrated to cause testicular toxicity through inhibition of DNA synthesis Thomas, 1996).

4.4.7.5 Arsenic (As)

Arsenic may form part of the mining waste. Arsenic is a general cytotoxicant, which can elicit injury to most cells and organ systems. It chelates with alpha-lipoic acid, disrupting energy production from the Kreb Cycle. Alpha-lipoic acid is an essential co-factor for pyruvate dehydrogenase, an enzyme required in the Kreb Cycle. Arsenic is mostly in the form of arsenate in the biological system. It mimics the phosphate oxyanion in cells. “Substitution” of phosphate by arsenate effectively disrupts a variety of metabolic reactions, resulting in the inhibition of ATP formation. The general effect is toxicity to the cells (Chang and Cockerham, 1994).

4.4.7.6 Mercury (Hg)

Mercury may also form part of the mining waste. Mercury is a naturally occurring element present in rocks and ores. It is found as a trace component of many minerals, with continental rocks containing an average of around 80 ppb. It often has significant correlation with carbon, sulphur and zinc. Its concentration varies with location depending on the nature of the bedrock and degree of mineralization. Up to as much as 1000 µg/g maybe contained in some ores. The general terrestrial concentration of mercury appears to be in the order of 0.05 ug/g (Wren et al., 1995). Mercury is well-known to bioaccumulate or bioconcentrate in aquatic food chains. Bioaccumulation occurs because mercury when methylated, is very effectively absorbed by a variety of aquatic organisms. Unlike in aquatic ecosystems, bioaccumulation of mercury in terrestrial ecosystems is relatively low.

Inhalation of mercury vapour (elemental mercury) may produce acute, corrosive bronchitis and interstitial pneumonitis. If not fatal, it may be associated with central nervous system effects such as tremors or increased excitability. Exposure to inorganic mercuric ions increases risks of kidney damage. Mercury vapour and organomercury are potent neurotoxicants. Methylmercury is well-known as an extremely toxic substance in the environment. The sysmptoms of methylmercury poisoning (Minimata disease) are mainly neurological in nature. It includes ataxia, constriction of visual field, sensory disturbance, impairment of speech, impairment of hearing, tremors, metnal disturbance, and many others (Chang and Cockerham, 1994).

4.4.7.7 Manganese (Mn)

Manganese may also constitute one of the heavy metal wastes of mining. This metal is neurotoxic and could induce Parkinson-like syndromes and degeneration of the caudate nucleus, basal ganglia, and substancia nigra (Chang and Cockerham, 1994).

4.4.8 Natural Hazards Due to Extreme Climate Events

The increasing frequency and intensity of extreme climate events are being attributed as direct consequences of global climate change, which is primarily due to global warming. As stated by the Manila Observatory (2010) in its paper *Technical Primer on Climate Change in the Philippine*, “Climate change will increase the magnitude and frequency of weather hazards to an unknown degree”. This phenomenon poses an increased risk of disasters in the Philippines, as risk is not only proportional to the magnitude of events but on the number of people affected and their capacity to recover from the impacts of an event.

Other direct impacts of climate change in the Philippines are significant increases in frequency of high extreme ambient temperature (>35°C), which manifests as significant increase in the frequency of hot days and warm nights; drier dry seasons (March to May for Palawan); and wetter rainy seasons (September to November for Palawan). Based on climate modeling conducted by PAGASA for the various regions of the Philippines, annual mean temperatures are expected to rise by 0.9 degrees Celsius to 1.1 degrees in 2020 and by 1.8 degrees to 2.1 degrees in 2050" (Hilario, et al., n.d.). PAGASA likewise predicted that "the drier seasons of March-April-May will become drier still, while the wetter season of September, October and November will become wetter" (Hilario, et al., n.d.).

Based on the modeling conducted by PAGASA, the Province of Palawan will experience a 7.2% decrease in rainfall in the months of March to May and a decrease of 2.6% for the months of June to August for the years 2006-2035. However, the wettest season of September to November will experience a mean rainfall increase of 19.6%. By the year 2050 (2036-2065), PAGASA predicts a trend of 9.0% rainfall decrease for the dry months of March to May. The Province is predicted to experience a rainfall increase for all other months (7.3% for December to February, 1.0% for June to August and 6.9% for September to November).

4.4.8.1 Projected Hazards by 2020

The projected increased rainfall intensity during the wet months of September to November implies greater risks from hazards brought about by flooding, landslides, soil erosion, siltation of surface water bodies, and loss of soil fertility. The unusually drier periods during the months of March to May, coupled with ambient temperature extremes, implies greater risks from fire, low water supply, greater airborne dusts, drying up of water reservoir, and dry season related diseases (i.e. respiratory ailments, heat strokes, etc.).

4.4.8.2 Projected Hazards by 2050

The period from 2036 to 2065 is predicted to experience a decrease in rainfall in the months of March to May. The rest of the months will experience increases in rainfall, with the rainiest months being September to November. The decrease of rainfall in the dry months, coupled with increased frequency in the occurrence of high extreme temperatures, could result to greater risks from drying up of surface water bodies, fire, greater airborne dusts, and diseases that thrive during the dry and hot seasons (i.e. respiratory ailments, heat strokes, prickly heat, nose bleeding, exacerbation of heart conditions, etc.). Assuming that the mining operations in the area is still ongoing, this could also mean greater risks from occupational safety and health hazards, as workers become more prone to fatigue, dizzy spells, dehydration, and heat stroke in extremely hot conditions. They may also suffer more from skin irritations and contact dermatitis, due to increased sweating and more airborne dusts. The temperature rise is expected to bring about an increase in the frequency, strength and range of tropical cyclones (Manila Observatory, 2010).

4.5 WORST-CASE ACCIDENT SCENARIO ANALYSIS OF DIESEL IN STORAGE

4.5.1 Consequence Analysis

The consequence of the worst-case accident scenario involving diesel was analyzed in order to visualize the extent of the hazard footprint in the event of the most severe accident scenario, which is assumed to involve the entire maximum amount of diesel that can be contained in the two (2) storage tanks or an amount of 2,344.8 tons of diesel.

The accident scenarios were selected/ formulated based on the principle that such will give the highest accident consequences. As such, the highest possible amount of the substance of consideration was employed. The largest inventory of liquid fuel is found in the liquid fuel storage tanks.

The consequence of fire and/or explosion accidents involving liquid fuel storage was analyzed using the methodology described in IAEA-TECDOC-727 Manual (IAEA, 1996). The consequence analysis assumed maximum inventory of liquid fuels at the storage site. A summary of the parameters and results of the consequence calculation and their references within the IAEA-TECDOC-727 Manual are in **Table 4.5.1**. **Figure 4.5.1** shows the fatality hazard zone that may arise from the postulated worst-case accident scenario for diesel storage.

Table 4.5.1. Parameters and results of consequence modeling of diesel fire/explosion worst case accident scenario

Parameters	Value	Reference/ Explanation
Maximum capacity of 2 diesel storage tanks	2345.8 tons	RTNMC data
Reference Number	1	Table IVa (flammable liquid, v.p. <0.3 bar at 20^{o}C, storage with tank pit)
Effect category classification	BI	Table IVa
Max. effect distance (fatality radius)	50 m	Table V
Max. effect area (fatality zone)	8000 m^2	Table V

Summary of Results. Based on worst-case fire/explosion accident scenario modelling using IAEA-TECDOC-727 Manual, the maximum specified amount of diesel that can be stored at the diesel storage site may exert a fatality radius of 25 to 50 m from the fuel storage area and a maximum fatality zone of 8000 m^2, with circular characteristics. As shown in **Figure 4.5.1**, the hazard zone of the worst-case accident scenario may involve at least one residential structure.

Figure 4.5.1. Fatality zone of the postulated worst-case accident scenario arising from fire/explosion hazards from diesel storage at the RTNMC fuel farm site.

4.5.2 Frequency Analysis

Frequency analysis for the diesel fire/explosion scenario yielded a probability number of 8.0 or an equivalent frequency value of 1 x 10^{-8} events per year or an accident probability of one event per 100 million years. The frequency of accident occurrence was estimated using the methodology described in IAEA-TECDOC-727 (IAEA, 1996). The same assumptions in the consequence calculation section were applied. Results of the frequency calculation are listed in **Table 4.5.2**, together with the parameters and basis for the computations.

Table 4.5.2. Frequency value and basis of calculations for the diesel fire/explosion worst case accident scenario

Parameters	Value	Reference/ Explanation
Reference Number	1	Table IVa
Effect Category	BI	Table IVa
$N^*_{i,s}$	8	Table IX
n_1	0	Table X(a); frequency of loading = 24 per year
n_f	n.a.	Table XI
n_o	0	Table XII (average industry practice)
n_p	0	Table XIII
Probability Number ($N_{i,s}$)	8.0	
Frequency ($P_{i,s}$), events per year	**1 x 10^{-8}**	Table XIV

4.5.3 Risk Characterization

Based on the results of the calculations of the consequence and frequency analyses, indicative risk values were derived. The worst-case accident scenario (a fire/explosion accident involving the entire contents of the two diesel storage tanks filled to capacity) would create a maximum fatality radius of 50 m from the storage tanks. The probability of this event occurring is estimated at one event per 100 million years. Assuming that the probability of death to a person exposed to the accident within the said hazard radius is 100%, the indicative location-specific individual fatality risk (LSIFR) within the said 50-m radius was estimated using the equation given by the Dutch Ministry of Housing, Spatial Planning and Environment (VROM). The said equation is described in Section 2.6 of this document. The probability of failure was assumed to approximate the frequency of accident occurrence. Result and bases of the LSIFR computation are shown in **Table 4.5.3**. The equation used in computation of LSIFR Individual Risk (IR) is summarized below:

$$\mathbf{IR = P_f * P_{d/f}}$$

Where: $\mathbf{P_f}$ = the probability of failure
$\mathbf{P_{d/f}}$ = the probability of an individual dying in the case of failure, assuming the permanent unprotected presence of the individual

Table 4.5.3. Result and bases for the computation of indicative LSIFR

Parameters	Value	Reference/ Explanation
$\mathbf{P_f}$	1 x 10^{-8} events/year	**Table 3.5.2** (assumed to approximate accident frequency)
$\mathbf{P_{d/f}}$	1	100% fatality was assumed to occur within the hazard zone
Indicative LSIFR (IR)	1 x 10^{-8} fatalities/year	IR = P_f * $P_{d/f}$
LSIFR criterion	1 x 10^{-6} fatalities/year	DAO 2003-30

Based on the above computation, the derived indicative LSIFR value was **1 x 10^{-8} fatalities/year,** a value that is much lower than the standard individual fatality risk of **10^{-6} fatalities/year**. As such, it may be said that the individual fatality risk from the storage of diesel at the RTNMC fuel storage farm is low and may well be within acceptable levels.

4.6 RISK MANAGEMENT

The risk assessment conducted showed that risks expected from the project are low and can be prevented and/or controlled with application of appropriate mitigation measures. In particular, risk from explosion and fire hazards associated with diesel storage are low and within acceptable limits based on DENR criteria. Other hazards identified are mass movement of rocks and soil, flooding and mass release of sediments from settling ponds, exposure to toxic heavy metals, occupational safety hazards, and natural calamities. The control and prevention of project-associated risks is dependent on RTNMC's capability to pursue their risk management and emergency plans.

It would be for the interest of the Company and the surrounding communities that identified risks be further managed and reduced to as low as can be reasonably attained. Reasonable in this context means a balance between the values of increased safety, environmental protection or lives saved and the costs involved in the process of risk reduction. Major considerations in risk reduction are appropriate project design; compliance with standards in the design, construction and maintenance of the mining equipment and facilities; well-maintained safety systems; well-trained and motivated workforce; and the establishment of an appropriate emergency response and contingency systems.

4.6.1 Safety Policies and Guidelines

RTNMC has been in the business of nickel mining in Rio Tuba for several years. A review of its general accident reports from the years 2012 to 2015 showed that most of the accidents reported were non-lost time accidents. Only two (2) cases were lost time accidents (LTA). The Company enjoys a good reputation as far as health and safety program implementation is concerned. It has also consistently formulated and implemented an annual Safety and Health Program (SHP), which incorporates an Emergency Preparedness and Response Plan, for the period.

In compliance with DAO 2000-98 the Company provided copies of the SHPs to the MGB Regional Office. The Company has regularly allocated a sizable budget for its annual SHP. It has a dedicated hospital for its workers, employees and their dependents. Each SHP contains a well-defined safety policies, rules and protocols, and organization. It likewise contains a geo-hazard map of its various sites, which identifies the landslide susceptible areas as well as the flood prone areas. In conjunction with this, it has formulated detailed plans of action for identified contingency situations. It also has plans for training and equipping personnel to face various contingency situations.

Pursuant to its SHP, the Company has consistently implemented safety trainings for management personnel, employees and contractors. It also provided its workers and employees with appropriate PPEs such as hard hats, gloves, and safety goggles. Its facilities are provided with firefighting equipment and facilities. Fuel storage tanks are provided with appropriate bund walls.

To prevent and/or control the identified risks and hazards in its new nickel mining project in Mt. Bulanjao (AMA-IVB-144A), RTNMC should continue to vigorously pursue the implementation of its Safety and Health Program and its Emergency Preparedness and Response Plan that are appropriately adapted to the new project.

4.6.2 Emergency Preparedness and Response Plan

The succeeding sections discuss the 2019 Emergency Response and Preparedness Program of RTNMC which will be adopted for the operation of the proposed mining project in Bulanjao.

4.6.2.1 The Emergency Response and Preparedness Program

This **Emergency Response Plan** was prepared by RTNMC as an administrative guide to individuals providing essential services in the event of major emergency. The Resident Mine Manager activates it whenever such emergency reaches proportions beyond the capacity of routine procedures. The company coordinates closely with the local police, fire department, hospital and other concerned agencies during an emergency.

The major goals of the ERP are the preservation of life, the protection of property and the continuity of project operations. The administrative/management office and the Central Safety and Health Committee will be responsible for formulating and maintaining the standard operating procedures to be followed in the event of a disaster.

4.6.2.2 Scope of the Plan

The formulated ERP covers the following threats that require immediate response:

- Tropical typhoon
- Flood
- Vehicle accident
- Blasting explosion
- Acid spill
- Methanol fire
- Fire
- Oil spill
- Aircraft incident
- Breach of siltation dikes
- H_2S Gas Leak
- Ore Spill
- Chemical spill at Assay Laboratory

It is applicable to the local mine lease area, plant site area, airport area, townsite area, Macadam road and pier site area.

4.6.2.3 Requirements

The ERP includes the basic requirements to alleviate the impacts of each encountered emergency event. These are the control and support coordination

Control

The function of directing and coordinating all actions including other organizations with the essentials of the event is the responsibility of the Safety Engineer. The Resident Mine Manager on the other hand instructs and advises the Safety Engineer as needed.

Support Coordination

The Safety Engineer has the full authority to appoint and direct personnel and to secure any needed service vehicle or equipment based on the requirements of the imposed threat.

4.6.2.4 Duties and Responsibilities

Emergency Response Team

With the advice of the Resident Mine Manager, Safety Manager or Safety Engineer, the team shall execute the emergency procedures.

Resident Mine Manager

He has the full management and directive over the Emergency Response Team. He is also responsible with the information dissemination both internally and externally should a major accident occur.

Safety Manager

Preparation of an Emergency Response plan and ensuring that all staff and contractors are aware and familiar with the emergency procedures shall be the responsibility of the Safety Manager.

Safety Engineer

Essentially, the Safety Engineer directs action in an emergency, directs the assigned committee members, connects with the outside organizations and initiates the necessary action for those injured during the accident and has the capacity to direct in case of fire occurrences and ensures the availability of ambulance and other needed transport vehicles.

Safety Supervisor

The main function of the Safety Supervisor is to ensure that measures indicated in the procedures are observed, effectively executed and communicated to the workforce.

Crisis Management Team

The main responsibility of this team is to ensure all resources needed in the response are available. The team shall be composed of Division and Department Managers, Safety Manager, Security Consultant, Medical director, Chief Mine Engineer, Accounting Head, COMREL Manager, Legal Officer, IT head and RTNW Union President.

Response Teams

The following teams shall be responsible for the execution of the appropriate emergency response procedures in case each corresponding threat occurs:

- *Oil Spill Emergency Response Team;*
- *Ore Spill Emergency Response Team;*
- *Silt/Water Impounding Structure Emergency Response Team;*
- *Fire Brigade Team;*
- *Flood and Typhoon Reaction Committee;*
- *Assay Laboratory Chemical Spill Emergency Response Team;*
- *First Aid and Rescue Team; and*
- *Natural Disaster Response Team*

Support Group

The following support groups shall coordinate with the Safety Engineer and will initiate appropriate actions as per instruction:

- Mine Operation Department;

- Maintenance Department;
- Transport Section;
- Finance Section;
- Relief Section;
- Medical Section;
- Security Section;
- PCO Section;
- Safety Section; and
- Electrical.

4.6.2.5 Emergency Communication System

RTNMC has devised a communication system, to deliver immediately the message to the responsible group.

Device	Procedure
Telephone	Dial – 611 (RTNFI Hospital) Dial – 811 (Safety) Dial – 805 (Security) Dial – 835 (MLO Dispatcher) • Give your name and location. • State briefly and clearly nature of emergency. • Stay if possible at emergency site until emergency personnel arrive.
Two-way Radio	• Call “Emergency, Emergency, Emergency”. • Give your name and location. • State briefly and clearly nature of emergency. • Assist where possible at emergency site until emergency personnel arrive.

4.6.2.6 Summary of Emergency Procedures

Table 4.6.1 summarizes the contingency procedures for each identified accident.

Table 4.6.1 Emergency Preparedness and Response

Incident	Contingency Procedure
Accident at Work Place	For the specific procedures for each case, please refer to ***Annex 4.1.1*** pages 14 to 22. • General Instruction in Giving First Aid • Transporting an injured person
Material transportation spill	The following procedures were formulated in the event of spillage of materials during transport truck accident along Macadam Road and ore spill during transportation at sea: 1. For the procedure in case nickel ore materials spillage happens along the Macadam Road refer to ***Annex 4.1.1*** pages 23 to 24. For the procedure in case nickel ore materials spillage happens at sea-route for tugboat and loaded barge from jetty to vessel refer to ***Annex 4.1.1*** pages 24 to 25.
Natural Disasters	<u>*Earth Quake*</u> 1. When shaking begins, everyone shall: a. DROP, COVER, HOLD ON. Move only a few steps to a nearby safe place or the designated muster point. b. Stay indoors until shaking stops and make sure it’s safe to exit. c. Stay away from windows d. Stay calm but must alert. e. If outdoors, find a clear spot away from buildings, trees, and

Incident	Contingency Procedure
	power lines of electric cable. Drop to the ground. f. If in car slow down and drive to a clear place. Stay in the car until the shaking stops. 2. When the shaking stops: a. The Safety Engineer shall coordinate with the electrical group to sound the alarm signal and activate the whole Emergency Response Team to act on the possible result of the aftershock. He shall maintain communications with the RMM, to the Crisis Management Team and all the leaders of other ERT. b. If safe to do so, the Safety Engineer shall direct everybody to the evacuation areas with the aid of other ERT and support group c. The PCO shall then report immediately the incident to the concerned Government Agencies. *Landslide* In the event of landslide, the following will be carried out: 1. Every employee shall: a. Stay alert and awake. b. Listen to a battery-powered radio. c. Listen for any unusual sounds that might indicate moving debris,such as cracking trees and flowing or falling mud. d. Be especially alert when driving. Embankments along roadsides are particularly susceptible to landslides. e. Watch the road for collapsed pavement, mud, fallen rocks, and other indications of possible debris flows. f. Be prepared to move quickly. Don’t delay. Save yourself, not your belongings. 2. After the landslide, the Safety Engineer shall: a. Activate the whole Emergency Response Team to act on the possible impact of the landslide. b. He shall maintain communications with the RMM, to the Crisis Management Team and all the leaders of other ERT. c. If safe to do so, he shall direct everybody to the evacuation areas with the aid of other ERT and support group. *Flood or Typhoon* For the procedures to be carried out in the event of flood or typhoon, please refer to ***Annex 4.1.1*** pages 27 to 33.
Threat and Bomb Explosion	In this case, the Security Coordinator shall act as the Incident Commander and directly reporting to the Resident Mine Manager. For the procedures for bomb attack prevention, refer to ***Annex 4.1.1*** pages 34 to 35. For the procedures to be carried out in case of bomb threat, refer to ***Annex 4.1.1*** pages 35 to 37.
Dengue/ Malaria Outbreak	The following procedures shall be strictly observed during outbreak: 1. Search and destroy possible breeding places of dengue-causing mosquitoes like flowers pots, vase, discarded plastic bags, bottles, old tires, cans, earthen jars, coconut husks, roof gutter, water drums, and other containers that might hold clean stagnant water. 2. Self-protection measures include wearing long sleeves or long pants. 3. Seek early consultation because dengue is crucial. 4. Say no to indiscriminate fogging.
Fire and Explosion	In case of fire emergency, the following procedures stated in ***Annex 4.1.1*** pages 39 to 42 will be followed.
Tailings dam and other silt and water impounding	Procedural details for the following are provided in ***Annex 4.1.1*** pages 42 to 47: • Identification of the impounding structure; • Identification of the location of risks;

Incident	Contingency Procedure
structures	• Access from the RTNMC Admin Building; • Other Silt/Water Impounding Structure; • Possible Failure of Structures; • Level of Emergency; • Remedial Measures; • CBNC Silt/Water Impounding Structure; • Communication and Activation Emergency Response Team; • Evacuation; and • Equipment.
Explosion of pressurized tanks and vessels	Procedural details are provided in ***Annex 4.1.1*** pages 48 to 49.
Oil Leak/Spill	See ***Annex 4.1.1,*** pages 50 to 63 for specific procedures.
Aircraft Incident	See ***Annex 4.1.1,*** pages 64 to 67 for specific procedures.
Assay Laboratory Chemical Spill	See ***Annex 4.1.1***, pages 67 to 69 for specific procedures.

4.6.2.7 Emergency Response Team

The Emergency Response Team (ERT) is headed by the Resident Mine Manager as the Overall Commander while the Safety Engineer acts as Incident Commander. The ERT Team Members are the Department Manager Power/Electricity, Division Manager Production, Division Manager Services, Division Manager Mechanical, and other division, department and section units (**Figure 4.6.1**).

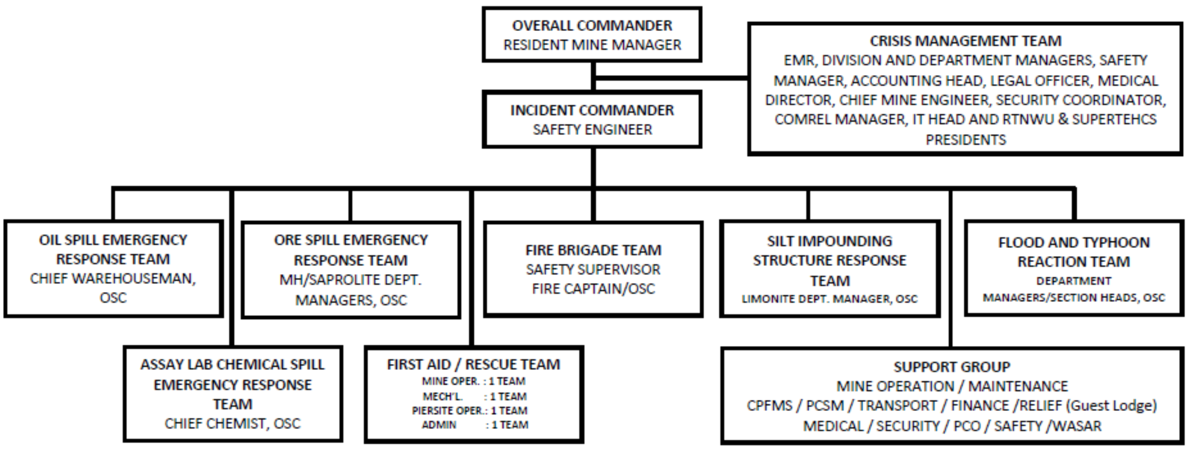


Figure 4.6.1. The RTNMC Emergency Response Team

4.7 SUMMARY AND RECOMMENDATIONS

Hazards associated with the Project are mass movement of soil/rocks from waste dumps and mine sites; mass release and/or leaching of heavy-metal contaminated sediments from settling ponds; flooding; occupational safety hazards; fire/explosion hazards from storage of fuels (diesel); exposure to dusts and toxic heavy metals; siltation and contamination of surface water bodies with heavy metals; soil erosion and loss of soil fertility; and natural calamities, especially during extreme climate events. Exposure to heavy metals and minerals from mining activities and wastes may exert toxicity impacts to people, animals and plants in the affected areas.

Occupational safety hazards may occur at the various operation units from project site preparation to barge/ship loading. Outcome of occupational safety hazards include deaths and injuries resulting from ground/structure failure, fall from heights, being struck or crushed by equipment parts or falling rocks/debris, vehicular/equipment accidents, and others. Mass movement of soil and rocks may occur at waste dumps, mine sites and in disturbed elevated areas. Mass release of contaminated sediments and flooding may arise mainly due to breach of containing walls of impoundment and dikes especially at settling ponds and overburden storage facilities. Such incidents may be triggered by natural events such as extreme climate events (torrential rains, strong typhoons, storm surges, etc.) earthquakes and subsidence; faulty engineering design; inadequate maintenance of structures; and sabotage. Water contamination could result from the release of heavy metals, minerals, and mining overburden and wastes to water bodies.

The surface water bodies could also become heavily silted and contaminated with heavy metals. Fire/explosion hazard is chiefly attributable to bulk storage diesel.
The consequence and frequency analysis from fire/explosion hazards due to liquid fuel storage was quantified using the methodology described in the IAEA-TECDOC-727 Manual (IAEA, 1996). Hazards and risks from other activities and concerns were mostly descriptive and qualitative in nature. The calculated indicative LSIFR from the worst-case accident scenario modelling was 10^{-8} fatality per year, a figure that is lower than the DENR LSIFR criterion, which is 10^{-6} fatality per year.

Particular recommendations to mitigate and manage the identified hazards are listed in **Table 4.7.1**.

Table 4.7.1. Identified hazards and corresponding mitigating measures

Hazard Classification/ Unit Operation	Major Hazards	Initiating/ Contributing Factors	At Risk Sector	Mitigating Measures
A. Fire and Explosion				
1. Liquid Fuel Storage (Diesel)	Fire following major releases/ spills	• Presence of ignition sources; breach of containment; mechanical impacts; exposure to fires and high heat; corrosion; defective or substandard materials; vandalism	• Persons, equipment and structures within the hazard area.	• Remove/reduce ignition sources in the area. • Ensure regular inspection and maintenance bund containments (bund capacity should at least be 110% of the tank's capacity). • Ensure regular inspection and maintenance of tanks, pipings, hoses, valves, gauges and other accessories. • Maintain a safety radius or buffer zone around the facility. • Ensure provision of fire control devices and systems. • Ensure strict adherence to Emergency Preparedness and Response and Plan (EPRP). • Ensure maintainance of properly functioning fire trucks, fire extinguishers and other fire fighting equipment.
B. Flooding and/or Mass Movement of Rocks and Soil				
1. Waste Overburden Dumps and Mine sites	• land and rock slides • siltation of surface water bodies • runoffs from overburden may contain toxic heavy metals and minerals which may contaminate surface water bodies	• heavy rains, typhoons, earthquakes, defective engineering design, sabotage	• personnel, workers and contractors, surrounding communities • ecological entities	• Ensure regular inspections and proper maintenance of containment berms. • Batter off final waste dump slope to at most 20 degrees. • Use wastes and overburden as backfill. • Ensure implementation of rehabilitation plan on waste dumps. • Ensure proper siting of the overburden/waste storage facility.
2. Settling Ponds	• Breach of containment of ponds and drainage system could cause flooding of low-lying areas; siltation and contamination of surface water bodies and possibly ground water with toxic heavy metals and substances	• natural disasters (earthquakes, extreme climate events); engineering problems; sabotage	• surface waters • aquatic ecological entities • surrounding communities • mine workers and contractors	• Ensure appropriate siting, design and construction of the facilities. • Ensure regular, as well as emergency. inspections and monitoring of structures • Ensure proper and regular maintenance of the facility. • Strictly implement security measures to prevent sabotage of infrastructures.
C. Occupational Safety Hazards				
1. Site Preparation				
a. surveying	• fall from heights • vehicular accidents	• inherent geological formations; adverse weather conditions; human error; vehicular	• surveying team	• Ensure that vehicles used are well maintained and suitable for the terrain. • Strictly implement safety protocols.

Hazard Classification/ Unit Operation	Major Hazards	Initiating/ Contributing Factors	At Risk Sector	Mitigating Measures
		failure		
b. Clearing and Waste Stripping	• being struck by felling trees, debris and equipment part • vibration and noise from power saws and other equipment • vehicular and equipment accidents (overturning, fall from heights, etc.)	• human error; equipment failure; adverse weather conditions	• clearing team	• Adopt and implement the safest methods/ technology. • Ensure that persons doing specialized tasks • (eg. Tree felling) are fully trained. • Use of well-maintained equipment. • Ensure use of personal protection gears
c. Laying Out	• fall from heights; being struck by vehicles and earth moving equipment • vehicular and earth moving equipment accidents • electrocution	• human error, equipment/ vehicular failure • breach of protocols	• workers, drivers and operators at site	• Use of well-maintained and suitable equipment and vehicles. • Use of properly trained crew and operators, especially drivers of large equipment like cranes and earth moving vehicles.
2. Contour Mining Operation				
a. Drilling and Excavation	• fall from the edge of a bench • being struck by falling rocks/debris at the foot of a face • inhalation of and contact with dusts which predisposes to respiratory diseases • Harmful noise levels • Being struck by a moving part of the drilling equipment	• Human error • breach of protocols • equipment failure • face instability	• Drilling operators and assistants	• Use of well-maintained and suitable equipment and vehicles. • Use of properly trained crew and operators, especially drivers of large equipment like cranes and earth moving vehicles.
b. Ore Extraction	• inhalation of and contact with dusts, nickel and other toxic heavy metals which could predispose to respiratory and skin diseases and heavy metal-induced diseases.	• lack of or inappropriate protective equipment	• Mining area operators and workers	• Ensure use of appropriate personal protection equipment. • Use of appropriate equipment and vehicles with protective operator cabin.
c. Loading	• Being struck by falling rocks from loading arm • falls while gaining access to operator's cabin	• breach of protocols • human error • failure of hydraulic system and other	• driver, operator, assistants, trespassers	• Ensure that drivers are well-trained. • Ensure use of appropriate and properly maintained vehichles and equipment. • Ensure implementation of safety protocols.

Hazard Classification/ Unit Operation	Major Hazards	Initiating/ Contributing Factors	At Risk Sector	Mitigating Measures
	• vehicular accidents	equipment • uneven ground		
3. Transport of Ores and Overburden	• Vehicular accidents (fall from edge of bench, collision with other vehicles or structures, overturning, etc.) • inhalation of and/or contact with dusts • high level noise	• incompetent driving • heavy rains and flooding • trespassing • breach of protocols • brake failure	• driver, pedestrians, driver of smaller vehicles	• Avoid operation during inclement weather. • Maintain proper security and cordon off hazardous areas. • Ensure good maintenance and regular testing vehicles, especially of brakes. • Driver/operator cabs are protected from dusts and heat. • Restrict access to vehicles
4. Ore Stockpiling	• Inhalation of and contact with dusts and heavy metals could predispose to respiratory/skin/eye diseases and heavy metal-induced diseases.	• airborne dusts especially with strong winds	• workers, drivers of equipment	• Provide workers and operators with personal protection equipment (e.g. masks, gloves, googles).
D. Natural calamities due to extreme climate events (as predicted in years 2020 and 2050)				
1. Increased frequency, intensity and range of tropical cyclones	• flooding of low lying areas; rock and land slides; storm surges and tidal flooding	• poor engineering design and zoning, poor maintenance of structures, defective warning systems; infrastructures along coastlines, riverbanks and flood plains	• personnel and workers of the project; contractors, nearby communities especially along coastlines and in river banks	• Ensure regular review of the Project's ERPP to ensure its adequacy and effectiveness to respond to changing situations. • Ensure strict implementation of and compliance with the safety and health program, especially the EPRP. • Ensure regular and timely inspections and monitoring of containment dikes, retaining walls, and other retaining structures. • Ensure that all personnel, workers and contractors are properly oriented of the EPRP and ensure the regular conduct of emergency drills for situations such as fires, tsunami, flooding and earthquakes. • Conduct seminars, workshops, and other education/ information campaigns on climate change, its impacts and appropriate responses to mitigate impacts (tailored to the specific condtion in the area).
2. Increased intensity and frequency of rains during wet season (Sept. to Nov.)	• flooding of low lying areas; rock/ land slides; tidal flooding; increased soil erosion and loss of soil fertility	• same as above	• same as above • farmers	
3. Drier dry seasons (March to May) and increased ambient temperatures	• fire incidents; increased airborne dusts; drying of water reservoirs and sources; increased diseases (i.e. respiratory, skin diseases,	• presence of ignition sources, especially near storage of fuel and chemicals; indiscriminate disposal of live cigarette	• personnel, workers, contractors, nearby communities	• Ensure the implementation of the rehabilitation and reforestation program of mined-out areas and other denuded areas. • Strictly implement fire prevention and control measures and protocols.

Hazard Classification/ Unit Operation	Major Hazards	Initiating/ Contributing Factors	At Risk Sector	Mitigating Measures
	heat strokes, dizzy spells other diseases linked with hot, dry seasons)	butts • inadequate dust suppression system; forest/ vegetation denudation		• Ensure strict implementation of dust suppression measures. • provide personnel protective equipment to workers, especially dust masks, eye goggles.
E. Earthquakes and Tsunamis	• collapse of infrastructues and buildings; spillage of fuel and chemicals predisposing to fires and toxic events; land slides; tsunami	• poor engineering design and zoning; poor maintenance of structures and equipment; location of buildings and other infrastructures along coastlines	• *same as above*	• Formulate and implement an earthquake and tsunami emergency response plan that includes the following: monitoring and warning system; system of communication within and outside the mine site; SOPs for all personnel, workers and contractors; and evacuation plan. • Conduct regular and timely orientation and drills of all personnel, workers, contractors, as well as nearby communities, on the earthquake/tsunami emergency response plan and procedures. • Ensure regular and timely inspections and monitoring of all buildings and infrastructures within the mine site. • Ensure proper zoning and location, as well as good engineering, of buildings and other infrastructures.

Social Development Plan/Framework and IEC Framework

5

This chapter discusses the proposed Social Development Plan (SDP) and Information, Education, and Communication (IEC) Framework for the Rio Tuba Nickel Mining Corporation (RTNMC). The success of implementing the SDP depends on how well the plan is and how its host communities respond to the benefits that can be drawn from the programs of the company which may or may not adopt the existing SDMP of RTNMC depending on the recommendations of the Mines and Geosciences Bureau (MGB) and consultation with the stakeholders. A sustainable progressive living shall be the target of the RTNMC. The IEC activities shall create an operational discourse between the company and the impact communities. The discussions below are also based on the Focus Group Discussion (FGD) and Key Informant Interview (KII) which are further elaborated in *Chapter 2* of this Environmental Impact Statement (EIS) document.

5.1 SOCIAL DEVELOPMENT PLAN FRAMEWORK

The Social Development and Management Program (SDMP) is a requirement under the Philippine Mining Act of 1995 (RA 7942) and defined in its Implementing Rules and Regulations (DAO 96-40) and the most recent Consolidated Implementing Rules and Regulations (DAO 2010-21), which requires mining companies to set aside an amount equivalent to 1.5% of their annual operations costs. These will be used to fund Social Development Programs (SDP) for the communities affected by their mining operations. The program is designed for implementation for a period of five (5) years and to be renewed during the project life.

The project's SDMP normally aims to prevent/ mitigate and/or enhance the projects that have unfavorable or beneficial impacts on people's livelihood, health, and environment. The process of formulating the project's SDMP shall be actively participated in by the Mines and Geosciences Bureau (MGB), the Municipal Planning and Development Officer (MPDO) and/or other government agencies whose mandates cover the management of projects posed by project operations. The KIIs, FGDs and household surveys conducted by the EIA team confirmed that the Proponent has exerted efforts in addressing the various health, livelihood and environmental issues and concerns of the communities based on the current SDMP 4 that RTNMC is implementing for the existing nickel operations within a different MPSA.

RTNMC has introduced various livelihood options that addressed the needs of the communities. However, based on previous studies and on-site experiences, expressing the need for a project is not enough to ascertain its success. It is thus recommended that identification of livelihood projects must be done with consideration of the factors affecting sustainability. This can be done through trainings and consultations not only with the community but with the various factors who will play a part in the planning and implementation of the project. Market factors, support mechanisms such as credit, infrastructure (roads, processing/ post production facilities, storage facilities), available technologies, communication, to name a few are important for the realization of the project objectives.

The other dimensions of the projects like health and safety, education and recreation, environment and sanitation, peace and order have been basically given focus by the proponent. It is recommended that health and safety initiatives done by RTNMC (conduct of medical missions, provision of subsidy to the RTN hospital, medical check-up of regular personnel and family members) be continued with the addition of not only performing regular medical examination of regular employees but also of contractual workers who are with the company three (3) or more months due to the increasing incidence of sexually transmitted diseases that are reported "quietly" due to the social stigma attached to the disease.

RTNMC has actively supported the educational concerns of the communities and this is seen as vital to carry on for the intellectual health and growth of the community. On the other hand, recreational facilities such as parks, basketball courts, and gymnasium were established with the joint efforts of the local government and the proponent for the communities' physical well-being.

On the environment and sanitation, the best practices of RTNMC in collaboration with the Local Government Unit (LGU),the community and regional DENR office on rehabilitating and restoring the environment have positively translated to the benefit of the communities and environment, as well. These practices deserve to be continued and sustained.

Peace and order efforts jointly tackled by the members of the community, LGU, police force and RTNMC need to be continued with agreed upon rules and regulations for implementation.

Addressing the spiritual dimension of the communities is vital to instill in them the good moral values in relation to how these can be harnessed to become responsible stewards of our environment. Consultations with the various groups in close coordination with the spiritual leaders can be initiated by RTNMC through the ComRel.

Ballpark figures shall be estimated once specific projects have been identified and proposed though various consultations with concerned LGU officials and other sectors in the potentially affected communities. RTNMC shall apportion some of their funds through a percentage allotted from its direct mining revenues and royalties given to the IPs and Corporate Social Responsibility (CSR) funds.

RTNMC is currently implementing SDMP 4 for its existing nickel operations. It started in year 2019. For the proposed operation in Mt. Bulanjao, which will be under a different ECC, RTNMC in coordination with the stakeholders and the MGB shall decide on the projects that may be adopted continuously for the proposed application.

Table 5.1.1. Social Development Plan Framework

Concerns	Responsible Community member/ beneficiary	Government agency/ non-government agency and services	Proponent	Indicative timeline	Source of fund
1. Gender response livelihood/employment and credit facilities (Men, women, youth and elderly) - identification of appropriate livelihood options based on the various factors that affect sustainability - conduct of trainings on capability enhancement, skills development and other initiatives that would support the success of the livelihood projects - formulation and implementation of phase out plans for livelihood projects implemented	Association Chairperson or representative of directly and indirectly affected barangays specifically men, women, youth and elderly	- LGU municipal planning office - MSWD - TESDA - micro-finance /small enterprise financing institutions	Community Relations Office	Pre-construction; Construction Operation	LGU-IRA/ Proponent Potential credit sources/ cooperatives
Health and Safety - continuation of the provision of health services and medical missions by proponent - continuation of the yearly physical and medical check-up of regular employees and respected families. Contractual staff of 3 months and more should likewise be subjected to medical check-up as incidences of sexually transmitted diseases have been silently reported to exist.	Barangay kagawad for health/ Barangay Health Workers of directly and indirectly affected communities	- MHO - Barangay Health workers - Barangay Disaster management	Community Relations Officer	Pre-construction; Construction; Operation	LGU-IRA/ Proponent
2. Education and Recreation - continuation of the support and subsidy given by the proponent to existing elementary, high school, ALS and ILS facilities and centers. - continue to extend scholarships to	Barangay kagawad for education - project affected communities	- DepEd - ALS/ILS proponents	Community Relations Officer	Pre-construction Construction Operation	LGU-IRA/RTNMC

Concerns	Responsible Community member/ beneficiary	Government agency/ non-government agency and services	Proponent	Indicative timeline	Source of fund
deserving IP and non-IP students					
3. Environment and Sanitation - continuation of tree planting and other environment-related projects - conduct of environment-related projects	Barangay kagawad for environment - project affected community	- ENRO - MHO - DENR (community /regional)	Community Relations Officer; RTNMC environment officer	Pre-construction Construction Operation	LGU-IRA/RTNMC
4. Peace and order - continue the coordination among the community, lgu, RTNMC, PNP to implement rules and regulations for the peace and security of the residents	Barangay kagawad for peace and order - project affected community	- LGU - PNP	Chief Security Officer	Pre-construction Construction Operation	LGU-IRA/RTNMC
5. Spiritual - conduct of spiritual events with the priest and other spiritual leaders to instill good moral values in the community in relation to sustainable management of resources (natural, financial, manpower, technologies, etc.)	Barangay assigned catholic priest, pastor of different denomination Imam Tribal chieftains/ spiritual leaders	- Parish priest - pastor - Imam - tribal chieftains/ spiritual leaders	Community Relations Officer	Pre-construction Construction Operation	RTNMC

The Social Development and Management Plan (SDMP)

The SDMP seeks to integrate the proposed intermediations of RTNMC in favor of the various factors participating in the project. Empowerment of the stakeholders, especially the affected residents, is part of the social responsibility of the proponent. A consequence of this liberation is self-reliance, dignity and empowerment through financial independence. These may be attained through implementation of programs that will tap their productive potentials to the fullest in addition to assisting the community to become more productive and progressive.

The SDMP 1 (2004-2009) funds were allocated for components, listed according to funding amounts, (a) education, (b) social services, (c) livelihood, (d) infrastructure facilities. The funding priority is based on MOAs forged between companies (RTNMC and CBNC) and the municipality, affected barangay and tribal council, respectively. There were 11 barangays that benefitted from the SDMP projects. Ten barangays were located within the 10-km impact radius. However, one (1) barangay, Sapa, did not fall within the pre-determined geographical jurisdiction but was nevertheless included in the SDMP program because of its geopolitical circumstances.

An indigenous peoples' office came into being in 2004 to cater to the different benefits provided by the RTNMC to IP communities. Because of the seeming inferiority complex of the IPs, the small office was built within the mine site near the IP communities in order to provide a center easily accessible to address the different concerns of the IPs.

After the creation of this office, the Rio Tuba Nickel Foundation, Incorporated (RTNFI) was established by the Company. With the establishment of the RTNFI, realignment was done and provided different benefits to both IP and non-IP communities that affected some of the existing projects with these communities. Because of the changes in the provision of benefits, the IPs were affected and felt as a least prioritized or simply neglected group from the distribution of community development projects implemented in the locality. The National Commission on Indigenous People (NCIP) then suggested that the IPs must have their designated office as a recognized group which intended to separate from the management covered by RTNFI. RTNMC approved the establishment of the office for the Indigenous People and they officially called it as Indigenous People's Office (IPO) which also stands as non-government organization (NGO) for IPs. As a newly organized office, IPO was initially manned by some personnel from the RTNFI because of their familiarity in the management of community development activities. Two IPs who graduated under the scholarship program of RTNMC were also hired as Book keeper and Office Staff.

In September 2010, IPO was formally organized to Indigenous People's Development Office (IPDO) along with the creation of Memorandum of Agreement (MOA) between the Company and IP communities from the 11 impacts barangays. Through this document, the duties and responsibilities of IPDO were finally identified and agreed upon by both parties. Basically, the IPDO serves as a conduit to channel the benefits and funds from the Company through the royalty fee share and SDMP to the IPs and ensure that the provisions of IPRA law were complied. On the other hand, the NCIP also ensures that the concerns of IPs were properly addressed and monitors if the agreements stipulated in the MOA were complied with by both parties.

On March 27, 2015, an assembly was called to formally address the problems and miscommunication between RTNMC and the IP communities. During this meeting, a revised MOA was signed stipulating for the creation of the official guidelines for the new SDMP implementation system under the Community Relations Office (CRO) of RTNMC.

On the average, the annual SDMP budget per barangay in SDMP I and II was PhP5 million. This was more than 20 times the barangays' annual development budget from the government.

The SDMP program focused on the following components

- Livelihood – provision of farm tractors, fishing boats, carabaos, pigs, trainings and seminars, assistance in cooperatives and employment;
- Education – funding, material, or infrastructure support such as college, high school, and elementary scholarships; construction of new school buildings and classrooms,

and repair of existing classrooms;

- Social services – medical and health programs, provision of ambulance service, fire-truck, multi-cabs, motorcycles with sidecars, electric generators, petromax, I-Com radios, cellphones, water systems, water tanks, Jetmatic pumps; and
- Infrastructure – provision of day care centers, health centers, tribal halls, road repairs, gym and plaza, public library, irrigation system, multi-purpose pavements, church/mosques repair, and other public buildings.

While the SDMP is to be funded and implemented throughout the life of the project, the parties agreed to a first five-year MOA, which was mutually renewable. A five-year MOA allows for monitoring, trouble shooting, adjustment, and corrective practices for SDMP I. **Table 5.1.2** provides a summary budget of the SDMP I from 2004-2009.

Table 5.1.2. SDMP Summary Budget for June 2004 – July 2009

Programs	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	Total
Education	8,090,000	6,577,000	8,905,000	9,985,000	10,485,000	44,042,000
Infrastructure & Facilities	3,924,000	2,640,000	2,380,000	1,930,000	1,880,000	12,754,000
Livelihood Programs	11,393,500	1,155,000	540,000	265,000	402,000	13,755,500
Social Services	12,472,000	2,817,000	2,540,000	2,520,000	2,520,000	22,869,000
Total	**35,879,500**	**13,189,000**	**14,365,000**	**14,700,000**	**15,287,000**	**93,420,500**

In 2013, which was the last year of implementation of the second phase of the SDMP, RTNMC shouldered PhP31,896,336 or 1% of the Gross Mining Revenue (GMR) and PhP5,198.878 (1% of direct mining cost) for a total of PhP37,095,214.

The SDMP benefitted the 11 "impact" barangays and 14 indigenous cultural communities (ICCs) in terms of health, education, housing, and livelihood. At least 15% or PhP 6,284,132 of the SDMP budget was assigned to IEC/Training activities in 2013. For MTG development, at least 10% of the SDMP budget or PhP 753,197 was apportioned. About 75% of the SDMP fund was allocated to SDMP projects. Of this amount, PhP 67,607,234 was dispensed for maintenance and operation of the RTNFI hospital and PhP 34,181,741 was utilized in Community Development Projects. The total funds spent for the SDMP projects amounted to PhP 50,870,292 in 2013 and PhP 24,068,615 in 2014.

On the other hand, there were Community Relations Service activities undertaken jointly by CBNC and RTNMC where 70% was sourced from CBNC and 30% from RTNMC. The total expense incurred by RTNMC in 2013 was PhP 113,682,143 and PhP 125,639,711 in 2014.

There was an increase in RTNMC allocation of SDMP funds from its direct mining and production costs from 1% in 2013 to 1.5% in 2014. This resulted to an increase in its funds allocation to PhP 42,088,976. As for the 2013 expenses, there were basically the same expense items for 2014 which included the subsidies on RTNFI hospital, LVSMS School, GK Housing project, ILS Education, CRA and Secretariat.

Table 5.1.3. SDMP obligations funded and expenses incurred by RTNMC for 2013 and 2014

A. SDMP Obligations	2013	2014	Total
1. RTMNC Direct Mining cost	5,198,878 – 1% of DMC	42,088,976 – 1.5% of DMC	47,287,854
2. RTNMC royalty to IP Obligation 1% of GMR	31, 896,336		31,896,336
Total SDMP/ Royalty Obligation	**37,095,214**	**42,088,976**	**71,184,190**
B. SDMP Expenses	**2013**	**2014**	**Total**
1. IEC/Training at least 15% of SDMP budget	6,284,132	4,450,164	10,734,296
2. MTG Development at least 10% of SDMP budget	-	753,197	753,197
3. SDMP Projects at least 75% of SDMP budget	-	7,879,471	7,879,471
- RTNFI hospital	33,803,617	10,985,783	44,789,400
- Community Social Development Project	10,782,543		33,685,937
Total SDMP Expenses	**50,870,292**	**24,068,615**	**74,938,907**
C. Joint CSR expenses 70% CBNC, 30% RTNMC	**2013**	**2014**	**Total**
30% from RTNMC			
1. RTNFI Hospital		38,145,079	38,145,079
2. LSVMS School subsidy	8,281,258	22,903,394	31184652
3. GK Housing Project	5,493,371	302,449	5,795,820
4. ILS Education	9,493,372	5,487,095	14,980,467
5. Community Relations Assistance	39,544,142	28,758,620	68,302,762
6. Secretariat		5,097,606	5,097,606
Total CSR Expenses non-company employee /dependents	**62,812,143**	**100,694,244**	**163,506,387**
D. SDMP carryover expenses		876,852	876,852
E. Royalty to IP	66,176,683		66,176,683
Total expenditure	**113,682,143**	**125,639,711**	**239,321,854**

*Note: *ASDMP 2013 and 2014 Accomplishment report RTNMC*

The study done by Gaia South, Inc. in 2010 assessed the SDMP of CBNC and RTNMC and has found that both companies have significant achievements in terms of social development. First, there is top-level commitment for social development in Bataraza. Adherence to the levels of funding required in SDMP is critical. The funding for SDMP from 2009 to 2013 was projected to be nearly PhP400 million. This is the largest SDMP to date in terms of funding amount when implemented.

More significantly, CBNC and RTNMC have gone beyond the SDMP. Their non-SDMP programs such as the RTNFI Hospital, the LSVMS, ILS, CRA, and Gawad Kalinga initiatives have significant impacts on the economic, educational, livelihood, community organizing, values transformation, etc. Accordingly, these programs easily add another PhP300 million to the firms' social development expenditures.

There is also significant SDMP spending for infrastructure, health, education and social services, as well as public infrastructure such as utilities (water and electricity) and waste management. It was noted also that in the implementation of the SDMP, there is an active presence of both companies' ComRel and that documentation of SDMP and CRA projects is comprehensive.

Per SDMP III 4th quarter Report 2018, the total budget for 2018 was Php 50,673,494.45 and actual expenditure of Php 44,500,638.79 (88%) and unspent funds of Php 6,172,855.66 (12%). It is worthy to note that the budget allotted in 2018 was higher for non-IPs at PhP 17,832,606 with an 85% spending.

In 2018, a total of PhP 36,717,963 was allotted for SDMP projects and activities. The accomplished spending for the allotment was 90%.

The ComRel and management need to ensure that the funds allocated specifically for community projects must be dispersed at the appropriate time. Empowerment of the members of the community, both IPs and non-IPs, and sustainability of projects, to a certain extent, depends on the timely delivery of support services and resources.

Table 5.1.4. SDMP Financial Report for 2018

	ASDMP 2018 Budget	Actual to date	%	Unspent 2018	ASDMP 2019 Budget
DHNC	**36,717,963**	**32,926,138**	**90**	**3,791,825**	**26,629,863**
Non-IPs	*17,832,606*	*15,083,681*	*85*	*2,748,925*	*17,045,175*
IPs	*7,781,196*	*6,738,296*	*87*	*1,042,900*	*7,305,075*
Hospital Subsidy	*11,104,161*	*11,104,161*	*100*	*0*	*2,279,613*
IEC	**5,458,693**	**4,898,080**	**90**	**560,613**	**5,325,973**
MTG Development	**8,496,838**	**6,676,420**	**79**	**1,820,418**	**3,550,648**
Total	**50,673,494**	**44,500,638**	**88.2**	6,172,856	**35,506,484**
Accomplishment			*88%*	*12%*	

Non-SDMP Initiatives

RTNFI Hospital

The RTNFI Hospital was established 30 years ago to provide quality medical care to residents and stakeholders of the impact barangays. Its mission is to "render medical and dental care to the residents of Rio Tuba and neighboring Barangays," while its vision is to "attain a healthy community where people can enjoy longer, richer, and more fulfilling lives by taking control of their own health" (RTNMC 2009).

The RTNFI Hospital, a Level 1 Hospital duly accredited by the PhilHealth and Department of Health (DOH), is located within the RTN Townsite. It serves as a primary hospital with capability for emergency operations. For 2018, the manpower complement of RTNFI Hospital was composed of the following: nine (9) medical specialist including dentist, 4 resident physicians, 8 visiting consultants, 33 registered nurses, 63 ancillary service personnel and 17 outsourced personnel. The hospital has an authorized bed capacity of 30 beds and five bassinets. It provides emergency, out-patient, clinical laboratory, radiological, pharmacy, dietary, dental, and pastoral services.

The RTNFI hospital continues to play an important assistance role in the provision of health services especially with the inadequate government health system in the municipality/province. It is integral to both CBNC's and RTNMC's compliance of Mining Act requirement of provision of health services to IPs, as well as the CRA program.

The most common cause for hospital admissions were acute gastroenteritis and malaria (top two), pneumonia, APD, acute upper respiratory infections, urinary tract infections, acute bronchitis, amoebiasis, hypertensions, and bronchopneumonia. Outpatients complained mostly of upper respiratory tract infections (URTI), EENT case, hypertensions, acute gastroenteritis, among others. These cases indicate poor nutrition, hygienic conditions, and diet.

It might also be useful to highlight the fact that the SDMP provides for a medical outreach program via medical missions.

Educational initiative – LEONIDES S. VIRATA MEMORIAL SCHOOL (LSVMS)

The Leonides S. Virata Memorial School (LSVMS) is a Filipino, Catholic private school operated by RTNFI under the supervision of University of St. La Salle. Established in 1986, the school offers Kindergarten, Elementary and High school educational services to 1,233 students on a merit system. Forty-two percent of the students are dependents of CBNC, RTNFI, or RTNMC; while 50% are non-dependents. The school envisions a globally competitive community that is founded on the genuine La Salle virtues at the service of others. Its mission is the pursuit of excellence in the three dimensions of mind, body and soul. Tuition fees are highly subsidized and cost from PhP 120-300 a year for dependents and PhP 400-600 /year for non-dependents. The top five students get full scholarships and free books.

Educational initiative – SDMP scholarships

A fundamental component of the SDMP is the scholarship program. The SDMP has supported an increasing number of students at various educational levels from a total of 300 during SY 2005-2006 to 591 during SY 2008-2009. The SDMP scholarship program enabled 78 students to graduate from college. For School Year 2015-2016, through the SDMP Scholarship Program, 129 elementary, 315 and 430 college students for a total of 874 benefitted from the scholarships given.

Educational Initiative – INDIGENOUS LEARNING SYSTEM (ILS)

Beyond the formal educational system, RTNMC with help from CBNC initiated the Indigenous Learning System (ILS), which is an alternative literacy program designed specifically for indigenous cultural communities (ICCs) in Bataraza. Indigenous peoples (IPs) in Bataraza comprise a considerable percentage of the municipal population but are among the poorest and most vulnerable of the different population groups in the municipality. The ILS was formally launched on September 21, 2006 with the vision of helping IPs educate themselves. The ILS mission goals are to eradicate illiteracy among IPs; raise the level of functional literacy of the indigenous people; finish the equivalency of elementary and high school levels of education; hone employable skills to become more productive and effective citizens; and, develop proper values and attitudes necessary for personal, community and national development.

The ILS is an innovative and visionary program of RTNMC and CBNC that has been under-highlighted. The ILS goes beyond literacy training and involves other activities such as birth certificate registration, nutrition activities, livelihood, and skills training.

Gawad Kalinga Program

In May 18, 2006, RTNMC president, Atty. Manuel Zamora invited Gawad Kalinga (GK) officers Jose Ma. Montelibano and Mari Onquiñena to visit Rio Tuba to explore the possibility of a partnership between CBNC/RTNMC and GK to assist IPs in Bataraza. The

Gawad Kalinga[1] (GK) is a community development movement seeking to address inadequate housing and poverty in Philippine urban slums and rural areas. In 2002, GK initiated the “GK777” project to build 700,000 homes in 7,000 communities, in seven years. GK professes a transparent framework that is community, self-learning, and self-help driven; taps social networks, and explores household livelihood security issues.

CBNC and RTNMC hope that the GK model of community development will complement their programs, which assist IPs become economically and socially secure amidst a fast changing Bataraza/Rio Tuba that is increasingly integrated to the market economy. As the EPRMP 2006 report noted, Bataraza has a long history of natural resource use starting with logging during the American colonial period to mangrove harvesting to nickel mining in the past 30 years. Observers have noted though that the state of IPs, specifically the *Palaw’an,* has minimally improved despite the extraction of the natural resource wealth. Originally hunter-gatherers, in-migration, agriculture, commercial activities, natural resource competition and use, increasing urbanization, and continuing penetration of the market economy into rural, upland, and IP communities have reduced the *Palaw’an* farming, hunting, and gathering areas. Because of acculturation, many *Palaw’an* have also adopted lowland Christian and Muslim practices.

One significant implication of adopting GK’s holistic, participatory, transparent, and long-term community development model for IPs is that it contradicts the conventional wisdom that IPs do not desire middle class, lowland types of development. Providing a middle class type, lowland community development program to IPs presents academic, cultural, and developmental questions that influence emerging corporate social responsibility (CSR) programs of CBNC and RTNMC as embodied in the CBNC-ComRel and SDMP activities as well as the rest of the mining sector in the Philippines. The GK sites also complement the SDMP activities and provide a parallel model for a SDMP.

The GK Ocayan Village is turning out to be a showcase area. Aside from the homes being built, the livelihood component for the village includes a farm, fishpond, restaurant, and bread and breakfast. Expansion plans include a duck farm.

Community Relations Assistance (CAR)

Apart from the SDMP, both CBNC and RTNMC implement the Community Relations Assistance (CRA) program, which is an open-ended assistance mechanism to stakeholders. CRAs commonly cover health services assistance, welfare, social services, sponsorships, donations, and general assistance requested by beneficiaries, which are subject to discretionary approval by CBNC/RTNMC. According to the COMREL of CBNC, they see the reduction of CRAs as evidence of improving capacities of local residents and communities, which is one of their goals.

Annex 5.1.1 lists the social projects of the company from 2011 to 2018 that may be used as reference in developing the SDMP project for the expansion. Most of the projects implemented in the earlier years had been completed. There were some projects reported as ongoing like barangay electrification, hydropower project, feeding programs, provision of over the counter medicines, immunization, medical/death assistance to name a few. On the other hand, some projects had already been reported as completed and accomplished. These include the construction of infrastructures like roads, health centers, school facilities, conduct of training programs, etc. Some projects had been targeted for a certain year but have been put on hold and reported to be pursued the following year.

However, as identified in the previous study conducted by Gaia South in 2010, there are areas for improvement such as in the implementation of livelihood projects and the educational support program. The earlier study recommended the following:

- Improvement of the capabilities/capacities and enhancement of coordination and communication among and between the companies and the various stakeholders vis-à-vis SDMP implementation;
- Streamlining of the implementation of the SDMP programs in order for the recipient communities to better benefit from these. Complaints (from communities) about project deferments due to delays in funding and document requirements were noted and are affecting the communities' "trust" of the companies;
- Strengthen coordination between the three (3) organizations involved in the SDMP implementation – CBNC, RTNMC and RTNFI – and to keep their communication lines open in order to improve the implementation of SDMP 2; and
- Feasibility studies or even ad hoc assessments of the feasibility of SDMP-funded projects are necessary.

A full organizational assessment of RTNMC CRA Office, CBNC ComRel and RTNFI is needed to determine SWOT and organizational needs vis-à-vis vastly expanded SDMP funding and emerging concerns over the long term. Considering that the current SDMP and non-SDMP programs will be funded to the tune of around PhP600 million for next five (5) years to be implemented in 11 barangays and 24 ICCs. As such, a nimble, flexible, competent and resourceful institution with the requisite manpower will be necessary to ensure that resources are not wasted.

Aside from further strengthening and adopting the earlier recommendations, it is proposed that not only should the implementation of the SDMP programs be streamlined but should also involve the identification of the appropriate project specially on livelihood options. Identification should not be based on the wants but rather should stem from the need. Not stopping there, the ComRel in consultation with the community members and other participating actors in the project should be able to highlight and consider not only the financial support but also the other vital support mechanisms required such as markets and marketing factors, technologies available, constraining and facilitating laws, regulations and ordinances in relation to the proposed income generating opportunity, infrastructure and facilities. The technical, socio-economic and environmental dimensions for the sustainability of the project must also be at the forefront of the decision-making process.

5.2 INFORMATION, EDUCATION AND COMMUNICATION (IEC) FRAMEWORK

More than a requirement that needs to be complied with, RTNMC views IEC program as an effective tool in building good relationship with its partner Barangays. The ComRel office conducts consultations/IECs to increase awareness of the stakeholders regarding the operations of RTNMC. The frequency of these consultations depends on issues that are raised / consulted by the stakeholders.

In addition to the IEC meetings or discussions RTNMC ComRel office conducts, educational tours (lectures) are also part of its IEC activities. The IEC campaign is geared towards increasing the awareness of the following:

- Residents of the 11 impact barangays and their respective sitios;
- Students of various schools on Educational Tour;
- Company visitors and various groups that are first-time visitors to the Mine; and
- Organized groups (e.g., religious, civic, government and non-government organizations, etc.) who intend to hold their activities in the company premises.

IEC on Air

In order to provide constant information, maximum exposure in disseminating information on programs, events and updates, RTNMC entered into contract with *Radyo Natin Bataraza* (an FM Station operating in Rio Tuba) which includes plugging and advertisement everyday and 18 times a month for 30 minutes program on air, as part of the IEC mechanism of the company.

DWRI's *Radyo Inogbong* features a radio program hosted by the COMREL Manager of RTNMC. The program airs every Saturday of the month. In addition, RTNMC has also entered into contract with DYER-AM an environmental radio station in Palawan and DYPR that airs RTNMC-related information daily.

IEC on Print Ads

RTNMC joined and supports the Kabuhayan, Kaunlaran and Kalikasan (KKK), a non-stock, non-profit organization that serves as the public relations arm of mining companies operating and/or existing in Palawan.

KKK promotes responsible mining in the province that shall respect and protect the communities and the environment, and provide sustainable benefits to society. It releases a quarterly publication/newsletter as well as flyers to enlighten the people and disseminate right information regarding mining operation.

RTNMC Newsletter

A group of writer and editorial staff headed by COMREL Department Manager was formed for RTNMC Newsletter called the ORE FEED. It was created to inform the public on the operation and other happenings /updates inside the community of RTNMC and its adjacent communities. The Ore Feed is a sixteen-page publication released once every two (2) months.

The company has adopted a number of extension strategies that covered both print and radio, in addition to face to face meetings and consultations with the communities. However, it was observed during the latest key informant interviews and focus group discussions conducted in the affected barangays, that there was still confusion experienced by some members of the barangays as to the procedures and processes to follow to be able to solicit assistance provided by RTNMC. It is recommended that information on the basic forms required, documents to be attached, available support systems offered by the company, procedures to be followed, etc. should be disseminated to the communities. A SWOT analysis of the various extension strategies adopted by the company should be conducted to serve as inputs in management decision making.

A recommendation forwarded is for the RTNMC ComRel, IEC team, representatives from schools/students, LGU, POs, NGOs and other concerned sectors to conduct a SWOT analysis of the extension strategies already being implemented and results of which will serve as inputs for determining the most effective and efficient strategy to circulate information. Consequently, management will have knowledge on their current state of IEC. Moreover, **Annex 5.2.1** includes the lists of IEC programs of RTNMC that were implemented from 2011 to 2018 for its nickel operations. These strategies shall be adopted and improved by the company for the proposed expansion project in Mt. Bulanjao. **Table 5.2.1** summarizes the IEC plan of RTNMC.

Table 5.2.1. RTNMC IEC Plan

Target sector	Major topics of concern in relation to project	IEC Scheme/ Strategy/ Methods	Information Medium	Indicative timelines and frequency	Indicative cost (PhP)
Households and LGU officials of direct and indirect impact barangays Students POs , NGOs	- Project description	Individual and group methods Multi-media	Flyers FGDs Radio broadcast Key informant interviews Consultations Hand-outs Site tours	Continuing	Based on cost of Radio broadcast time Cost of flyers/IEC materials Number of participants Venue
RTNMC ComRel, IEC team Representatives from school, affected communities, LGU, NGOs, POs	- EIA findings - Actual impacts/ measures/ monitoring guidelines - Company procedures with regards to requests from community members - Conduct of SWOT analysis for the various extension strategies adopted by the company should be conducted to serve as inputs in management decision-making.	Group method	Key informant interviews Consultations/ meetings Focus group discussion	Prior to construction	20,000

Environmental Compliance Monitoring

6

Rio Tuba Nickel Mining Corporation

This chapter shall discuss the proposed monitoring measures to be implemented by the Rio Tuba Nickel Mining Corporation (RTNMC) at all phases of the proposed mining project. The proposed monitoring scheme was based on the environmental and impact assessment and impact management presented in the previous chapter. Furthermore, this chapter shall reflect the current environmental compliance of RTNMC for its existing operation within MPSA 114-98-IV which will be considered in the proposed Bulanjao project.

6.1 THE ENVIRONMENTAL QUALITY PERFORMANCE LEVEL

For its current operation within MPSA 114-98-IV (Beneficiated Nickel Silicate Ore Project) and MPSA 2013-2005-IVB (Gotok Limestone Quarry Project), RTNMC has secured several permits/ licenses/ clearances/ certificates from the Department of Environment and Natural Resources in compliance with the environmental laws (**Table 6.1.1**).

Table 6.1.1. DENR Environmental Laws

Environmental Laws	Permits		Date of Issue	Expiry Date
RA 9275 Philippine Clean Water Act of 2004	A/C No.			
	PO No.	2016-DP-PAL-02-060	09 December 2016	09 December 2019
PD 1586 Environmental Impact Statement System	ECC 1	ECC-CO-9612-008-302[a]	11 December 1997	Superseded
	ECC 2	ECC-CO-1312-0043[b]	09 March 2015	N/A
RA 6969 Toxic Substances and Hazardous and Nuclear Control Act of 1990	DENR Registry ID	GR-4B-53-00012	11 September 2015	N/A
	CCO Registry	CCO-PCB-R4B-RIO-1	22 October 2015	N/A
	Importer Clearance No.	-	-	-
	Permit to Transport	-	-	-
RA 8759 Philippine Clean Air Act of 1999	A/C No.	-	-	-
	PO No.	2016-POA-D-0453-027	18 April 2016	17 April 2021
	PO No.	2017-POA-D-0453-027	07 March 2017	06 March 2022

Source: 4th Quarter of 2018 Self-Monitoring Report of RTNMC
Notes: [a]ECC of the RTNMC's Nickel Laterite Project
[b]ECC of the RTNMC's Beneficiated Nickel Silicate Ore (Production/Extraction Output) Project

The proposed mining project of RTNMC shall be situated on a new mining area located adjacent to its current Mineral Production Sharing Agreement (MPSA). Since, the proposed area is within a different MPSA, RTNMC was required by the Environmental Management Bureau (EMB) to apply for a separate Environmental Compliance Certificate (ECC) covering components of the proposed mining project.

As a proof of the company's compliance, RTNMC also made sure that the standard set by DENR are not exceeded. This is thru the implementation of the Environmental Quality Performance Level (EQPL) Management Scheme embedded it its monitoring plan.

The EQPL allows RTNMC to perform management measures even before the standard limit of a certain parameter is exceeded. It provides a particular management measures for whenever a level (alert, action and limit) denoted by a pre-determined limit has been exceeded. For this particular project, the proposed environmental monitoring plan is provided in **Table 6.1.2**.

6.2 SELF-MONITORING PLAN

Table 6.2.1 shows the current self-monitoring program being implemented by RTNMC as reported in its 4th Quarter 2018 Self-Monitoring Report (SMR) (**Annex 6.2.1**).

Table 6.2.1. Self-Monitoring Program of RTNMC for its current nickel mining project

Aspect	Parameters	Stations

Hazardous waste	• Quantity
	  • Storage
	  • Treatment
	  • Disposal
		• Entire operation

Water Pollution	• Discharge location • Volume of waste water discharge, (m3/day) • Waste water characteristics for conventional pollutants: TSS, Color, pH, Oil & Grease (Stations 4 & 5) and BOD (Stations 4 & 5) • Waste water characteristics for other pollutants: As, Cd, Pb, Mn, Ni	Monthly/Quarterly • Station 1 – Upper Tagpisa (Control Station) • Station 2 – Upper Magas-Magas (Entry point to siltation ponds) • Station 2A – Upper Togpon Pond (Discharge) • Station 3 – Lower Tagpisa Pond • Station 4 - Lower Kinurong Pond (Discharge) • Station 5 – Lower Togpon Pond (Discharge) • Station 6 - Confluence of (4) and (5) located after Togpon Bridge (Reference Effluent Discharge) • Station 7 – Confluence of (4) and (5) touching the mangrove areas • Station 8 – Togpon-Kinurong Tributary to Rio Tuba River • Station 9 – Gamayon Tributary to Rio Tuba River • Station 10 – Log Pond Tributary to Rio Tuba River
Air Pollution	**Ambient Air Quality** • Quantity of fuel consumed, L • Particulates, (µg/Ncm)	Monthly/Quarterly • Station 1 – Pier Stockyard A • Station 2 – RTN Town Site Oval • Station 4 – Magazine Area • Station 5 – Tagpisa Area
	Noise level monitoring • Noise level, dB	Monthly/Quarterly • Station 1 – Front of Omar Residence • Station 2 – Front of Valdeztamon Residence • Station 3 – Near Hulguin Residence (Front of Sto. Niño Chapel) • Station 4 – Near Gate 2, Townsite
ECC Conditionalities	• Status of Compliance • Action/s Taken	Quarterly
Solid Waste Characterization/ Information	• Average quantity of solid waste generated, MT/month • Average quantity of solid waste generated, MT/quarter • Brief description of solid waste management plan	Monthly/Quarterly
Environmental Management Plan/Program	• Status of Implementation • Action/s Taken	Quarterly
Accidents and	• Date	Quarterly

Aspect	Parameters	Stations
Emergency Records	• Area/Location • Findings and observation • Action/s taken • Remarks	
Personnel/Staff Training	• Course/training description • No. of personnel trained	Quarterly

Source: 4th Quarter Self-Monitoring Report (SMR) of RTNMC, 2018

For the proposed mining project, a separate SMR shall be prepared by RTNMC. The content of the report shall remain the same, except the stations being monitored for a certain aspect. **Table 6.2.2** shows the proposed self-monitoring program for the consideration of RTNMC and the MMT upon agreement.

Table 6.2.2. Self-Monitoring Program of RTNMC for its proposed nickel mining project (AMA-IVB-144a)

Aspect	Parameters	Stations
Hazardous waste	• Quantity • Storage • Treatment • Disposal	Entire operation
Water Pollution	• Discharge location • Volume of waste water discharge, (m^3/day) • Waste water characteristics for conventional pollutants: BOD, TSS, Color, pH and Oil & Grease • Waste water characteristics for other pollutants: Mn, As, Cd, Pb, Ni	**Monthly/Quarterly** *Effluent* • Siltation ponds *Freshwater body* • Downstream of Rio Tuba • Downstream of Ocayan River and • Downstream of Sumbiling River
Air Pollution	• Ambient Air Quality • Quantity of fuel consumed, L • Particulates, (µg/Ncm)	**Monthly/Quarterly** • Residential Areas (Brgys. Taratak and Rio Tuba)
	Noise level monitoring • Noise level, dB	**Monthly/Quarterly** • Residential Areas (Brgys. Taratak and Rio Tuba)
ECC Conditionalities	• Status of Compliance • Action/s Taken	Quarterly
Solid Waste Characterization	• Average quantity of solid waste generated, m3/month • Average quantity of solid waste collected, m3/month • Brief description of solid waste management plan	Monthly/Quarterly
Environmental Management Plan/Program	• Status of Implementation • Action/s Taken	Quarterly
Accidents and Emergency Records	• Date • Area/Location • Findings and observation • Action/s taken • Remarks	Quarterly
Personnel/Staff Training	• Course/training description • No. of personnel trained	Quarterly

6.3 MULTI-SECTORAL MONITORING FRAMEWORK

The current members of the MMT of RTNMC are various representatives from the following groups/ offices/ organizations:

- Philippine Economic Zone Authority (PEZA);
- Mines and Geosciences Bureau (MGB) MIMAROPA;
- Apostolic Vicariate of Puerto Princesa (AVPP);
- Haribon Palawan;
- Palawan Council for Sustainable Development (PCSD);
- DENR- Provincial Environment and Natural Resources Officer (PENRO);
- Bureau of Fisheries and Aquatic Resources (BFAR);
- Department of Health (DOH);
- Environmental Management Bureau (EMB) Palawan;
- Environmental Management Bureau (EMB) MIMAROPA;
- Bataraza Christian Muslim Palawano Asso, Inc.(BACRISMUPAL);
- Indigenous People (IP) Representatives;
- LGU-Bataraza;
- LGU-Barangay Rio Tuba for Nickel;
- LGU-Barangays Sandoval and Iwahig for Limestone; and
- City Environment and Natural Resources Office (CENRO).

Provided in **Table 6.3.1** is the compliance monitoring program being implemented by the MMT.

Table 6.3.1. MMT Compliance Monitoring and Validation Report (CMVR) for the Rio Tuba Nickel Silicate Ore Project and Gotok Limestone Quarry Project of RTNMC

Aspect	Parameters	Stations
Compliance Monitoring Result and Discussions		
A. Compliance to Project and Location and Coverage Limits (as specified in ECC and/or EPEP	-	-
B. Review and Validation of Proponent's Self-Monitoring Report	-	-
B.1.1 Compliance to other ECC Conditions	-	-
Air Quality Impact Assessment	• PM10 (µg/Ncm) • TSP(µg/Ncm)	Quarterly • Station 1 – Pier Stockyard • Station 2 – RTN Town Site Oval • Station 4 – Magazine Area • Station 5 – Tagpisa Area • Station 6 – Southwest Gotok Quarry Area • Station 7 – Southeast Gotok Quarry Area
Water Impact Assessment	• Waste water characteristics for primary parameters: TSS • Waste water characteristics for other pollutants: Mn, Cr^{+6}, Cd, Fe, Ni, Pb, As	Monthly/Quarterly • Station 1 – Upper Tagpisa (Control Station) • Station 4 - Lower Kinurong Pond (Discharge) • Station 5 – Lower Togpon Pond (Discharge) • Station 6 - Confluence of (4) and (5)

Aspect	Parameters	Stations
		located after Togpon Bridge (Reference Effluent Discharge) • Station 7 – Confluence of (4) and (5) (500 meter downstream of Station 6) • Station 14 – Oning (Gotok Spring) • Station 15 – Gotok Entry Tunnel (Underground)
A. Compliance with good practices in Solid and hazardous Waste Management	• Type of waste • Adequacy of handling, storage and disposal based on ECC/EPEP commitments • Remarks	Entire Operation
B. Compliance with good practices in Chemical Safety Management	• Adequacy of the risk management, training, handling and emergency preparedness being implemented • Remarks	-
C. Field Findings and Observations		
B.2 Compliance to Impact Management Commitment in EIA Report & EPEP	• Mitigating Measures ○ Planned vs. Actual Observation	
A. Compliance with Social Development Plan Targets	• Status of compliance • Remarks	-
B. Complaints Verifications and Management	• Nature of Complaint • Resolutions made	-

Source: 3rd Quarter Compliance Monitoring and Validation Report (CMVR) of RTNMC, 2018

The same set of MMT shall perform monitoring and validation activities once the proposed mining project is operational.

6.4 ENVIRONMENTAL COMPLIANCE MONITORING

Based on the CMVR submitted by the MMT for the 3rd Quarter of 2018 (**Annex 6.4.1**), RTNMC has complied with all the ECC and/or EPEP conditionalities as seen in **Table 6.4.1**.

Table 6.4.1. Summary of RTNMC's compliance as reported in the 3rd Quarter CMVR of MMT for 2018

Requirements		Complied		Remarks / ECC or EPEP Condition
		Yes	No	
Compliance with ECC Conditions/ Commitments	Validity	✓		RTNMC applied for separate ECC for the Gotok Limestone Quarry Project
	Project coverage/ limits /components	✓		Included in the ECC
	EMP and updates as deemed necessary	✓		A 2010 revised EPEP was submitted to MGB IV-B for both projects. Updates are reflected in the submission of the Annual EPEP. AEPEP 2018 was approved by MGB IVB on 28 February 2018 (2018-02 MIMAROPA)

Requirements		Complied Yes	Complied No	Remarks / ECC or EPEP Condition
	Regular reporting of Self-Monitoring Results by the project proponent	✓		The 1st Quarter SMR, 2nd Quarter SMR and 3rd Quarter SMR were submitted to EMB IV-B on 16 April 2018, 16 July 2018 and 15 October 2018, respectively.
	Other sectoral requirements mandated by other agencies to be complied with	✓		Renewals of permits were secured during the first semester. These include Mayor's Permits for RTNMC facilities and other permits specified in the ECC-CO-1312-0043 – Part III. Condition 1,2,3,4,5,6,7,8.
Compliance with EPEP Commitments	Implementation of Environmental Impact Control Strategies	✓		Implementation of the approved 2016 AEPEP is continuous. RTNMC is ISO 14001:2004 + Cor. 1:2009 (Environmental Management System) Certified. Valid from 2016-05-17 until 2018-09-14.
	Safety	✓		The 2016 Annual Safety and Health Program for the projects were approved by MGB IV-B on 8 January 2016.
	Rehabilitation	✓		Mining Rehabilitation and Reforestation Program is included in the activities of approved 2016 AEPEP.
Compliance with SDMP Commitments		✓		The 2016 Annual Social Development and Management Program was approved by the MGB IV-B on 15 April 2016. SDMP activities are continuously being implemented.
Complaints Management	Complaint receiving set-up	✓		Complaint regarding mining operation, Environmental Laws, DENR Permits, SEP Clearance are included in the MMT functions
	Case investigation	✓		MMT conducts investigation.
	Implementation of control measures	✓		-
	Communication with complainant/ public	✓		-
	Complaint documentation	✓		-
Accountability- qualified personnel are charged with routine monitoring of the project activities in terms of education, training, knowledge and experience of the environmental team		✓		The company has a MEPEO with two (2) sections, namely the Pollution Control Office (PCO) and the Mine Rehabilitation and Reforestation Unit (MRRU). Both sections are composed of technically competent personnel.

Source: 3rd Semester Compliance Monitoring and Validation Report (CMVR) of RTNMC, 2018

The trend in the water quality and air quality conditions was presented in *Chapter 2*.

6.5 ENVIRONMENTAL GUARANTEE AND MONITORING FUND COMMITMENTS

For its existing operation, RTNMC signed a Memorandum of Agreement (MOA) on 28 July 2003 together with CBNC, MGB-IVB, Provincial Government of Palawan, Municipal Government of Bataraza, Palawan Council for Sustainable Development (PCSD), residents of Brgy. Rio Tuba, residents of Sitio Gotok, Brgy. Iwahig, Katutubong Palawan, HARIBON

Foundation, and Bataraza Christian Muslim Palawano Asso, Inc. (BACHRISMUPAL). The MOA states that pursuant to Section 181 of the DENR Administrative Order (DAO), a Mine Rehabilitation Fund (MRF) shall be established. The current MRF of RTNMC/CBNC is in two (2) forms: Monitoring Trust Fund (MTF) and Rehabilitation Cash Fund (RCF). The MTF in the form of cash amounts to PhP 50,000.00 to cover the expenses of the monitoring activities. This amount is being replenished on a monthly basis. The RCF totals PhP 5,000.000.00 to ensure compliance with the approved rehabilitation activities. An Environmental Trust Fund (ETF) amounting to PhP 200,000.00 was also established by the companies.

Table 6.1.2. Environmental Monitoring Plan with EQPL for proposed Rio Tuba Nickel Mining Project (AMA-IVB-144A)

Key Environmental Aspect per Project Phase	Potential Impacts per Envt'l Sector	Parameters to be monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Method	Frequency	Location			Alert	Action	Limit	Alert	Action	Limit
Construction Phase													
➢ Pit Planning and surveying ➢ Site Clearing ➢ and overburden removal ➢ Field office and motor pool construction ➢ Access road construction ➢ Drainage canal and Settling pond construction	➢ Vegetation removal and loss of habitat ➢ Threat to existence and loss of important local species ➢ Threat to abundance, frequency and distribution of important species	Diversity and species richness (Abundance and Frequency)	Quadrat sampling for flora and transect monitoring for fauna	Semi annual	Within the tenement area and vicinity	RTNMC MEPEO Officer/ PCO Third party consultant	Include in MEPEO Budget	30% abundance and frequency reduction of flora along the monitoring stations 30% reduction of abundance and frequency of common and endemic avian species observed on site as based on the baseline data	40% abundance and frequency reduction of flora along the monitoring stations 40% reduction of abundance and frequency of common and endemic avian species observed on site as based on the baseline data	50% abundance and frequency reduction of flora along the monitoring stations 50% reduction of abundance and frequency of common and endemic avian species observed on site as based on the baseline data	Assess extent of vegetation clearing and identify areas within the EP for reforestation Use indigenous and native species as well as fruiting trees reforestation species Minimize revving-up of vehicles and heavy equipment	Establish green corridors and shelterbelts Conduct immediate rehabilitation once mined out Establish off-limit zone for vehicles along areas identified as conservation areas and shelterbelts	Assess areas prone to soil creep or landslide and stabilize slope area and rehabilitate Institute biodiversity offset areas Conduct enrichment planting with emphasis on Assisted Natural Regeneration (ANR)
	➢ Soil erosion, loss of topsoil/ overburden	Volume of topsoil conserved and integrity of stockpile	• Record keeping of topsoil volume conserved • Inspection of stockpiles to check for soil erosion • Mapping of storage sites	Semi annual	Within the tenement area and vicinity	RTNMC MEPEO Officer/ PCO	Include in MEPEO budget	Volume of topsoil conserved is less than 70% of the estimated volume needed for future rehabilitation	Volume of topsoil conserved is less than 60% of the estimated volume needed for future rehabilitation	Volume of topsoil conserved is less than 50% of the estimated volume needed for future rehabilitation	Notify heavy equipment operator to set aside topsoil and identify additional storage area	Implement volume quota to heavy equipment operator to set aside top soil and maximize additional storage area	Future acquisition of topsoil from adjoining areas to be used for rehabilitation
		Rate of erosion	• Photo-documentation • Use of bottle caps (caps protects soil underneath and form pillar overtime; height of pillar will indicate erosion rate) • Use of erosion monitoring box	Monthly	Within and adjacent to construction sites	RTNMC MEPEO Officer/ PCO	Include in MEPEO budget	Presence of several rill erosion along cleared areas	Presence of gullying along cleared areas	Occurrence of severe erosion, soil creep and landslide	Construction of drainage canal to divert storm run-off	Implementation of slope stabilization techniques	Installation of gabions and engineering techniques to control severe erosion
	➢ Generation of solid and hazardous waste	Volume of solid and hazardous waste generated	• Record keeping of generated solid and hazwaste, mode of disposal and volume disposed or recycled	Monthly	Within and adjacent to construction sites	RTNMC MEPEO Officer/ PCO DENR-accredited hazwaste transporter	Include in MEPEO budget	Foul odor from waste disposal site	Sighting of pest such as rats and roaches	Spread of disease to surrounding areas	Review of housekeeping practices when pests are present at the holding areas Continuous collection, treatment and disposal by DENR- accredited hazwaste treater	Pest eradication Immediate clean-up of the temporary storage site and disposal accumulated wastes Immediate disposal or treatment of hazardous wastes	All waste from the kitchen should be contained. Compost pit should be covered Use of environmental friendly materials
	➢ Degradation of surface water	Color, TSS, pH and heavy metals (Mn, As, Cd, Pb and Ni)	In-situ sampling , grab sampling and laboratory analysis	Monthly	At rivers and streams draining the proposed	RTNMC PCO Third party	Include in MEPEO budget	<u>Freshwater body</u>	<u>Freshwater body</u>	DENR Standard Limit for Class C as stipulated in DAO 2016-08[1]	Reconsider design runoff flow rate and rate of particle	Addition of embankment and other flood control measures for the	Immediate desilting of silt ponds

[1] The Water Quality Guidelines and General Effluent Standards of 2016 was used for the monitoring of the water quality parameters of freshwater

Key Environmental Aspect per Project Phase	Potential Impacts per Envt'l Sector	Parameters to be monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
	quality				mine site	consultant		➢TSS –64 mg/L ➢Mn – 0.16 mg/L ➢As –0.016 mg/L ➢Pb – 0.04 mg/L ➢Ni – 0.16 mg/L	➢TSS – 72 mg/L ➢Mn – 0.18 mg/L ➢As – 0.018 mg/L ➢Pb – 0.0450 mg/L ➢Ni – 0.18 mg/L	➢If pH is lower than 6.5 or higher than 9 ➢TSS – 80 mg/L ➢Mn – 0.2 mg/L ➢As – 0.02 mg/L ➢Cd – 0.005 mg/L ➢Pb – 0.05 mg/L ➢Ni – 0.2 mg/L	settlement of the silt ponds to ensure effectiveness	reduction of runoff flowrate and containment of runoff	Establishment of additional silt pond
	➢ Degradation of air quality	Ambient PM-10, TSP, SO_x,and NO_x	24-hour ambient air monitoring for PM-10, TSP, SO_x,and NO_x	Quarterly		RTNMC PCO Third party consultant	Include in MEPEO budget	➢SO_x – 144.5 µg/Ncm ➢NO_x – 120.5 µg/Ncm ➢TSP – 184.5 µg/Ncm ➢PM-10 – 120.5 µg/Ncm	➢SO_x – 162.5 µg/Ncm ➢NO_x – 135.5 µg/Ncm ➢TSP – 207.5 µg/Ncm ➢PM-10 – 135.5 µg/Ncm	DENR Standard Limit as stipulated in the IRR of Clean Air Act ➢SO_x – 180 µg/Ncm ➢NO_x – 150 µg/Ncm ➢TSP – 230 µg/Ncm ➢PM-10 – 150 µg/Ncm	Identification of possible source of pollutant	Temporarily halt operation and do corrective measures Conduct of maintenance of equipment/ machinery identified as the source of pollution Increase frequency of water spraying	Stop operations and resume only when corrective measures were in place Replace equipment that emits high concentration of pollutants or use better fuel Increase frequency of water spraying
	➢ Increase in ambient noise level	Sound level (db)	24-hour sound measurement using hand-held sound meter Noise Meter	Monthly	Bulanjao construction area and residential areas	RTNMC PCO	Minimal cost	3 dB less than limit	2 dB less than limit	1 dB less than limit	Identification of possible source of noise Issuance of ear plugs	Maintenance, adjustment or replacement of mufflers and installation of noise reduction apparatus	Change of equipment or noise minimization device Limit operations during daytime hours
	➢ Threat to workers / public health and safety	Safety record, accident/ fatality incidence/ occurrence	Record keeping	Daily	Bulanjao construction area	RTNMC Safety officer	Minimal cost	Increase in frequency of non-lost time accident	Occurrence of non-fatal lost time accident	Occurrence of fatal lost time accident	Conduct quarterly safety briefing and orientation to laborers and workers Installation of safety signages along accident prone areas within the construction site	Conduct daily inspection of construction area Conduct daily briefing on safety program	Work stoppage along accident area and identify proper safety measures and implement specific safety procedures and protocol
	➢ Social impacts	Number of jobs generated for locals, training programs and other social development programs	Record keeping	Monthly	Barangay Rio Tuba, Ocayan, Taratak and secondary impact areas	RTNMC MEPEO officer/ PCO and ComRel	Minimal cost	Number of locally hired employees fall down to less than 40% of the total workforce SDMP accomplishment falls below 80% of targets	Number of locally hired employees fall down to less than 20% of the total workforce SDMP accomplishment falls below 60% of targets	No locals are employed by the company in the last six months SDMP accomplishment falls below 40% of targets	Review hiring policies Review SDMP programs and determine reasons for the poor implementation of the program	Implement more skills training program to empower residents Identify alternatives for the SDMP program to improve accomplishment	

Key Environmental Aspect per Project Phase	Potential Impacts per Envt'l Sector	Parameters to be monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Method	Frequency	Location			Alert	Action	Limit	Alert	Action	Limit
	➢ Complaints Management	Number of valid complaints	Record keeping	Daily	Bulanjao construction	RTNMC MEPEO officer/ PCO and ComRel	Minimal cost for record keeping	Formal complaint submitted can be resolved at the ComRel level	Intervention from the Upper Management is needed to resolve a formal complaint	Complaint is broadcasted over mass media	Institution of grievance system Conduct regular IEC to inform and justify the activities being undertaken by RTNMC during construction	Notify RTNMC Admin for complaint and take remedial measures to address complaints Investigate all complaints, conduct dialogue with communities and implement mitigating measures Compensate affected communities	Conduct in depth investigation and identify root cause for all valid complaints Institute measures to avoid occurrence of similar problems
Operation Phase													
➢ Development drilling ➢ Clearing and overburden removal ➢ Limonite mining and stockpiling ➢ Soft saprolite ore mining ➢ Hard saprolite ore mining ➢ Waste material handling ➢ Saprolite ore beneficiation involving solar drying of raw soft ore, reclamation of solar dried ore, screening and crushing, transfer of marginal ore to stockpiles ➢ Ore hauling and stockpiling of beneficiated saprolite ore ➢ Direct limonite ore hauling to HPAL Plant ➢ Limonite ore stockpile retrieval and delivery to HPAL plant	➢ Vegetation removal and lost of habitat ➢ Threat to existence and loss of important local species ➢ Threat to abundance, frequency and distribution of important species	Diversity and species richness	Quadrat sampling for flora and transect monitoring for fauna	Semi annual	Within and adjacent to Bulanjao mining area	RTNMC MEPEO Officer/ PCO Third party consultant	Include in MEPEO budget	30% abundance and frequency reduction of flora along the monitoring stations 30% reduction of abundance and frequency of common and endemic avian species observed on site as based on the baseline data	40% abundance and frequency reduction of flora along the monitoring stations 40% reduction of abundance and frequency of common and endemic avian species observed on site as based on the baseline data	50% abundance and frequency reduction of flora along the monitoring stations 50% reduction of abundance and frequency of common and endemic avian species observed on site as based on the baseline data	Assess extent of vegetation clearing and identify areas within the EP for reforestation Use indigenous and native species as well as fruiting trees reforestation species	Establish green corridors and shelterbelts Conduct immediate rehabilitation once mined out	Assess areas prone to soil creep or landslide and stabilize slope area and rehabilitate Institute biodiversity offset areas
	➢ Rehabilitation and reforestation program	Survival rate of seedlings	Survey and performance monitoring	Semi annual	Within and adjacent to Bulanjao mining area	RTNMC MEPEO Officer/ PCO Third party consultant	Include in MEPEO budget	If survival rate is 80%	If survival rate is 70%	If survival rate is 50%	Assessment of planting area condition to include possible infestation/ ascertain debilitating factors	Restocking or replanting seedlings	Immediate assessment of soil viability and if necessary soil amelioration should be done prior to planting
	➢ Generation of solid waste	Volume of solid waste generated including volume recycled and disposed to the landfill	Estimation of volume	Weekly	Within and adjacent to Bulanjao mining area	RTNMC MEPEO Officer/ PCO Third party consultant	Include in MEPEO budget	Foul odor from waste disposal site	Sighting of pest such as rats and roaches	-	Review of housekeeping practices when pests are present at holding areas Spread of disease to surrounding areas	Pest eradication Immediate clean-up of the temporary storage site and disposal of accumulated wastes	All waste from the kitchen should be contained Compost pit should be covered
	➢ Degradation of surface water quality	<u>Effluent</u> pH, TSS, Mn, As, Cd, Pb and Ni <u>Freshwater body</u> pH, TSS and heavy metals (Mn, As, Cd, Pb and Ni)	In-situ sampling, grab sampling and laboratory analysis	Monthly	<u>Effluent</u> Siltation ponds <u>Freshwater body</u> Downstream Rio Tuba, Ocayan			<u>Effluent</u>	<u>Effluent</u> ➢TSS – 90 mg/L	DENR Standard Limit for Effluent as stipulated in DAO 2016-08 (Class C) ➢If pH is lower than 6.0 or higher than 9.5 ➢TSS – 100 mg/L	Reconsider design runoff flow rate and rate of particle settlement of the silt ponds to ensure effectiveness	Addition of embankment and other flood control measures for the reduction of runoff flowrate and containment of runoff	Immediate desilting of silt ponds Establishment of additional silt pond

Key Environmental Aspect per Project Phase	Potential Impacts per Envt'l Sector	Parameters to be monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost	EQPL Management Scheme					
			Method	Frequency	Location			EQPL Range			Management Measure		
								Alert	Action	Limit	Alert	Action	Limit
					River and Sumbiling River			➢TSS – 85 mg/L ➢Mn – 1.7 mg/L ➢As – 0.034 mg/L ➢Cd – 0.0085 mg/L ➢Pb – 0.085 mg/L ➢Ni – 0.85 mg/L Freshwater body ➢TSS –64 mg/L ➢Mn – 0.16 mg/L ➢As –0.016 mg/L ➢Pb – 0.04 mg/L ➢Ni – 0.16 mg/L	➢Mn – 1.8 mg/L ➢As – 0.036 mg/L ➢Cd – 0.009 mg/L ➢Pb – 0.095 mg/L ➢Ni – 0.9 mg/L Freshwater body ➢TSS – 72 mg/L ➢Mn – 0.18 mg/L ➢As – 0.018 mg/L ➢Pb – 0.0450 mg/L ➢ Ni – 0.18 mg/L	➢Mn – 2 mg/L ➢As – 0.04 mg/L ➢Cd – 0.01 mg/L ➢Pb – 0.1 mg/L ➢Ni – 1 mg/L DENR Standard Limit for Class C as stipulated in DAO 2016-08 ➢If pH is lower than 6.5 or higher than 9 ➢TSS – 80 mg/L ➢Mn – 0.2 mg/L ➢As – 0.02 mg/L ➢Cd – 0.005 mg/L ➢Pb – 0.05 mg/L ➢Ni – 0.2 mg/L			
	➢ Impact on freshwater biology	Species richness of freshwater organisms -Fish -Macro Vertebrates -Plankton -Benthos	Limnological assessment and plankton sampling using plankton net	Semi annual	Downstream Rio Tuba, Ocayan River and Sumbiling River	RTNMC MEPEO Officer/ PCO Third party consultant	Include in MEPEO budget	30% abundance and frequency increase in Chlorophytes and Euglenophytes and prevalence of Chironomids.	40% abundance and frequency increase in Chlorophytes and Euglenophytes and prevalence of Chironomids. Presence of Nematodes and slime like algal blooms.	50% abundance and frequency increase in Chlorophytes and Euglenophytes and prevalence of Chironomids Year-round presence of slime like algal blooms.	Observation of frequency and extent of siltation and identify sources of silt Investigate source of nutrient rich waters	Temporarily stop effluent discharge and re-assess holding capacity of the dam and	Stop mine operations
	➢ Impact on marine biology	Species richness of marine organisms - Fish - Corals - Seagrass - plankton	Underwater survey Field sampling	Semi annually	Mouth of Tuba river	RTNMC MEPEO Officer/PCO	Include in MEPEO budget	High siltation of marine waters specially along the pier and at the mouth of Tuba river	Continuous siltation even after periods of rain	Decrease in species diversity along stations Occurrence of algal bloom	Observation of frequency and extent of siltation Identification of sources of silt	Improve efficiency of silt ponds by conducting maintenance or construction of additional ponds Intensify mangrove planting along the river mouths	Stop mine operations and install additional silt ponds and check dams to manage siltation of rivers
	➢ Groundwater contamination	pH, TDS, hardness, turbidity, Total and Fecal coliform and heavy metals such Mn, As, Cd, Pb and Ni	Grab sampling and laboratory analysis	Monthly	Community wells located at the impact areas	RTNMC MEPEO Officer/ PCO	Include in MEPEO budget	➢ TDS – 400 mg/L ➢ Hardness - 240 (as $CaCo_3$) ➢ Mn – 0.36 mg/ ➢ As – 0.04 mg/L ➢ Cd – 0.002 mg/L ➢ Pb – 0.006 mg/L ➢ Ni – 0.016 mg/L	➢ TDS – 450 mg/L ➢ Hardness - 270 (as CaCo3) ➢ Mn – 0.38 mg/L ➢ As – 0.045 mg/L ➢ Cd – 0.0025mg/L ➢ Pb – 0.008 mg/L ➢ Ni – 0.018 mg/L	DENR Standard Limit as stipulated in PNSDW ➢ pH 6.5 – 8.5 ➢ TDS – 500 mg/L ➢ Hardness - 300 (as CaCo3) ➢ Mn- 0.4 mg/L ➢ As – 0.05 mg/L ➢ Cd – 0.003 mg/L ➢ Pb – 0.01 mg/L ➢ Ni – 0.02 mg/L	Map out location of contaminated or groundwater sources and observed for one quarter Determine possible sources of contamination	Abandon groundwater resources	
	➢Generation of solid and hazardous waste	Volume of solid, oil sludge hazardous waste generated	➢ Record keeping of generated solid and hazwaste, mode of	Monthly	Hazardous waste storage facility	RTNMC MEPEO Officer/ PCO DENR-	Include in MEPEO budget	Accumulation of solid and hazardous wastes	Evidence of leakage, spillage or signs of damage of hazardous waste containers	Complaints from workers and laborers	Continuous collection, treatment and disposal by DENR- accredited	Reduction on the use of raw materials which are potential source of	Use of alternative materials which are more environment friendly

Key Environmental Aspect per Project Phase	Potential Impacts per Envt'l Sector	Parameters to be monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Method	Frequency	Location			Alert	Action	Limit	Alert	Action	Limit
			disposal and volume disposed or recycled			accredited hazwaste transporter					hazwaste treater	hazardous wastes Immediate disposal or treatment of hazardous wastes	
	➢Degradation of air quality	Ambient PM-10, TSP, SO_x, and NO_x	24-hour ambient air monitoring for PM-10, TSP, SO_x, and NO_x	Quarterly	Bulanjao area and residential areas	RTNMC PCO	Include in MEPEO budget	➢SO_x – 144.5 µg/Ncm ➢NO_x – 120.5 µg/Ncm ➢TSP – 184.5 µg/Ncm ➢PM-10 – 120.5 µg/Ncm	➢SOx – 162.5 µg/Ncm ➢NOx – 135.5 µg/Ncm ➢TSP – 207.5 µg/Ncm ➢PM-10 – 135.5 µg/Ncm	DENR Standard Limit as stipulated in the IRR of Clean Air Act ➢SOx – 180 µg/Ncm ➢NOx – 150 µg/Ncm ➢TSP – 230 µg/Ncm ➢PM-10 – 150 µg/Ncm	Identification of possible source of pollutant Use of tarpaulin to cover ore during hauling	Temporarily halt operation and do corrective measures Conduct of maintenance of equipment/ machinery identified as the source of pollution Increase frequency of water spraying	Stop operations and resume only when corrective measures were in place Replace equipment that emits high concentration of pollutants or use better fuel Increase frequency of water spraying
	➢Increase in ambient noise level	Sound level (db)	24-hour sound measurement using hand-held sound meter Noise Meter	Monthly	Bulanjao area and residential areas	RTNMC PCO	Minimal cost	3 dB less than limit	2 dB less than limit	1 dB less than limit	Identification of possible source of noise Issuance of ear plugs	Maintenance, adjustment or replacement of mufflers and installation of noise reduction apparatus	Change of equipment or noise minimization device Limit operations during daytime hours
	➢Threat to workers / public health and safety	Safety record, accident/ fatality incidence/ occurrence	Record keeping	Daily	Bulanjao mining area, haulage roads, stockyard and pier site	RTNMC Safety officer	Minimal cost	Increase in frequency of non-lost time accident	Occurrence of non-fatal lost time accident	Occurrence of fatal lost time accident	Conduct quarterly safety briefing and orientation to laborers and workers Installation of safety signages along accident prone areas within the construction site	Conduct daily inspection of construction area Conduct daily briefing on safety program	Work stoppage along accident area and identify proper safety measures and implement specific safety procedures and protocol
	➢Social impacts	Number of jobs generated for locals; training programs; and other social development programs	Record keeping; Social Impact Assessment	Monthly Every five (5) years for SIA	Host communities and secondary impact areas	RTNMC MEPEO officer, PCO and ComRel SIA Third party consultant	Minimal cost	Number of locally hired employees fall down to less than 40% of the total workforce SDMP accomplishment falls below 80% of target	Number of locally hired employees fall down to less than 20% of the total workforce SDMP accomplishment falls below 80% of target	No locals are employed by the company in the last six months SDMP accomplishment falls below 40% of target	Review hiring policies Review SDMP and determine reasons for the poor implementation of the program	Implement more skills training program to empower residents Identify alternatives for the SDMP projects to improve accomplishment	
	➢Complaints management	No. of valid complaints	Record keeping	Daily	Host communities and secondary impact areas	RTNMC MEPEO officer, PCO and ComRel	Minimal cost	Formal complaint submitted can be resolved at the ComRel level	Intervention from the Upper Management is needed to resolve a formal complaint	Complaint is broadcasted over mass media	Institution of grievance system Conduct regular IEC to inform and	Notify RTNMC Admin for complaint and take remedial measures to	Conduct in depth investigation and identify root cause for all valid complaints

Key Environmental Aspect per Project Phase	Potential Impacts per Envt'l Sector	Parameters to be monitored	Sampling & Measurement Plan			Lead Person	Annual Estimated Cost	EQPL Management Scheme					
								EQPL Range			Management Measure		
			Method	Frequency	Location			Alert	Action	Limit	Alert	Action	Limit
											justify the activities being undertaken by RTNMC during construction	address complaints Investigate all complaints, conduct dialogue with communities and implement mitigating measures Compensate affected communities	Institute measures to avoid occurrence of similar problems

Decommissioning/ Abandonment/ Rehabilitation Policy

7

Rio Tuba Nickel Mining Corporation

This chapter presents the plan of actions to be implemented once the mine ceases its operations. The rehabilitation procedures and mine closure plan of Rio Tuba Nickel Mining Corporation (RTNMC) will be discussed in the following sections.

7.1 ABANDONMENT PLAN

Per Section 187 of DENR Administrative Order (DAO) 2010-21, the proponent should submit an integrated Environmental Protection and Enhancement Program (EPEP) and Final Mine Rehabilitation and/or Decommissioning (FMR/DP) to the Mine Rehabilitation Fund (MRF) Committee and Contingent Liability Rehabilitation Fund (CLRF) Steering Committee, through the Regional Office concerned and the MGB Central Office, respectively. The report shall include the financial requirements to cover all activities from decommissioning to post-decommissioning. Possible post-mining land uses shall be discussed with the stakeholders, implementation schedules, system of environmental compliance guarantees, monitoring and reporting shall also be included in the FMR/DP. Detailed information on the following may be considered in the FMR/DP:

- A description of the project and its various facilities as well as reasons for abandonment and schedules of phase-out or abandonment;
- Assessment reports made on aspects concerning the environmental, social, and public health;
- Suggested options or alternatives for the host communities including its workers so that only minimal dislocation will result from the decision to abandon the project;
- Mapped rehabilitation program for mined-out areas;
- Environmental, social and economic projections of host communities years after the company has abandoned the project;
- Cost of mine closure plan indicating the mine rehabilitation cost per activity and a schedule of payment of the Final Mine Rehabilitation and Decommissioning Fund; and
- Maintenance and monitoring plan to evaluate the effectiveness of the closure and final rehabilitation measures.

The abandonment plan of RTNMC shall also consider the following to ensure its effectiveness:

- Mapped rehabilitation program for mined-out areas must indicate the forest, coastal areas, water bodies and other important environmental resources; these plans shall include specific rehabilitation activities, persons responsible for implementation and the amount of funds to be committed for rehabilitation;
- Company officials who will preside over or be responsible for the implementation of the phase-out or abandonment plan; and
- Action plan of the company and concerned authorities on severance benefits and dislocation compensation.

The strategy for disposal of corporate facilities, *e.g.* water system, medical facilities or equipment and others that may provide social services, with the goal of moving some of them to the community is also included in the abandonment plan.

Specifically, the plan shall involve the following:

- Proper disposal of any residual toxic material in the heavy equipment shop and other areas of concern and the stabilization of the dump sites/landfills. Proper documentation must be made regarding the location and contents of the dump sites/landfill;
- Dismantling the plants, shops, and other facilities;
- Stabilizing and re-vegetating the slopes, waste dumps, and rockfill dams, other open and disturbed areas to make them blend with the natural landscape;
- Filling up and riprap of the catch basins, settling ponds, oil water separator, etc.;
- Eliminating risks of flooding and slope failure;
- Putting the altered areas to the programmed land use; and
- Designing the closure to minimize post-closure maintenance.

An Annual EPEP (AEPEP) shall also be submitted by RTNMC to MGB. The AEPEP shall contain discussion on the nature and extent of the project such as ore reserves, transportation, power supply, list of equipment used in mining operations, workforce information and development schedule. Furthermore, it shall also discuss the specific strategies that are being implemented by RTNMC to limit and control the possible impacts of the project to the environment (land, water and air) and people that are listed as follows:

- Land Resources and Vegetation
  - Implementation of the rehabilitation standards set by DENR and its implementing agencies; and
  - Mining rehabilitation and reforestation of the mined-out areas and non-mineralized denuded areas within and outside the mining claims, including mangroves.

- Water Resources
  - Implementation and improvement of the siltation prevention measures such as sediment barriers and containment ponds;
  - Proper disposal of all solid wastes, used oil and other consumable wastes; and
  - Treatment of sewage water coming from townsite prior to discharge.

- Noise
  - Restriction of hours of activities and implementation of work schedules based on climatic conditions;
  - Use of rock breakers in breaking hard rock portions;
  - Construction of series of humps along Macadam road; and
  - Construction of sound barriers.

- Air quality
  - Implementation of dust suppression techniques such as frequent water spraying, setting up of speed limits and proper maintenance of haulage road;

- People
  - Continuous support of RTNFI hospital operation;
  - Continuous support to the development of the Leonides S. Virata Memorial School (LSVMS);
  - Continuous support to the operation of ILS; and
  - Implementation of the Annual Social Development and Management Program (ASDMP).

The report shall also enumerate approaches of the monitoring scheme and the total cost of the AEPEP. This EPEP document shall consider the areas covered by AMA-IVB-144A.

7.2 REHABILITATION PROGRAM

RTNMC practices progressive rehabilitation. In general, the effective mine life will be a minimum of 10 years. The rehabilitation activities would be within at least five (5) years after the completion of mining activities and cessation of limonite ore retrieval from stockpiles.

7.3 FINAL LAND USE

The final land use shall be presented, discussed and agreed with the stakeholders together with MGB representatives. To be consistent with the existing proposed decommisioning plan of RTNMC, among the options for post-land use include residential, pastureland, industrial tree plantation, aquaculture, ecological park, and forestland. Further assessment and market study shall be done to qualify the final land use appropriate in the area. Please refer to **Table 7.3.2** for the initial plan that may be considered by RTNMC.

The general closure criteria for the RTNMC Project are based on the DENR-prescribed goals of mine closure, namely, physical stability, chemical stability, visual acceptability and productivity of self-sustaining condition. As a reference, the slope and other FMR/DP requirements of the mine components are shown in **Table 7.3.1**.

Table 7.3.1. Slope and other FMR/DP requirements

Mine Component	Slope	Slope Length	Others
Hilltop of fluve	20H :1V or flatter		Overall positive drainage
Hillslope or pitwall	4H : 1V, 5H : 1V	15 to 30 m, less than 50m	Use of cross-slope ditches or furrows; preferred hill slope shape is concave and complex
Toe or pit floor	20H : 1V or flatter		Overall positive drainage
Sedimentation pond	4H : 1V, 5H : 1V	15 to 30 m, less than 50 m	Heavy metals and impounded sediments unloaded
Drainage channel or emergency spillway	To mimic natural streams in grade	To mimic natural streams in banks and armoring	Design rainfall is 24-hour 1:1,000 years event
Forest plantations			Preference to endemic species; post-planting maintenance works are critical. CENRO's help is needed to train the communities on the care and maintenance of the plantations.

Source: FMRDP for Rio Tuba Nickel Silicate Project, 2008

Table 7.3.2. Specific post-mining land uses and closure criteria

Project facility or structure	Specific post-mining land use	Closure criteria
Pit voids	Forestland	• Stable slopes as provided in the List of Slope and other FMR/DP Requirements; • Lined drainage channels. Drainage channel

Project facility or structure	Specific post-mining land use	Closure criteria
		designed for 24 hours 1:100 years rainfall with ample width and size to allow for partial blockage of sediment established and surface regarded for long-term erosion control; and • Vegetative cover, using a combination of fast growing grass (*Crytococcum* sp., *Brachiaria reptans*, *Paspalum conjugatum*, or *Willughbeia* sp.) as understorey component and to cover the ground immediately. Shrubs and tree will also be part of the vegetative cover. Use of Batino and *Trema* sp., which have excellent growth and development in marginal soil condition and are also good source of lumber. Include Narra to avoid monoculture. Soil conditioned to enhance plant growth based on field trial tests.
Crushing/ Screening Plant	Forestland	• Spillage and wastes removed; • Used and unused chemicals removed; • Cables, pipes, concrete, masonry, storage tanks, equipment, structures and unnecessary materials removed; • Sludge, wastes, oil and chemical-contaminated soils and material hauled out; • Drainage channel designed for 2 hours 1:100 years rainfall with ample width and size to allow for partial blockage of sediment established and surface regarded for long-term erosion control; • Hardstands deep ripped and covered with conditioned soil to enhance plant growth based on field trial tests; and • Planted with endemic species.
Sedimentation ponds	Fish pond/lagoon	• Slopes stabilized as provided in the List of Slope and other FMRDP Requirements; • Drainage channel designed for 24 hours 1:100 years rainfall with ample width and size to allow for partial blockage of sediment established and surface regarded for long-term erosion control; • Pond water compliant with DENR standards for Class C water body; • Lagoon use for aqua culture; and • 20 meter buffer zone replanted with grass and other endemic species.
Pier ore stockpile	Coconut plantation	• Remaining ore hauled out; • Hardstands deep ripped and covered with conditioned soil to enhance plant growth based on field trial tests; and • Planted with coconuts.
Industrial areas • Preventive maintenance shop • Mechanical building • Light equipment shop • Warehouse building • Pier and sea craft maintenance office • Fuel tank farm • Assay laboratory	Forestland	• Spillages and wastes removed; • Used and unused chemicals removed; • Cables, pipes, concrete, masonry, storage tanks, equipment, structures and unnecessary materials removed; • Oil and chemical-contaminated soils and material hauled out; • Hardstands deep ripped and covered with conditioned soil to enhance plant growth based on field trial tests; and • Revegetated with endemic species.
Offices	Forestland	• Industrial wastes removed;

Project facility or structure	Specific post-mining land use	Closure criteria
• Mine office • Administration building • Safety office • Mine lookout office • Airport office and hangar • Carpentry shop		• Cables, pipes, concrete, masonry, storage tanks, equipment, structures and unnecessary materials removed; • Hardstands deep ripped and covered with conditioned soil to enhance plant growth based on field trial tests; and • Revegetated with endemic species.
Access roads and slopes	Some as forestland; others for road	• Flattened embankments (refer to List of Slope and other FMRDP Requirements); • Planted with any of the following species: Palawan agoho, *Trema* sp., and/or Batino. Stabilize road cuts/embankments using *Scleria scrobiculata* along the contour (strip planting) and *Crytococcum* sp. between strips of *Scleria sp.* Planting should be dense enough to provide ground cover as soon as possible; • Lined drainage channels; • Hardstands deep ripped and covered with conditioned soil to enhance plant growth based on field trial tests; and • Revegetated with endemic species
Pier	Pier	• All wastes removed; and • Oil spills decontaminated.

Institutional Plan for EMP Implementation

8

Rio Tuba Nickel Mining Corporation

The Institutional Plan of Rio Tuba Nickel Mining Corporation (RTNMC) is presented in this chapter. RTNMC has a well-established Environmental Management Unit (EMU), Community Relations (ComRel) Office, and Safety Unit that will address the possible environmental, social and public health impacts of proposed mining areas as enumerated in *Chapter 2*. Along with the Multi-Partite Monitoring Team (MMT), these units shall ensure that the operations, environment and stakeholders co-exist in a healthy expanse by fulfilling their responsibilities as presented in the Environmental Management Plan (EMP) in *Chapter 3*.

8.1 POLICY STATEMENT

The operation of RTNMC is guided by the principle of "sustainable development" as it promotes socio-economic progress, environmental management, pollution control, safety among employees and community residents, healthy lifestyle and good relationship with the stakeholders.

The primary objectives of RTNMC as an organization are the following:

- To continuously implement its various community development initiatives to enhance the socio-economic progress of our host community and other stakeholders under a sustainable framework of development;

- To continuously promote the concept of sustainable development as the company firmly believes that mining can be sustainable;

- To continuously implement the various environmental and pollution control programs to mitigate the adverse impact of mining operation to the environment;

- To continuously promote the safety and health of its personnel and religiously comply with all pertinent policies, rules and regulations relative thereto; and

- To continuously undertake appropriate information and education campaign among members of the mining community and stakeholders to increase their level of knowledge and awareness on the mining operations, safety, health, and environmental programs that the company is undertaking.

The succeeding sections discuss the various organizations that support the operation of RTNMC. Error! Reference source not found. **Figure 8.1.1** shows the minesite organizational table.

8.2 ENVIRONMENTAL MANAGEMENT UNIT (EMU)

A Mine Environmental Protection and Enhancement Department (MEPED) was organized by RTNMC to implement the set of environmental programs for the mining activities. The Environmental Officer leads this unit and reports directly to the Resident Mine Manager and the President. The following are the main duties of the EMU Manager:

- Plan and manage the implementation of the environmental management plans (EMP);
- Monitor and evaluate the effectiveness of the mitigating and enhancement measures;
- Monitor compliance of Contractors on their implementation of provisions of the Environmental Management Plan (EMP) which covers their respective activities;
- Provide support, implement, monitor and assess the Environmental Management Systems (EMS ISO 14001);
- Plan, recommend and implement modifications or additional environmental measures deemed necessary to effectively protect the environment;
- Coordinate with relevant agencies including the Local Government Units (LGUs) to ensure their effective participation in the implementation of the EMP; and
- Initiate, plan and implement rehabilitation and abandonment programs.

The EMU Manager must be adept in the decision-making process especially on instances where environmental management measures have to be developed or enhanced. **Figure 8.2.1** shows the MEPED Organizational Chart.

In compliance with DAO 2015-07, RTNMC was granted ISO 14001 EMS Certification on May 17, 2016. This further assures that the company shall continue to enhance the positive impacts and mitigate the negative impacts of the mining operation. **Figure 8.2.2** reflects the ISO organizational chart of RTNMC.

8.3 COMMUNITY RELATIONS (COMREL) OFFICE

A Community Relations Office (CRO) headed by a ComRel officer was established by RTNMC to focus on the social development and management programs of the company. It is the responsibility of ComRel to:

- Implement and monitor RTNMC's Social Development and Management Program;
- Initiate linkages and partnership with other organizations; and
- Implement the Information, Education, and Communication (IEC) Campaign.

RTNMC and CBNC also established a Community Relations Assistance (CRA) program to cater open-ended assistance mechanisms to stakeholders. Among the covered support from the CRA are health services, welfare, social services, sponsorships, donations and general assistance not covered in the SDMP. The approval of which is being done by both the RTNMC and CBNC.

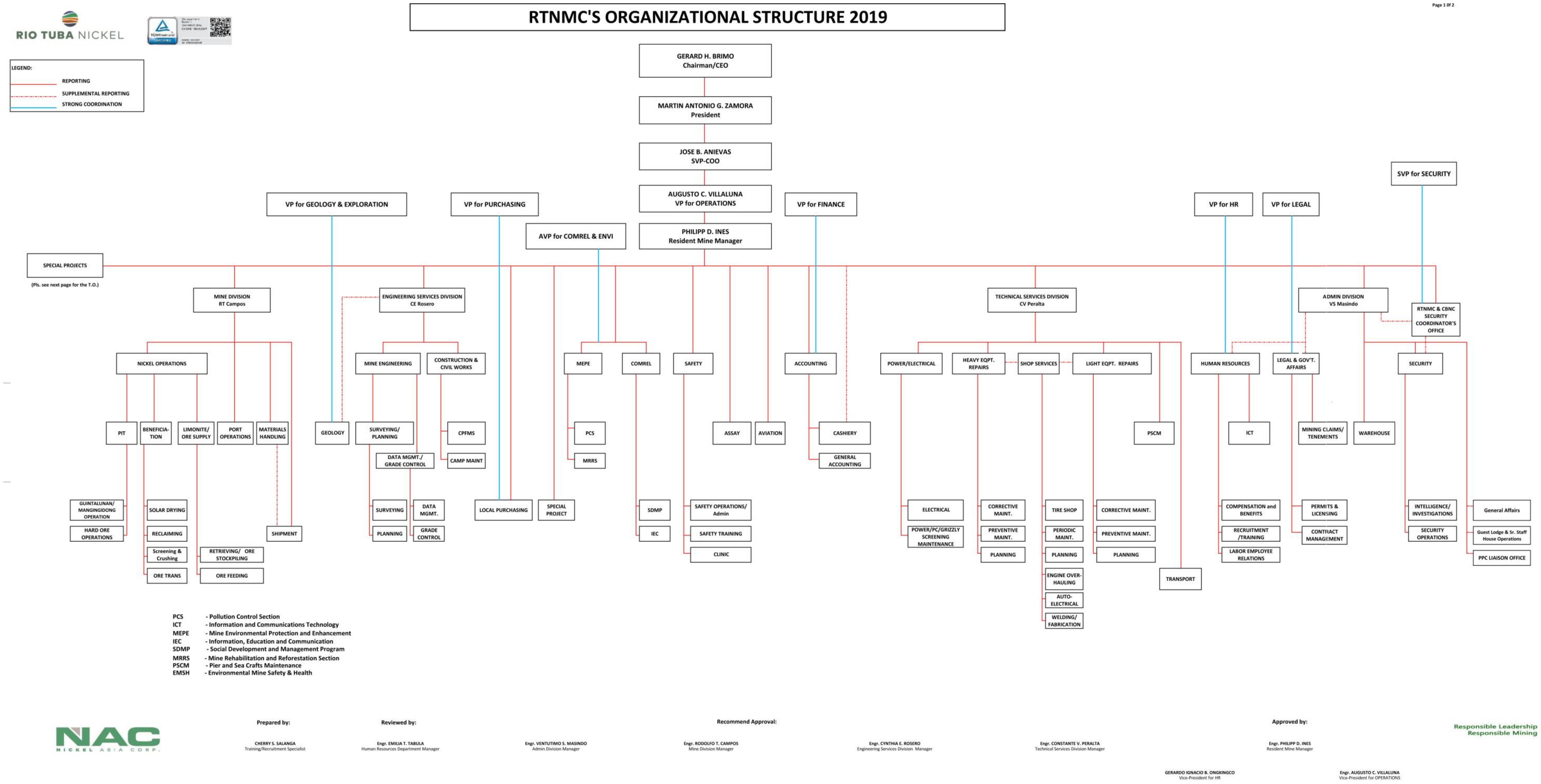


Figure 8.1.1. Minesite organizational table

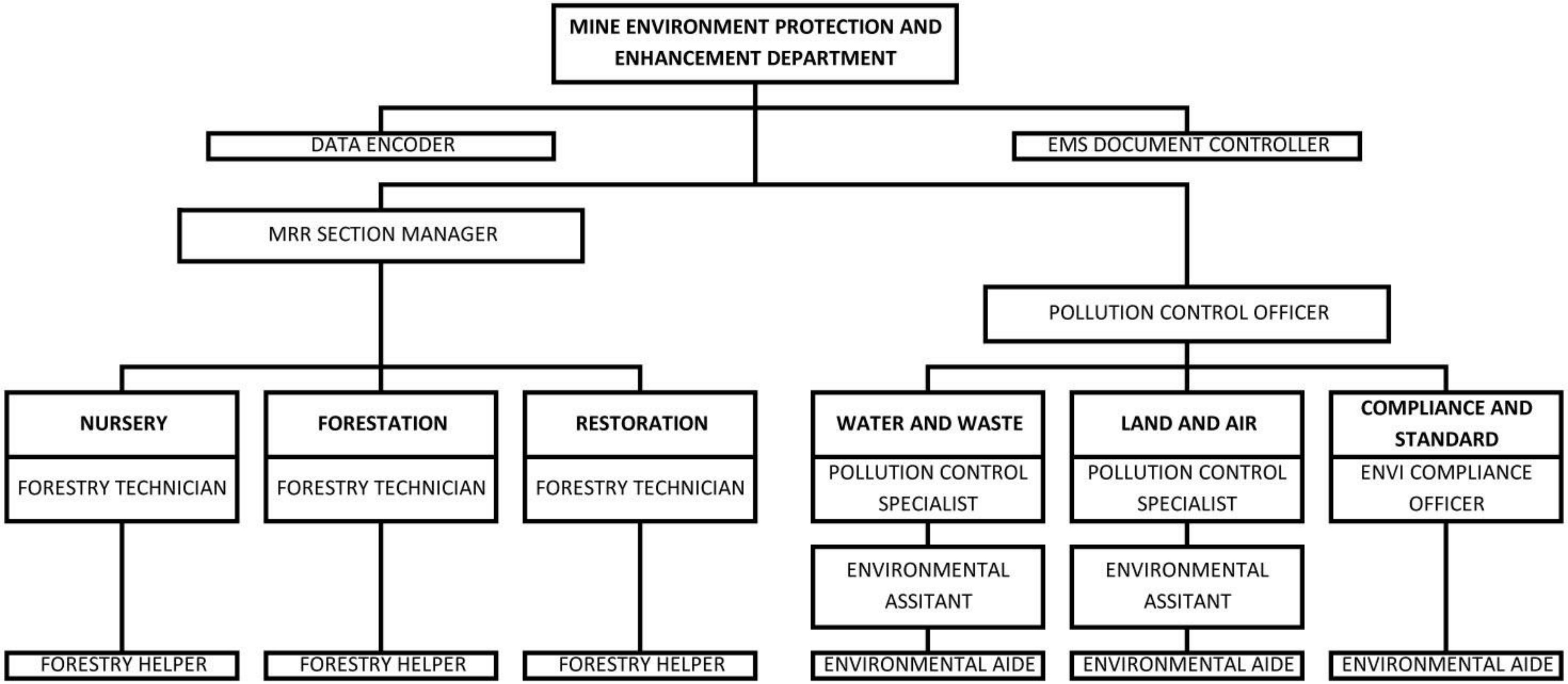


Figure 8.2.1. RTNMC MEPED organizational chart

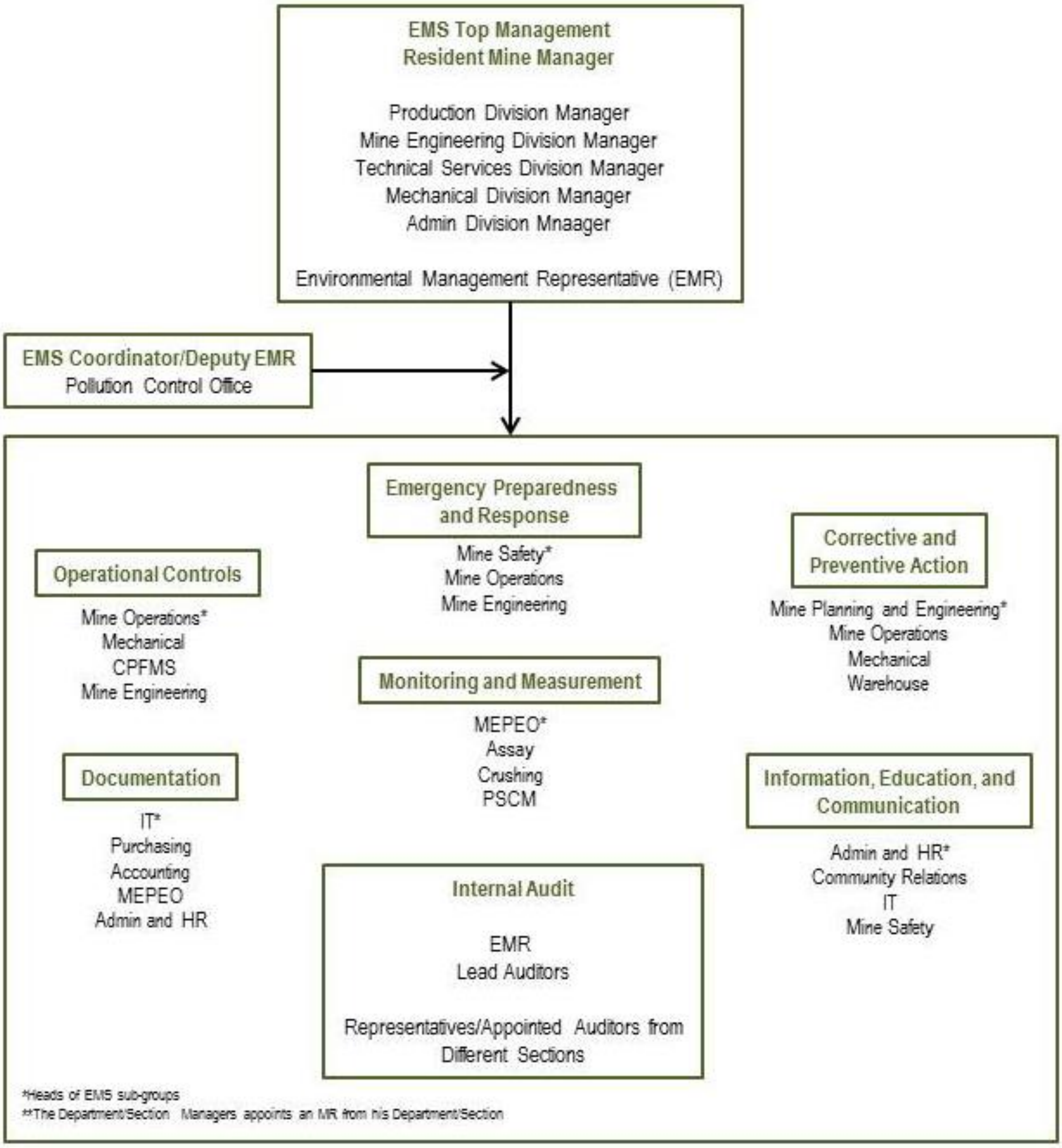


Figure 8.2.2. RTNMC ISO Organizational Chart

Upon the establishment of CBNC in 2003, the Rio Tuba Nickel Foundation, Inc. (RTNFI) was established. The RTNFI, in general is in charge of accounting the expenses incurred under SDMP 3 as well as the costs in supervising the LSVMS, RTNFI Hospital and Indigenous Learning System (ILS). It is composed of the Board of Directors, President, Vice President, Executive Director and Secretariat. **Figure 8.3.1** shows the organizational chart of RTNFI.

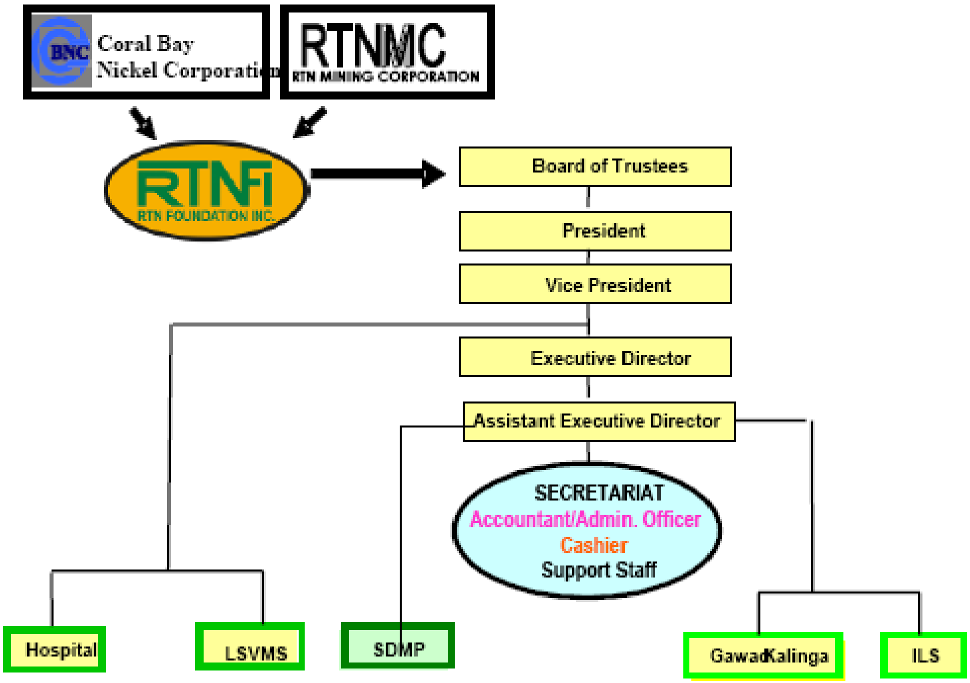


Figure 8.3.1. RTNFI Organizational Chart

Upon operation of the Bulanjao project, RTNMC shall also coordinate with the Mines and Geosciences Bureau (MGB) regarding the set-up in implementing and reporting the SDMP of RTNMC considering that the current SDMP is now on its fourth term and the proposed Bulanjao project will be under a separate ECC. The matter shall be properly addressed, resolved and finalized with the MGB according to existing rules.

8.4 SAFETY OFFICE

The safety office is responsible for ensuring the safety and health of all workers. At present, RTNMC has one (1) full-time Safety Engineer and twelve (12) full-time Safety Inspectors directly reporting to the Resident Mine Manager. Safety is instilled to all employees as safety and health responsibilities are included in the job description of department/section heads, foremen and supervisors. General Safety Rules and Regulations and Standard Operating Procedures in accordance with DAO 2000-98 otherwise known as the *"Mines Safety and Health Standards"* is in place and a health management system has been established and is being maintained and improved continually.

8.5 MULTI-PARTITE MONITORING TEAM (MMT)

The Multi-Partite Monitoring Team (MMT) which is composed of representatives from various sectors is responsible mainly in assessing and validating the RTNMC's compliance to environmental standards as indicated in the ECC. Members are involved in the actual monitoring, sampling and analyzing of samples. Other responsibilities of the MMT include:

- Setting up the environmental standards and criteria specific to the Project and its location;
- Conducting trainings for MMT members for more effective monitoring activities;
- Deciding on the merits of complaints filed against the Proponent and acting on these complaints; and
- Planning of the annual monitoring work and financial plan.

The Memorandum of Agreement (MOA) states that the general role of the MMT including their functions, roles, and duties of each member and committee. Currently, the MMT of RTNMC is consist of the representatives below, which may be extended upon the Bulanjao project starts:

- Philippine Economic Zone Authority (PEZA);
- Mines and Geosciences Bureau (MGB) MIMAROPA;
- Apostolic Vicariate of Puerto Princesa (AVPP);
- Haribon Palawan;
- Palawan Council for Sustainable Development (PCSD);
- DENR- Provincial Environment and Natural Resources Officer (PENRO);
- Bureau of Fisheries and Aquatic Resources (BFAR);
- Department of Health (DOH);
- Environmental Management Bureau (EMB) Palawan;
- Environmental Management Bureau (EMB) MIMAROPA;
- Bataraza Christian Muslim Palawano Asso, Inc.(BACRISMUPAL);
- Indigenous People (IP) Representatives;
- LGU-Bataraza;
- LGU-Barangay Rio Tuba for Nickel;
- LGU-Barangays Sandoval and Iwahig for Limestone; and
- City Environment and Natural Resources Office (CENRO).

The proponent shall set aside the funds which will enable the MMT to conduct its activities based on the agreed upon function of the team. Apart from this, RTNMC will ensure that all stakeholders are well represented to guarantee a more transparent and factual monitoring data available to the public.