ENVIRONMENTAL PERFORMANCE REPORT AND MANAGEMENT PLAN (EPRMP)

For The Proposed

6 x 135 MW CIRCULATING FLUIDIZED BED COAL-FIRED POWER PLANT EXPANSION PROJECT

Barangays Tambobong and Balacanas, Villanueva, Misamis Oriental

FDC
Misamis Power Corporation
A SUBSIDIARY OF FDC UTILITIES, INC.

June 2021

Prepared by:

technotrîx integrated services corp.
Unit 1206 12th Floor The Trade and Financial Tower 32nd Street cor. 7th Avenue, Bonifacio Global City
Barangay Fort Bonifacio Taguig City 1634 Email : technotrix.tisc@gmail.com Contact No.: (02) 7373 1456

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Table ES-1 Project Title and Basic Project Information

Name of Project	**PROPOSED 6 x 135 MW CIRCULATING FLUIDIZED BED COAL FIRED POWER PLANT EXPANSION PROJECT**	
Existing ECC	**ECC No.: ECC-CO-1304-0012**	
Project Location	Phividec Industrial Estate, Barangays Tambobong and Balacanas, Municipality of Villanueva, Misamis Oriental	
Project Category per EMB	"Category A-2 Existing and to be expanded, modified and/or rehalilitated": Environmentally Critical Project (ECP) / MC 2014-005	
Memorandum Circular 2014-005	Power Plant Project ≥ 30 MW	
Project Classification per EMB Memorandum Circular 2014-005	3.2.4 Other Thermal Power Plants (e.g. Coal, diesel, bunker)	
Project Size	Total gross plant capacity (existing and expansion) = 6 X 135 MW = 810 MW	
Existing Capacity	3 x 135 MW	
To be installed Capacity	Additional 3 x 135 MW	
	Existing Facilities	**Additional Facilities**
Project Area	**84.4 has (including foreshore area)**	Existing project site with foreshore area Additional 3 has for coal conveyor Additional 12 has for coal yard **Total 99.4 has**
Summary of Major Components	3 x Circulating Fluidized Bed (CFB) Boilers Steam conditions at turbine inlet ≥240 bar, @ 593˚C	Additional 3 x 135 MW Circulating Fluidized Bed (CFB) Boiler Total 6 x 135 MW Same steam conditions
	Three (3) sets steam turbines and electric generators Reheating, regenerating, condensing type. Speed 3600 rpm Capacity 158.8 MVA Power factor (lag) 0.85 Voltage [20-29] kV Frequency 60 Hz 138 kV AIS (Air Insulated Switchyard)	Additional 3 Steam Turbines and Electric Generators Reheating, regenerating, condensing type Speed 3600 rpm Capacity 158.8 MVA Power factor (lag) 0.85 Voltage [20-29] kV Frequency 60 Hz 138 kV AIS (Air Insulated Switchyard)

	Covered Coal Storage Yard (19 hectares active area) In-plant coal distribution system i.e.. covered conveyors, capacity of 167,500 MT for 30 days	Same storage yard active area additional covered conveyors for total capacity (existing and additional) of 204,800 MT for 19 days
	15 has. Ash Repository	Additional 9 has. Ash Repository Total: 24 has
	Jetty (For 55,000 DWT Vessel) Pier-resisting concrete deck, 180m platform with mooring dolphins, berth 278m, trestle 315m	Same jetty (55,000 DWT Vessel) Additional slipway or mooring dock of 100-150m length.
	Switchyard w capacity of 476.5 MVA	Total capacity of 794.1 MVA for existing and expansion projects.
	Air Pollution Control Devices (APCDs) 3 X Electrostatic Precipitators (ESPs) with Capacity of 1 set each unit or total of 3 sets	Air Pollution Control Devices Additional 3 sets ESPs for total capacity of 6 sets for original and expansion projects
	Wastewater Treatment Plant (WWTP) Capacity of 30 tph	Same type of WWTP with additional capacity of 33 tph for a total of 63 tph
	River Water Pumping Station with capacity of 2x120 tph	Same facility, pumps will be upgraded to 2x190 tph
	Raw water treatment plant with capacity of 2x100 tph	Same raw water treatment plant with additional of 3x80 tph Total capacity for original and expansion plant of 440 tph
	Access Road 1250 meter long and 12m average width	Additional plant roads with added 810 m long and 6m average width
	Others staff house 2000 sq. m) and warehouse & workshop (2000 sq.m.)	Additional Dormitory 1,400 sqm and expansion of warehouse & workshop to a total area of 3000 sqm
Project Cost	within the range of P 20 Billion to P 30 Billion pesos	
Construction Period	Thee (3) year time frame through plant acceptance from the EPC.	
Proponent Name	**FDC MISAMIS POWER CORPORATION** Contact Person: **Mr. Roderick Fernandez** Unit D, 11th Floor, Cyber Sigma, Lawton Avenue, McKinley West, Fort Bonifacio, Taguig City 1630 Telepone No.: +632.575.1600 / +632.819.6131	
EIA Preparer / Consultant	**TECHNOTRIX INTEGRATED SERVICESS CORP (TISC)** Contact Person: **Hazel A. Victoriano**, Managing Director Unit 1206 Trade and Financial Tower, 7th Ave. corner 32nd St. Bonifacio Global City, Taguig City Telephone No.: (02) 7373 1456 Mobile No.: 0917 178 0865 E-mail address: technotrix.tisc@gmail.com	

ES 1.1 Project Description Summary

This submitted EPRMP Report has been prepared in compliance with DAO 2003-30, the Implementing Rules and Regulations (IRR) of PD 1586 and related new issuances. The basic paradigm that ECC is a Planning Tool is adopted in the EPRMP. The applicable provisions of DAO 2017-15 (Guidelines on Public Participation Under the Philippine Environmental Impact Statement (EIS) System are also incorporated. In a more macroscopic perspective the paradigm of Sustainable Development that "development and environmental protection are interdependent and indivisible" is embodied in the EIS System.

The Proposed Expansion Project involves the construction and operation of additional 3 x 135 MW units of Circulating Fluidized Bed (CFB) Coal Fired Power Plant. FDC Misamis Power Corporation (FDCMP) the Proponent and Owner of the Project has been operating since 2016 the same capacity in the same project site

A basic rationale for the expansion project is to contribute to the sustained and robust development of Mindanao which requires electricity as a major infrastructure support.

ES 2.0 EIA Process Documentation

ES 2.1 The EIA Team *(Proponent & Preparer Team members, module of involvement, expertise)*

The composition of the EIA Team in compliance with EMB MC 2011-005 is shown in **Table ES-2**. Resource Persons/Expert Companies were also engaged and are also listed hereunder

Table ES-2 Team of EIA Preparers

Team Member	Module	EMB Registry No.	Company
Edgardo G. Alabastro, Ph.D.*	Team Leader; Air & Water	PCO-257	TCSI Consolidated Group, Inc. (TCGI)
Hazel A. Victoriano	Asst. Team Leader		Technotrix Integrated Services, Corp. (TISC)
Lorelie A. Bueza	Project and Sociology Coordinator		Technotrix Integrated Services, Corp. (TISC)
Benjamin Francisco	Marine and Fresh Water Ecology (Team Leader)	PCO-038	TCGI Resource Person
Jean Ravelo	Geology	-	TCGI
Virgilio Pantaleon	Coral Reef, Seagrass	-	TCGI Resource Person
Jose Rene Villegas	Marine Team	-	TCGI Resource Person
Ernie Fontamillas	Marine Team	-	TCGI Resource Person
Michael Francisco	Fisheries	IPCO-040	TCGI Resource Person
Engr. Emerson Darroles	Oceanography	-	TCGI Resource Person
Nazario Sabello	Air Quality	-	TCGI Resource Person
Rachel V. Dinglasan	Technical/Research	-	Technotrix Integrated Services, Corp. (TISC)
Proponent's External Expertise			
Design and Engineering Consultants			

ES 2.2 EIA Study Schedule & Area

The delineation of the EIA Study Areas is based on the Direct Impact Area (DIA) and the Indirect Impact Area (IIA). These study areas are identified in the discussions of the specific modules, i.e. Land, Water, Air and People.

The guidelines provided by the Revised Procedural Manual are used for the delineation of the DIA and IIA, to wit:

a) Direct impact area (DIA) is … the area where ALL project facilities are proposed to be constructed/situated and where all operations are proposed to be undertaken. For most projects, the DIA is equivalent to the total area applied for an ECC.
b) Indirect Impact Area (IIA) …an IIA can be the stretch of the river/s OUTSIDE the project area but draining the project site which can potentially transport Total Suspended Solids and other discharges from the project towards downstream communities.
c) …Further, the interphase/overlap of the biophysical DIA with socio-cultural environment shall define the socio-cultural DIA after the EIA is completed…

Direct Impact Area (DIA)

- The project site itself.
- Portions of the Macajalar Bay wherein the existing and additional cooling water intake and outfall structures and the pier are located;
- Portion of the Tagoloan River where in the river water intake and piping structures are located
- The plume of air pollution discharges from the plant's boilers wherein the Ground Level Concentrations (GLCs) exceeds the Clean Air Act Guidelines.

The Indirect Impact Area (IIA)

- The population and social centers which are outside the air dispersion plume i.e the Environmentally Sensitive Receptors (ESRs)
- PHIVIDEC-owned access road leading to the project site

The guidelines provided by DAO 2017-15 are as follows:

DIA for Air Quality Impacts

-Areas with project Ground Level Concentration (GLCs) of emissions higher than the ambient standard based on air dispersion/transport modeling studies (worst case scenario)

The air dispersion modeling does not reveal emissions higher than the ambient standard at worst case scenario of all of the 6 x 135 MW units operating at the same time at maximum capacity. Although a failure in the operation of the Electrostatic Precipitator (ESP) , the main APCD may occur, the ESP will be either automatically shutdown or immediately by manual mode so this is deemed not the scenario referred to for consideration of the DIA, inasmuch as DIA is reckoned from sustained and long term operations.

DIA for Water & Quantity Impacts

-The extent of water body/ies where the water quality are projected to exceed the ambient standards based on relevant worst case scenario discharge modeling studies (sediment and pollutant discharges)

-Areas using the groundwater that could possibly be contaminated by project activities involving the use and disposal of toxic chemicals and hazardous wastes or construction of underground facilities.

-Areas where there are existing users of the same source of natural resources (e.g. water) that the proposed project will be using
-The ambient standards for water are not exceeded as discussed in Section 2.2.
-Groundwater will not be used in the project.

-The Tagoloan river is the area where there are existing users of the same source of water that the project will be using. Thus Tagoloan river is a DIA.

DIA for impacts on Land

-Areas directly vulnerable to potential flooding or inundation that may be cause by the project
-Areas where there will be disturbance of habitat

The project will not cause flooding.
The habitat for the expansion project which are few standing trees are in the project site, which is already defined as a DIA under DAO 2003-30.

DIA for impacts on People

-Directly affected areas based on the results of the socio-economic impact assessment studies conducted including ancestral domain of indigenous communities that may be affected, if any

There are no ancestral domains of indigenous communities.

The socio economic impact is reckoned from the benefits arising from ER 1-94 which is likewise the same IIA delineated in DAO 2017-15.

The IIA shall be delineated for impacts on people and shall include those in the vicinity of the DIA who will either benefit or be affected indirectly by the project.

The communities that will benefit from ER 1-94 and thus the IIA. However, the DIA from “People” perspective is the same as the IIA reckoned from socio economic benefits.

The municipalities, barangays and LGU areas that will benefit from ER 1-94 are considered to be IIA.

The map of the DIA and IIA is shown below:

Figure ES-1. Direct and Indirect Impact Areas of the Project site in Google Earth Map

The following are the activities that were conducted for this study. Continuing activities will be based on the results of the Technical Review.

Table ES-3 EIA Study Schedule

ACTIVITY	DATE	AREAS COVERED
Bathymetric Survey	On-going	Proposed project site and immediate vicinities
Marine Study	On-going	Proposed project site and immediate vicinities
Secondary Data Research		DIA communities at Villanueva
Air Dispersion Modelling	February 2020	Proposed project site and immediate vicinities
SOCIAL PREPARATION UNDERTAKEN		
Initial Perception Survey	July 16, 2019	Barangay Tambobong, Balacanas and San Martin
Information, Education and Communication (IEC)	July 16, 2019	All impact Barangays, Municipality and General Public invited to the IEC meeting
Public Scoping	October 4, 2019	Villanueva Multipurpose Gym
Technical Scoping	December 6, 2019	EIA Conference Room, EMB Central Office
Perception Survey	October 4 to 6, 2019	Provided in **Annex 11**. Public Participation Activities

The public participation activities have been undertaken

ES 2.3 EIA Methodologies

The EIS Methodology is adopted in the EPRMP screening form. The EPRMP screening form is the signed Formal Checklist with the EMB and the Environmental Impact Assessment Review Committee (EIARC) Members, the Proponent and EIA Consultant indicating therein the requirements and the content of the EPRMP report. The signed EPRMP Screening Form is shown in **Annex 1.**

Table ES-4 EIA Methodology

Module / Section	Baseline	Methodology
LAND		
Land Use Classification	**Secondary data:** Municipality of Villanueva, Misamis Oriental Comprehensive Land Use Plan (CLUP).	Assessment of the compatibility of the proposed project vis-à-vis actual land use and approved Comprehensive Land Use Plan / Zoning Classification. Site is in PHIVIDEC Industrial Estate. Delineation of Protected Areas classified under the NIPAS

Module / Section	Baseline	Methodology
Geology	**Secondary data:** Geologic, seismic, liquefaction, slope hazard maps and evaluation based on government data and maps. **Primary data:** Soil investigation report	Identify and assess project impact in terms of the changed in topography including existing hazard as maybe aggravated Conduct of EGGAR./ MGB Methodology
Pedology	**Primary data:** Soil quality sampling and testing **Parameters Considered** • Nitrogen • Phosphorus • Potassium • pH • Organic Matter • Micronutrients • Trace metals e.g. Pb, Hg, As, Cd, Cr hexavalent, etc.	Sampling and tests for the physical and chemical properties and erodibility potential of the soil, ongoing erosion processes and assesses the erosional impacts of the project. .
Terrestrial Ecology	**Not Applicable**	
WATER		
Hydrology / Hydrogeology	**Secondary data:** Existing drainage system. Historical flooding occurrences	Identification and assessment of project impact on the change in drainage morphology, local drainage and resulting effects of flooding
Marine Water Quality	**Primary data:** Standard Methods for Water Quality Sampling and Monitoring. **Water Body Classification:** DENR Class SC **Parameters Considered** • pH • temperature • BOD_5 • COD • DO • Oil and grease • TSS • Heavy Metals: Hg, Cd, As, Cr, Pb, • Fecal / Total Coliform	Assess impacts on siltation of surface and coastal marine waters DAO 2016-08 Analytical Methods: by DENR recognized laboratory Metals : Spectophometry AAS Cold Vapour AAS for Hg Coliform : Multiple Tube Fermentation BOD : Azide Modification Winkler O & G: Gravimetry (n-Hexane extraction) DO : Winkler/Titrimetric pH : Electrometry TSS : Gravimetry Based on SMR

<table>
<tr><th>Module / Section</th><th>Baseline</th><th>Methodology</th></tr>
<tr><td>Oceanography</td><td>Primary data:

Bathymetry
Water Current
Analysis of available proximate tides data
Hydrodynamic modeling
Particle dispersion modeling and map
Storm surge hazard, exposure, vulnerability, risk maps.

Update thermal plume model</td><td>Tidal Stations

Echo sounder or equivalent</td></tr>
<tr><td>Marine</td><td>Primary data: Abundance / density / distribution of ecologically and economically important species, mangroves, benthism planktons, coral reefs, algae, seaweeds, sea grasses

Presence of pollution indicators</td><td>Transect, manta tow and spot dives surveys, marine resource characterization (e.g. city/municipal and commercial fisheries data), Key informant interview.
Microscopic Examination</td></tr>
<tr><td colspan="3">AIR</td></tr>
<tr><td>Ambient Air Quality</td><td>Primary data: Ambient air quality sampling and testing.

DENR Classification Ambient Air and Noise Classification: Class A

Parameters Considered:
TSP
PM_{10}
SO_2
NO_2
CO
Trace Metals: Hg, Pb, Cd, Cr, As,</td><td rowspan="2">Methodology: Standard Methods for Ambient Air Quality Sampling by Volume Sampler<table><tr><td>TSP</td><td>Graseby High Volume Sampler</td><td>Gravimetric</td></tr><tr><td>PM10</td><td>Graseby High Volume Sampler</td><td>Gravimetric</td></tr><tr><td>SO_2</td><td>Gas Bubbler Sampler</td><td>Pararosaniline</td></tr><tr><td>NO_2</td><td>Gas Bubbler Sampler</td><td>Griess Saltzman</td></tr><tr><td>Noise</td><td>Type 2 – Sound Level Meter</td><td>Instantaneous reading</td></tr></table>
Based on SMR.</td></tr>
<tr><td>Ambient Noise Quality</td><td>Primary data: Noise Meter</td></tr>
<tr><td>Contribution in terms of GHG</td><td>Data on Greenhouse Gases</td><td>Estimation of projected greenhouse gasses (GHG)
Based on International Convention</td></tr>
<tr><td colspan="3">PEOPLE</td></tr>
<tr><td>Demographic Profile / Baseline</td><td colspan="2">Primary data: Conduct of Public Perception Survey, Public Scoping
Secondary data: Comprehensive Land Use Plan (CLUP) of Municipality of Villanueva</td></tr>
</table>

Public Participation

DAO 2017-15 on Public Participation is being strictly complied with. The summary matrix of issues and concerns raised during public participation activities are provided below. Full documentation of Public Participation Activities is provided in **Annex 11.**

Table ES-5 Information, Education and Communication (IEC), 16, July 2019

Sector or Representative Who Raised the Issue/Suggestion	Issues/Suggestions Raised by Stakeholder	Proponent's Response
Engr. Balmorea LGU Misamis Oriental	Is there a carbon sink in the Area?	Ms. Ana Miso: May initial discussion po kami sa lugar na malapit sa planta. Specially Tagoloan and Villanueva LGU's.
	Regarding sa monitoring system na pinepresent kanina, im just concerned for the health of the population as part of the province. I hope you have the baseline on the illnesses.	Ms. Jean Ravelo: Just for the record, the FDC will be expanding, the present reforestation of the area for the carbon sink is in Salvador which is far from Tagoloan, so can it be done here or nearer the FDC plant? And our officer Ms. Ana, answered that it is being addressed and it is on consultation with the LGU's.
	What is the effect of the coal in terms of:Health problems	Mr. Krisler Pascual: We will do the health impact study. Dr. Edgardo Alabastro: As an EIA preparer we can assure you that would be included in our EIS report.
BFAR Region 10	This is an expansion project, and I just would like to know if you have already send letter to the Local Government Unit because this is part of your expansion project. Because in BFAR we want to be assured that there will be no coral that will be affected for your objective.	Mr. Eric Fernandez: Thank you for your question. As presented by Dr. Ed, this is the first step for the permitting process. So we will present the project to all stakeholders and eventually we will securedall the permits with all LGU's. So wala pa po kaming sinesend dahil ito yung pinaka first step sa permitting processes.
	Pero as you mention kanina, only the DENR mention on the process, BFAR should be involve. Ayoko lang na mag start tayo ng mali kasi it happens na in other areas. And also, we should involve academe for the study of this corals.	Ms. Jean Ravelo: Kanina sinabi ko na ang purpose ng IEC na to is for us to know kung sino pa ang dapat ma involve lalo na sa susunod nating pagkikita sa Public Scoping para masala natin sila
Renoir A. Abrea Mindanao State University	In your presentation, my understanding is this is an already an expansion and there's and existing powerplant and in operation. What is the condition of the environment before this powerplant? By this time, if you can show to us that there is no destroyed to environment, you are compliant to the DENR. · Baseline Information in corals	Mr. Eric Fernandez: We conducted baselines and signed several MOA. Dr. Ed is also our preparer for the existing plant. Dr. Edgardo Alabastro: We the preparer we've done baseline before and we will do again the baseline for confirmation of our baseline before.

Sector or Representative Who Raised the Issue/Suggestion	Issues/Suggestions Raised by Stakeholder	Proponent's Response
Marine Biologist MFSU	Volume of water that we will draw from the sea? Effects: * Planktons Meron bang chlorination na ginagamit ang planta ninyo? Kasi kung wala, possible na mag clog down yung mga pipes ninyo.	Mr. Sam Lamorena: We have 3400 ships in the entire ocean in the world. Plankton will never damage in our operation. The intake is located so far away in the outlet. We assured you that the proper bathymetric survey was properly identified the problems. These technologies that are applying are approved by the scientist and engineers and also knowledgeable peoples.
Jose Oliver Ello MENRO LGU Villaueva	· Small percentage of local employment We have so many graduates in Villanueva, why are 70% of your people is outside the province? The priority of your employment and the ECC condition is not followed. That was the best SDP program that will be given to the people.	Ms. Josephine Ong Cayabyab: Duly noted sir.
Kagawad Casino Municipality Villanueva	Concerned about Employment	Ms. Josephine Ong Cayabyab: Duly Noted sir and we will answer in the Public Scoping
Boboy Sabal Board Member Provincial	Timeline of implementation in expansion	Eric Fernandez: Yung growth rate po ng Mindanao is napaka taas compare to Luzon and Visayas. Mr. Eric Fernandez: Noted sir.
Kawagad Leonciod Vilannueva	Kailangan ba talaga ng expansion? Kasi ang Villanueva ay may dalawa ng coal power plant. So kung mag eexpand pa, paano na yung impacts lalo nyan?	Mr. Kailangan I support yung capacity para ma supplayan yung economic growth ng Mindanao.
Engr. Marie Jo. T. Asa DEPED	Hinihingi lang po namin na may additional pang tulong from FDC. Sana maisama nyo sa program nyo yun para po sa mga kabataan. Maybe a little bit share to the education.	Ms. Josephine Ong Cayabyab: We are looking for a more sustainable benefit from the community. Noted po.
NCIP	Meron bang population ng IPs malapit sa planta?	Ms. Josephine Ong Cayabyab Wala po.
Mun. Kagawad Edgardo A. Permi SB Villanueva Committee Chairman on Envi.	Prioritization of electrification in Villanueva. Dapat full electrification sa road and households. • ER-194	Ms. Josephine Ong Cayabyab Noted
Felipe C. Valdehuesa Jr. Municipal Councilor LGU Tagoloan	Kailangan ba talaga ng expansion?	Ms. Josephine Ong Cayabyab Noted.

Sector or Representative Who Raised the Issue/Suggestion	Issues/Suggestions Raised by Stakeholder	Proponent's Response
Dr. Elnor Roa MSU Naawan	Requesting to increase the number of employees in Barangay Balacanas FDC should provide technical trainings	Ms. Josephine Ong Cayabyab Noted
Phividec	Sana hindi na maulit ung mga issues na na encounter during MMT before. Anong document ang iaaply dito EIS or EPRMP? I would like that FDC should be transparent to this expansion project. And I hope another concerned individuals should be part of the MMT.	Dr. Edgardo Alabastro: Ang iaapply po namin ditto ay EIS sa central office.
Not Identified	Meron ba kayong plan na mag shift ng technology? Like renewable energy?	Mr. Eric: Fernandez Renewable Energy is another area of planned energy projects For this particular project there will be no shift in technology

Table ES-6 Public Scoping, October 4, 2019 at Villanueva Gym, Misamis Oriental

NAME / AFFILIATION	ISSUES AND CONCERNS	RESPONSE
Dax Jara Phividec - 1A	A. Suggestion for Preparer / Consultant to possibly answer issues raised based on facts from the operation of the existing FDC Power Plant considering the preparer of both projects is the same. B. Suggest from LGU - Villanueva, FDC Misamis and other concerned stakeholders to sit down together and formulate certain agreement and mechanism to address issues regarding priority employment and possibility such mechanism will be used for future MMT (Multi-partite Monitoring Team) validation activities.	**Dr. Ed Alabastro (Preparer):** Information to be included in the EIS DC NOC CC and HR to coordination for the sit-down meeting with LGU/DENR to discuss improvement of local employment.

NAME / AFFILIATION	ISSUES AND CONCERNS	RESPONSE
Engr. Walter Encinas, REE CAAP, Area 10	For Air mitigation, what is the percentage (%) of CO emitted by the current per generators (Boilers? What is the limit of CO%? For Water, currently, what is the exact status of coral a. Directly on the area of FDC's water? b. 5 km from the Power Plant c. Within Macajalar Bay?	Results to be included in the EIS. Results to be included in the EIS.
Rendir Abrea MSU -N	What is the volume of sea water to be used in the operation	**Dr. Alabastro**: the preparer was requested to answer the volume of sea water, but may we refer the answer to FDMC, strictly there is no volume of sea water, there is a volume of river water. The volume of sea water is not really relevant because the volume of water is really circulating and no volume of water was used. **EMP, Dr. Myrna** - requested to answer the question (in) to quantify the volume **Roy of FDC MPC** - Volume of seawater being used which drastically below the limit allowed in our water permit from NWRB
Anshawer Bara-acal MSU-IIT	Can you disclose the percentage composition of flue gasses that should emit from the smoke stack as a result of coal burning? And how do you mitigate it if it exceeds in DENR standard	**Kishler Pascual of FDC MPC** - Provided flue gas composition which is within DENR regulation.

ES 3.0 EIA Summary

ES 3.1 Summary of alternatives considered in terms of siting technology selection/operation processes and design

Siting alternatives

There are no other feasible project site alternatives considering that the project involves only the expansion and or upgrading of the existing facilities; the existing project site is already developed, same pier will be used, same access road (with minor addition) will be utilized and major components will be located in the same project area. More importantly " Proof of Authority Over the Project Site" is already covered by the lease Agreement with PHIVIDEC. Further discussions are provided on pages 1-16.

Technology Selection and alternatives

The Circulating Fluidized Bed (CFB) utilized for the original project is the same selection made for the expansion project because of:

(a) successful experience and environmental performance with this technology
(b) common facilities will be used such as ash yard, coal storage yard, warehouse, jetty, and conveyor systems
(c) an alternative technology, e.g. pulverized bed coal power plant, may create more technical, operational and environmental complications as well as compatibility between existing and expansion aspects. The same raw material (coal) will be used and therefore an alternative technology selection is not favored.

The same raw material (coal) will be used and therefore an alternative technology selection is not favored.

Cost consideration is necessarily a selection factor also. Other systems which may be considered more updated such as supercritical or ultracritical technologies are also options. However, higher costs are involved which ultimately impacts on the economic benefits as will be reflected in power costs. Different technologies may also require new manpower skills which are already available for the original CFB technology.

Summary of baseline characterization (in relation to the results of the regular monitoring of projects impacts and environmental performance)

Table ES-7 Summary of Key Baseline Characterization

Resource	Parameters	Characterization
Land	Flora & Fauna	Not significant, due to site already developed and disturbed prior to implementation of the expansion project.
	Topography	Site is relatively flat and already developed.
Water	Ambient Water Quality	Based on SMR, compliant with standards.
	Corals and other Marine Species	Essentially the same as pre-project baseline.

Air	Ambient Air • **TSP** • **PM_{10}** • **SO_2** • **NO_2** • **CO** • **Trace Metals: Hg, Pb, Cd, Cr, As**	Compliant with Clean Air Standards based on SMR.
	Noise Level	Compliant with DENR Standards
People	Perception Survey	In the absence of clear guidelines on baseline parameters for "People" the results of the perception survey may be used to characterize these baselines. In particular a. Knowledge of the Project b. Perceived positive and adverse impacts.

ES 3.2 Concise integrated summary of the main impacts and residual effects after applying mitigation (based on the results of the long term monitoring and compared with the previous baseline including assessment of the effectivity of the measures and the proposed changes to consider the expansion)

By way of clarification, based on Revised Procedural Manual 2003-30, Residual Impacts / Effects are the remaining impacts after implementation of preventive and mitigating measures. The summary of the main impacts and residual effects after applying mitigation is shown below.

Table ES-8. Summary of Key Major Impacts and Residual Measures

Environmental Aspects	Major Impacts	Option for Mitigation	Residual Measures
LAND	Disturbance of the existing terrestrial flora and fauna; Minimal, land is developed	Avoidance if needed	None needed
	Disturbance of the site topography/landform	Minimum	None
	Disturbance/Changes with Construction of new access roads	Not applicable	None
	Generation of Domestic and Solid Wastes From construction workers and plant operators.	Minimal, number of persons involved small. Septic Vaults Recycle/disposal	None
	Generation and Disposal of Toxic and Hazardous Wastes The SMRs indicate no significant THWs	Enhanced THW reduction programme.	None
WATER	Potential disturbance of aquifers	No underground water extraction.	None
	Abstraction of Water from Tagoloan River	Optimize Process Water Usage Choice of abstraction point	None

Environmental Aspects	Major Impacts	Option for Mitigation	Residual Measures
		Compliance to NWRB Water Permits	
	Potential impacts on corals and other marine species	Judicious choice of inlet, outlet of cooling water	None
	Cooling Water Outfall to Macajalar Bay – Potential Thermal Effects	Choice of Outfall site Minimization of cooling water usage and outfall temperature Engineering intervention on CW return discharge system Minimize use of cooling water system	None
AIR	Degradation of air quality	Buffer zones Technology Intervention Quality Coal Feed	None
	Normal vehicle impact (noise, vibration) on properties of the households residing along the haul and access roads for the proposed project	Use of silencers and mufflers for heavy equipment	None
PEOPLE	The host barangay/municipality which will benefit from the Company's SDP ER 1-94	Enhancement	Community benefits
	Threat to public health and safety	IEC	None No proven residual effects of coal power plant on health

ES 3.3 Risks and uncertainties relating to the findings and implications for decision making

Considering that the project is expansion in nature and to be located at the same site as the original project and moreover, there have not been experienced risks and uncertainties during the operation of the original project, there appears to be no risks and uncertainties that will affect the decision making process on project implementationl

Moreover, based on the discussions of the Environmental Risk Assessment (ERA) **Section 4**, there appears to be no risks that cannot be managed through engineering intervention.

However, the risks that provide challenges are those that are related to climate change:

- **Strong Typhoons**

  Aberrations/strong typhoons may be experienced as an effect of climate change. However, these do not prevent implementation of the project because of the short-term nature of typhoons. Emergency measures such as the evacuation of personnel will be developed.

- **Earthquake and related risk**

  The project and the other adjacent facilities have not been adversely affected by earthquakes that have hit Mindanao. Moreover, the design of the plant takes into consideration the probability of seismic events. Therefore, these aspects are not deemed to have any implication on whether the project will be pursued or not.

- **Storm Surges and Sea Level Rises**

Storm surges have been previously experienced in Iligan Bay during Typhoon Sendong, but the sites affected were farther out from the pier of the Project. In any event, the risks and uncertainties that may arise are not deemed vital to decision-making concerning the viability of the project.

Sea Level Rise is not expected to create adverse implications for decision making because at worst case scenario, only the pier operations will be affected.

For mitigation measures against storm surge and sea level rise, sea wall with 4.3 m elevation was installed in the shoreline area and the site is finished at 3.8m elevation above sea while the buildings floor elevation is at a minimum of 4.2m elevation. Jetty has an average of 6m. Elevation.

SECTION 1. PROJECT DESCRIPTION

1.0 BASIC PROJECT INFORMATION AND BACKGROUND

The FDC Misamis Power Corporation (FDCMPC) currently owns and operates a 3 x 135 MW circulating fluidized bed (CFB) coal-fired power plant in Villanueva, Misamis Oriental and granted by the DENR Central Office an **Environmental Compliance Certificate ECC No. ECC-CO-1304-0012.** Since its commercial operation in 2016, Mindanao has shown strong economic growth, faster than the national average, and with this comes increased energy requirements necessary to sustain this growth. To contribute to the region's continued development, FDCMPC is proposing to expand its current facility with another 3 x 135 MW power generating units.

FDCMPC, in compliance with DENR AO 2017-15, conducted a public scoping activity for the proposed project expansion following the information, education and campaign activity in July 2019.

1.1 Project Location and Area

The proposed expansion project will be cited within the existing power plant located inside the PHIVIDEC industrial area. The power plant and ancillary sites are within the political jurisdiction of Barangays Balacanas, Municipality of Villanueva, Province of Misamis Oriental.

Inasmuch as the raw water requirement for process use (principally as Boiler Feed Water) will be sourced from the Tagoloan River, the political boundary will extend to Barangay Sta. Cruz, in the Municipality of Tagoloan.

The area for the existing and expanded power plant and auxiliaries is 98.4 hectares. The Project will acquire anadditional area of 3 hectares for the conveyor system and 12 hectares for the coal yard. These areas are exclusive of that for the pier and the pumping station at Tagoloan River.

The geographical coordinates of the power plant, are provided in Table 1-1

Figure 1-1. Location of the Proposed Project (source: Agusan River Basin Task Force)

The maps showing the political (barangay, municipality) boundaries of the project site are presented in

- **Figure 1-2.** Map showing the barangay boundaries of the proposed project
- **Figure 1-3.** Map Showing the Provincial Boundaries of Municipality of Villanueva
- **Figure 1-4** Map Showing the Provincial Boundaries of Misamis Oriental
- **Figure 1-5.** Map Showing the Regional Boundaries of the Project Site

1.1.1 Map showing sitio, barangay, municipality, province, region boundaries, vicinity, proposed buffer surrounding the area and primary and secondary impact areas

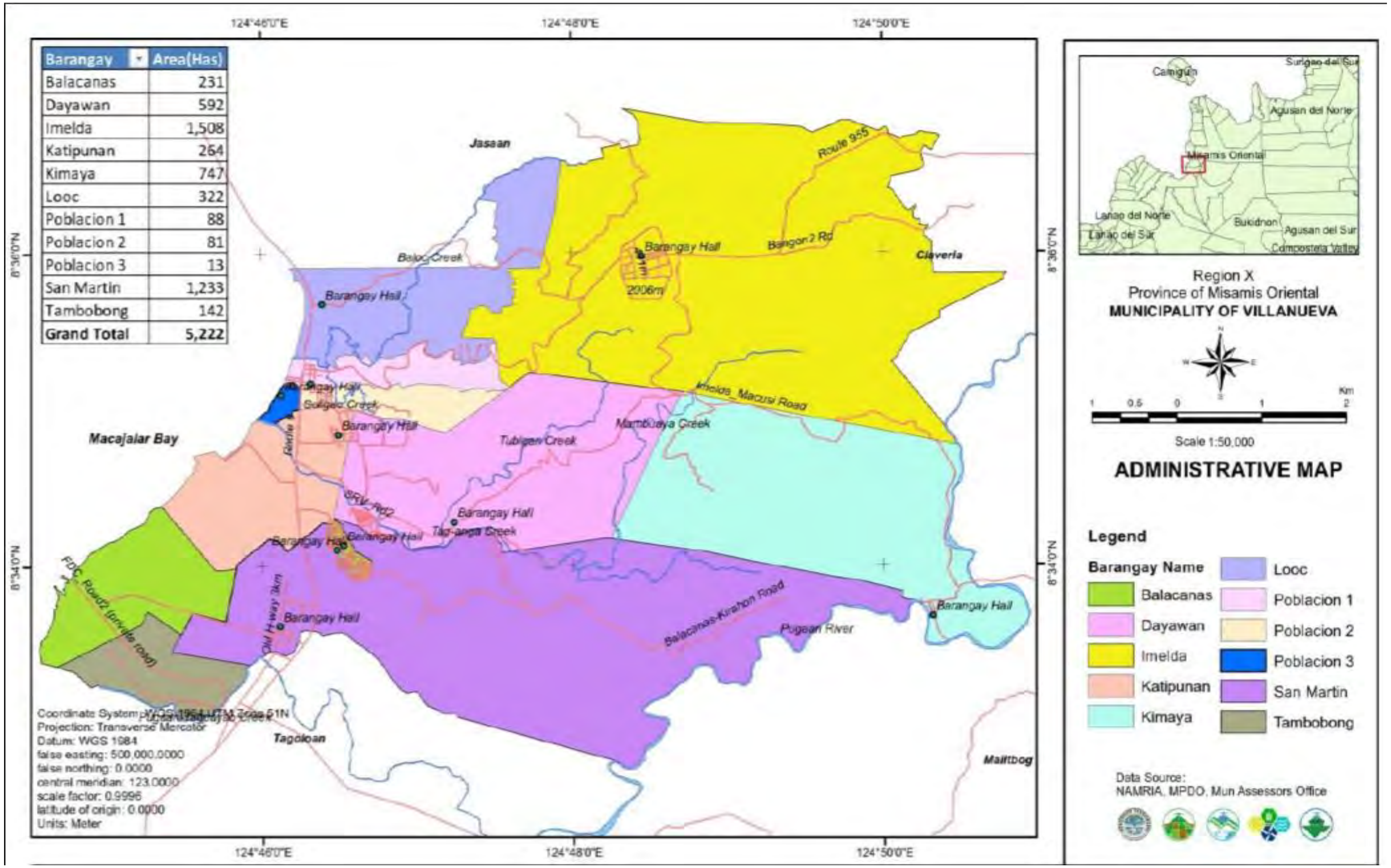


Figure 1-2. Map showing the barangay boundaries of the proposed project

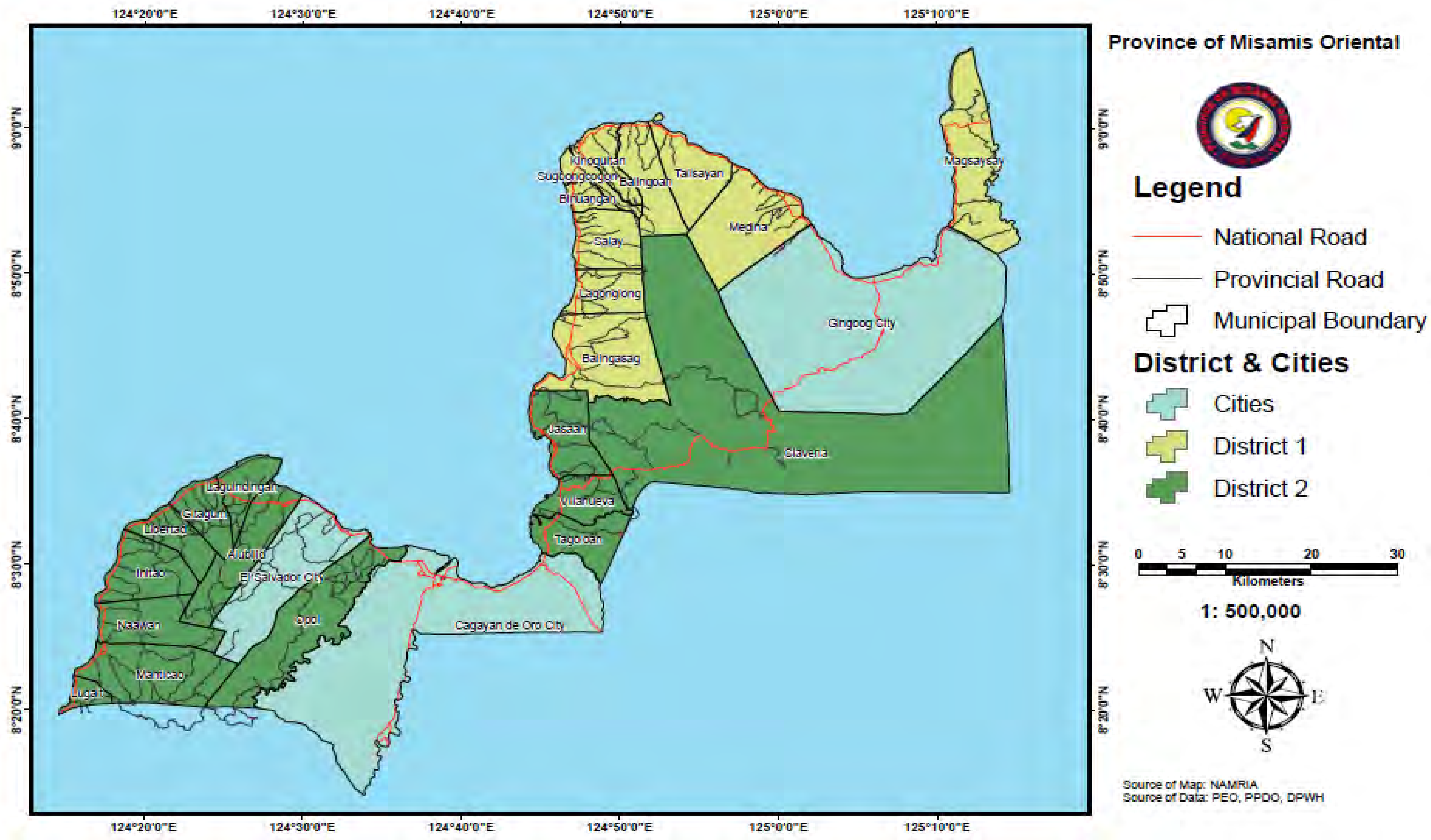


Figure 1-3. Map Showing the Provincial Boundaries of the project

Source https://en.wikipedia.org/wiki/Northern_Mindanao#/media/File:Ph_northern_mindanao.png

Figure 1-4. Map Showing the Provincial Boundaries of the Project

Vicinity

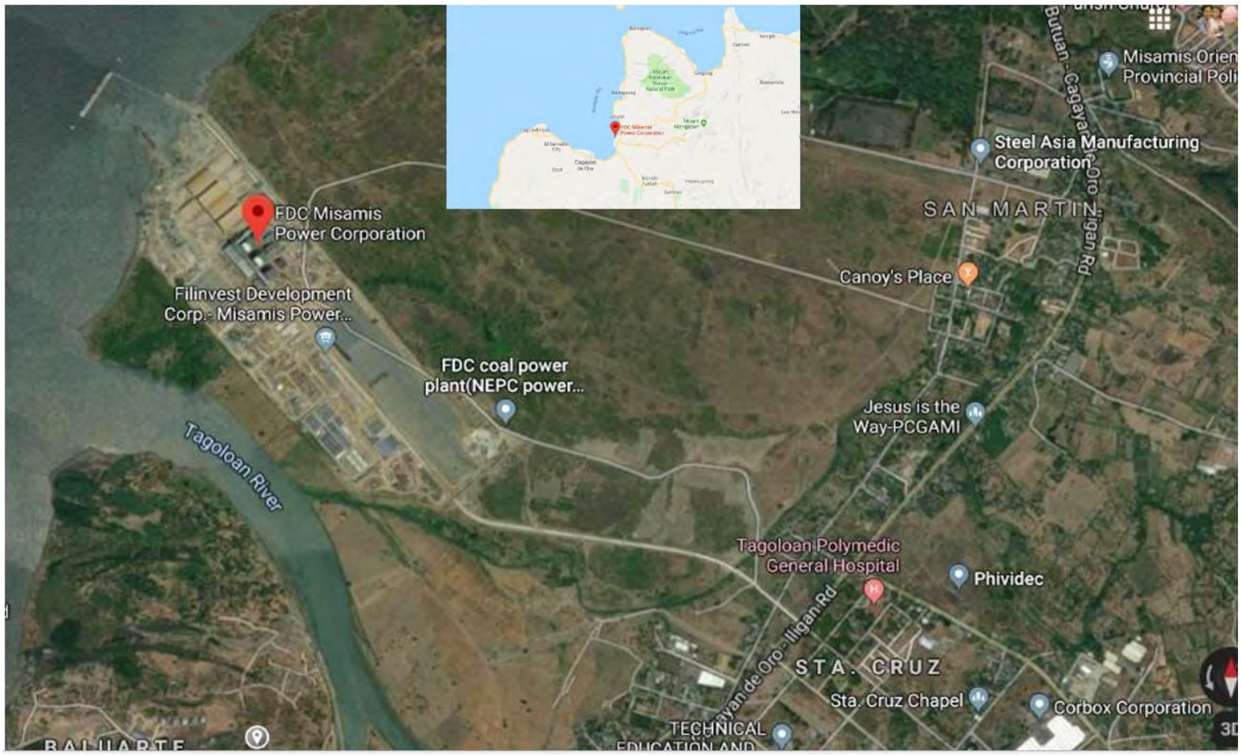


Figure 1-5. Map Showing the Vicinity of the Project Site (source: Goggle Earth)

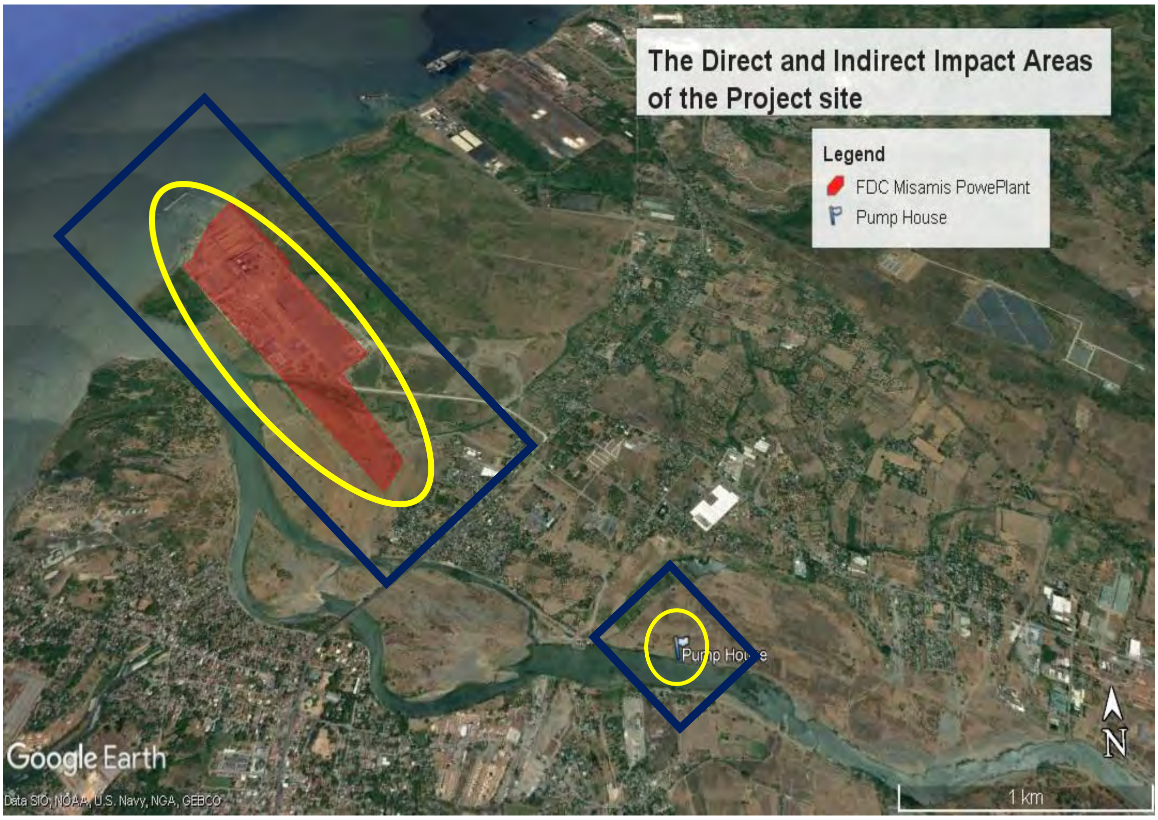


Figure 1-6. Shows the initially delineated buffer zone (source: Goggle Earth)

1.1.2 Delineation of Impact Areas

The delineation of the EIA Study Areas is based on the Direct Impact Area (DIA) and the Indirect Impact Area (IIA). These study areas are identified in the discussions of the specific modules, i.e. Land, Water, Air and People.

The guidelines provided by the Revised Procedural Manual are used for the delineation of the DIA and IIA, to wit:

a) **Direct impact area (DIA)** is the area where ALL project facilities are proposed to be constructed/situated and where all operations are proposed to be undertaken. For most projects, the DIA is equivalent to the total area applied for an ECC.
b) **Indirect Impact Area (IIA)** can be the stretch of the river/s OUTSIDE the project area but draining the project site which can potentially transport Total Suspended Solids and other discharges from the project towards downstream communities.
c) Further, the interphase/overlap of the biophysical DIA with socio-cultural environment shall define the socio-cultural DIA after the EIA is completed…

Direct Impact Area (DIA)

- The project site itself.
- Portions of the Macajalar Bay wherein the existing and additional cooling water intake and outfall structures and the pier are located;
- A portion of the Tagoloan River where in the river water intake and piping structures are located
- The plume of air pollution discharges from the plant's boilers wherein the Ground Level Concentrations (GLCs) exceeds the Clean Air Act Guidelines.

The Indirect Impact Area (IIA)

- The population and social centers which are outside the air dispersion plume i.e. the Environmentally Sensitive Receptors (ESRs)
- PHIVIDEC-owned access road leading to the project site

The guidelines provided by DAO 2017-15 are as follows:

DIA for Air Quality Impacts
-Areas with project Ground Level Concentration (GLCs) of emissions higher than the ambient standard based on air dispersion/transport modeling studies (worst case scenario)

The air dispersion modeling does not reveal emissions higher than the ambient standard in the worst-case scenario of all of the 6 x 135 MW units operating simultaneously at maximum capacity. Although a failure in the operation of the Electrostatic Precipitator (ESP), in the main APCD may occur, the ESP will either enter in automatic shut down or go into manual mode immediately, so this is deemed not the scenario referred to for consideration of the DIA, inasmuch as DIA is reckoned from sustained and long term operations.

DI for Water & Quantity Impacts
-The extent of water bodies where the water quality are projected to exceed the ambient standards based on relevant worst-case scenario discharge modeling studies (sediment and pollutant discharges)

-Areas using the groundwater that could possibly be contaminated by project activities involving the use and disposal of toxic chemicals and hazardous wastes or construction of underground facilities.

-Areas where there are existing users of the same source of natural resources (e.g., water) that the proposed project will be using

The ambient standards for water are not exceeded as discussed in Section 2.2.
Groundwater will not be used in the project.

The Tagoloan river is the area where there are existing users of the same source of water that the project will be using. Thus Tagoloan river is a DIA.

DIA for impacts on Land
-Areas directly vulnerable to potential flooding or inundation that may be cause by the project
-Areas where there will be disturbance of habitat

The project will not cause flooding.
The habitat for the expansion project which are few standing trees are in the project site, which is already defined as a DIA under DAO 2003-30.

DIA for impacts on People
-Directly affected areas based on the results of the socio-economic impact assessment studies conducted including the ancestral domain of indigenous communities that may be affected, if any

There are no ancestral domains of indigenous communities.

The socio-economic impact is reckoned from the benefits arising from ER 1 -94 which is likewise the same IIA delineated in DAO 2017-15.

The IIA shall be delineated for impacts on people and shall include those in the vicinity of the DIA who will either benefit or be affected indirectly by the project.

The communities that will benefit from ER 1-94 and thus the IIA. However, the DIA from "People" perspective is the same as the IIA reckoned from socio economic benefits.

The DIA and IIA are shown in **Figure 1-6**

Table 1-1 summarizes the delineation of the Impact Areas based on DAO 03-30 and DAO 2017-15.

Table 1-1 Impact Areas

Rationale	Major Impacts	Site/Impact Areas
DIRECT IMPACT AREA		
Air	Degradation of air quality	At the vicinity of site and Host communities, notwithstanding there are no exceedances to standards.
Land	Generation of solid and domestic wastes	At the vicinity of site
	Degradation of soil quality	At the vicinity of site which includes the ash pond.
Water	Disturbance of marine species	Not applicable no disturbance. Nevertheless Macajalar Bay is included as DIA because of its importance.
	Degradation of water quality	No degradation of Macajalr Bay

Rationale	Major Impacts	Site/Impact Areas
	Existence of other users of surface water	Tagoloan River
People	Socio Economic impacts of ER 1-94	The host communities
INDIRECT IMPACT AREA		
Land	Normal vehicle movements impact (noise, vibration) on properties of the households residing along the haul and access roads for the proposed project.	Access roads
	Impact on public access	
Water	Potential water resource competition	Not applicable No ground water extraction
People	The host barangay/municipality which will benefit from the Company's SDP/SDMP	Host Communities
Air	Fugitive dusts along roads outside of project site	Not applicable, access road is already developed

The Buffer Zone

The buffer zone is the geographical area that insulates the impact of the project to the affected resources and is generally arbitrary in nature. In **Figure 1-6** below, the initially delineated buffer zones serve to cushion the effects of the power plant and the ash pond on land water and Environmentally Sensitive Receptors (ESRs) like settlers.

DIA : The areas inside the yellow contour
IIA : The areas outside the yellow contour and inside the blue box

Figure 1-7. Map Showing the Primary and Secondary Impact Areas

It maybe noted from the above map that the Indirect Impact Area is essentially the "People" IIA

1.1.3 Geographic Coordinates (Shape File Data) of Project Area (Use WGS 84 DATUM –GPS Setting)

The geographical coordinates of the project site/land and of the ash repository pond and river pumping station are given in **Table 1-2 and Figure 1-7.**

Table 1-2 Geographical Coordinates (in WGS 84)

Point	Coordinates
POWERPLANT	
1	8°33’39.32”N 124°44’40.93”E
2	8°33’39.47”N 124°44’40.97”E
3	8°33’40.41”N 124°44’42.14”E
4	8°33’43.81”N 124°44’41.82”E
5	8°33’50.44”N 124°44’43.67”E
6	8°33’55.34”N 124°44’48.16”E
7	8°33’56.10”N 124°44’45.92”E
8	8°33’48.09”N 124°44’52.71”E
9	8°33’40.52”N 124°44’59.00”E
10	8°33’33.02”N 124°45’5.30”E
11	8°33’25.39”N 124°45’11.45”E
12	8°33’17.46”N 124°45’18.31”E
13	8°33’13.91”N 124°45’13.94”E
21	8°33’9.30”N 124°45’8.07”E
22	8°33’16.83”N 124°45’59.77”E
23	8°33’24.32”N 124°44’53.21”E
24	8°33’31.82”N 124°44’47.21”E
RAW WATER PUMPHOUSE	
1	8°32’23.51”N 124°46’8.10”E

Figure 1-8. The power plant facility indicating therein the geographical coordinates

Figure 1-9. Location of the Raw Water Pumphouse indicating therein the geographical coordinates

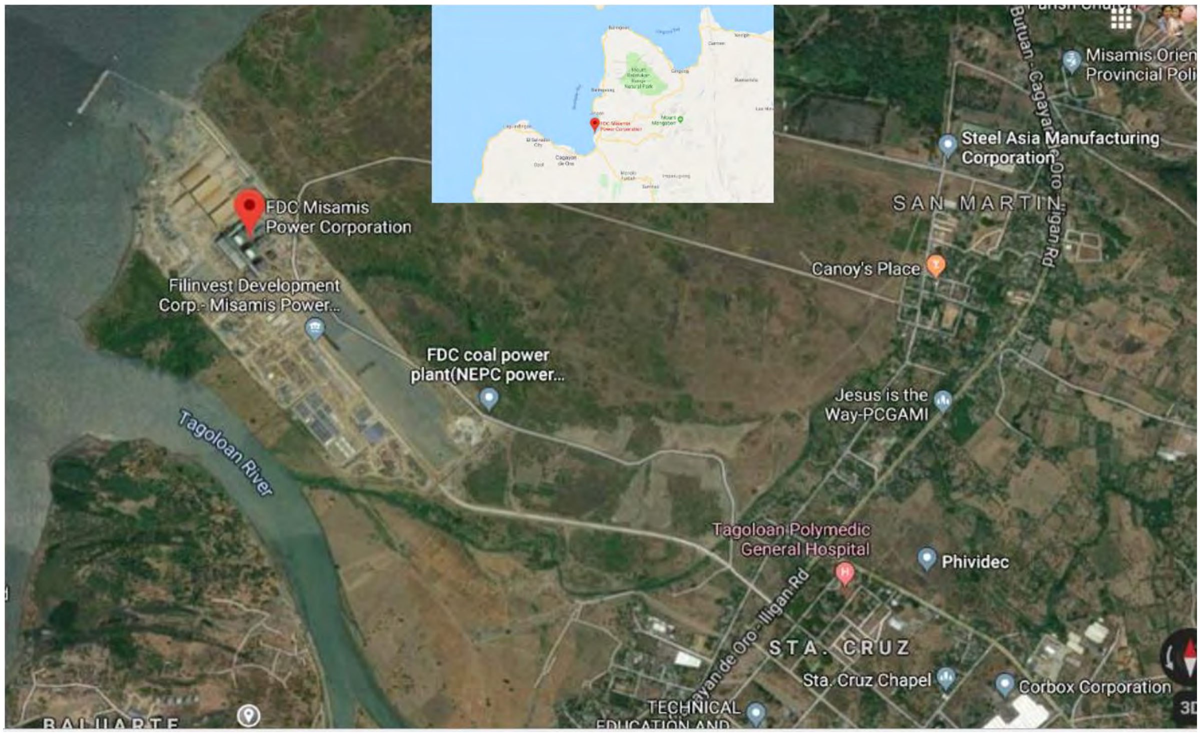


Figure 1-10. The Site of the Project in a Google Earth Map

1.1.4 The vicinity and the accessibility of the project site/area

The site is easily accessible by road through the main highway thence through the access road within and owned by PHIVIDEC Estate.

Figure 1-11. Map Showing the Access Waypoints to the Project Site

Plate 1-1 Aerial photograph showing the facilities and the covered coal yard

Plate 1-2 Photograph showing the stack, covered coal yard, image of the pier and the Macajalar Bay

1.2 Project Rationale

The prospects for the robust economic and social development of Mindanao continuous for the mid and long term.

Power is a key supporting infrastructure to such development. The primary rationale for this Project is to ensure the reliable and cost-friendly supply of power to the Island in response to the supply-demand outlook projections of the DOE as may be seen in **Figures 1-12** and **1-13**.

- The FDC Misamis Power Corporation is planning to expand its current operations to address the need for additional power in Mindanao. The proposed expansion will contribute to increasing the electric power supply in the region.
- The need for additional supply is because of economic development in the region. Gross regional domestic product in Mindanao has been above 7% in 2017 and 2018. For the past three years, the average growth in peak demand in the Mindanao is the highest among the three island grids with consumption growth rate at 8%.
- Mindanao posted a 6.91% average growth in peak demand while Luzon is at 6.83% and Visayas at 5.12%.

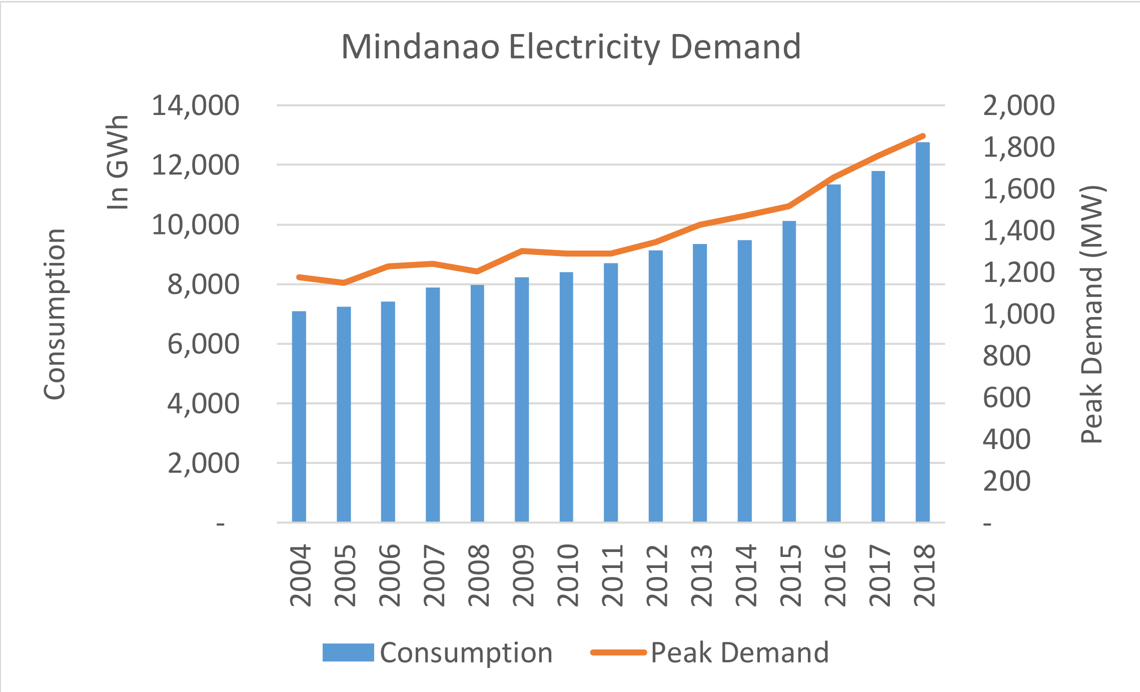
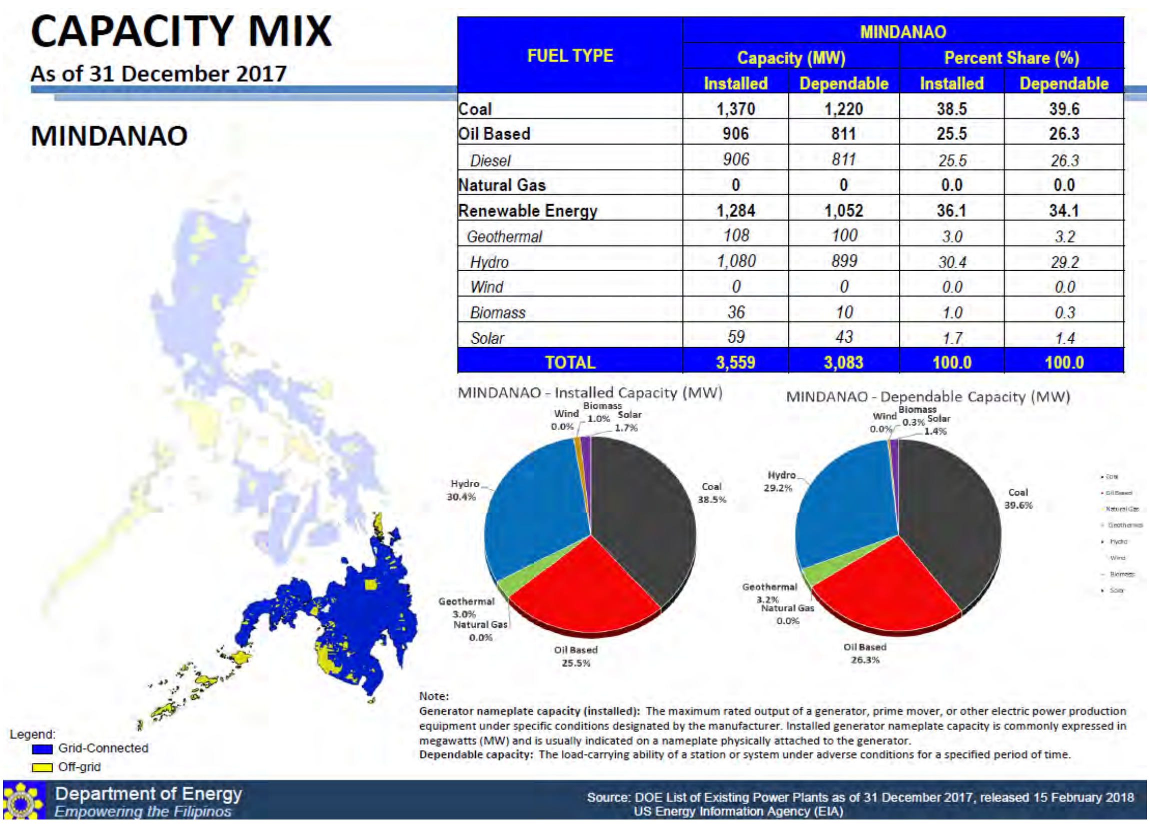


Figure 1-12. The Mindanao Power Demand and Consumption (Source: DOE)



FUEL TYPE	MINDANAO Capacity (MW) Installed	Dependable	Percent Share (%) Installed	Dependable
Coal	1,370	1,220	38.5	39.6
Oil Based	906	811	25.5	26.3
Diesel	*906*	*811*	*25.5*	*26.3*
Natural Gas	0	0	0.0	0.0
Renewable Energy	1,284	1,052	36.1	34.1
Geothermal	*108*	*100*	*3.0*	*3.2*
Hydro	*1,080*	*899*	*30.4*	*29.2*
Wind	*0*	*0*	*0.0*	*0.0*
Biomass	*36*	*10*	*1.0*	*0.3*
Solar	*59*	*43*	*1.7*	*1.4*
TOTAL	3,559	3,083	100.0	100.0

Source: DOE

Figure 1-13. Projected Capacity Mix for Mindanao

As seen in Figure 1-13 Coal is the dominant source of energy for the Mindanao Power Plants.

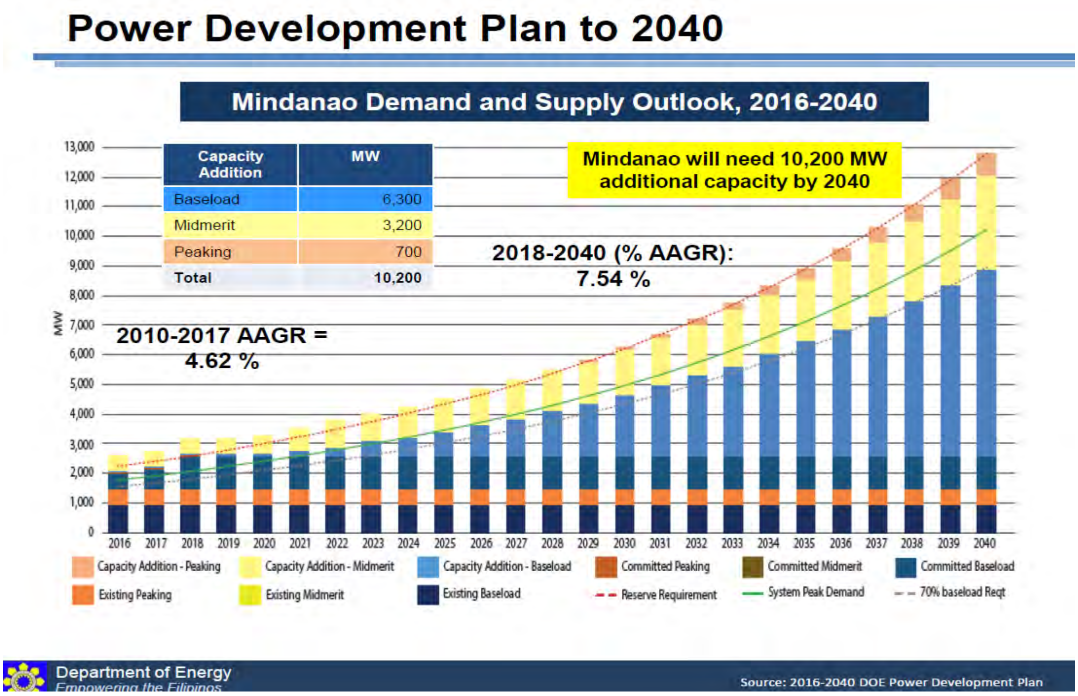


Figure 1-14. The Power Development Plan for Mindanao (Source: DOE)

The Socio-Economic Benefits from ER 1-94.

Moreover, the extensive benefits derivable from the DOE mandated ER 1-94, diagrammatically illustrated in **Figure 1-15** cannot be overemphasized.

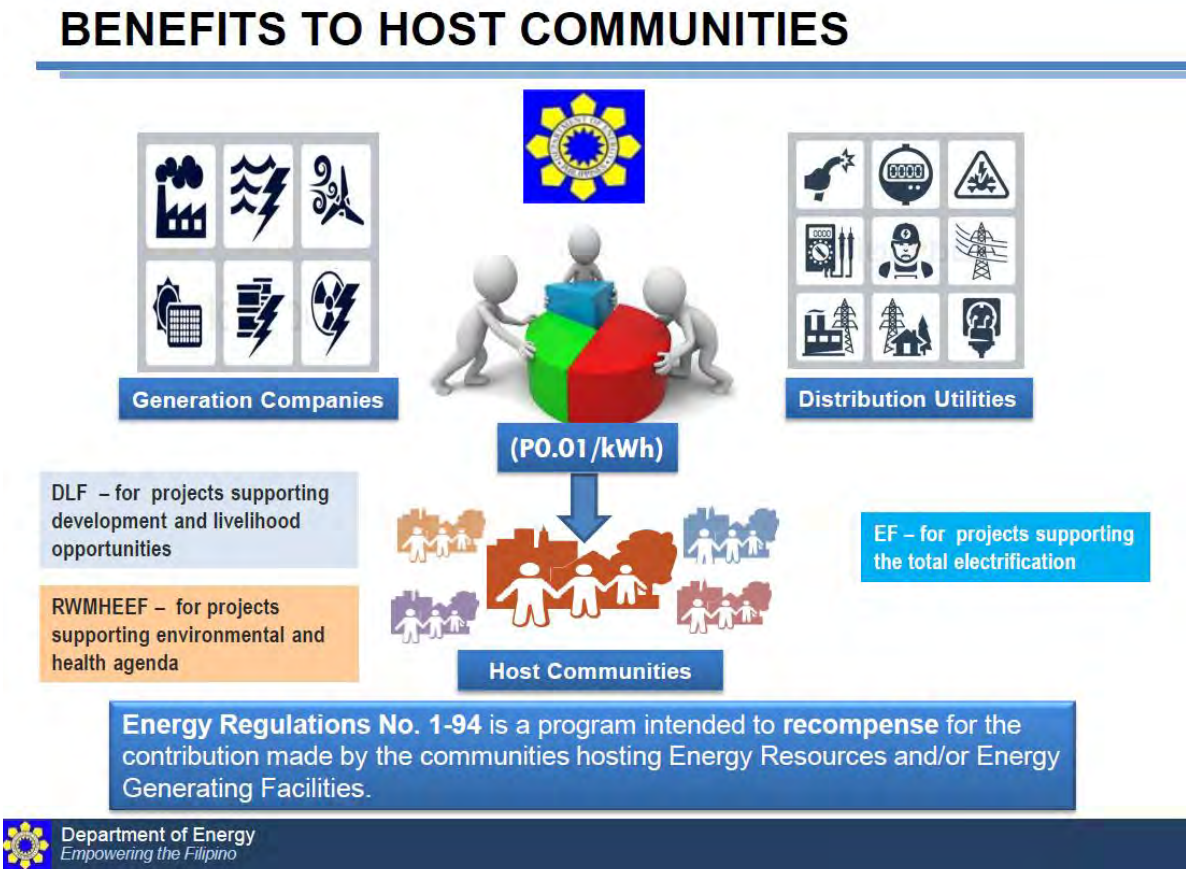


Figure 1-15. Benefits to the Host Communities through ER 1-94

Regional/Local economic development in terms of contribution to sustainable development agenda or current development thrusts

The project will immensely contribute to the continuing growth of Mindanao especially in the light of projected robust economic and social development in the Island. The investments/existing projects in the Misamis Oriental corridor and Mindanao in general cannot be sustained without power supply.

On the national level

The growth of Mindanao, being a key economic bastion in the entire national economic agenda is needed to support the entire country development.
Inasmuch as the project involves capacity expansion in the same project sites and uses the same technology and energy source as in the current successful operations, it is deemed that there are no other viable project alternatives.

1.3 Project Alternatives

1.3.1 Criteria used in determining options for facility siting, development design, process/technology selection, resource utilization and discuss how the decisions on preferred options were made.

Siting:
There are no other project alternatives considering that the project involves only the expansion and or upgrading of the existing facilities.

The project site is already developed, same pier will be used, same access road will be utilized and major components will be located in the same project area.

Technology Selection/Operation Processes and design Selection for storage:

Inasmuch as the project involves expansion and moreover in view of the successful existing operations of the original project (3 x 135 MW CFB Coal Power Plant), it is logical to adopt the same process and technology as that for the original project.

Criteria for Resource Utilization

Being capacity expansion in nature, the criteria for process/technology selection and resource utilization are limited to the same as the existing project plant configuration and design. More importantly, the current operation has been undertaken successfully both in terms of technical and environmental performances.

Support Facilities (i.e. energy/power generating facility, water supply system)

The existing support facilities will be likewise utilized; the raw water will be sourced from the Tagoloan River.

Pollution control devices and corresponding facilities being served or connected

By the nature of the project, being an expansion the same support facilities and pollution control abatement devices are to be utilized but the capacities will be different.

Footprint of proposed layout of project facilities.

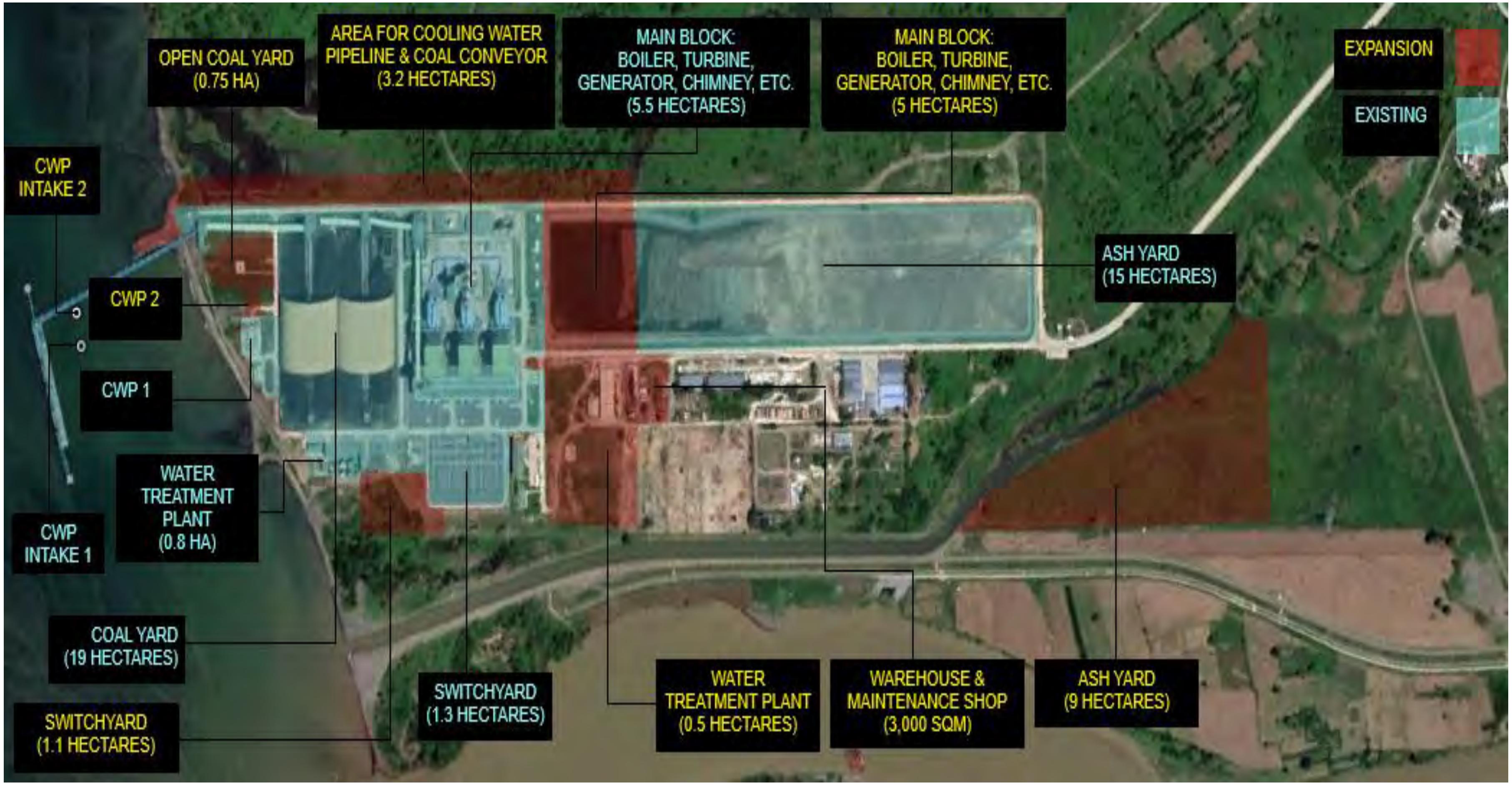


Figure 1-16 Proposed Layout/Footprints of Project Facilities (Existing and Expansion)

Resources: Alternatives sources of power, water, raw materials and other resources needed including factors significant to the selection such as supply sustainability and climate change projections

Coal as source of energy is readily accessible compared to natural gas, which often is not as easy to obtain. Heavy fuel is likewise often not readily accessible.

Water

Sea water is immediately available for cooling purposes

Contextualization of the determination of preliminary options in terms of project site factors significant to the selection such as sustainability and susceptibility to:

The development and operation of the proposed plant capacity expansion at full capacity is not seen to induce liquefaction, landslides, or mudflows based on the discussion in Section 2.1; rather, the project has low to moderate susceptibility risks to these natural hazards.

However, investigation of the regional geological setting as well as the results of the geotechnical and soil investigation reveal that the proposed site is near one active fault and is underlain by layers of sand with varying degrees of consistencies.

To mitigate the potential effects of the geologic nature to the project and vice-versa, the following recommendations are to be considered:

- For auxiliary buildings in plant area, shallow foundation can be adopted for ordinary building and underground pipelines and pipe ducts, which have lower load and lower deformation requirements. During design, it's required to consider as much as possible the deep burial of foundation, and take the Layer ⑥ "hard shell", which is located in the upper part of ground surface, as the bearing stratum.

- Pile foundations should be adopted for power house, stack, main substation, transfer station, dry coal shed, hydraulic structure, bucket wheel machine, coal belt conveyor gallery, and auxiliary buildings that have higher load.

- According to the composition of foundation soil on construction site, the engineering experience for adjacent operating power plant (Mindanao Power Plant), and the construction experience of Cagayan in Mindanao, it's better to select the Precast driven pile for this project.

- On the one hand, precast driven pile can enhance the bearing capacity of the foundation, on the other hand, in the process of hammer construction through the foundation soil compaction, the impact on the saturated sand and silt foundation liquefaction resistance good treatment effect. At the same time, according to our construction experience in Indonesia's 3 x 142 mw coal-fired power plant project in Bali Island, PHC pipe pile also can be used, pile diameter 400 mm to 600 mm.

- Therefore, it's recommended to adopt the precast driven pile. Besides, based on the construction experience for Mindanao Power Plant and Cagayan de Oro City, square precast driven pile can be adopted on the site, which has the sectional dimension of 300mm-500mm.

- **Lateral Load Resistance (Ground shaking)** Lateral loads developed as an inertial force due to earthquake and wind load acting on the sides of the building. This lateral load must be evaluated during the design phase using the National Building Code and the Structural Code of the Philippines as minimum guide. This lateral load will be resisted by the passive and frictional resistance of the foundation. Area of foundation shall be designed to have larger lateral resistance against the total base shear triggered by seismic load or wind load.

- **Excavation and Fill.** Excavation shall be braced by using sheet piles with water beams. Excavation is prone to collapse and could affect adjacent structures. Filling materials necessary to elevate the building floors of the proposed steel plant shall use base course type of fill materials. Compaction shall be done at optimum water content.

1.3.2 Summarize and discuss the comparison of environmental impacts of each alternative for facility siting, development design, process/technology selection, resource utilization

The environmental impacts for the various alternatives

On Siting Selection

Inasmuch as the siting option is limited to the present site at which the operations of the original project have been undertaken, the environmental impacts of the selected site which is the present land leased from PHIVIDEC are deemed addressed. The table below nevertheless shows the environmental impacts if a new site is chosen for the project.

Table 1-3. Summary Table of Major Environmental Impacts if a new site is chosen

Environmental Resource	Potential Major Impacts
Land	Extensive Land Clearing/Impacts on faunal species
	Additional construction works/Impacts on additional solid waste generation Additional change in landform
Water (Marine)	May likely involve different discharge points for cooling water return/Domain of temperature rise and mixing zone Thus likelihood of greater impacts on marine life, e.g. corals
Water (River)	May result in different site of water abstraction from Tagoloan River
Air	Change in domain of air dispersion/Will involve larger domain Additional air pollution concern due site of boilers and APCD will be in two different sites
People	Manageable additional impacts (employment, livelihood, traffic from new access road)

On Technology Selection

Similarly inasmuch as the technology option is the use of the existing technology the environmental impacts comparison is deemed as having already addressed the environmental considerations. Nevertheless, the Table below provides additional considerations and also considers other types of power plants.

Table 1-4 Technology Selection Options

Technology	Key Selection Criteria and Environmental Aspects			
	Energy Source	Water	Others	Climate Change
Thermal Power Plants				
Ultra-Supercritical Pulverized Coal	Good quality Coal Availability and Cost	Sea Water availability for cooling purposes	Pollution Abatement systems built in technology Thermal effects addressed by design of cooling water system Higher efficiency	Built-in air pollution control system
Circulating Fluidized Bed Subcritical Boiler Technology (This Project)	Good quality Coal Availability and Cost	Sea Water availability for cooling purposes Fresh water for boiler operations	Thermal effects addressed by design of cooling water system Environmental Compliance proven based original plant Fuel flexibility	Built-in air pollution control system
Sub-critical Pulverized Coal Technology	Good quality Coal Availability and Cost	Same	Lower combustion efficiency compared to CFBC and Ultra-supercritical PC thus more emissions under same operating conditions	Same as above
CCGT	Availability of LNG and terminal to supply power plant. Cost of building LNG terminal LNG Availability and Cost are key issues.	Requires storage facilities at sea	Efficient. Relatively cleaner fuel	Lesser GHG emissions (CO2)
Diesel Power Plants	LSFO-Issue of Cost and Availability	May not require cooling by sea water	Logistics Issue with impacts on transport	GHG emissions Relatively higher
	HSFO		Environmental Issues on Sulfur Dioxide emission	
Renewable Energies				
Hydro Power Plant	The water or river system is not available in area.	Not Applicable	Not Applicable	GHG emission Friendly

Technology	Key Selection Criteria and Environmental Aspects			
	Energy Source	Water	Others	Climate Change
Solar Power Plant	Land area for this size of power plant not available	Not Applicable	Not Applicable with additional impact on terrestrial ecology.	GHG emission Friendly
Wind Power Plant	Wind regime not proven available in the area.	Not Applicable	Same as above	GHG emission Friendly
Others, Geothermal	Geothermal field not available	Not Applicable	Same as above	GHG emission Friendly
Non-Conventional				
Nuclear Power Plant	Needs government policy and/or congressional intercession.			Essentially Carbon neutral

1.3.3 Consequences of not proceeding with the project or the "no project: scenario.

Under this scenario:

- Opportunities to sustain and enhance the power supply requirement of the whole region
- Opportunities for the enhancement of the barangay and the City both in terms of economic and social well-being will be denied.
- Opportunities for job and livelihood generation will be prejudiced.

1.4 Project Components

The major project components are shown in the layout of facilities in **Figure 1-17** superimposing the original with the expansion facilities.

1.4.1 General layout facilities

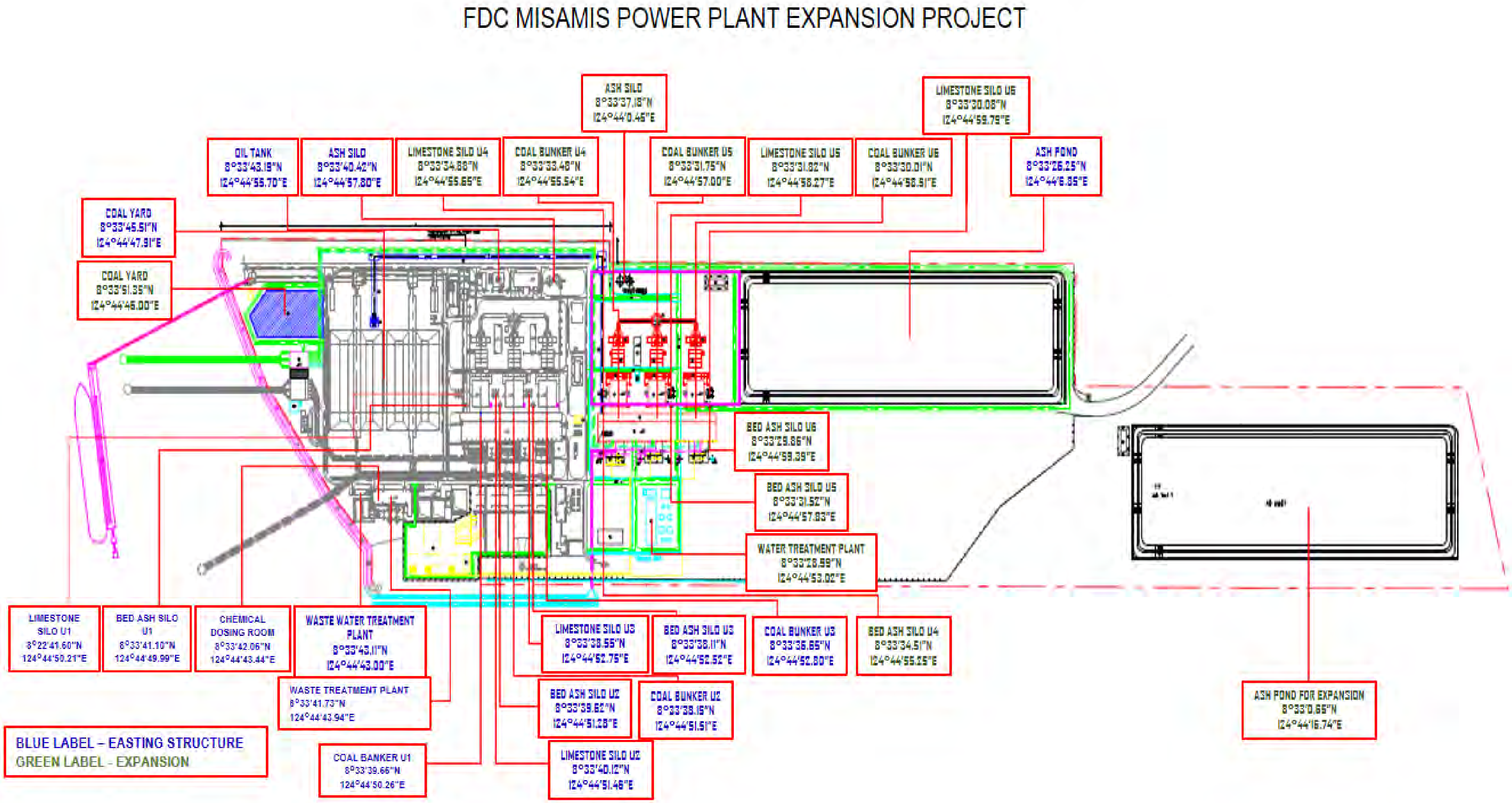


Figure 1-17. Existing Plant Layout Superimposing Therein the Layout of the Expansion Facilities

1.4.2 Maps showing in particular, the location and boundaries of project area, location and footprint of main facilities, storage and support facilities, and proposed buffers.

The matrix of the existing components and the proposed expansion is shown in Table 1-5:

On the areas, these are also shown in the Figure1-18 and summary table below:

With respect to areas the comparison between the original and the expansion projects for the major components is shown below:

Table 1-5 Summary Matrix of Areas Original and Expansion Project and Facilities

Major Components	Facility Type	Approximate Areas (In Hectares)		
		Original	Expansion (Additional)	Total Expansion Areas
Boiler Room		3,441 sq.m.	Additional 2,294 sq.m.	Total 5,735 sq.m.
Smoke Stacks		352.32 sq m	333.29 sq m.	Total 685.61 sq.m.
Main Block		Approx. 5.5 has.	Approx. 5.0 has.	Total Approx. 10.50 has.
Switch Yard/Ancillaries	Support Facilities	Approx.1.3 has.	Approx. 1.1 has.	Total approx. 2.4 has.
Coal Yard (Covered)	Support Facilities	1.9 has. active area	2.65 has.	4.55 has. active area
Coal Yard (Open)	Support Facilities	2.65 has.	0.075 has.	0.075 has.
Coal Conveyor	Support Facilities	1-1.2 m width x 1,450 m long	Additional 0.8-1.0 m width x 934m long	Total 0.8-1.2 m width x 2,384 m long
Pier	Structure Facilities	180m platform with mooring dolphins, berth 278m, trestle 315m	Additional slipway or mooring dock of 100-150m length.	180m platform with mooring dolphins, berth 278m, trestle 315m Plus 100-150 m long mooring dock
Water Treatment Plant (For Process Water)	Support Facilities	Approx. 8,0500 sq m	Approx. 5,000 sq m	Total approx. 13000 sq m
Waste Water Treatment Plant		Approx. 4,200 sq m	Approx. 3,000 sq m	Approx 7,200 sq m
CW Intake Pipe		294 m length x 2.2 m diameter per unit	301 m length x 2.2 m diameter per unit	Total estimated 1,500 m length x 2.2 m diameter
CW Outlet Pipe		266 m length x 2.2 m diameter per unit	195 m length x 2.2 m diameter per unit	Total estimated 1,200 m length x 2.2 m diameter
Hazardous waste Storage & Materials Recovery Yard		400 sq.m.	500 sq.m.	900 sq.m.

Major Components	Facility Type	Approximate Areas (In Hectares)		
		Original	Expansion (Additional)	Total Expansion Areas
Staff house, warehouse, workshop		4 000 sq.m.	Additional 2,500 sq.m.	6,500 sq.m.
Non Warehouse Storage		300 sq.m.	0.5 has.	0.53 has.
Ash Yard	Structure Facilities	15 has.	Additional 9 has.	24 has.
Access Road, including bridge over creek	Structure Facilities	1250 m length x 12 m width	Additional 810 m length x 6 m width	Total of 2016 m length x 6-12 m width
Temporary Areas for Construction		2.5 has.	2.5 has.	2.5 has.
EPC Temporary Office		Completed	5 has.	6 has.
Scrapyard			1	

Others for the expansion project:

a. Shed for fire truck & ambulance
b. Parking

Figure 1-18. The Major Project Components Indicating Therein the approximate Areas involved

Summary Table Environmental Impacts for Siting Options

The site for the expansion project is the same as for the existing plant except for additional requirements for specific components, e.g., expansion of coal conveyor, ash yard, power block. The existing plant area covers 84 hectares while the total area for the expansion project is 98.4 hectares, which includes the foreshore area.

Environmental Impacts for Siting Options

Table 1-6 Summary Table of Siting Options

Aspects	Different Site	Same Site
Land		
Authority Over Site	Needs to be Secured	Lease agreement with PHIVIDEC is on hand
Faunal resources	Maybe major disturbance	Disturbance will be insignificant since the site is already developed. Major earthworks occurred during construction for the original project.
Landform	Major disturbance	No major Essentially none, site already developed
Siltation/Sedimentation	Major during construction	Deemed insignificant, site already developed
Ash Management	Requires development of new ash yard	More manageable; common ash repository area
Access Roads	New construction	Minor expansion only along same alignment
Air		
Fugitive Dust during Construction	Significant dust produced from major earthworks	Deemed insignificant, minor earthworks
Air emission during operations	Manageable but will be more involved; stacks will be at different site APCD more difficult to manage	Stacks are co-located thus better air dispersion Easier control of APCD
Water		
Thermal effects on Macajalar or nearby water body	Development of new cooling water system will require additional personnel and additional cost to the plant	Better control of thermal effects; thus minimizing potential effects on marine ecology
Wastewater discharge	Manageable but more difficult because of different locations of sources and points of discharge	Streamlined and better management of power plant effluent
Environmental Performance Monitoring		
Air & Water Monitoring	More difficult because of varied sampling locations	More manageable

1.4.3 Identification of major components including technical details such as specifications, capacity, number, etc.), including the cooling water system.

The major preliminary technical details for the components are provided below. FDCMPC will firm up the details during the Detailed Engineering Design (DED) phase after ECC issuance.

- **Boiler and Auxiliary Systems**

The boiler and auxiliary systems consist of a water-cooled furnace, superheater and reheater systems, desuperheater systems, convection pass, coal silo, CO2 firefighting system, coal feeding system, coal crushers, coal conveying system, combustion system, soot blowing system, boiler start-up system, structural steel, platforms and walkways, piping systems and instrumentation and control system.

The furnace volume, fluidization velocity, and particle retention time shall be sufficient to maintain efficient combustion at all loads without accumulation of slag on the walls, tubes or hoppers that would interfere with the boiler's continuous operation ease of removal of ash from the bottom of the furnace. The CFB furnace shall be designed to minimize erosion due to movement of bed material.

The furnace and associated equipment shall be designed to minimize NOX and SOX emissions in compliance with the requirements of the relevant Philippines rules and regulations, including, but not limited to those for air emissions, noise emissions, wastewater quality, and return seawater temperature.

The feedwater heating system is designed to optimize the temperature of the feedwater being delivered to the boiler economizer inlet header through the check valve and stop valve at the economizer inlet where it is further heated in the economizer by the residual heat of combustion gas. The feedwater then passes through the furnace walls or evaporator section, separators, furnace roof and back pass walls.

- **Superheater and Reheater Steam system**

This system is integral to the (CFB) boiler system whereby control of steam temperature is optimized.

- **Combustion system**

General

The combustion chamber shall be a water-cooled membrane wall welded enclosure with an expanded fluidized bed at the base. A distributor shall be used to introduce combustion. A means shall be provided, integral with the combustion vessel, to remove larger particles from the flue gas stream leaving the furnace and recycling these to the combustion chamber through a loop seal. If cyclones are used to capture solid particles leaving the furnace, they shall preferably be steam or water-cooled from the boiler circuit. If refractory lined cyclones are utilized, evidence of a design with at least five years of successful operation of this design on similar boilers shall be provided.

A loop seal shall be provided to balance the pressure between the CFB furnace and the cyclone. The loop seal may be steam or water-cooled by the boiler circuit, or refractory lined.

Before being put into operation, the refractory in the furnace and cyclones shall be cured to meet the requirements of the power plant

- **Coal Silo/ Storage**

The boiler will be supplied with coal bunkers with at least 12 hours of active storage based on the worst case (i.e. lowest heating value) fuel identified at the engineering and design phase, with a redundant configuration for the coal bunkers and feeders. An individual bunker will be provided above each coal feeder to enable the isolation of a bunker and associated feeder for maintenance purposes.

- **Coal Feeder**

The coal feeders shall be of the gravimetric type with variable speed drives. The feeder coal inlet opening shall be equal to or larger than the raw coal silo outlet opening. The entire coal feed system shall include any sealing or mixing air that may be used. Each boiler unit shall be capable of achieving Boiler MCR with one fuel feed train out of service, an “n + 1” configuration and with a capacity margin of 15%. Corrective maintenance shall be able to undertaken on the out-of-service train while the boiler is online at Boiler MCR.

- **Coal Crusher**

FDCMPC will use coal feeders that are of the gravimetric type with variable speed drives. The entire coal feed system will include any sealing or mixing air that may be used. Each boiler unit shall be capable of achieving Boiler MCR with one fuel feed train out of service, an “n + 1” configuration and with a capacity margin of 15%. Corrective maintenance shall be able to undertaken on the out-of-service train while the boiler is online at Boiler MCR.

- **Coal Chutes and Valves**

A set of isolating gates shall be provided at the coal bunker outlets, and coal shall be transferred from each bunker outlet to a feeder. Equipment shall be provided to detect loss of coal head seal. Diverter chutes shall be provided to enable the emptying of the bunkers.

- **Limestone and sand feed system**

A complete limestone supply system shall be provided to enable control of sulfur oxides from the combustion of coal. The limestone addition shall reduce the emission of sulfur oxides (SOx) to comply with the emission regulations, when firing any fuel within the Design Coal Envelope. The design shall include a 25% margin on the maximum calculated limestone throughput. A limestone storage silo shall be provided with an active capacity of at least 7 days, based on firing coal with the maximum sulfur content, and shall be supplied complete with isolating valves and down spout piping to rotary valves feeding into a surge bin.

A sand supply system shall be provided to feed sand to the boiler for initial loading and bed make-up. This shall include a sand storage silo with an active capacity of at least 3 days of boiler operation at MCR. The feed system design shall include a margin of at least 25% on the maximum calculated sand throughput.

Supplies of sand and limestone will be delivered by truck to the power station site. The Contractor shall provide equipment for direct unloading of limestone and sand deliveries from bulk trucks (Pneumatic Conveying System) to their respective silos. From these silos, the limestone and sand shall be conveyed to the boiler. Lime stone unloading/storage connection/fittings shall be suitable for available bulk trucks connection.

- **Oil burner**

Oil burners will be used by the boiler during start-up and for coal firing stabilization during low load operation.

The start-up fuel is industrial diesel oil. The start-up fuel system shall be capable of supplying a minimum heat input of 30% of Boiler MCR. Ignition of the industrial diesel shall be by means of a reliable and easily serviceable high energy spark igniter.

- **Soot blower**

A complete soot blowing system will be used to effectively remove all forms of ash from the superheaters, reheaters, economizers, air preheaters and other surfaces as required.

The arrangement of the soot blowers shall be based on the geometry of the heat transfer surfacer as well as tube spacing to ensure complete cleaning of the surfaces. Tube shields will also be provided for erosion protection.

- **Combustion Air and Flue Gas System**

General

The combustion air and flue gas system supply primary and secondary combustion air and to discharge the flue gas to the stack.

- **Coal Handling System**

General

The primary function of the coal handling system is to unload, store and transport coal to the raw coal silos of the boilers. The coal will be delivered and then unloaded, weighed, sampled and transported to the storage shed. The coal handling system includes the following sub-systems:

1) Coal unloading system,
2) Coal sampling system
3) Redundant transfer conveyors,
4) Coal storage system, Stacking/reclaiming system, Emergency reclaiming system,
5) Screening and crushing system,
6) Dust suppression systems and
7) Fire protection systems

- **Coal Unloading and Stacking System**

Coal will be delivered by bulk coal vessel which will berthed at coal unloading jetty. The coal vessels will be unloaded by continuous ship unloaders and the coal transferred via the jetty and trestle conveying system to the coal storage yard.

The coal is transferred from the coal storage yard to the coal silos by reclaiming to the conveyor transfer system.

- **Dust Collection System**

The dust collection system consists of facilities for collecting the dust and spraying the reuse water produced during the transfer of the coal to the coal silos.

For dust collecting system, Electrostatic Precipitator (ESP), the main APCD will be used the general specifications given below:

The Electrostatic Precipitator removes the particulate matters which are carried in the flue gas stream as fly ash. The flue gas stream after leaving the steam generator heat recovery zone will pass through the electrostatic precipitator through the parallel openings. The flue gases are introduced to the plate-formed positively charged electrodes. Electrically isolated spray electrodes are suspended on which a negative voltage is applied. Under the influence of the electrical field, the particles adhere on the positive plate electrodes. The particles adhered to the plates are shaken by an automatic, periodic vibration of a hammer mechanism from the plates, then falls into the dust funnel and is pneumatically conveyed to the fly ash silo. From the silo, fly ash is transported for further use as building material in the cement industry or to the ash repository. The efficiency of the electrostatic precipitator is nearly 99.5%. The fly ash collected in the separators or discharge funnels is fine, dry and abrasive with a typical temperature of 140°C.

An ESP will be dedicated for each boiler/steam generator, and is intended to control particulate matters.

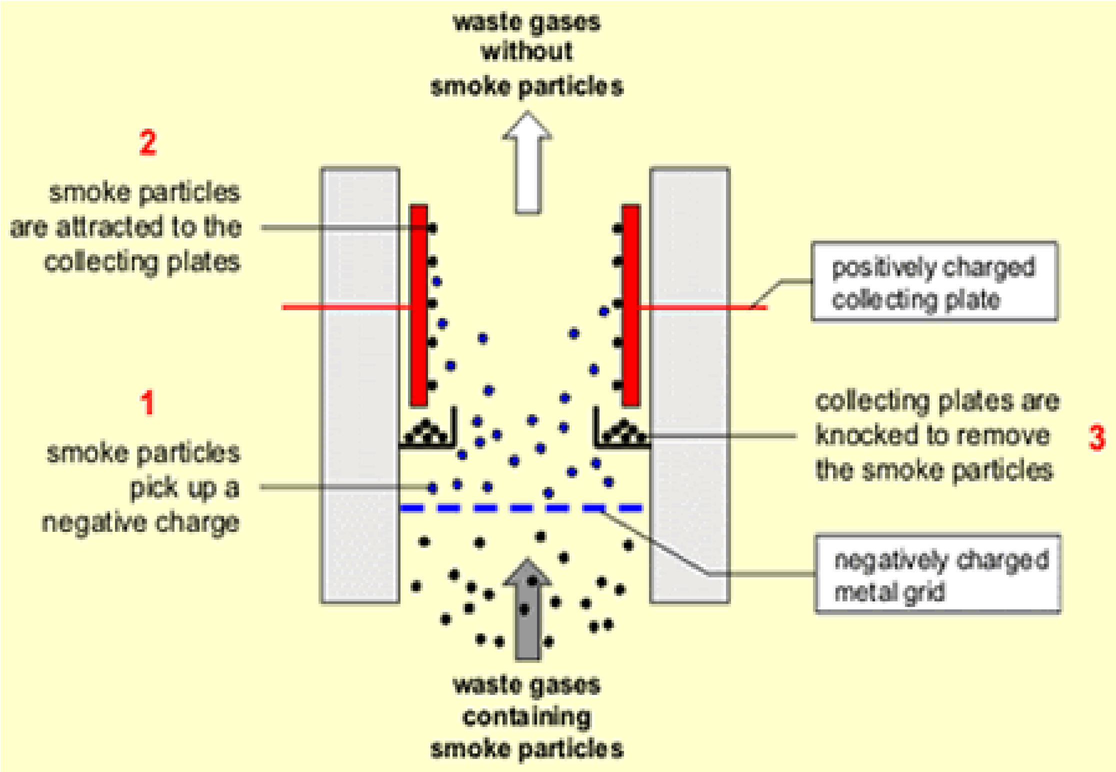


Figure 1-19   Illustration of the Principles of Operation of an Electrostatic Precipitator

The table below gives the major specifications of an ESP.

Table 1-7   Major Specifications of an ESP

General Specifications	Electrostatic Precipitator
Duration Life	Over 30 years
Filter Efficiency (%)	≥ 99.9
Concentration of dust after filtration (mg/Nm3)	≤ 40
Gas pressure drop inlet to outlet	By design
Humidity Resistance	By design

- **Fire Protection System**

The fire protection system for the Facility will be designed to meet the requirements and recommendations of NFPA 850. The system will include but not limited to fire suppression systems, independent fire detection systems, standpipe, and fire hose stations, fire loop system, and portable fire extinguishers.

➢ **Ash Handling System**

General

The ash handling system collects, removes and transports bottom and fly ash to ash silos for temporary storage prior to being loaded into trucks for removal to the ash disposal area or off-site use. The bottom and fly ash systems will be designed to handle the ash generated when operating at BMCR and firing coal with the maximum ash content and the silos will be sized for 48 hours of storage.

Table 1-8. Generation rates of Bottom and Fly Ash

Items	Unit	Bottom Ash	Fly Ash
Production Rate	tonne / hr / unit	1.50	6.01
Silo size 48 hours	Tonnes	390	1559
Ash density	Kg / m3	1,100	650
Volume	M^3	252	1583*

- **Ash Production Quantity (per one unit of power plant)**

Total coal ash = production Up to 10% (As Received Basis) of total coal combustion quantity under BMCR conditions

Bottom ash = Up to 20% of total ash formed

Fly ash = Up to 95% of total ash formed

- **Fly Ash**

Fly ash collected in the economizer, air preheater and the electrostatic precipitator hoppers will be pneumatically transported in a dry state to the fly ash silo where it will be stored and discharged it into trucks for removal to the ash disposal area or off-site. The transport system shall include three (3) 50% capacity, two (2) in operations and one (1) in standby, fluidizing air blowers.

The ash piping, elbows and fittings will be composed of suitable abrasion-resistant piping and fittings of high hardness. In particular, elbows are made of carbon steel or cast iron having an abrasion-resistant liner.

- **Bottom Ash**

The bottom ash system will collect and transport bottom ash from the bottom of the furnace to the bottom ash storage silos. The bottom ash conveying system will include crushers to properly size the bottom ash prior to storage.

The capacity of the bottom/fly ash silos is designed for a minimum of 48 hours of storage of bottom/fly ash production under BMCR conditions.

High temperature bottom ash discharged from the lower part of the furnace will be broken finely by the crusher and then transported and stored in the bottom ash silo.

- **Ash Repository Pond**

Offsite external ash pond shall be designed compliant to applicable Philippines Regulation. Protection composite liners shall be provided to prevent leachate contamination of the groundwater, surface water and soil. Groundwater monitoring wells shall be provided at selected locations adjacent to the ash pond. A minimum six (6) groundwater monitoring wells at external ash pond shall be provided. Higher number of groundwater monitoring wells shall be provided at suitable locations around the ash pond if required to allow proper groundwater contamination monitoring. A leachate collection and rain runoff drainage system shall be provided. The leachate system may consist of a leachate collection layer with a pipe network to convey the leachate to the sedimentation pond and waste water treatment facility.

➢ **Turbine / Generator and Auxiliary System**

The function of the steam turbine is to transform the thermal energy of the steam generated in the boiler into kinetic energy, which in turn is transformed to generate electric power. Some of the thermal energy is extracted from several points during the turbine cycle and is used for heating feed water, and the remainder is discharged to the circulating water system through condenser.

- **Feed water System**

The feed water system delivers the feed water from the feed water storage tank to the boiler economizer inlet through high pressure feed water heater via the boiler feed water pumps. A secondary function of the boiler feed pumps is to deliver desuperheating water to the desuperheater of the boiler. Pumps shall be capable of running in parallel with each other throughout the full operating range.

- **Condensate System**

The condensate system condenses the exhausted steam from the turbine within the condenser, collects condensate in the hot well, and delivers it to the feed water storage tank through the gland steam condenser; the low pressure feed water heaters and the deaerator.

Each unit will have its dedicated condensate system.

- **Circulating Water System**

The circulating water system supplies the cooling water (sea water) to the condenser and condenses the turbine exhaust steam. The system also supplies the cooling water (sea water) to the closed circuit cooling water heat exchangers in order to eliminate the heat load from various plant equipment.

- **Light Oil System**

The function of the ignition light oil system is to unload from the tank lorry, store, transfer and supply ignition oil to the boiler, auxiliary boiler, emergency diesel generator, etc. This system consists of an ignition light oil storage tank, ignition light oil pump, related piping and fittings, and instrumentation.

- **Raw Water Supply and Pre-treatment System**

The raw water shall be supplied from the Tagoloan River wherein a river station pump station is already installed.

1.4.4 Identification and description of support facilities and infrastructure requirements such as energy/power generating facility (if any) or energy source, water supply/storage, storm water drainage, sewerage treatment, telecommunications, safety/emergency facilities, accommodation and similar facilities

The Support facilities and infrastructure requirements of the project for both existing and proposed expansion were provided in **Table 1-5.**

1.4.5 Identification and description of pollution control devices and waste management system for the waste materials; wastewater, air emissions, domestic wastes, toxic and hazardous wastes, non-toxic and non-hazardous wastes, etc.

- **Air Pollution Control Devices (APCDs)**

By nature of similarity of process and operation the same APCDs will be employed in the expansion project as were used in the original project.

The main APCD is the Electrostatic Precipitator (ESP) discussed in the foregoing in terms of its operating principles.

The boiler stacks are also considered as aspects of the APCD because of their role in the dispersion of gaseous discharges to the atmosphere.

- **Waste Management System**

The waste management system of the original project shall be the same as that for the expansion project and is discussed hereunder.

The Waste Water Treatment Plant

The Waste Water Treatment Plant consist of the following systems:

- Oily Waste Water Treatment System
- Contaminated Condensate Treatment System
- Non-chemical Waste Water Treatment System
- Chemical Waste Water Treatment System
- Sewage Treatment System

Figure 1-20. The Wastewater Treatment Facility

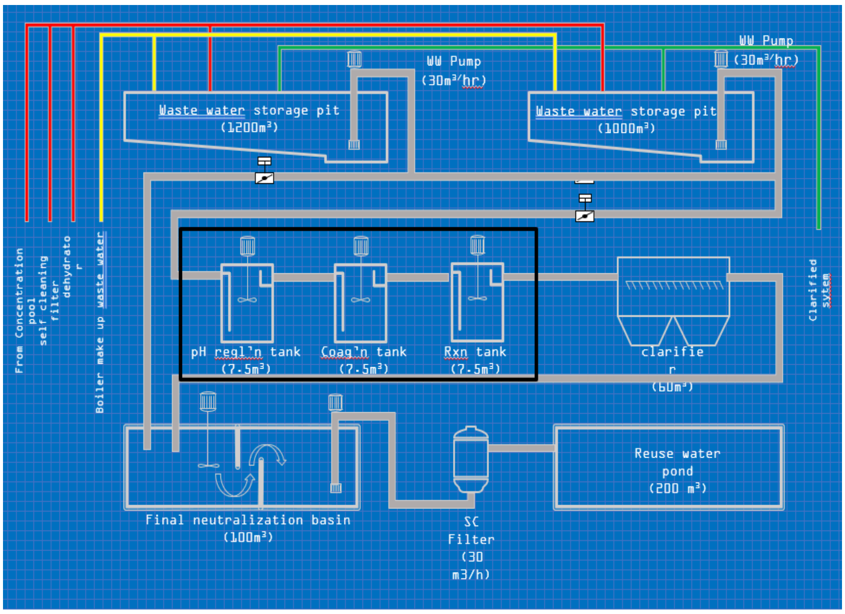


Figure 1-21. The Existing Wastewater Treatment Plant Process Diagram

Note: The above existing Wastewater Treatment Facilities and Waste Water Treatment Plant Process Diagram will be the same as for the expansion project

Wastewater Process

All wastewater is dumped into the wastewater pits. The wastewater pH is adjusted in the pits before being transferred by a pump to a series of tank namely, pH regulation tank, coagulation tank and reaction tank. The continuously runs until the Reused water pond is full.

In the pH regulation tank, acid or caustic soda is injected, whichever is necessary, whenever there is a need to further adjust the pH. Coagulant chemical is injected to the coagulation tank to form flocs from the dirt in the wastewater. Coagulant aid chemical is injected in the reaction tank so bigger flocs can be formed. The wastewater with the flocs then passes through an inclined plate clarifier which filters out the sludge in the wastewater and only allow the clear water to pass through it.

The treated wastewater flows out of the inclined plate clarifier and goes into the Final Neutralization basin. pH is adjusted in this tank. Treated wastewater overflows to the next tank which is the called the Clarified Water Pit. A pump sucks in water from the Clarified Water Pit and let it pass through the Self-cleaning Filter. At the outlet of the Self-cleaning filter, a three-way valve is installed that allows treated wastewater to return to the wastewater pit if pH is not within specification (6-9) as well as turbidity. On the other hand, if the parameters are within specs, treated wastewater will flow towards the Reused Water pond. This is the storage for treated wastewater that will be used for fly ash unloading and other plant uses.

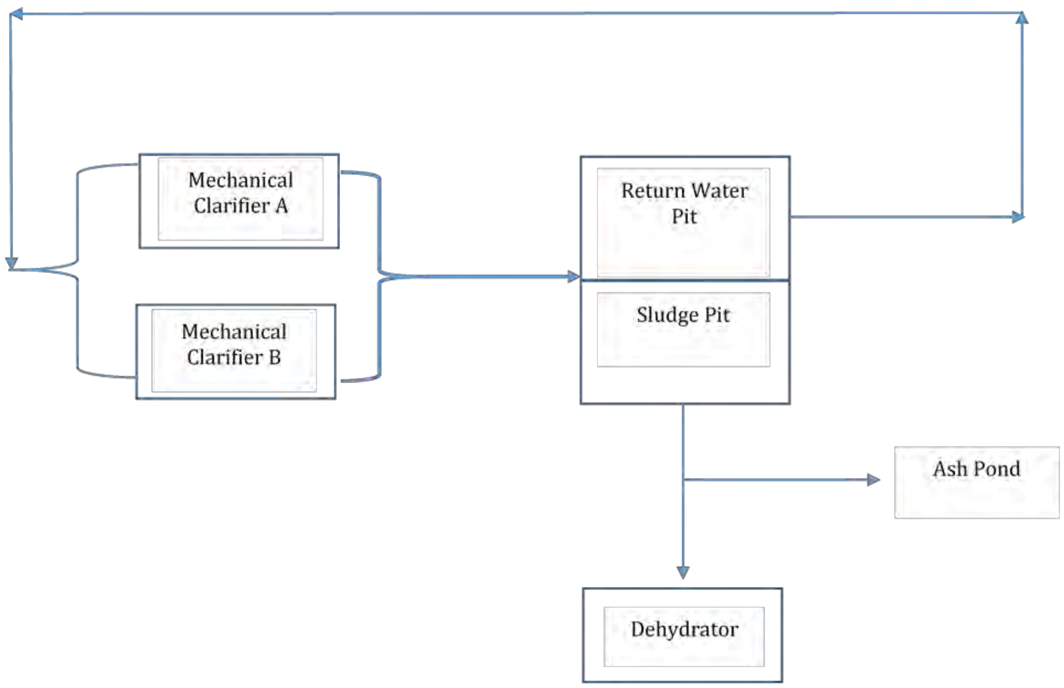


Figure 1-22. Sludge from Clarifier

Note: (integrated in the overall wastewater process flow. Figure 1-23).

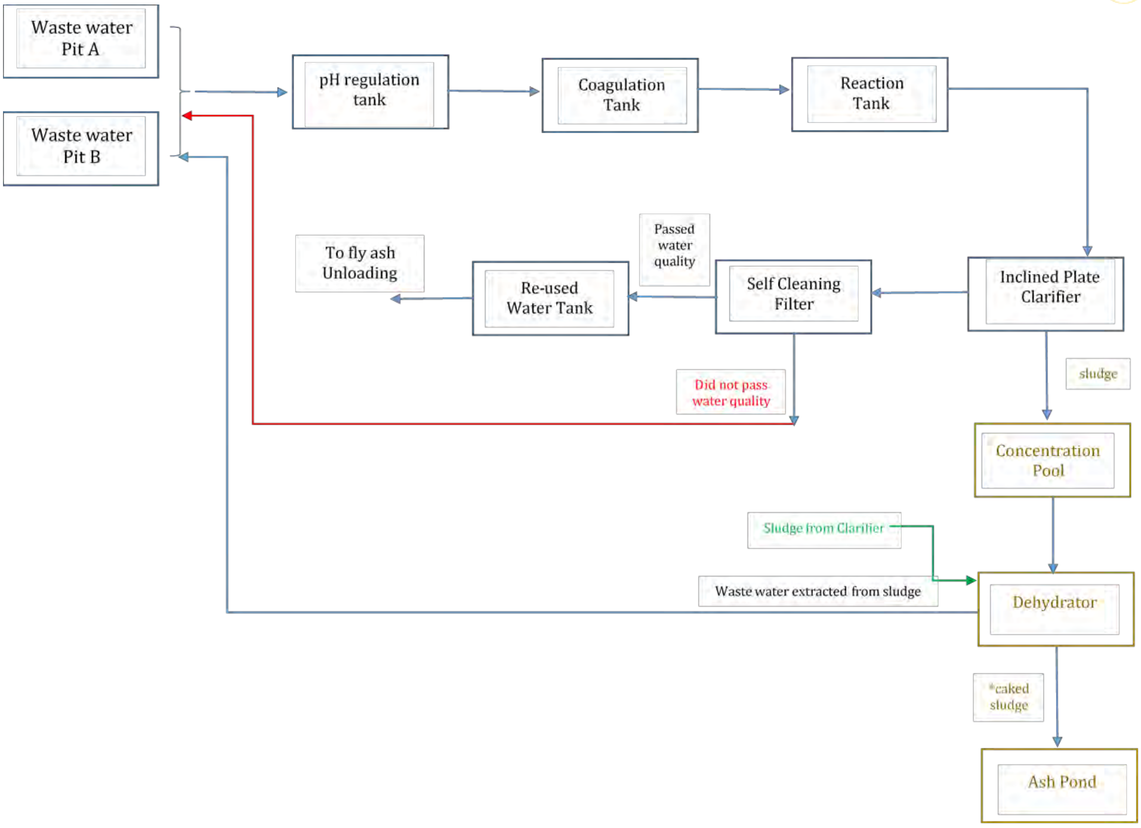


Figure 1-23. Wastewater Process Flow

1.5 Process / Technology

1.5.1 Technology Description and Performance Specification

The main feature of the process/technology is the combustion process in which coal as fuel is fired in a Circulating Fluidized Bed (CFB) furnace. CFB technology utilizes the fluidized bed principle in which crushed fuel and limestone are injected into the furnace or combustor. The particles are suspended in a stream of upwardly flowing air which enters the bottom of the furnace through air distribution nozzles. The balance of combustion air is admitted above the bottom of the furnace as secondary air. While combustion takes place at 800 to 900°C, the fine particles are elutriated out of the furnace. The particles are then collected by the solid separators and circulated back into the furnace. The particles circulation provides efficient heat transfer to the furnace walls and longer residence time for fuel and limestone utilization.

The general operating principle of fluidized bed combustion involves the feeding of crushed coal into the boiler and burning it utilizing a bed that consists of inert material such as sand. The bed is characterized with a high heat capacity thus making it highly suitable for burning fuels with high moisture content, eliminating the need for separate fuel drying before the boiler. With this high heat capacity of the bed material the quality of the fuel can vary more than in other boiler types.

Before the main fuel can be fed to the boiler, the bed is heated to a temperature which guarantees safe auto – ignition. Pre – heating will be accomplished using diesel oil fuel.

In the Circulating Fluidized Bed Combustion (CFBC) type of fluidized bed, the air velocity of the bed which is about 4.5-5 m/s causes the circulating action and the effect of fluidization. The combustion air is introduced to the boiler in several levels. The primary air flows upwards and fluidized the bed while the secondary air is injected above the bed. The combustion temperature in fluidized bed boiler is lower than in grate or pulverized firing, typically at 800 – 900 ^{0}C. At this relatively low combustion temperature, NOx which is invariably generated as a result of the mixture of Nitrogen and Oxygen in the air is maintained at lower emission levels.

Sulfur dioxide will be removed in the combustion process by adding limestone or dolomite to the bed, (if necessary) thus eliminating the need for an external desulphurization process and the problem of eventual disposal of sulfur. The calcium oxide formed from the calcination of limestone reacts with the SO_2 to form calcium sulfate which is removed from the flue gases together with fly ash. The low combustion temperature in fluidized bed systems is optimal for limestone requirements because the required calcium to sulfur ratio for a given SO_2 removal efficiency is low in this temperature range. The CFB has therefore built-air pollution control features.

The conceptual diagrams for a CFB process is shown in **Figures 1-24**.

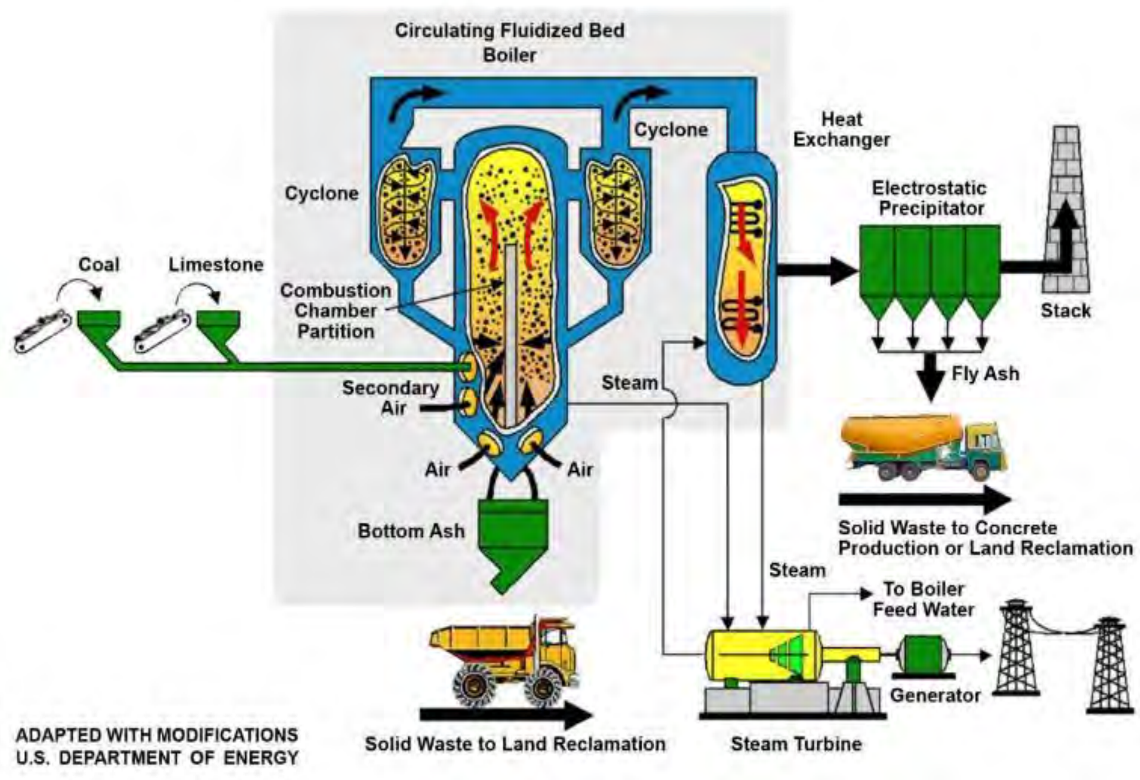


Figure 1-24. The Circulating Fluidized Bed Combustion Process

For the particulate matters (PMs) the project will employ the Electrostatic Precipitator System (ESP), shown diagrammatically in **Figure 1-19.**

Principle of Operation

The Electrostatic Precipitator removes the particulate matters which are carried in the flue gas stream as fly ash. The flue gas stream after leaving the steam generator heat recovery zone will pass through the electrostatic precipitator through the parallel openings. The flue gases are introduced to the plate-formed positively charged electrodes. Electrically isolated spray electrodes are suspended on which a negative voltage is applied. Under the influence of the electrical field, the particles adhere on the positive plate electrodes. The particles adhered to the plates are shaken by an automatic, periodic vibration of a hammer mechanism from the plates, then falls into the dust funnel and is pneumatically conveyed to the fly ash silo. From the silo, fly ash is transported for further use as building material in the cement industry or to the ash repository. The efficiency of the electrostatic precipitator is nearly 99.5%. The fly ash collected in the separators or discharge funnels is fine, dry and abrasive with a typical temperature of 140°C.

Material and water balance for the total capacity of the project.

The overall material balance for the total capacity of the project is shown below: The Input material, i.e. coal feed is converted into the output materials, i.e. fly ash and bottom ash and combustion gases. No chemical reactions are involved and thus no chemical compounds enter into the balance.

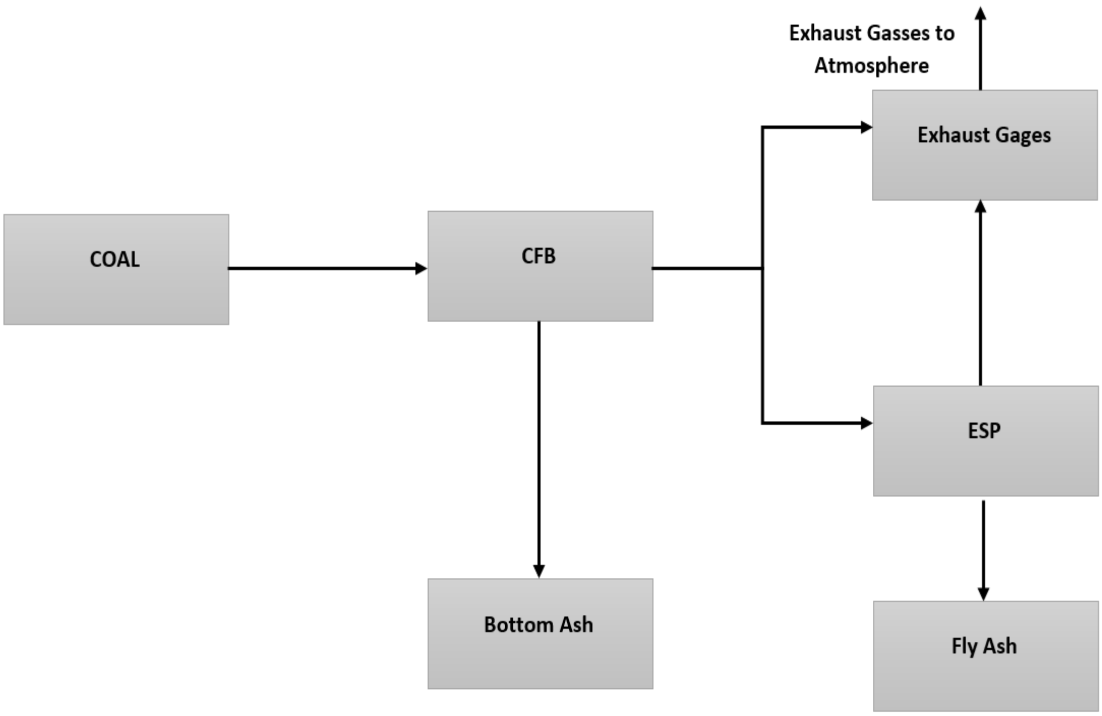


Figure 1-25. Overall Total Material Balance

The corresponding flow rates based on ongoing design calculations are:

Basis: Maximum flows at 1 x 135 MW Full Operations

INPUTS

Coal 1624 mt/day From Figure AI-4

OUTPUTS

Fly Ash 6.01 mt/hour or 129.92 mt/day

Bottom Ash 1.5 mt/hour or 32.48 mt/day
Total Ash 162.4 mt/day
Exhaust Gases (By difference) 1461.6 mt/day

More detailed material (and heat) balances (for 1 – 135 MW unit) are provided below:

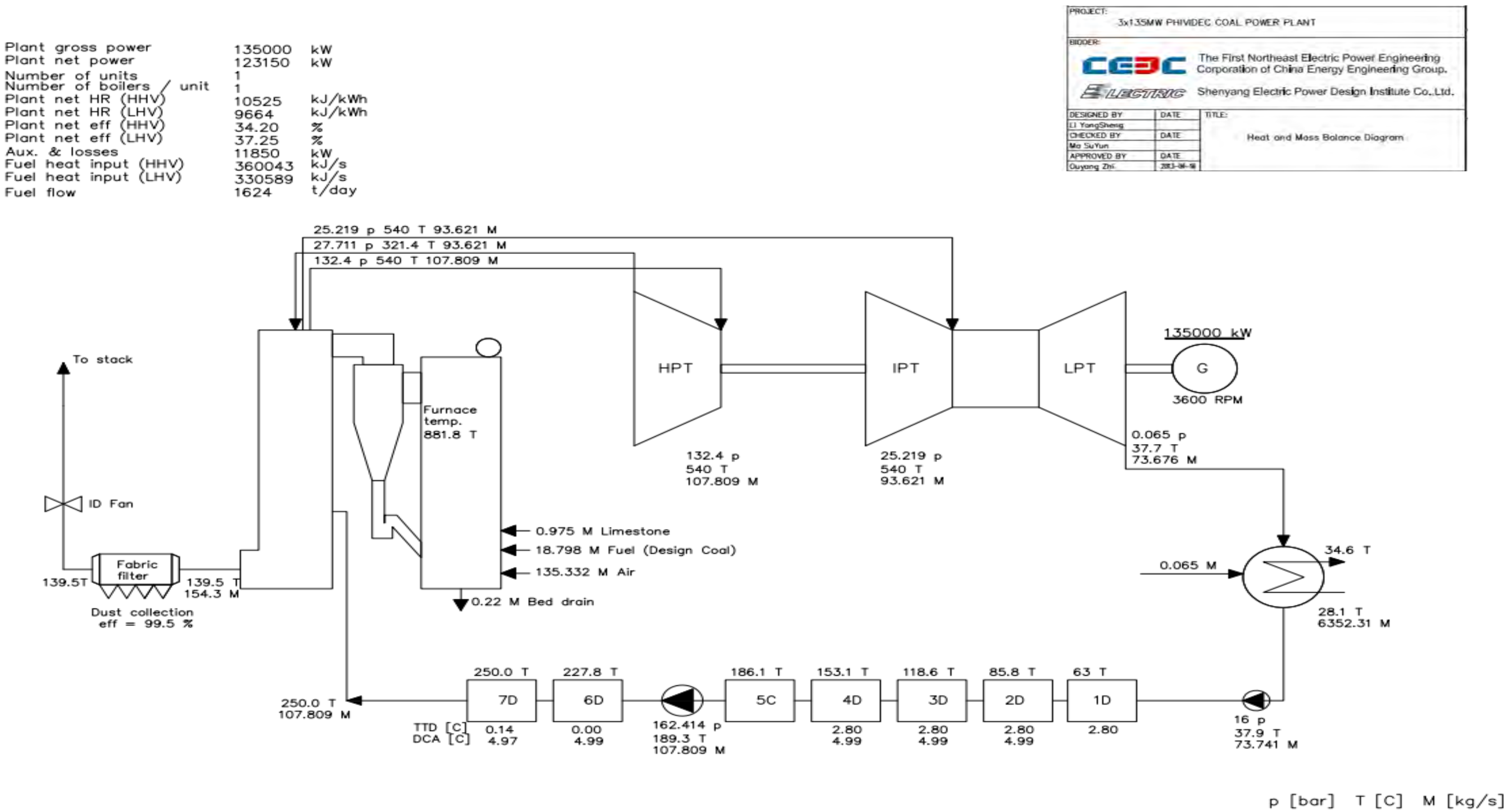


Figure 1-26. A More Detailed Material and Heat Balance

The process water balance is provided below:

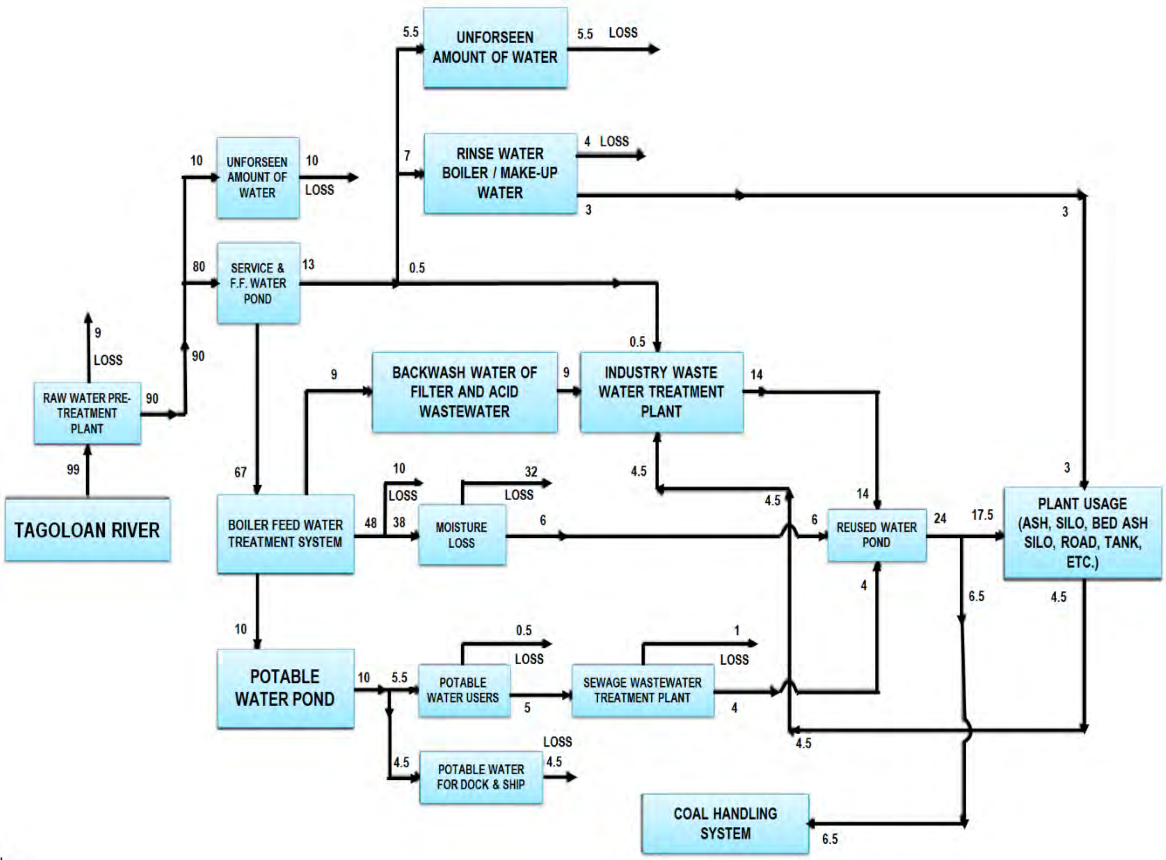


Figure 1-27. The Freshwater Balance at Full 6 x 135 MW Plant Operation

The sea water balance is provided below indicating that the volume of cooling water extracted from Macajalar Bay is the same volume returned inasmuch as the CW system is a once through process.

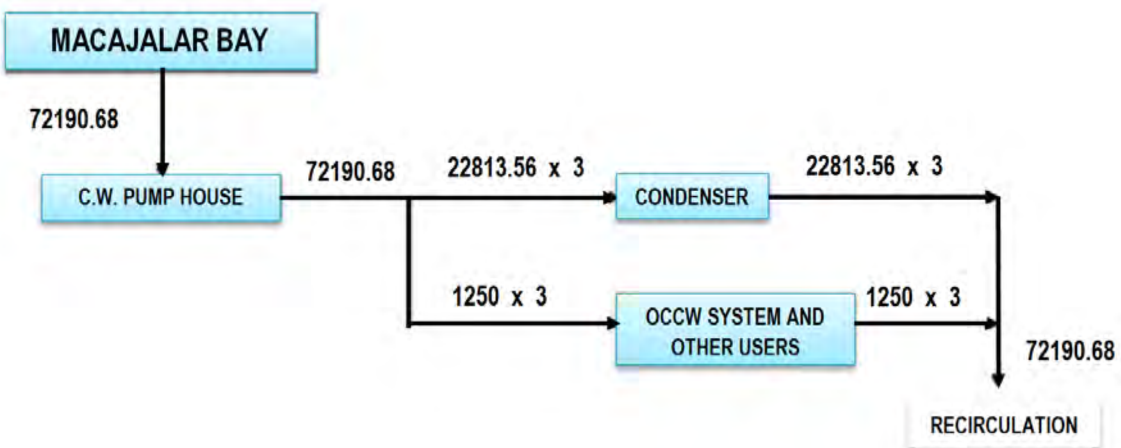


Figure 1-28. The Sea Water Balance at Full 6 x 135 MW Plant Operation

1.5.2 Description of the pollution control devices and water waste management system.

a) Waste Management System

- **Ash Management System**

Although the residue ash (bottom and fly ash) are not expected to be classified as hazardous wastes, the management of such will be judiciously planned in consideration of potential perceptions by communities on ash from coal power plants.

Included herein are details and calculations on the used and remaining capacity, including the proposed expansion, and the remaining life span as well as the agreements with the 3rd party fly ash buyer.

Estimated volumes of ash generation, i.e. the used capacity based on actual records and not on calculations. This is shown in the Table below.

a. The actual generation rate of generation of bottom ash and fly ash are shown below:

Table 1.9. Historical record of Ash Generation

YEAR	Total Coal Consumption (Mtons)	F/A UNLOADED (WET), tons	F/A UNLOADED (DRY), tons	Bottom Ash Silo, tons		
				U1	U2	U3
2016	160,790	11,943	2,440	1,175		
2017	651,681	25,390	0	2,165		
2018	903,101	39,797	720	6,124		
2019	1,137,726	29,784	20,860	5,058		
2020	956,926	34,272	13,980	4,837		
2021 As of April	290,539	3,732	4,420	714		

Using the above historical data, the remaining life span is based on the total remaining capacity of the ash pond (existing and the proposed new ash pond) minus the total tonnage of the bottom ash deposited divided by the estimated annual rate of deposition.
Therefore: Remaining life span = 12 years if there will be no off-takers of the ash products

We considered using the existing ash disposal area of 15 hectares and proposed new area of 9 hectares for development, and considering ash pile height of 12m, ash ponds will be filled-up around 12 years if there will be no off-takers, after taking out the volume of the already used ash pond portions. Considering the current information of around 3 to 4 bulk trucks of hauling fly ash from the plant site daily, the years for the ash ponds to be filled up will be increased by at least 2 years. These will be improved once the contract with other cement companies and recycling projects with LGUs are finalized.

Ash dikes can be constructed in stages and can be discussed during the final design stage of the project. For the existing ash pond, ash dike construction was discussed to be in two stages. The initial 3.5m height ash dike in stage one (relative to ash disposal bottom) was constructed by the EPC contractor, while the next stage will be under FDCMPC's scope. For the expansion project, the new EPC contractor will now be responsible for construction and the capacity of ash it can accommodate from the existing and additional three units.

The above estimates are based on 6 x 135 MW Coal Power Plant operations atthe capacity of the ash disposal facility. This is also based on 100% plant utilization and 90% availability, the estimated fly ash generated for 6 units is about 256,072 tons per year while bottom ash generated is about 64,018 tons per year.

Fly ash is being sold or provided to cement plant companies such as Holcim, Republic Cement and GTS Construction for mixing with clinker in the production of cement and construction materials. FDC has an ongoing contract with Holcim and GTS Construction while contract with Republic Cement is still in the finalization stage. The consideration of recycling the bottom ash to manufacture useful products such as hollow blocks and bricks are also being discussed with LGUs concerned.

Key aspects of the Agreement in terms of an MOU or a MOA are provided in Annex 15, with the confidential details necessarily excluded.

A typical Fly Ash Handling System shown in Figure 1-29, below is briefly described below.

The fly ash handling system shown employs compressed air as the transport medium of ash being collected at the collecting hoppers of the electrostatic precipitator. The ashes collected in the hoppers are pneumatically conveyed in a specially designed pipe to the fly ash storage bin.

The fly ash storage bins are equipped with telescopic unloaders for discharging fly ash to bulk tankers for recycling of ash outside the plant and ash mixer-humidifier unloaders for discharging fly ash to dump trucks for disposal to ash repository.

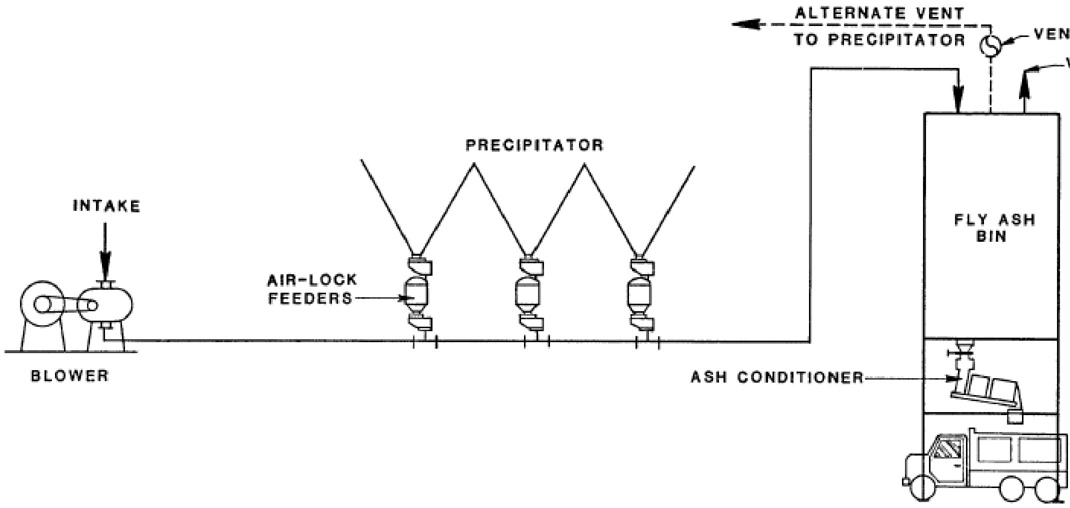


Figure 1-29. Typical Fly Ash Handling System

- **Bottom Ash Management System**

The base design of permanent ash disposal repositories shall be compliant with the environmental regulation framework of the Philippines government and local authorities. The ash repository capacity shall be based on a life span of 30 years

An impermeable layer of HDPE liner shall be applied on the compacted ground and another approximately 100mm layer of sand before placing the gravel layer of approximately 300mm.

The area shall be designed with sufficient drainage system in order to drain out the water collected above the impervious HDPE membrane. The said waste water shall be directed to A Coal Dust Settlement basin before discharging them into natural water course in order to ensure compliance to the of permissible level of Total Suspended Solid TSS in accordance to the Philippines Environmental Code and Standard.

The ash repositories shall be raised above grade with a robust working surface that facilitates running on and off of trucks and front end loaders. These shall be designed to take account of any long term settlement expected.

b) Air Pollution Control Devices/Systems

- **The Clean Technology Features of the Plant**

In order to assure compliance with the emission standards of the Philippine Clean Air Act, the coal feed shall be of acceptable quality especially with respect to metallic elements.

The boiler will operate at temperature lower than the value that would cause formation of NOx. Sulfur capture by limestone will be built in the Circulating Bed System.

The use of CFB renders greater operating efficiencies, thus lesser fuel usage and lesser emission rates of potential pollutants.

- **The Boiler Stacks**

Boiler stacks will be engineered such that the resulting emission plume will meet the ambient air concentration standards and the GLCs will not reach the population center.

- **Aqueous Effluents/Wastes**

Septic tanks will be installed at strategic places to manage domestic liquid wastes.

Miscellaneous effluents and wastes which could include (a) accidental oil spills (b) chemical drains (c) spent chemicals from the Demineralizer System will be collected and piped to a central waste treatment unit. One option for separating the oil is by gravity process from which recovered oil/sludge will be drummed and disposed through a third-party accredited disposal company. The treated will be discharged to the receiving basin, the Macajalar Bay.

A discussion of the APCD which primarily is the Electrostatic Precipitator is discussed in the foregoing including design efficiency in terms of percent capture of PMs

The current operation of the original 3 x 135 MW Power plant has demonstrated successful management of the bottom ash through its disposal in an ash repository pond.

Regular monitoring of the ground water quality is reported in the SMR. Ground water reflects the absence of ash leachates to the underground water thus suggesting the acceptable performance of the ash management system. Moreover, shown below is the detailed P & ID (Process and Instrument Diagram) for the Ash Handling System. (Enlarged clear copy is provided in **Annex 9D**)

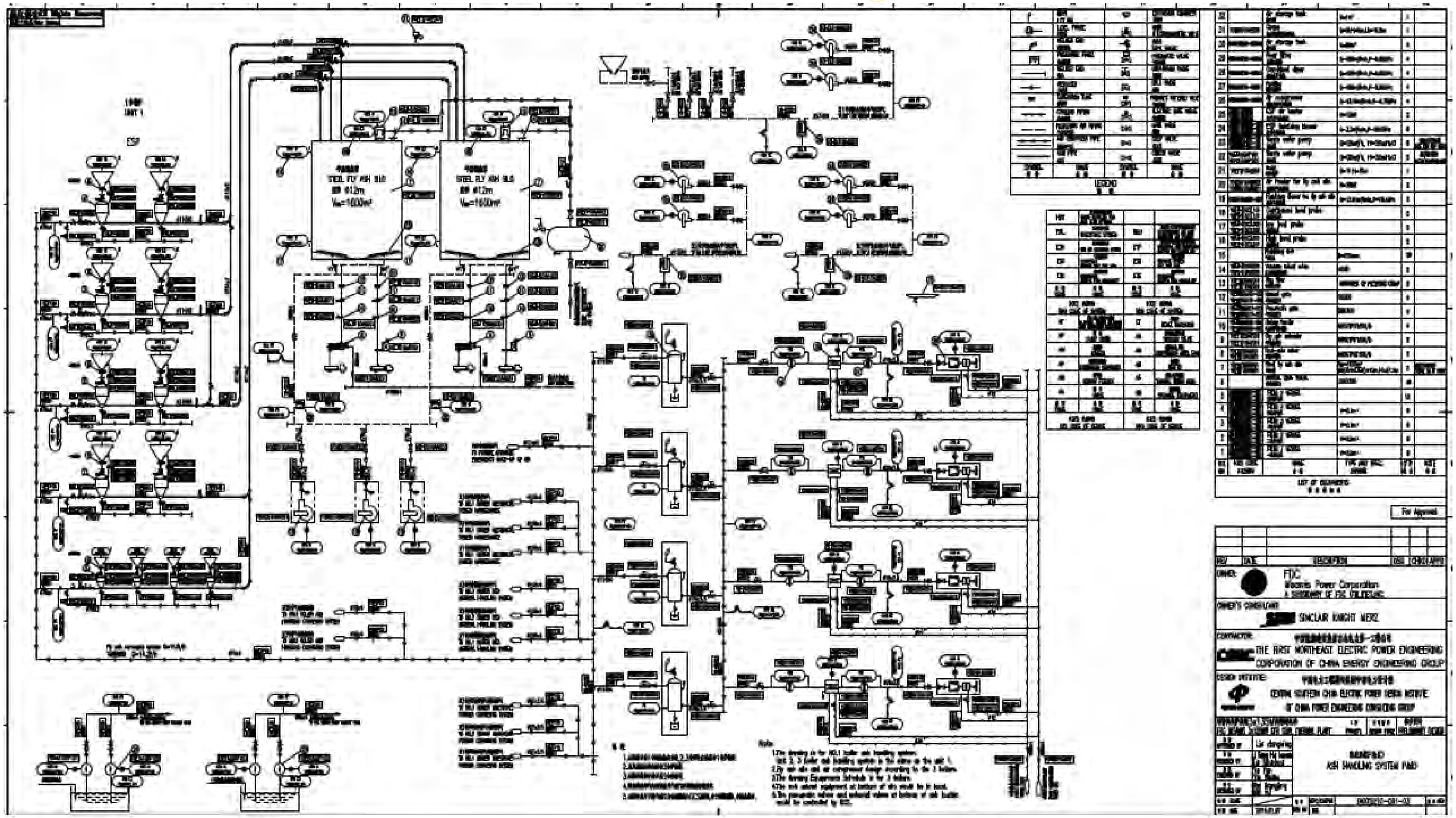


Figure 1-30. Process and Instrumentation Diagram for Ash Management

1.5.3 Description of the operations and maintenance of facility.

The discussion on the operations is made in the description of the process technology presented in the foregoing.

With respect to maintenance of the facility, the EPC has provided maintenance manuals for appropriate use of the plant's maintenance personnel.

The plant philosophy for maintenance is not only to ensure continuous operations but equally important to prevent emergency or unplanned shutdowns which could ultimately result in deviation from environmental performance. Thus if the APCD experiences unplanned shutdowns PMs would be discharged to the atmosphere at uncontrolled conditions.

Typical contents of the manual are:

Regular maintenance shutdown. Historically, the power plant is shutdown for maintenance purposes for a period of 21 days each and a total of 3 of preventive maintenance shutdowns per year for the 3 units.

Spare parts inventory as prescribed by the EPC contractor is faithfully complied with. As a matter of policy, major spare parts such as parts for relief valves, instrumentations, are kept at the warehouse.

Type of Critical Spare parts	Minimum Inventory
Mechanical	39
Electrical	13
Instrumentation & Control	21

The Complete list of spare parts is provided in Annex 9E.

- **Impacts on the ecosystem of each process, as shown in the process flow of the power plant.**

The overall process flow of the power plant is shown below which is the same presentation made to the public during the Public Scoping activity.

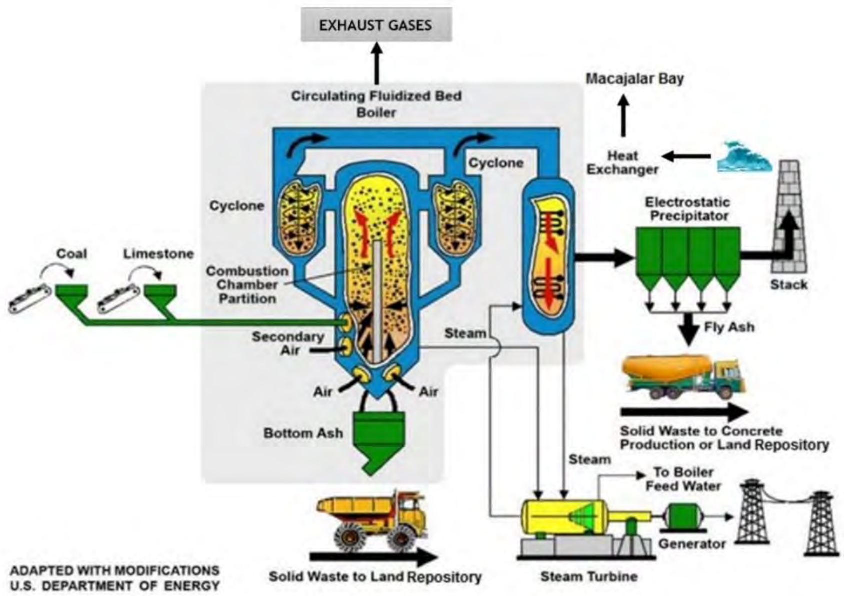


Figure 1-31. The Overall Process Flow Diagram

Based on the above **Figure** the major processes involved and the associated environmental impacts and corresponding mitigating measures are summarized as follows:

Table 1-10. Processes Impacts and Mitigating Measures

Process	Impacts	Mitigating Measures	Remarks
Combustion of Coal	**Generation of gases to the atmosphere**	Boiler system to reduce SO2 ESP to remove PM Reduction of NOx through boiler design Engineered stack	Circulating Fluidized bed design using limestone for SO2 capture Electrostatic capture of fine particles (PMs) Low temperature design Height and Diameter design for air dispersion
Condenser cooling using once through sea water	**Thermal effects at cooling water outfall**	By design, minimize outlet temperature, optimize flow rate Discharge zone at minimal or no corals	Thermal plume modeling as input to design
By product of combustion	**Bottom ash residues** **Fly ash residues**	Ash to land repository Quality coal to minimize bottom ash Disposed to 3rd party user	Engineered ash repository with membranes separating layers of ash deposits. Fly ash component of cement manufacture

1.6 Project Size

1.6.1 Total power generating capacity, filter plant capacity, and port capacity and dimension.

The expansion project size is 3 x 135 MW Coal Fired Power Plant. The total project size comprising of the original and the expansion project is 6 x 135 MW.

1.6.2 Total Project Area in sq.m. or hectare.

The total leased area is 84.4 hectares (same with existing FDCMPC. An additional 3 hectares will be acquired for the installation of additional conveyor system. A new ash repository area of 9 has. will be constructed inside the leased area.

1.7 Development Plan, Description of Project Phases and Corresponding Timeframes

A description of the activities during the various project phase will provide inputs for impact Identification, environmental management plan and social impacts/appropriate socially-oriented program.

Impacts due to the construction of the raw water pumphouse.

The schedule of project activities and corresponding timelines are shown in ***Figure 1-33.***

There will be no major construction activities involving the existing raw water pumphouse and thus there would not occur significant impacts on Tagoloan River as a result of construction works. As maybe gleaned from the diagrammatic illustration below of a typical river water pumphouse, the main features of the pumphouse are only the installed submerged pump and the piping system for delivery of water to the power plant site.

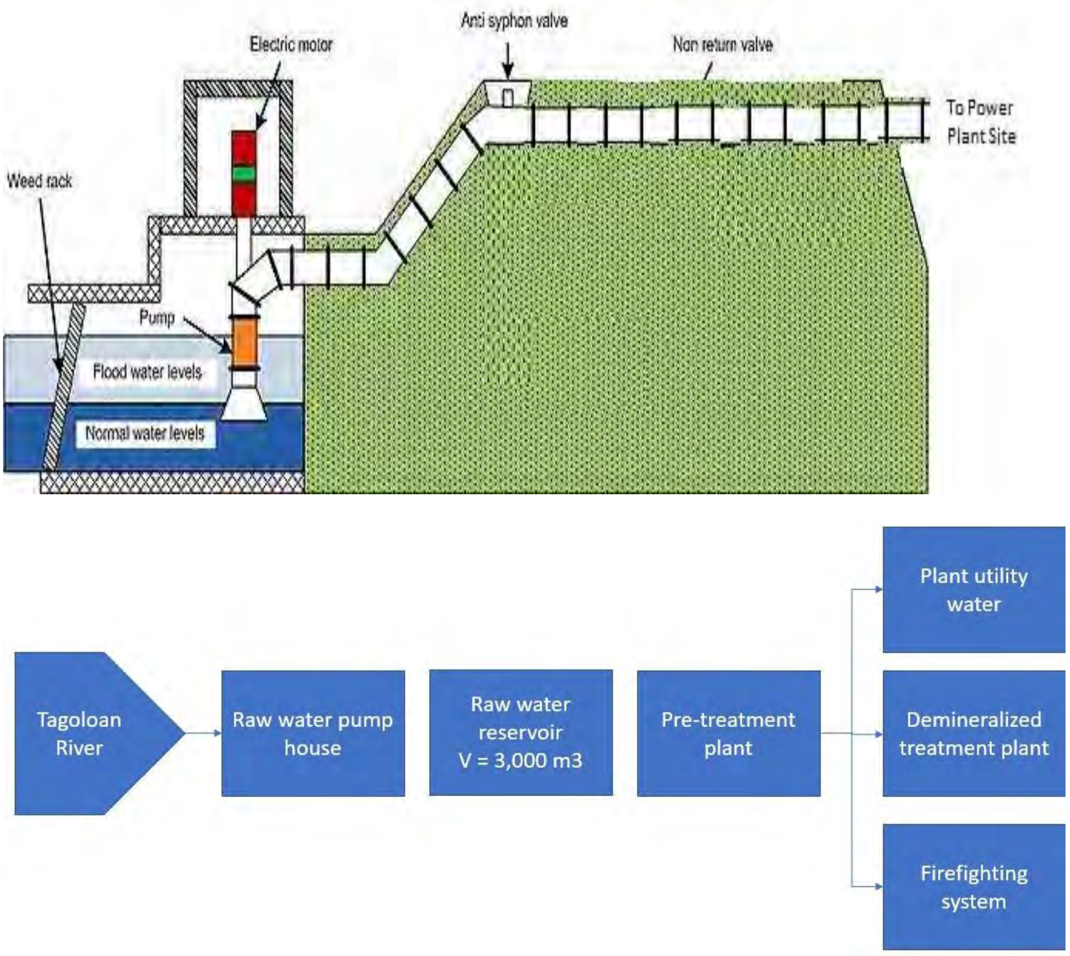


Figure 1-32. Diagrammatic Illustration of a River Water Pumphouse

Top figure is the physical illustration, bottom figure is the process illustration showing therein the various usages of the river water

Moreover the size of the pumphouse is located near the river and not on the river body itself.

The indicative project timeline of the expansion project reckoned from acquisition of the ECC is provided below:

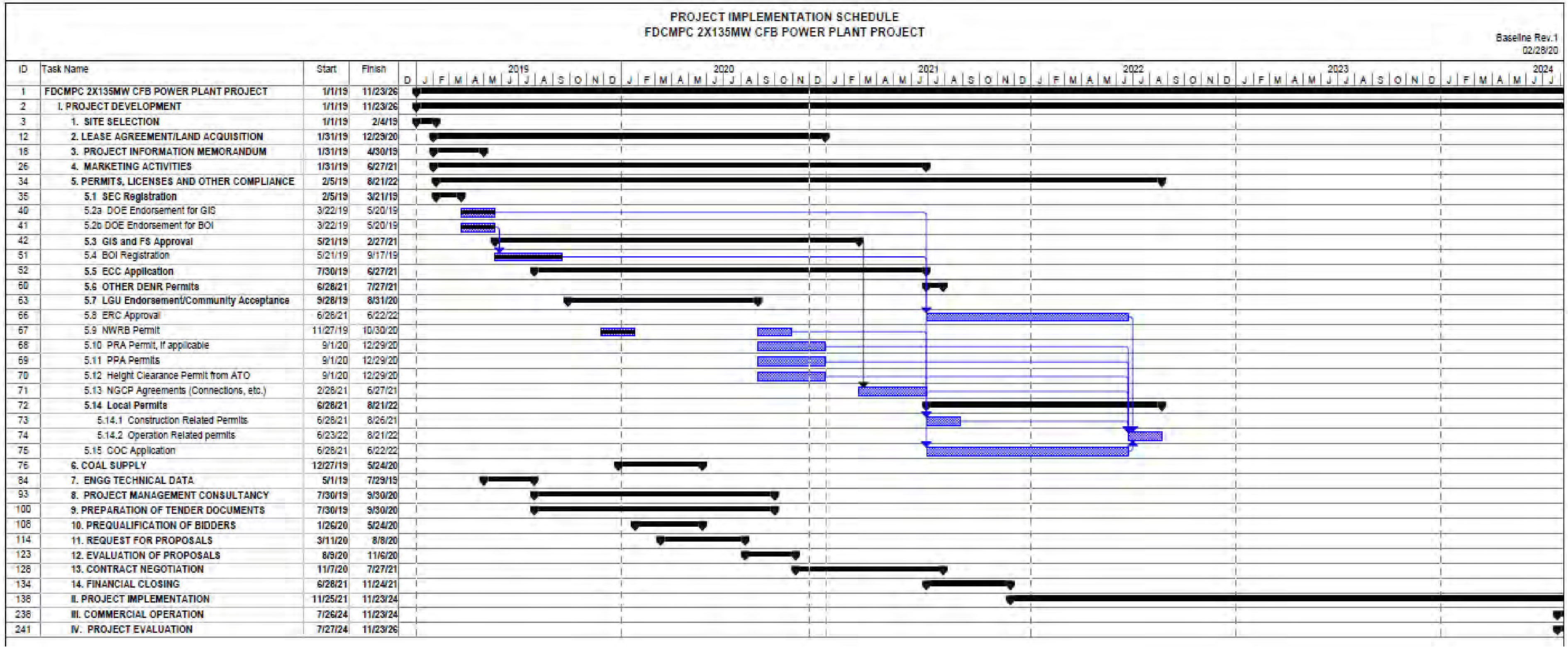


Figure 1-33. Indicative Expansion Project Timeline

1.7.1 Pre-construction/ Pre-operational phase

This involves the exploration stage, project planning, the securing of appropriate Clearance(s) and permit(s) from the DENR / EMB principally the ECC Feasibility studies which include economics evaluation are integral part of this phase.

1.7.2 Construction/Development phase

Phases to be described in terms identifying specific activities (with special attention on those with significant environmental impacts as well as climate change adaptation options relevant to the project and project activities) and corresponding projected implementation timeframes:

Site Preparation Works

This will involve earthworks, vegetative clearing, possibly the disturbance of standing trees, inland transport of construction equipment

The potential impacts include: minor change in landform, erosion potential, generation of fugitive dusts, disturbance of trees, clearing of vegetation, generation of construction scraps and debris, discharge of domestic waste water.

Installation of water intake structures at the Tagoloan River and Macajalar Bay.

Water Abstraction and Treatment Plant

The raw water shall be used for power cycle make-up, auxiliary cooling heat exchanger, fire-fighting system, plant service and potable water requirements.
Under this option the Raw Water System of the plant will source water from the Tagoloan River at a location which is upstream of the tidal limit. The estimated distance (straight line) between the source and the power plant is about 3 kilometres.

Pre-treatment System

A pumping station will be constructed with a redundant pump near to the river, a complete raw water supply infrastructure and delivery pipework from the River to the power plant. The water extracted from the river shall be stored in a reservoir that has a minimum storage capacity of 24 hrs. The water will then be pumped to a water pre-treatment system which utilizes fully automatic gravity sand filters with provision for backwash mechanism. The filtered water shall be stored in a clear well which shall include pumps that will supply filtered water to the potable water system, demineralized water treatment plant, domestic water supply and fire-fighting system.

A typical layout of a river pump station is shown below:

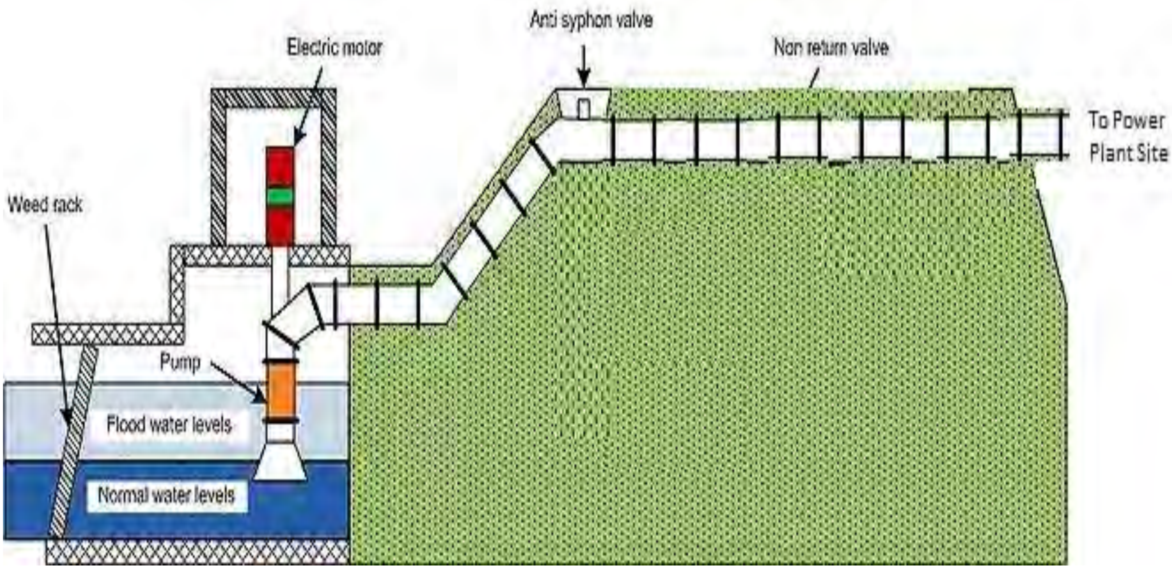


Figure 1-34. Typical layout of a river pump station

The estimated storage capacity of the system is 3,000 cu. meters.

Demineralized Water Treatment Plant

Demineralization shall be achieved by cation-anion units, in series, with cation-anion mixed bed units. The flow rate shall be based on a twenty hour service run per train with not more than four hours regeneration downtime per train.

The cation exchangers shall be supplied complete with strong acid cation resin. Degasifiers complete with blowers and degasified water tanks located between the cation exchangers and anion exchangers shall be supplied for the removal of gaseous carbon dioxide. The anion exchangers shall be supplied complete with strong anion resin. The mixed bed exchangers shall be supplied complete with a strong acid macroporous resin and a strong base quaternary ammonium macroporous Type I anion resin.

Regeneration System

Facilities for regeneration of exhausted resin inside each of the ion exchange units shall be provided
Acid and Caustic Storage Tanks

Acid storage tanks and caustic storage tanks shall be provided. They shall have a total capacity of two weeks' supply of acid / caustic for the regeneration requirement. The chemical storage tanks shall be situated at ground level in bunds which shall be lined with appropriate chemical resistant coating. Provision shall be made for filling the acid and caustic bulk storage tanks from a road tanker and shall include quick connect / disconnect couplings, a standpipe rising vertically from the loading point and then falling gently to the storage tank. The filling connection points shall be contained within the bund. An emergency shower near filling point shall be provided.

Effluents and Drains

All chemical waste shall be discharged to the neutralization pump. A neutralization system shall be designed to neutralize chemical wastewater to achieve a pH value in the range of 6.0 to 9.0 to produce a relatively non-corrosive wastewater. All necessary equipment to automatically maintain this effluent range shall be provided. The sump should be internal / external water proofing with appropriate lining.

Demineralized water treatment plant building

The Demineralized water treatment plant building shall be sized for 3 x 135 MW units. The building shall be steel framed with sheet metal roofing, with insulation. Walls shall be brick, lined and painted internally. Floors shall be reinforced concrete with acid resistant coating. Acid resistant paint or tiles shall be provided on areas handling chemicals.

Construction at the frontage of the Macajalar Bay

The location of the structures to be constructed is shown in the conceptual drawings/project footprints in **Figure 1-16.**

- The cooling water intake structure and piping
- The cooling water outfall structure and piping

The pier

The existing pier will be adequate for the handling of coal deliveries and is not planned for upgrading at this time.

The pier columns are trestle type; thus avoiding water circulation impacts.

To support these structures there had been individual structural elements such as piles, which had been embedded at the certain points in the sea bed.

The construction activities at the Macajalar Bay and Tagoloan River will necessarily involve the use of barges or boats to transport equipment, materials and personnel to the specific construction areas.

The intake to be constructed at the Macajalar Bay will be designed such that there will be no damage to the existing coral system. The outfall will be connected on the canal constructed by DPWH flowing toward Macajalar Bay.

Construction at the Power Plant facilities

The specific activities during this phase are:

Construction of Work area, Dormitory and Temporary Facilities (Temfacil) for the construction workers will be among the first construction activities.

Site preparation works which will involve:

- Clearing and grubbing. The site is partly developed and is not forested. Disturbance to trees may not be involved.

- Earthworks. Excavation for foundation works and for the underground cables and pipings as well as for the drainage system will be undertaken. The size of footings shall be determined such that working soil pressure or pile stress shall not exceed the allowable soil bearing pressure or allowable pile bearing capacity. The relevant factors of safety shall be applied. Foundations for structures are expected to comprise of shallow footings and deep piles.

The installation and construction of equipment and facilities will be undertaken when the site shall have been prepared.

Other major activities and their potential impacts are:

- Movement of construction vehicles - This will result in air emission discharges

- Activities of workers such as the use of toilet facilities, cooking of meals and other. These will result in domestic waste and solid waste generation

1.7.3 The Operations Phase

The significant activities which may have environmental impacts are:

Operation at the pier

Transport of coal by conveyor systems from the pier to the storage and thence to the boiler
Potential for accidental oil spill could not be ignored.

Uptake of sea water and discharge of cooling water return

The uptake of sea water may create some turbulence of the sea bed depending on the volumetric rate of update and distance from the sea bed.

The potential for entrainment of marine species e.g. shell fish exist especially during periods that such species may be abundant such as during hot months.

Likewise the possibility of entrainment of sea bed silts exist considering the already turbid/silty conditions of the marine waters.

Discharge of cooling water return will carry with it thermal effects. The elevated temperature will eventually cool down in a “mixing zone”.

Process water treatment

Uptake of raw river water from the Tagoloan River

Carryover of muds/silts from the already murky river water is a possibility.

Operation of the boiler system, steam generation and balance of plant.

Following are the major components of the project that will operate at this phase

The Fluidized Bed Steam Generation System

The Steam Generator receives coal from the Material Handling System, fuel oil from the Fuel Oil Supply System, combustion air from the Combustion Air and Flue Gas System, and feedwater from the Boiler Feed System to produce steam at the operating conditions required by the steam turbine.

The combustion process necessarily generates gaseous by products which are regarded as pollutants, depending on their individual concentration levels. These are

- SOx
- PM
- NOx
- CO

Volatile harmful elements/substances if present in significant concentrations in the coal feed may also be released to the atmosphere. Among these which has to be carefully monitored and managed through appropriate selection of coal is Mercury which has a low volatilization temperature.

Auxiliary equipment/systems

The following briefly describes the auxiliary equipment and process for each unit.

Fuel Oil Supply

The Fuel Oil Supply System provides fuel oil to the steam generator for the start-up burner and to aid in heating the fluidized bed.

Boiler Feed System

The Boiler Feed System provides feedwater from the deaerator storage tank to the economizer inlet, raises the feedwater temperature through regenerative heating, and provides the flow path for spray water to various desuperheating stations.

Main Steam System

The Main Steam System conveys superheated steam from the steam generator super heater outlet to the steam turbine stop valves.

Steam Turbine Generator

Thermal energy contained in the steam is transformed into kinetic energy and thence into electric power by the generator. Portion of the thermal energy generated in the turbine cycle is used for feed water preheating.

The Cooling System

The cooling system uses recirculating sea water to cool the various hot streams such as the turbine exhaust steam in condensers.

After passing through the condensers the cooling water passes through a piping system to allow natural cooling from the ambient air prior to ultimate discharge to the Bay.

Combustion Air System
The Combustion Air System includes primary air, secondary air, and flue gases. The primary and secondary air systems provide combustion air to the furnace section of the steam generator.

Distributed Control System

The Distributed Control System (DCS) provides the heart of the instrumentation process which is vital not only for operational control but also to ensure that the built – in facilities to mitigate pollution will operate properly. The DCS provides modulating and digital control, monitoring, alarming, logging, data archiving, and indicating functions for the plant systems.

Coal Handling System

From the coal unloader, coal is conveyed into the covered coal storage, thence into the coal crushers, coal silo and finally into the boiler chamber.

Coal will be received at the pier from PANAMAX or SUPRAMAX vessels.

Electrical auxiliaries with potential impacts

Transformers

Avoidance of Polychlorinated Benzene (PCB) will be planned so that accidental oil spills will not create pollution hazards/risks from this toxic substances

Operation of Support Facilities

As described in the previous sections chemicals will be used in the treatment of raw water or marine water to produce Demineralized Water for the Boiler. Waste water treatment units will necessarily be constructed for the treatment of such.

1.7.4 The Decommissioning Phase

Decommissioning refers to the permanent stoppage of the power plant operations. The relevant aspects, waste generation, issues and built-in measures during this phase will be dependent on the decommissioning plan. The decommissioning plan necessarily starts with an Environmental Site Assessment (ESA) taking note in particular of any residual toxic substances especially in the soil.

As a matter of procedure, the Decommissioning shall be subject to submittal of a plan and approval thereof by the Environmental Management Bureau. Monitoring of the decommissioning activities may be made by the MMT and the EMB. Unless the Proponent is given clearance after the decommissioning works shall have been completed, it shall remain legally responsible for any residual impacts on the environmental resources. Any coal in stock will be sold to third party user.

1.8 Manpower

Pre-Construction/ Construction

Pre-construction manpower will be dedicated to the miscellaneous activities associated with project development, planning and the securing of various governmental permits. A minimal manpower complement will be involved during this phase. Most of the activities will in fact be undertaken by the incumbent staff and employees of the Company.

Construction requirements for manpower will largely depend on the schedule of workers that will be put up by the Contractor(s) which at this time have yet to be identified. Depending on the construction tasks/jobs that will be undertaken at a given time, the peak manpower complement could reach up to 500 personnel.

Operation

At least 190 workers will be employed on the plant site

The organizational chart and tabulation of manpower requirements are shown below:

Table 1-11. Tabulation of Manpower Requirements

Functions	Personnel Required	Estimated Numbers
Plant Management	Plant Manager	1
Operations	Operations Manager - 1	122
	Operations Personnel - 121	
Maintenance	Maintenance Manager - 1	56
	Maintenance Personnel - 55	
HSSE	HSSE Manager - 1	9
	HSSE Staff - 8	
Tech Training	Tech Training Manager - 1	2
	Training Specialist -	
	Total Number of Personnel	**190**

The current scheme for sourcing locally from host and neighboring LGU(s) that is being applied is discussed in the submitted EPRMP Section 8 and reiterated hereunder**.**

- Qualified local residents will be given priority. Opportunities for skill development will be provided to enhance the chances of local residents in being employed.
- There will be no discrimination with respect to sex and to senior citizens.

- Contractualization will be avoided to the extent practical and in accordance with laws existing at a given time.

- The applicable provisions of the DOLE are observed.

Figure 1-35. The Organizational Chart/Institutional Plan

Projected Timeframe

Project is estimated to be completed in a two (2) -year time frame through plant acceptance from the EPC.

1.9 Indicative Project Investment Cost

Projected cost is within the range of P 20 Billion to P 30 Billion pesos, and this will be finalized prior to financial closing and EPC contract implementation for this project.

Among the key considerations on the project cost are (a) the foreign exchange rate (b) the final cost of equipment and (c) updated construction costs.

SECTION 2. ASSESSMENT OF KEY ENVIRONMENTAL IMPACTS

2.1 THE LAND

The site is a private land owned and managed by the PHIVIDEC Industrial Authority. PHIVIDEC was established on the 13th of August 1974 through the Presidential Decree 538 as amended by PD 1491. Being in an industrial estate, there will be no change/inconsistency in land use. The Estate hosts other industrial plants such as a Coal Power Plant and a Sinter Plant shown in Plate 2.1-1.

The land for the plant facilities, pier facilities, and raw water pumping area will all be within the pre-existing sites except for the additional 3-hectare area for a new conveyor system, which will be located outside and adjacent to the existing plant. (**see Plate 2.1-3**)

On the other hand, the pier area is covered by a Foreshore Lease Agreement and applicable related permits.

A general perspective view of the site/land may be gleaned from the image of the site provided below and at the Collage of Photos at the end of this Section.

Plate 2.1-1 Aerial View of Site and Adjoining Projects

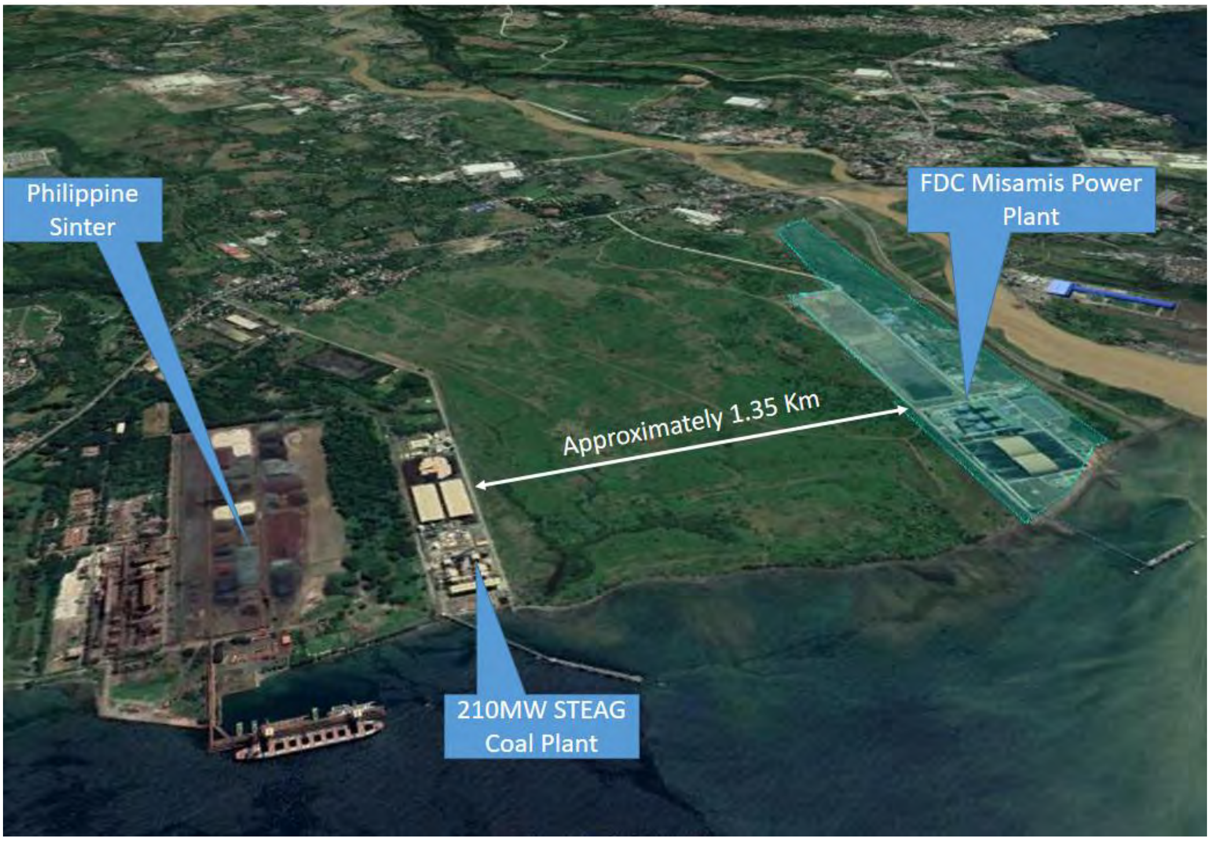


Plate 2.1-2 Photos of the FDCMPC Site Proper

Plates 2.1-3 Area of proposed Additional Conveyor System

Plate 2.1-4 Area of proposed Additional Ash Pond

From the above site photographs, the area is of flat terrain and there are sparse vegetation.

2.1.1 Land Use and Classification

2.1.1.1 Impact in terms of compatibility with existing land use and with coastal resource management plan, if any.

On coastal resource management, there are no compatibility concerns because:

- A foreshore lease agreement has been entered with PHIVIDEC, holder of the mother Foreshore Lease Agreement
- There are no official LGU coastal resource management plans

Description & Map showing the project area in relation to existing land area.

Being in an industrial estate, there will be no change/inconsistency in land use. The Estate hosts other industrial plants such as another Coal Power Plant and a Sinter Plant shown in **Plate 2.1-1.**

The Land Use Map shown in **Figure 2.1-1** indicates that the project site is in area classified as "**Industrial**".

2.1.1.1.1 Assessment of the compatibility of the proposed project in relation to the coastal resource management plan of the LGU, if any.

On Tagoloan

The major activities in Tagoloan are confined to a small portion of the river wherein water abstraction will be undertaken. There are no major activities on shore that will involve significant disturbance of terrestrial ecology.

Sea Use

The project site is fronting the coast with its jetty/pier facilities located within the Municipal Fishing Zone (**Figure 2.1-2**). Following (italized) is verbatim excerpts from the CLUP.

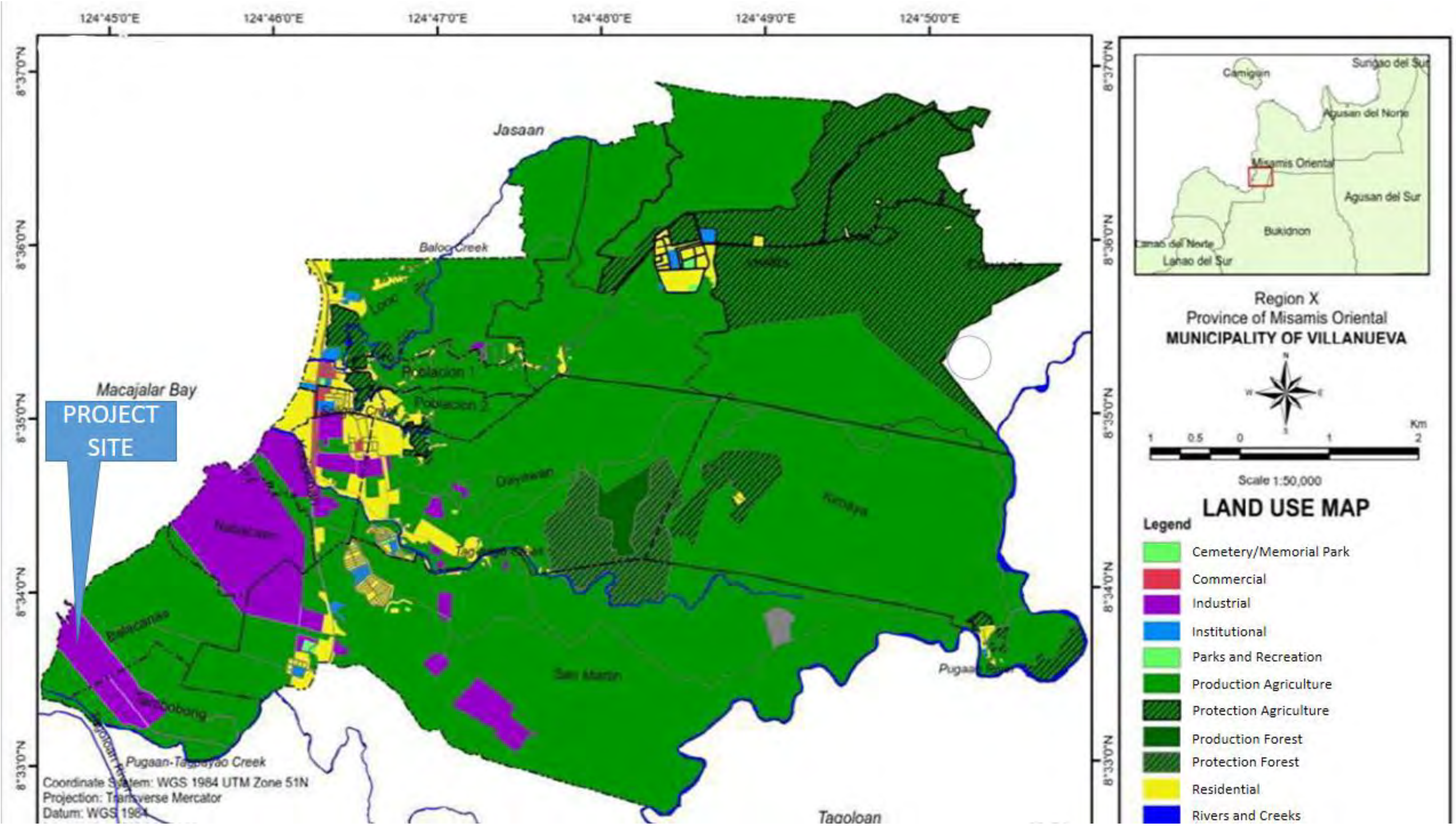
The municipal waters of 4,399.80 hectares consist of a 94% Municipal Fishing Area of 4,120.87. These are areas where registered municipal fisherfolks may capture marine species. Commercial fishing and use of illegal fishing methods in these areas are also prohibited.

An Anchorage of 162.25ha (3.7%) is reserved for anchorage of any size of international, inter-island cargo ships, fishing boats, yachts, passenger sips either drifting or anchored while waiting for their port docking schedule. A corresponding anchorage fee shall be paid and a 50m buffer zone from Fishery Reserve and Mari-culture Park areas shall always be observed.

A Port of 66.81 ha (1.5%), on the other hand, are offshore areas within the industrial establishments with special construction for docking facilities of seagoing vessels of any size.

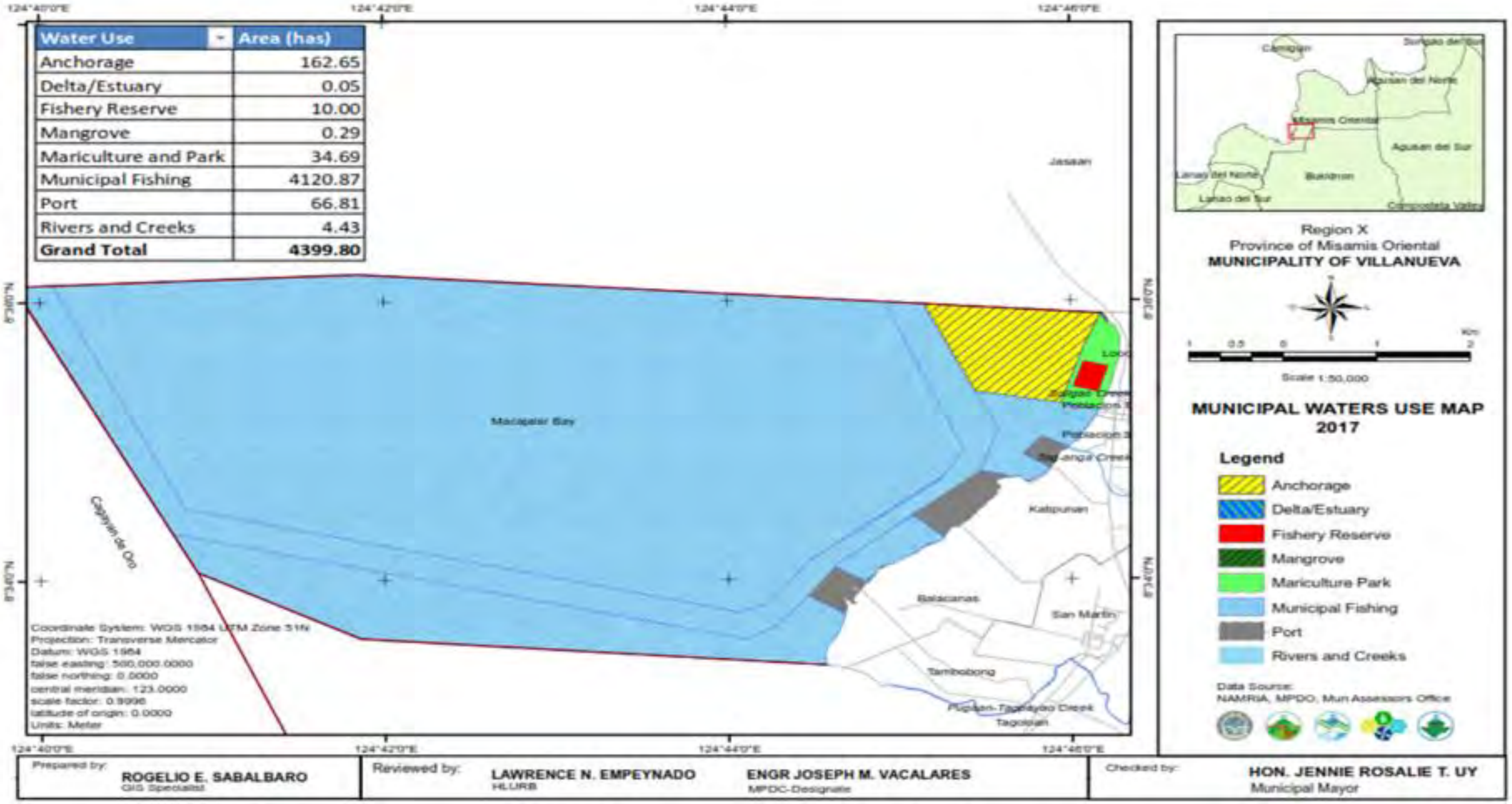
The Municipal Fishing Area, the Anchorage and the Port occupy 99.20% of the water area and or uses and the remaining water uses include a Mari-culture & Park of 35 hectares (.78%), which are areas allocated for fish cages and other commercial fishery culture such as seaweeds, shellfish, crabs and other marine resources for livelihood projects; Fishery Reserve of 10ha are Fish Sanctuaries (An increase in Fishery Reserve area was later identified, from 10ha to 76.81ha or 1.7 % of the total municipal waters); 4.4ha (10%) of Rivers and Creeks, which are inland water bodies; Mangrove of 0.29ha, which are considered protection forest areas; and another areas reserved for special development and conservation programs and this is where the inland river or creek mouth flow and meet the sea is a Delta/Estuary of 0.05ha.

A sea-lane of 504.33 hectares or 11.5 % is specified and this covers one kilometer wide corridors for the passage of all international and inter-island marine vessels, passing through, docking and departing from the municipal waters. Putting up structures such as fish aggregating devices (payao) markers, buoys, fishing and other related activities are regulated within this zone for safety purposes. Municipal fishing may be allowed in this area provided no incoming or outgoing vessels are schedule to dock or undock.



Source: Villanueva CLUP, 2017-2027

Figure 2.1-1. The Land Use Map of the Municipality of Villanueva



Source: Villanueva CLUP, 2017-2027

Figure 2.1-2 Existing Water Use Plan of Villanueva

2.1.1.2 Impact on compatibility with classification as an Environmentally Critical Areas (ECAs)

The matter of ECAs is reckoned from official declarations principally as embodied in the E NIPAS Act.

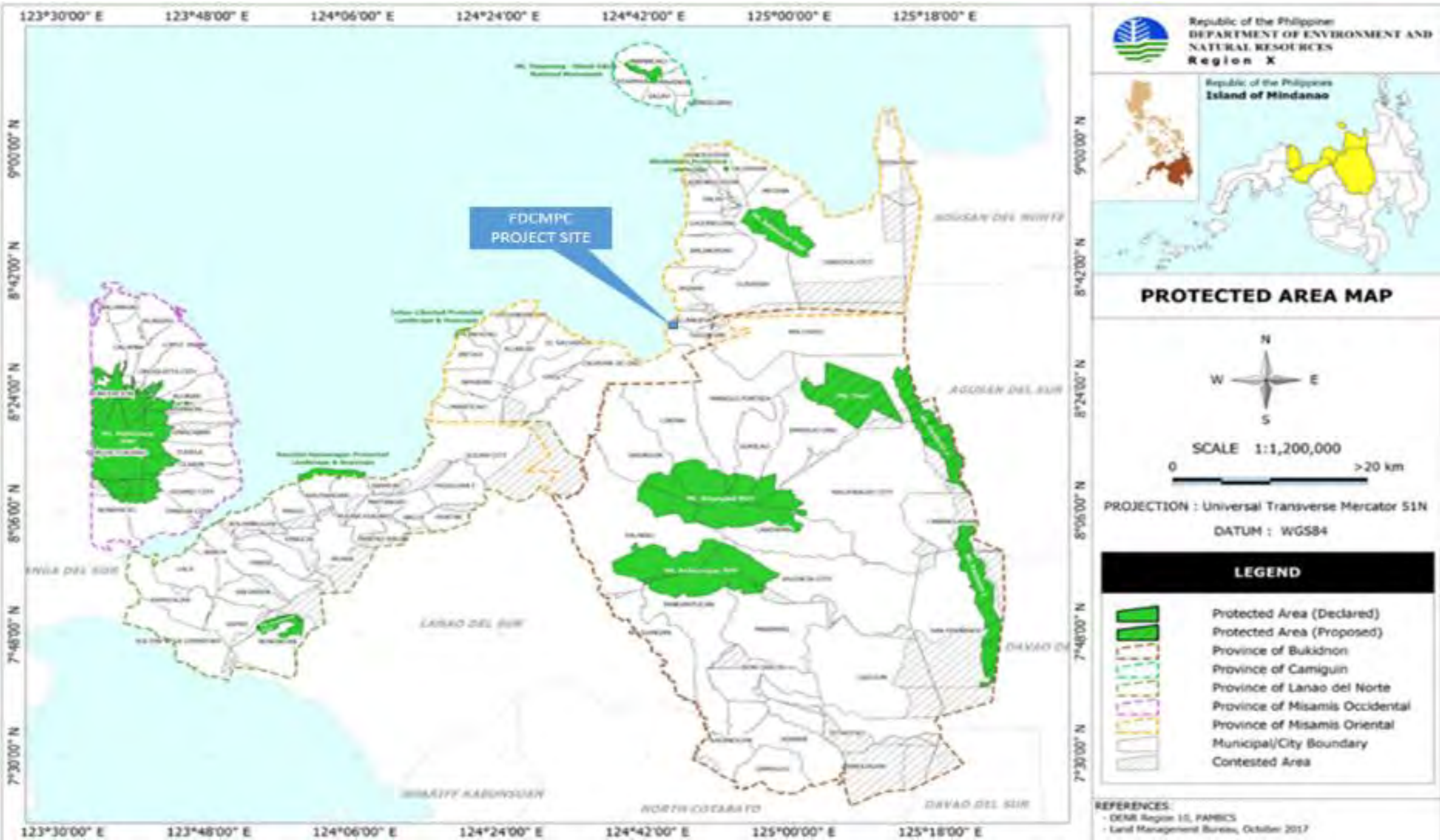
Inasmuch as the project site is located within the existing plant site of FDCMPC, there are no known protected area within or near the project site. Moreover other industrial establishments are located within the PHIVIDEC Industrial Estate. In the implementation of the original project, no issues have been raised in respect of ECAs.

Classified under the Expanded National Integrated Protected Areas System (ENIPAS ACT - RA 11038) as the Environmentally Critical Area nearest the project site is Mt. Balatukan Range in Misamis Oriental (8°46′12″N 124°58′48″E). The Project is compatible and does not conflict with this ECA because of the distance (34.1 km) from each other, shown in **Figure 2.1-3.**

The DENR Protected Areas.

The project is distant from the existing and the proposed declared protected areas as may be gleaned from **Figure 2.1-4** and hence does not impact on nor is impacted by these protected areas.

Figure 2.1-3 The NIPAs ECA (Mt. Balatukan) relative to the Project Site



Source: DENR-BMB R10, 2018

Figure 2.1-4 The DENR Declared Protected Areas in Region X

2.1.1.2.1 Areas vulnerable/susceptible to natural hazards where the project is located or near the project area, including maps.

This is discussed in details under Section 2.1.2.3 below.

The project site is susceptible to ground shaking, tsunami, subsidence, landslide, flooding, and minor storm surge. It is safe from ground rupture and liquefaction.

In the light of experiences with strong typhoons such as "Sendong" causing severe damages in the region and of "Yolanda" in Tacloban, vulnerability/susceptibility to met-ocean hazards cannot be ignored.

Mindanao, including the Cagayan de Oro-Misamis Oriental region, which historically has rarely experienced tropical cyclones, was hit during the period December 13 – 20, 2011 by a severe Tropical Storm "Sendong" (Washi), which brought 10 hours of torrential rains that triggered disastrous flash flooding over Mindanao. More than 200 mm of rain was reported in places where rivers were already swollen. During the overnight hours, hundreds of people were killed as flood waters and landslides destroyed homes along mountain sides. In some locations, flood waters rose by 3.3m in less than an hour. Residents impacted by these flood waters were forced to seek refuge on their roofs amidst 90 km/h winds.

The amount of rainfall reached 200 to over 250 mm (~8 to 10 inches along Mindanao's east coast where Sendong made landfall, but the highest amounts are along the northwest coast, where rainfall reached 300 to over 400 mm.

2.1.1.3 Impact in existing land tenure issues/s

Noting that (a) the expansion site will be in the same land wherein the existing power plant operates (b) the site is in an industrial estate and more importantly (c) there have not been experienced any land tenure issues it can be correctly stated that no **CADC-Certificate of Ancestral Domain Claim/CADT-Certificate of Ancestral Domain Title/CALC-Certificate of Ancestral Land Claim/CALT-Certificate of Ancestral Land Title** and other such related matters do not confront the project expansion. The planned additional coal conveyor system involving a small area of approximately 3 hectares will be located within the PHIVIDEC land and hence there are also no issues associated with this land area.

Settlers

Previous settlers in the project site were already relocated before PHIVIDEC leased the property to FDCMPC. Thus, there are no issues on settlers for the expansion project.

Right-of-Way (ROW)

There are no ROW issues for the power plant site, ROW will be relevant to the transmission line component of the project which, however, is not included in this EIA for the purpose of securing an ECC.

There are no possible tenurial/land issues because PHIVIDEC which has authority over the land has leased portion of the estate for use by the Project.

2.1.1.4 Impairment of visual aesthetics

There are no visually significant landforms/landscapes/structures as may be seen in the Collage of Photos shown at the end of this Section.

2.1.1.5 Devaluation of land value as a result of improper solid waste management and other related impacts.

Land value devaluation is reckoned from the value of the land for the project which is under lease with PHIVIDEC. The considerations for the lease are not influenced by issues, if any, relating to improper solid waste management which is particularly and under the responsibility of the lessee, if the Project Proponent.

Moreover, "improper solid waste management" is not deemed to be highly significant in the context of land value devaluation because:

a. By nature of the project, the normal solid waste generation arises from the domestic activities of the plant personnel, i.e. domestic garbage.

b. The SMRs report very small volumes of toxic and hazardous wastes generated which for the 4th Quarter 2020 was only 0.25 MT and additionally are properly handled pursuant to the regulations of RA 6969.

An isolated complaint involving alleged inappropriate solid waste disposal, referring to garbage is noted. However, as of this date (May 2021) this complaint has been resolved.

2.1.2 Geology/ Geomorphology

2.1.2.1 Change in Surface Landform/ Topography/Terrain/Slope

Topography / Geomorphology

The general terrain relief of the municipality of Villanueva is characterized by narrow coastal flats grading into steep slopes rising towards the relatively flat plateaus of its upland barangays. The barangays near the coast are generally composed of flat terrain extending from the coastline to a few kilometers towards the interior of the municipality.

These coastal plains are terminated along the foot slopes of moderately to very steep slopes which forms the base of the extensive plateaus in the area. Deep-cut valleys which characterize river courses are also predominant in the area. The elevated regions are incised by these rivers forming deep v-shaped valleys which generally trend east-west.

After the coastal plains, the terrain gently rises to 3-8% slope until it reaches its highest peak more or less at the center of the municipality with 18-30% slope. The elevation again lowers to 8-18% slope towards the eastern direction of the neighbouring Municipality of Claveria.

Steep slopes of 30-50% define the gorges of Napapong Spring and Tubigan Creek along portions of Barangay Imelda, Dayawan, Kimaya and eastern portion of San Martin. Areas with more than fifty percent (50%) slope comprises the rest of these gorges dropping down to the creeks running through the aforementioned barangays.

The project site sits on the deltaic plain of Tagoloan River, specifically on the northern side about 323m from the mouth. This deltaic plain has a very flat topography (0-3% slope) and becomes gently rolling as it goes farther from the river.

This flat terrain characteristic is shown in the topographic maps in **Figure 2.1-5** (Tagoloan-Villanueva area) and in the topographic survey map within the site in **Figure 2.1-**6. This is likewise reflected in the site photographs in **Plates 2.1-1** to **2.1-3**.

There are no planned changes in surface landform and topography. Furthermore, it will not cause alterations to the hydrologic conditions of affected slope. Similarly, there will be no impact to the physical configuration of the nearby creek.

Figure 2.1-5 Topographic Map of Tagoloan-Villanueva Area

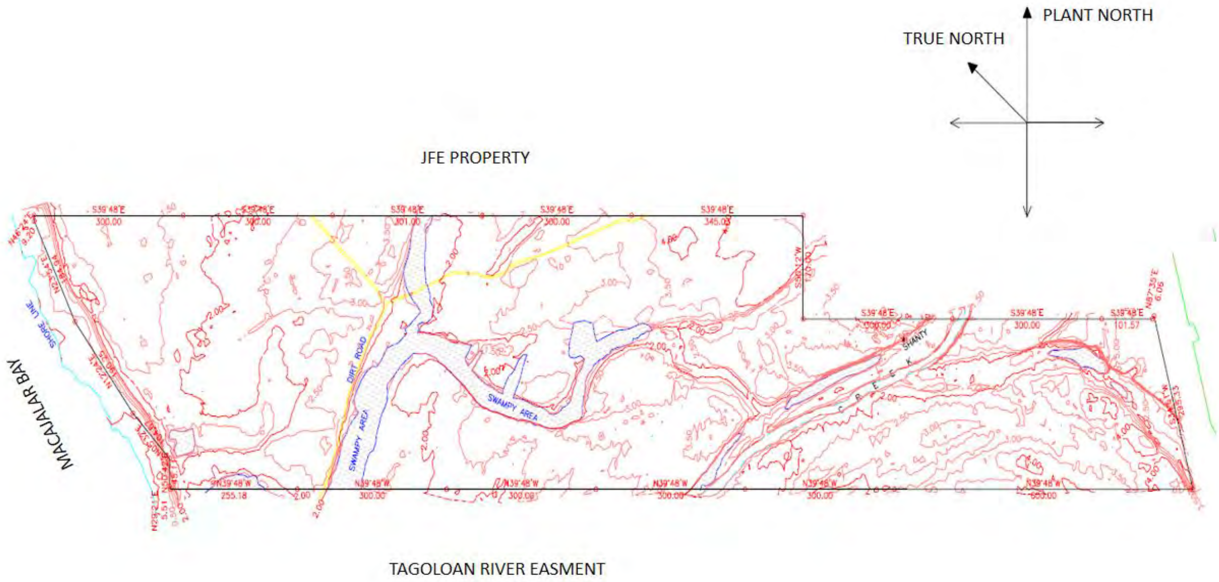


Figure 2.1-6 Topographic Map of Site

On the development of new access road; identification of the impacts that would arise from the activity, referring to **Figure 2.1-7:**

The white line is the main road; the blue line is the alternative road leading to the ash yard and the light blue line is the access bridge.

These access ways are in already developed areas which may be seen in the photograph below of portion of the access road.

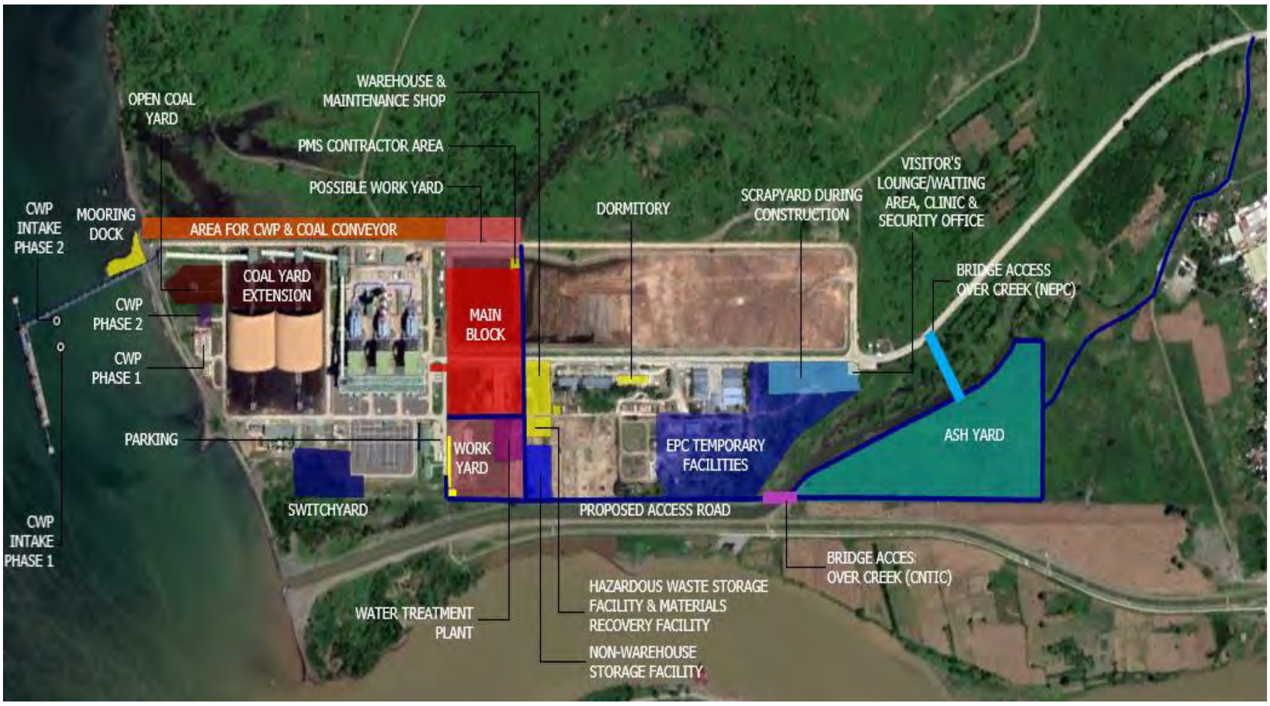


Figure 2.1-7. Map Showing the Access Waypoints to the Project Site

Plates 2.1-5. Photograph of the access road.

*Further it is also evident from the above photographs of the land areas for the access roads that **"changes in surface landform"** are deemed insignificant because of the flat terrain and that there are no forest cover or trees that will be disturbed.*

2.1.2.2 Change in Subsurface Geology/Underground Conditions

There are no significant changes in subsurface geology nor underground conditions with respect to the existing EIS relative to the proposed project's EPRMP, except for minor excavations and consequent backfilling for foundations of structures, as well as underground piping and electrical works and culvert/drainage system to be built. Under current planning, the excavated materials will be used as backfill materials.

The proposed modification of the project will only entail minimal land clearing (area is flat, open grassland) and expansion of the current project footprint.

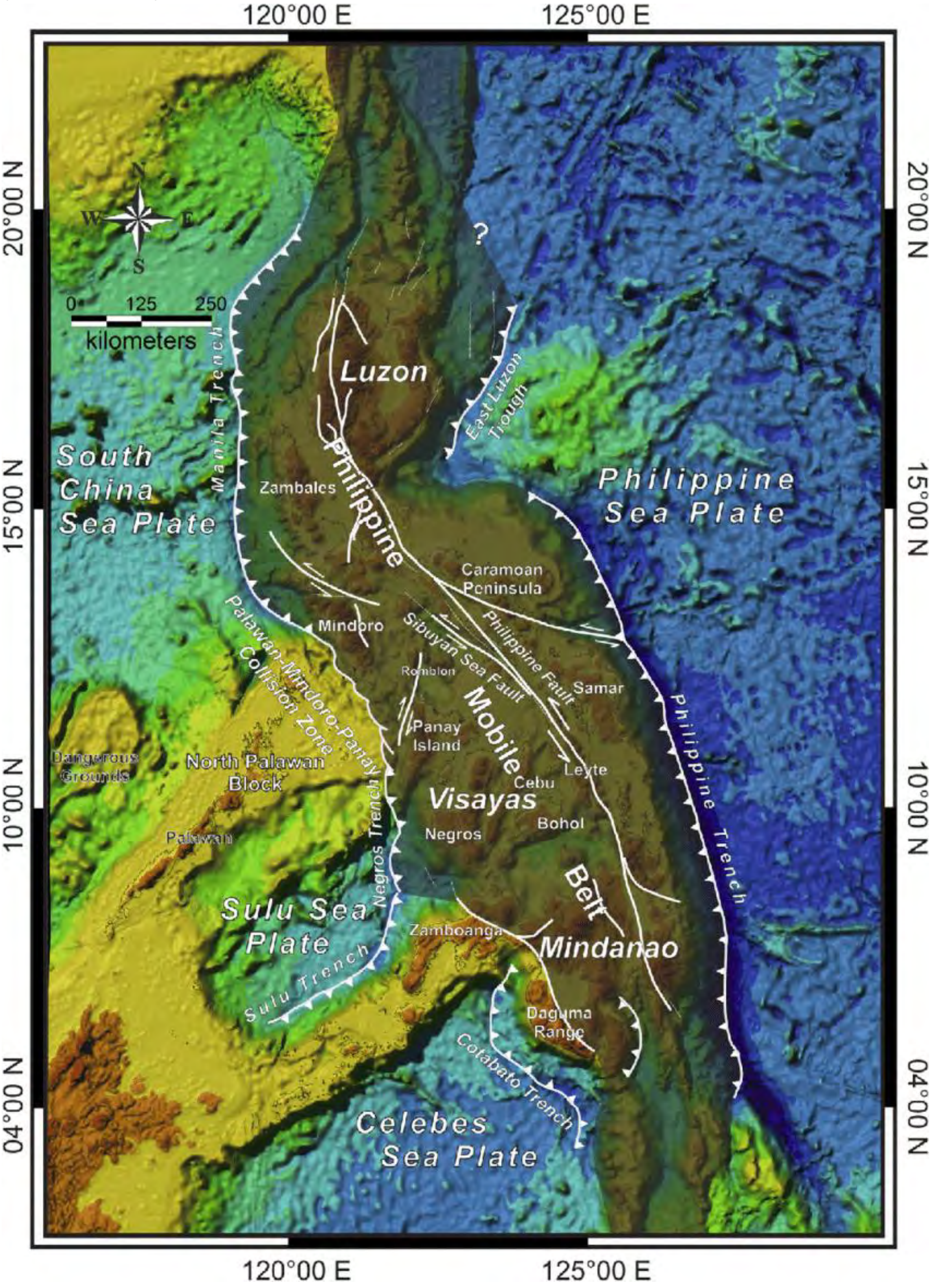
However, the disturbance of original soil and rock materials during construction works and land development exposes these materials to the surface where subsurface processes like oxidation, solar radiation, hydrolysis could affect their original characteristics. Progressive and systematic excavation and filling would minimize exposure of the soil or rock to the elements.

In the construction of the additional plant facilities, buried materials different from the original substrate will be introduced to the ground. To minimize risk of contamination or chemical alteration of the soil or rock, appropriate materials will be used for these components. These materials will be carefully selected to make sure that these are able to withstand stress conditions on the ground so incidences like seepage of contaminants will be prevented.

2.1.2.2.1 Regional Tectonic Setting Condition

The Philippine Archipelago is bounded by two major subduction zones with opposing polarity (**Figure 2.1-8**). The west-dipping East Luzon Trough-Philippine Trench lies to the east while the east-dipping Manila-Negros-Cotabato Trench lies to the west.

The Celebes Sea Basin is currently subducting at the Cotabato Trench located southwest of Mindanao Island. This has resulted to the formation of the Cotabato Island Arc or West Mindanao Arc which is made up of Miocene volcanics and plutons. The Central Mindanao Volcanic Arc is believed to have been formed by a detached lithosphere that is currently underneath the Central Mindanao Volcanic Arc (Cardwell, 1980).



Source: MGB, 2010

Figure 2.1-8. Major subduction systems bounding the Philippine Archipelago

2.1.2.2.2 Regional Stratigraphy

The province of Misamis Oriental is part of the Central Mindanao Stratigraphic Group (MGB, 2010). This is composed of an ancient volcanic arc encompassing the areas of Misamis Oriental, Bukidnon, Lanao del Norte, and the Mindanao Central Cordillera with a superimposed Quaternary volcanic complex defined by a NNW belt from Camiguin Is. In the north to Mt. Parker in the south.

Figure 2.1-9 shows the stratigraphic column of the Misamis Oriental-Bukidnon-Lanao (subdivided from the Central Mindanao Stratigraphic Group), representing volcanic deposits from eruptions of Quaternary volcanic centers.

Figure 2.1-10 is the geologic map of parts of Villanueva and Tagoloan generated by the Bureau of Mines & Geosciences-X (BMG) in 1984.

The stratigraphic column indicates that the Early Cretaceous Tago Schist constitutes the basement unit in the area, composed of garnitiferous quartz- sericite-epidote-amphibolite, greenschists, phyllite and slate. This is in fault contact with younger serpentinized peridotites of the Late Cretaceous Awang Ultramafic Complex (AUC). The AUC made up largely of serpentinites, underthrusts Eocene interbeds of graywackes, metaconglomerate and metavolcanics of the Himalyan Formation. This consists of graywacke, metaconglomerate, mylonite, metavolcanics and metadiabase. Unconformably overlying these older rock units are the Late Oligocene to Early Miocene Balongkot Limestone and Tuod Formation, which consist of carbonaceous limestone, and a sedimentary sequence intercalated with volcanic flows and volcanic breccias, respectively. These formations were subsequently intruded by the varying types of the diorites of the Middle Miocene Maniki Quartz Diorite. Associated with the quartz diorite are diorite, graonodiorite and andesite.

The carbonate sequence (conglomerate, pebbly sandstone, pyroclastic breccia tuffaceous sandstone and tuff) of the Late Miocene Opol Formation, Pliocene limestone and calcareous sediments of the Indahag Limestone and Iponan Formation, and Pleistocene agglomerate, sandstone and conglomerate of the Bukidnon Formation subsequently overlie the older rocks units. Capping the stratigraphy are slightly consolidated gravels of the Pleistocene to Holocene Cagayan Gravel.

The Miocene deposits of the Opol Formation, Pliocene Indahag Limestone, Pleistocene Bukidnon Fm Cagayan Gravel, and Quaternary Alluvium underlie the Tagoloan River floodplain and vicinities.

The Opol Fm was previously named Opol Sandstone by Capistrano (1946) for the rocks exposed at Opol, southwestern Misamis Oriental. Pacis (1966) used the term Opol Formation to include the conglomerate, pebbly sandstone, pyroclastic breccia tuffaceous sandstone and tuff in the area. It rests unconformably over the Himalyan Formation, but is conformable over the Tuod Formation. The formation is widespread on the western half of Misamis Oriental; and on the northern skirts of Mopoto mountain range facing Mindanao Sea. Exposures were also observed east of Tagaloan town.

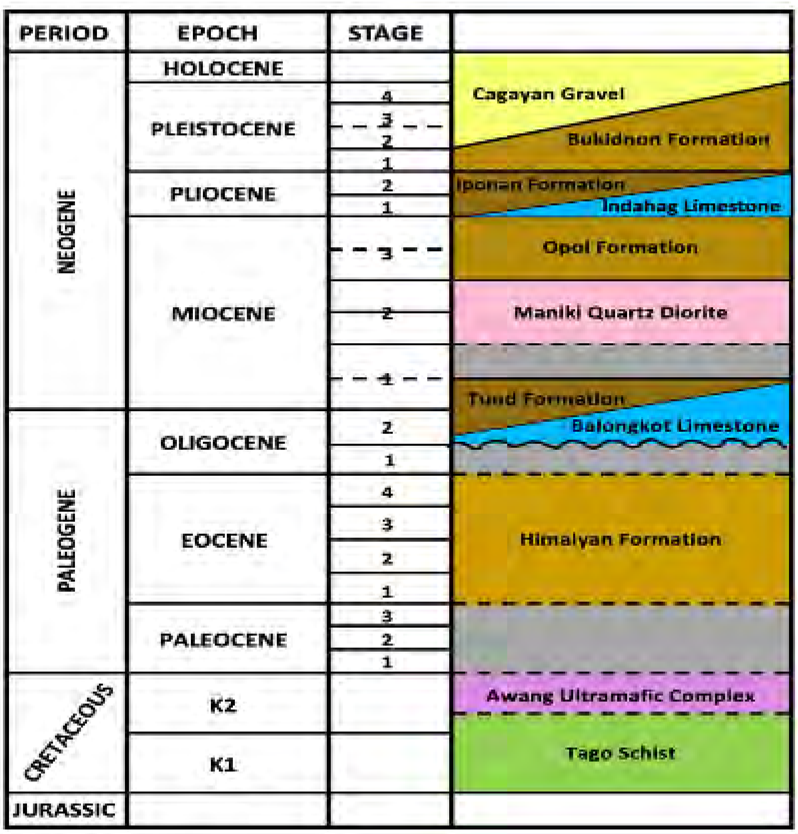
The pebbly sandstone, which occurs as thin layers, is fine- to medium-grained, poorly sorted and poorly cemented. The tuffaceous rocks are dark to light brown. The layers of conglomerate interbedded with these rocks are well cemented, poorly sorted with pebbles, cobbles and even boulders of basalt, chert, diorite and metamorphic rocks set in a sandy clay and tuffaceous matrix. The unit is assigned a Late Miocene age. Its thickness ranges from 100 to 150 meters.

The Indahag Limestone is composed of varying limestone deposits ranging from massive to well-bedded, and coralline with minor interbeds of clastic rocks of conglomerate, tuffaceous sandstone, and shale (MGB, 2010). Three distinct horizons have been observed in this formation and these are a lower section of coralline limestone, with interbeds of calcirudites, calcarenites, and calcisiltites, a middle section of limestone rubble and coral fingers, and an upper section of coralline limestone, calcarenite and limy tuff interbeds (Pacis, 1966 and MGB, 2010).

The Bukidnon Formation was named by Pacis (1966) for the exposures of agglomerate, tuffaceous sandstone, pebbly sandstone and conglomerate that cover the area east of Cagayan River. The conglomerate consists predominantly of angular to subangular pebble to boulder- sized clasts of volcanic rocks, schists and serpentinite. The Kapatagan Group of Tupas (1952) is probably correlative to the Bukidnon Formation. A Pleistocene age was assigned to the formation. The thickness of the Bukidnon is approximately 800 meters.

The Cagayan Gravel was previously called the Cagayan Terrace Gravel. The term Cagayan Terrace Gravel was designated by Pacis (1966) for the extensive exposures of gravel along the road from Cagayan de Oro City to the Lumbia Airport. Outcrops are found along the National Road in Cagayan de Oro City to Indahag road; from Bugo to Alae; and on the west bank of Cagayan River just before the airport.

The formation consists of intercalated gravel, sand, shale and tuffaceous sandstone. The slightly consolidated and poorly sorted gravel is composed of rounded to subrounded pebble- to boulder-sized igneous and metamorphic rocks. The shales and tuffaceous sandstones are slightly compacted. Molluscan shells were noted in the tuffaceous sandstone. A Pleistocene to Holocene age was assigned to the unit. Its estimated thickness is 100 meters. Deposition of the Cagayan Terrace Gravel probably took place in a deltaic environment. It may be correlated with the Cabanglasan Gravel.



Adapted from: Pe a, R. 2008. Lexicon of Philippine Stratigraphy

Figure 2.1-9. Stratigraphic Column of Misamis Oriental-Bukidnon-Lanao Stratigraphic Group

2.1.2.2.3 Regional Structural Geology

The nearest active fault to the study area based on the available data of PHIVOLCS is the Tagoloan River, which is about 4.2 km to the northeast (**Figure 2.1-10**).

2.1.2.2.4 Local Geologic Setting

The FDCMPC property is wholly underlain by Quaternary Alluvium. This is composed of unconsolidated silt, sand, and gravel on a generally flat to very gently sloping area.

Based on the geotechnical drilling/investigation conducted in the plant site in 2014, the Quaternary Alluvium is further subdivided for more detailed presentation as follows: Quaternary artificial accumulation layer (Q^{s}), Quaternary Holocene alluvial and diluvial layer (Q_4^{al+pl}), and Quaternary marine-continental deposit (Q_4^{mc}). Wherein, the Quaternary marine-continental deposit (sandy soil and clayey soil), which comprises the main stratum for the proposed power plant area, is distributed across the plant area. Quaternary Holocene alluvial and diluvial layer (Q_4^{al+pl}) is distributed nearby Tagoloan River in the southwest of proposed plant area, fresh water source area, valley among hills, and surface layer of plant area.

Quaternary artificial accumulation layer (Q^{s})

Layer ① filling soil: It belongs to recent deposit, which is mainly formed during the construction of houses by local villagers, construction of roads and backfilling of marshes, thus resulting in multiple colors and components. It mainly comprises of soft to firm clayey soil and loose-slightly dense sandy soil, pebbles, coral debris, and large amount of tree roots and humus in some parts. Before land acquisition, houses of local villagers are distributed in some sections. The foundation and floor houses contain 20-30cm thick concrete block, stone, pebble, and other construction wastes. 30-50cm thick loose boulders are found in some parts.

Quaternary Holocene alluvial and diluvial layer (Q_4^{al+pl})

Layer ② silt: Yellowish brown, light brown, light yellow; contains great amount of clayey soil; thick silty sand is intercalated in some parts; small amount of pebbles; cultivated soil in surface layer; contain great amount of plant roots; slightly wet; mainly soft; firm in some parts.

Layer ③ silty clay: Yellowish brown, light brown, light gray; contain great amount of silt; thin silty sand is intercalated in some parts; few pebbles can be seen in some parts; cultivated soil in the surface layer of some parts; contain great amount of plant roots; slightly wet; according to the status, it can be categorized into $^{3-1}$ soft layer and $^{3-2}$ firm layer.

Layer ⑤ silty fine sand: Gray, deep gray, greenish gray; contain great amount of silty soil and white mica; little gravel sand and coarse sand in some parts; little clayey soil and white shells in some parts; wet to saturated; Mainly loose; slightly dense in some parts.

Layer ⑥ moderate coarse sand with gravel: Gray, deep brown, grayish yellow; gravels mainly comprise of 20～30% weathered andesite and volcanic breccias; grain size exposed in the investigation borehole mainly reaches 1to7cm, and reaches the maximum of 15cm; Little clayey soil and silty sand is mixed in some parts; 30-50cm boulder and coral reefs can be seen in some parts; saturated; mainly slightly dense, some loose in some parts.

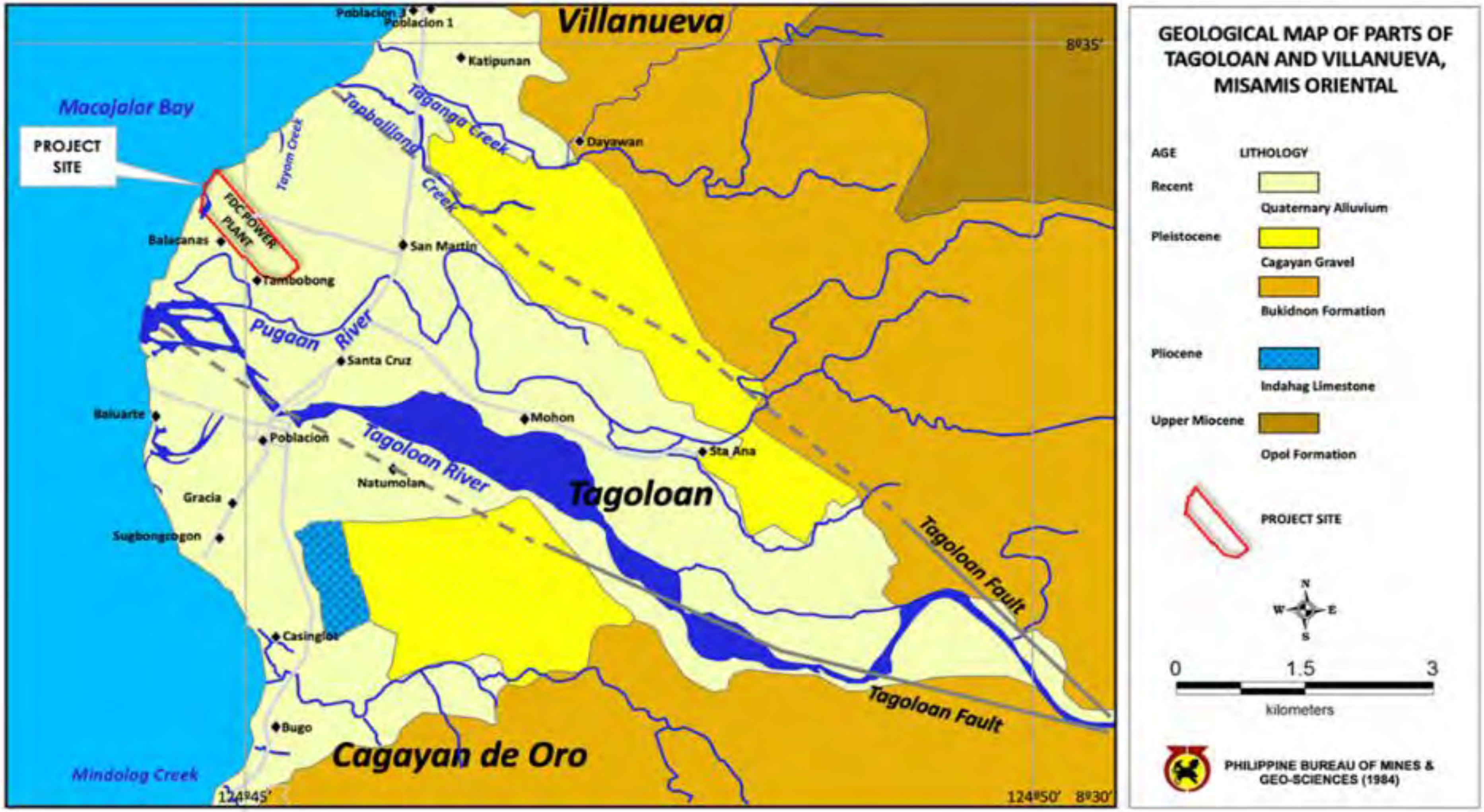
Quaternary marine-continental deposit (Q_4^{mc})

Layer ⑦ silty fine sand with silt interbed: Greenish gray, deep gray, deep brown; contain a great amount of silt and white mica, few thin clayey soil and micro-bedding development; few pebbles, gravels, and medium coarse and in some parts; white shell and coral debris can be seen in some parts; saturated; according to the compaction degree, it can be categorized into slightly dense $^{7\text{-}1}$ layer; $^{7\text{-}2}$ has medium density; $^{7\text{-}3}$ layer is dense.

Layer ⑧ silt: Deep brown, grayish brown, greenish gray; contain great amount of silty sand and white mica; thick clayey soil and thin rotten wood are intercalated in some parts; little moderate coarse sand and white shell can be seen in some parts; saturated; according to the compaction degree and its consistence, it can be categorized into $^{8\text{-}1}$ layer is stiff and hard; and $^{8\text{-}2}$ layer is very stiff.

Layer ⑨ moderate coarse sand with gravel: Gray, deep brown; gravels are mainly comprised of 10～20% weathered andesite and volcanic breccias; grain size mainly reaches 1to3cm, and reaches the maximum of 7cm; pebbles and gravels are concreted well in the shape of short and solid column; saturated; mainly medium dense; dense in some parts.

Layer ⑩ silty clay: Grayish brown, grayish green, deep gray; thin silt is intercalated; contain little amount of white shells; rotten wood can be seen in some parts; wet; mainly distributed in silt and silty sand layers in the shape of lenticle; according to its consistence, it can be categorized into stiff $^{10\text{-}1}$ layer and very stiff $^{10\text{-}2}$ layer.



Source BMG-X, 1084

Figure 2.1-10. Geologic Map of parts of Tagoloan and Villanueva, Misamis Oriental and vicinities

2.1.2.3 Inducement of Subsidence, Liquefaction, Landslides, Mud/ Debris Flow, etc.

A quick overview of the potential geohazards in the proposed project site was obtained from *HazardHunterPH***.** It is a tool that can be used to generate indicative hazard assessment reports on the user's specified location. All information used for the calculation of hazard assessment results are based on the most recent updates provided by PHIVOLCS for seismic and volcanic hazards, and PAGASA and MGB for hydro-meteorological/climatological hazards through the GeoRiskPH Integrated System.

The seismic hazard assessment shows that the nearest active fault is the Tagoloan River Fault located approximately 4.2km to the northeast, and hence, safe from ground rupture hazard. However, it is generally susceptible to liquefaction.

With regards to volcanic hazards, the nearest active volcano is Mt. Hibok-Hibok located 72.4 km to the north. There is no volcanic hazard threat.

For flood hazard, the area has very high susceptibility, with more than 2m flood height and/or more than 3 days flooding.

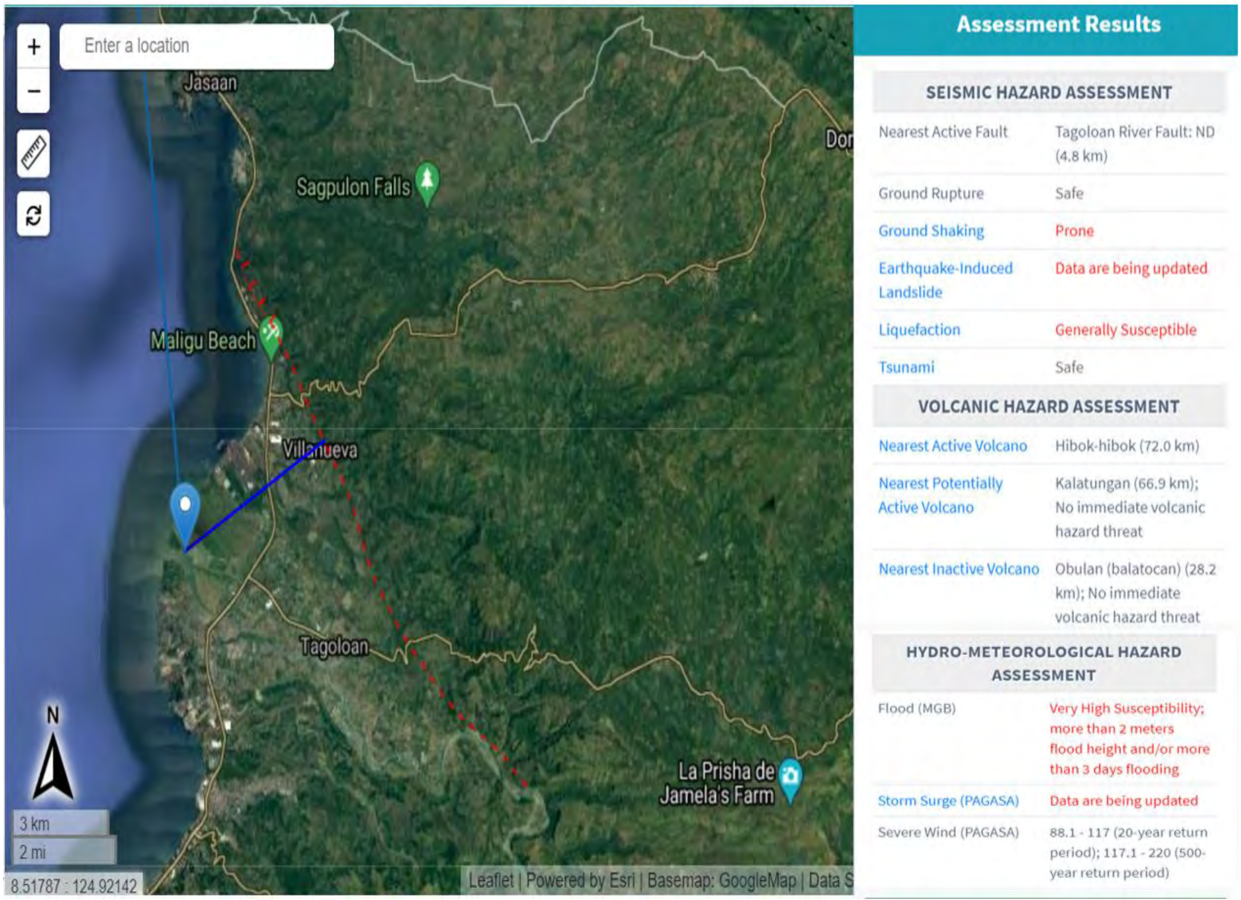


Figure 2.1-11. Hazard Assessment Map of Project Site

2.1.2.3.1 Seismic Hazards

Seismic hazard is the perceptible trembling to violent shaking of ground caused by either tectonic movements or volcanic activity. Areas that are more susceptible to this hazard are those underlain by unconsolidated soils and sediments deposited on the low-lying areas.

Although Mindanao has been the most seismically active among the 3 major island groups in the past decades (Mangao et al., 1994), most of the earthquakes occurred in the eastern portion of the island, where the southern extension of the Philippine Fault Zone (PFZ) and the Philippine Trench pass through, and in the southwestern region in the vicinity of Cotabato Trench. In general, the Municipality of Villanueva, which is located far from the three aforementioned earthquake generators, is not subject to excessive seismic activities. Tagoloan Fault, which is located approximately 4.2km from the plant, is considered as Type C fault, considered as capable of low to moderate magnitude earthquakes (M < 6.5). **Figure 2.1-11** shows the distribution of active faults and trenches in the Philippines. **Figure 2.1-12** is the seismicity map from 1608-2016 while **Table 2.1-1** lists the earthquakes that were experienced in the region from 1907-2016.

Plate 2.1-6. PHIVOLCS Certification

Republic of the Philippines
DEPARTMENT OF SCIENCE AND TECHNOLOGY
PHILIPPINE INSTITUTE OF VOLCANOLOGY AND SEISMOLOGY

Management System ISO 9001:2015

HASS-EQ-04

HAS-Mar-20-451

DATE: 04 June 2020
FOR: **TECHNOTRIX INTEGRATED SERVICES CORP.**
REPRESENTED BY: **EDGARDO G. ALABASTRO**
PURPOSE: Verify earthquake hazards

EARTHQUAKE HAZARD ASSESSMENT

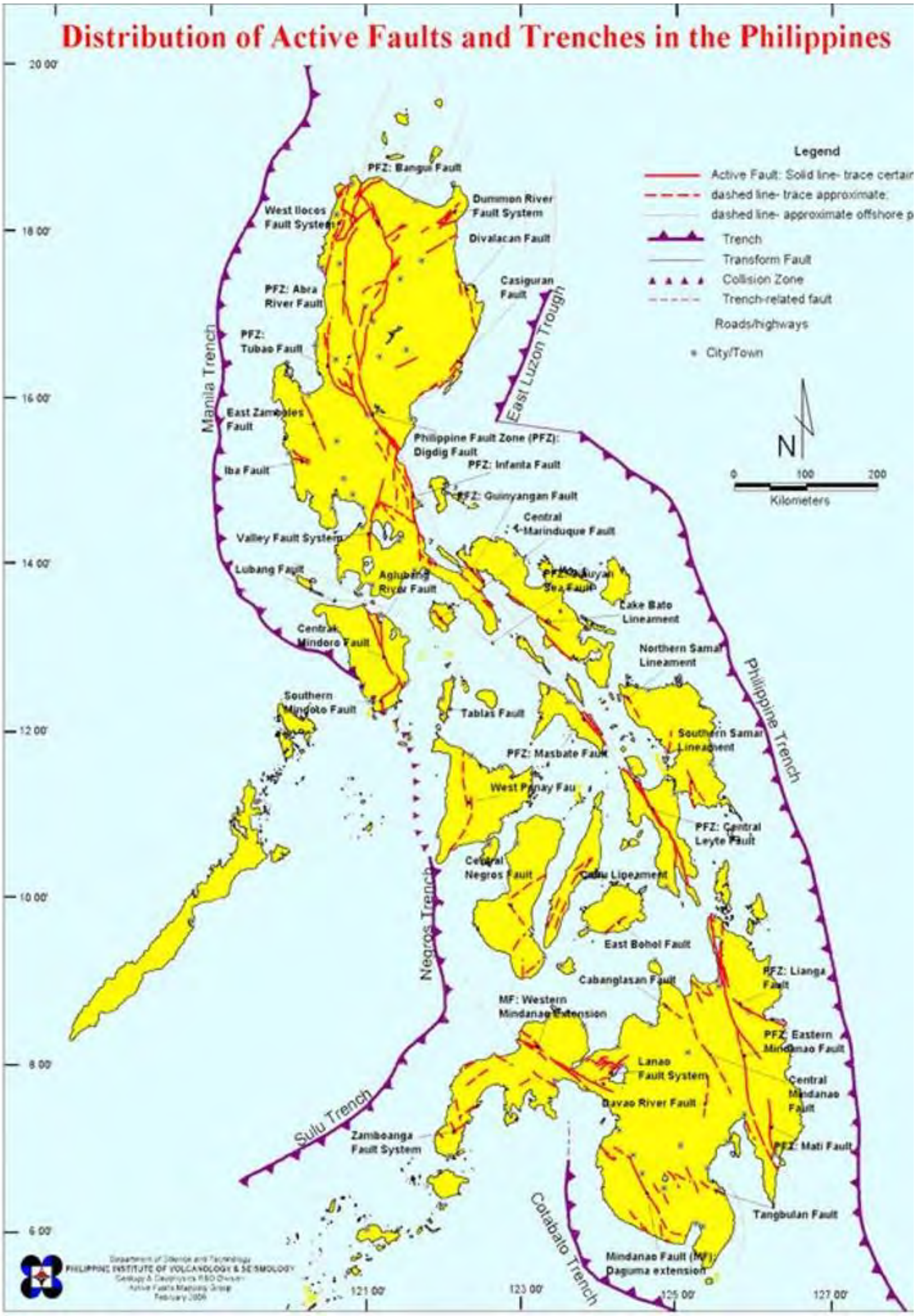
PROJECT NAME, LOCATION	GROUND RUPTURE	LIQUEFACTION	EARTHQUAKE-INDUCED LANDSLIDE	TSUNAMI
Proposed 3 x 135 MW Circulating Fluidized Bed Coal-Fired Power Plant Expansion Project of FDC Misamis Power Corporation; Brgys. Bacalanas and Tambobong, Villanueva, Misamis Oriental	**Approximately 3.9 kilometers west of Tagoloan River Fault**	**Susceptible**	**Safe**	**Susceptible**

EXPLANATION AND RECOMMENDATION

- ✓ All hazard assessments are based on the latest available hazard maps and on the location indicated in the vicinity map provided.
- ✓ Ground rupture hazard assessment is the distance to the nearest known active fault. The recommended buffer zone, or Zone of Avoidance, against ground rupture hazard is at least 5 meters on both sides of the active fault or from its zone of deformation.
- ✓ All sites may be affected by strong ground shaking.
- ✓ Ground shaking and liquefaction hazards can be mitigated by following the provisions of the National Building Code and the Structural Code of the Philippines.
- ✓ Tsunami threat to people's lives can be addressed by community preparedness and tsunami evacuation plan. Advice for tsunami evacuation comes from public agencies and local governments. But more importantly, coastal communities must learn to evacuate themselves when they recognize the three natural signs of tsunami, namely 1) strong ground shaking, 2) unusual rise or fall of sea level, and 3) strong or unusual sound coming from the sea.
- ✓ This hazard assessment supersedes previous assessment made by this office regarding the site.

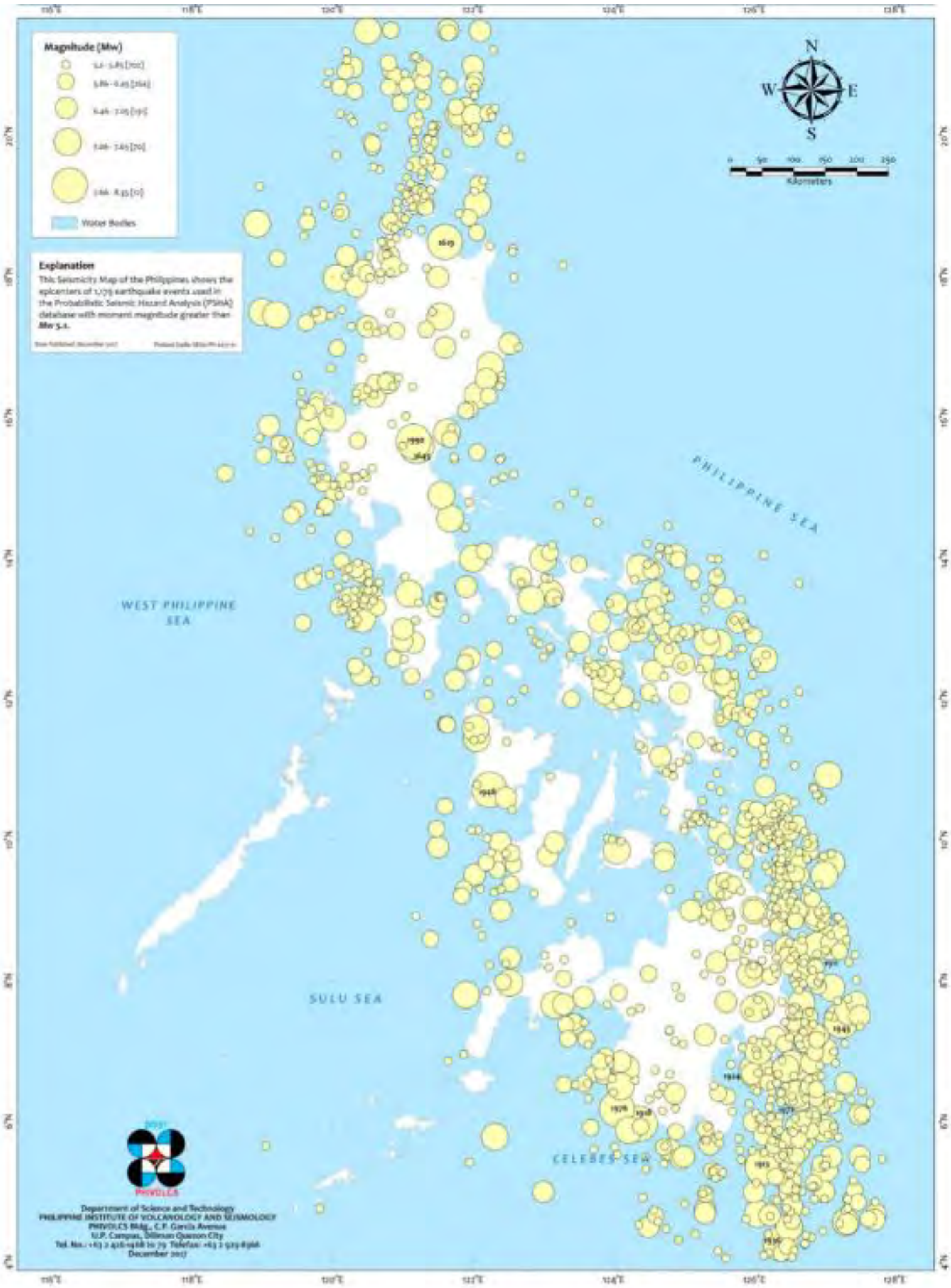
Assessed by: Jayvie Nadua-Balboa — Officer-of-the-Day
Verified by: Abigail C. Pidlaoan — Science Research Specialist II

Approved by: **ATURO S. DAAG** — **Division Chief**
V2-2017-05-19



Source: PHIVOLCS 2015

Figure 2.1-12. Distribution of Active Faults and Trenches in the Philippines



Source: PHIVOLCS, Dec 2017

Figure 2.1-13. Seismicity Map of the Philippines, with Moment Magnitude >5.1 (1608-2016)

Table 2.1-1. Earthquake Events in Mindanao with Magnitude of 5 and above (1907-2016)

Date	North Latitude	East Longitude	Depth (km)	Ml	Mb	Ms	Intensity Reports Near Villanueva
20-Jul-07	07.100	125.600	1			6.8	
02-Mar-23	06.500	124.100	33			7.2	
05-May-25	09.500	123.100	33			6.8	
30-Oct-26	09.500	124.500	520			6.3	
19-Dec-28	06.100	124.500	33			7.3	
28-Dec-28	07.500	123.100	33			6.9	
08-Apr-29	07.800	124.600	610			6.7	
04-Jun-29	06.500	124.500	300			7.0	
16-Jan-34	06.100	124.700	33			6.3	
04-Oct-35	06.000	125.000	400			6.5	
05-Oct-36	09.100	122.700	33			5.7	
22-Sep-40	07.500	123.500	33			6.8	
20-Oct-42	07.900	122.400	33			7.3	
30-Apr-49	06.500	125.100	130			7.4	
02-Jul-51	06.100	124.500	100			6.1	
06-Mar-55	09.500	122.500	33			6.1	
06-Mar-55	09.500	122.500	33			6.3	
31-Mar-55	08.000	124.100	96			7.3	
31-Mar-55	08.100	124.500	96			6.5	
10-Apr-55	08.000	125.000	33			6.5	
15-Nov-57	08.100	124.500	100			6.3	
23-Dec-60	08.300	125.700	67		5.0		
30-Apr-62	06.460	124.140	117		5.3		
13-Jul-62	09.870	122.560	79		6.0		
16-Feb-63	09.000	123.000	33		5.0		
02-Aug-63	06.100	124.900	105		5.0		
29-Sep-63	06.060	125.430	103		5.3		
17-Nov-63	07.000	125.000	33		5.6		
01-Mar-64	08.400	122.600	73		5.2		
26-Mar-64	08.200	122.200	59		5.3		

Date	North Latitude	East Longitude	Depth (km)	Ml	Mb	Ms	Intensity Reports Near Villanueva
04-Nov-64	06.900	125.700	62		5.5		
23-Jan-65	07.430	123.860	628		5.2		
21-Mar-65	06.350	124.060	61		5.1		
06-Apr-65	09.600	124.100	550		4.9		
22-Jun-65	07.210	123.530	58		5.8		
15-Jul-65	07.640	123.760	605		5.7		
22-Dec-65	06.670	124.110	552		5.2		
18-Feb-66	06.730	124.820	58		5.3		
16-Mar-66	09.480	122.180	38		5.2		
07-Oct-66	08.900	125.600	85		5.1		
07-Nov-66	07.260	125.530	84		5.0		
08-Jun-67	06.160	125.830	161		5.1		
03-Nov-67	06.190	125.780	87		5.0		
15-Nov-67	06.200	123.700	579		5.1		
06-Apr-68	07.470	124.140	41		5.2		
12-Nov-68	06.000	125.300	138		5.0		
12-Dec-68	09.690	125.780	122		5.6		
20-Dec-68	09.230	125.490	74		5.0		
17-Jan-69	08.390	124.310	45		5.1		
08-Aug-69	07.190	125.490	56		5.1		
14-Sep-69	06.270	125.560	54		5.1		
19-Sep-69	06.060	125.320	105		5.5		
05-Oct-69	07.300	123.700	51		5.4		
06-Oct-69	07.170	123.780	68		5.3		
07-Nov-69	06.950	124.620	412		4.9		
17-Nov-69	09.900	125.900	80		5.1		
07-Dec-69	09.670	125.630	35		5.2		
11-Jan-70	09.000	125.600	61		5.1		
17-Feb-70	09.800	125.900	83		5.8		
29-Apr-70	07.580	123.690	660		4.9		

Date	North Latitude	East Longitude	Depth (km)	Ml	Mb	Ms	Intensity Reports Near Villanueva
19-Aug-70	09.460	122.450	51		5.0		
09-Oct-70	06.460	124.150	570		4.9		
14-Oct-70	06.950	123.770	50		5.3		
04-Nov-70	06.600	124.750	381		5.0		
28-Feb-71	09.620	125.890	90		5.1		
24-Mar-71	08.930	125.700	59		5.5		
31-Mar-71	09.010	125.710	49		5.1		
31-Mar-71	08.950	125.680	33		5.4		
02-Apr-71	08.940	125.680	31		5.0		
15-Apr-71	09.050	125.760	35		4.9		
03-May-71	08.840	124.140	68		5.6		
24-May-71	09.370	124.450	540		5.0		
06-Jun-71	07.480	124.430	54		5.1		
22-Jul-71	07.800	122.900	33		5.0		
31-Dec-71	06.900	123.260	6		5.5		
24-Mar-72	07.150	123.750	33		5.5		
24-Mar-72	07.130	123.770	33		5.5		
04-Jul-72	09.410	122.520	58		5.5		
27-Aug-72	06.410	125.910	145		4.9		
01-Oct-72	07.470	123.750	613		6.0		
13-Dec-72	09.660	122.540	143		5.2		
21-Dec-72	09.200	123.950	565		5.2		
14-Apr-73	06.640	124.090	23		5.4		
14-Apr-73	06.640	124.030	57		5.4		
22-Jul-73	06.320	124.020	33		5.1		
02-Sep-73	07.410	123.740	6		5.3		
20-Sep-73	09.050	123.790	560		6.0		
22-Sep-73	06.320	124.600	528		5.1		
01-Oct-73	06.380	123.990	67		4.9		
06-Oct-73	09.730	125.620	82		5.5		CAGAYAN DE ORO RF3

Date	North Latitude	East Longitude	Depth (km)	Ml	Mb	Ms	Intensity Reports Near Villanueva
28-Oct-73	09.120	123.930	554		5.1		
12-Nov-73	06.340	123.350	141		4.9		
18-Jan-74	08.200	122.200	33		5.4		
18-Jan-74	08.200	122.300	54		5.1		
04-Feb-74	06.200	125.100	25		5.1		
12-Mar-74	09.400	125.600	48		4.9		
14-Mar-74	09.290	125.850	76		4.9		
21-May-74	08.160	122.980	77		5.0		
27-May-74	08.530	123.160	35		5.2		
26-Aug-74	09.330	125.910	88		4.9		
23-Feb-75	08.000	124.000	623	5.6			
14-Apr-75	09.800	125.300	38	5.0			
14-Apr-75	09.800	125.500	44	5.0			
02-May-75	09.200	125.400	33	5.0			
31-May-75	08.200	123.000	33	5.5			
22-Nov-75	08.130	125.810	69	5.5			
09-Dec-75	06.100	123.600	600	6.2			
16-Aug-76	06.080	123.920	33	6.3		7.9	
16-Aug-76	06.740	123.020	33	5.0			
23-Aug-76	06.500	124.100	50	5.0			CAGAYAN DE ORO RF4
14-Jun-78	08.270	122.140	33	5.5			
12-Dec-78	07.430	123.330	96	5.7			INT III - CAGAYAN DE ORO
11-Sep-79	08.090	125.290	33	5.4			
08-Jul-80	06.610	125.910	241	5.6			
08-Sep-80	09.280	125.810	49	5.6			
04-Jul-81	06.140	125.690	76	5.0			
19-Feb-83	08.720	124.010	630	5.9			
15-Jun-83	08.940	123.390	543	5.0			
22-Jun-84	08.750	123.920	633	5.7			

Date	North Latitude	East Longitude	Depth (km)	MI	Mb	Ms	Intensity Reports Near Villanueva
06-Aug-84	07.500	123.760	240	5.0			
18-Aug-84	06.300	125.920	33	5.0			
14-Dec-85	09.900	125.100	33	5.0			
17-Nov-86	06.000	123.500	33	5.0			
18-May-87	08.300	125.360	16	4.3	5.5	5.9	RF3 - CAGAYAN DE ORO; ONE PERSON KILLED IN BUKIDNON
26-Aug-87	09.290	122.270	58	5.0			
05-Jul-88	06.540	125.080	178	5.0			
07-Feb-90	09.800	124.710	64			5.0	
08-Feb-90	09.690	124.710	31		6.2	6.6	Int VI - CAMIGUIN; Int V - CAGAYAN DE ORO
08-Feb-90	09.660	124.540	33			5.1	
08-Feb-90	09.660	124.840	33			5.3	
08-Feb-90	09.730	124.640	34		6.0	6.5	
08-Feb-90	09.690	124.430	55			5.3	
10-Feb-90	09.530	124.880	33			5.2	
12-Feb-90	09.780	124.480	33			5.0	
03-Mar-90	09.300	124.800	97			5.5	
18-Mar-90	06.200	125.490	33			5.0	
26-Mar-90	09.250	125.610	39		5.6	5.5	INT IV - CAMIGUIN ISLAND
17-Apr-90	08.570	124.200	30			5.0	
16-Jul-90	09.220	125.520	33			5.3	
13-Oct-90	08.810	122.060	14			5.8	
24-Feb-91	09.210	125.210	58			5.2	
24-Apr-91	08.930	124.130	15			5.2	
05-May-91	09.000	125.780	67			5.0	
12-Jun-91	08.850	125.800	7			5.0	
19-Jun-91	06.520	123.290	55			6.1	
10-Jul-91	09.070	124.110	511			5.1	
19-Oct-91	08.170	122.390	14			5.4	
23-Oct-91	09.890	125.880	26			5.0	
02-Nov-91	08.830	123.390	56			5.1	

Date	North Latitude	East Longitude	Depth (km)	Ml	Mb	Ms	Intensity Reports Near Villanueva
18-Nov-91	08.380	125.180	6			5.3	
21-Nov-91	07.050	125.720	12			6.2	
18-Dec-91	09.240	122.870	15			5.4	
06-Feb-92	07.100	124.990	14			5.3	
07-Feb-92	08.900	123.960	1			5.1	
17-Mar-92	08.520	124.280	27			5.0	
24-Mar-92	07.130	124.920	18			5.0	
01-Apr-92	08.860	125.270	3			5.1	
07-May-92	06.730	124.590	10			5.1	INTENSITY I - CAGAYAN DE ORO
08-May-92	07.760	124.950	33			5.6	INTENSITY II - CAGAYAN DE ORO
09-May-92	07.810	125.060	17			5.0	INTENSITY III - CAGAYAN DE ORO
29-Oct-92	06.990	123.670	23			5.1	
29-Oct-92	06.990	123.670	23			5.1	
14-May-93	07.140	124.870	29			5.2	
16-Oct-93	07.530	123.400	33			5.6	
27-Oct-93	06.810	125.670	23			5.1	
23-Nov-93	06.380	125.720	14			5.1	
17-Feb-94	09.770	125.640	9			5.6	
13-May-94	07.880	123.300	5			5.7	
22-May-94	06.520	123.460	20			5.5	
06-Jul-94	06.500	125.900	110			5.6	
06-Nov-94	07.550	125.930	23			5.7	
20-Apr-95	06.290	125.750	4			5.0	
23-Apr-95	06.200	123.740	556			5.2	
06-Jun-95	07.410	123.740	6			5.0	
04-Nov-95	06.960	125.400	16			5.0	
27-May-96	09.980	124.100	3			5.6	HIBOK-HIBOK RF1
04-Aug-96	06.150	124.700	3			5.1	
28-Sep-96	09.950	125.410	224			6.2	BUTUAN CITY RF5; SURIGAO CITY RF3
17-Oct-96	06.400	125.490	7			5.6	

Date	North Latitude	East Longitude	Depth (km)	Ml	Mb	Ms	Intensity Reports Near Villanueva
03-Dec-96	09.710	125.550	7			5.1	
11-Jun-97	09.840	125.410	15			5.5	
05-Oct-97	06.180	125.460	190			5.3	
18-May-98	09.380	125.620	18			5.0	
23-May-98	08.370	124.000	623			6.2	
03-Sep-98	08.280	125.860	5			5.4	
23-Sep-98	09.710	125.500	15			5.4	
22-Dec-98	06.430	124.920	373			5.0	
05-Mar-99	06.330	122.150	25	5.5	6.0	5.5	
07-Jun-99	08.580	125.750	7			5.1	INT II - CAGAYAN DE ORO
09-Jun-99	08.600	125.650	14			5.0	
08-Jul-99	07.500	123.840	10	5.1	6.8	5.6	
16-Aug-00	06.186	124.880	24	4.7	5.7	5.1	
08-Oct-00	09.746	125.545	12	4.9	5.9	5.4	INT I- CAMIGUIN
01-Jan-02	06.102	125.847	126	5.1	6.0	5.6	INT I- CAGAYAN DE ORO; CAMIGUIN
14-Jun-02	07.661	123.909	3	5.0	5.9	5.4	INT III - CAGAYAN DE ORO; INT I - HIBOK-HIBOK
30-Dec-02	07.372	123.322	1	5.5	6.4	6.1	INT II- CAGAYAN DE ORO
26-May-03	06.805	123.646	562	5.9	6.8	6.8	
26-Feb-04	08.060	123.131	18	4.6	5.6	5.0	
26-Feb-04	08.177	123.294	20	4.6	5.6	5.0	
19-Dec-04	07.387	123.840	593	4.7	5.7	5.2	
19-May-05	06.278	125.771	124	4.8	5.7	5.2	
04-Oct-05	09.469	125.337	4	4.6	5.6	5.0	
19-Nov-05	06.252	125.926	71	5.0	5.9	5.4	
23-Jan-06	07.048	125.833	73	4.7	5.7	5.1	
16-Apr-06	05.994	125.060	213	5.0	5.9	5.5	
14-Nov-06	06.326	123.644	21	4.8	5.8	5.2	
15-Nov-06	06.540	123.631	5	4.9	5.9	5.5	
24-Nov-06	07.407	124.819	4	4.6	5.6	5.0	
06-Dec-06	09.640	122.185	25	4.6	5.6	5.0	

Date	North Latitude	East Longitude	Depth (km)	Ml	Mb	Ms	Intensity Reports Near Villanueva
12-Dec-06	06.584	125.927	56	4.8	5.7	5.2	
25-Apr-07	07.161	125.585	61	5.2	4.3	5.2	
09-May-07	06.633	124.013	584	4.8	5.7	5.2	
13-Jul-07	09.275	123.079	1	4.3	5.3	5.0	
21-Aug-07	07.084	123.546	24	4.6	5.6	5.0	
16-May-08	06.509	125.429	33	4.9	5.9	5.3	
17-May-08	06.010	125.142	111	4.8	5.8	5.2	
10-Jul-08	06.312	124.509	1	4.7	5.7	5.2	
21-Jul-09	06.012	125.926	89	4.6	5.5	5.0	
26-Aug-09	09.528	123.863	572	4.9	5.8	5.3	
18-Sep-09	06.496	124.700	74	5.1	6.1	5.7	
19-Sep-09	06.449	124.728	16	4.9	5.8	5.3	
04-Oct-09	06.793	123.658	627	5.9	6.8	6.6	
27-Oct-09	06.388	124.637	23			5.3	
11-Nov-09	09.367	125.584	16	5.2	6.1	5.8	INT III - CAGAYAN DE ORO; TAGOLOAN; INT II - CAMIGUIN ISLAND
13-Jan-10	06.584	124.307	7	4.7	5.7	5.1	
31-May-10	06.929	123.884	6	5.2	6.1	5.8	INT III - CAGAYAN DE ORO; INT II - VALENCIA BUKIDNON; ILIGAN
23-Jul-10	06.837	123.543	598	5.9	6.8	6.9	INT II - CAGAYAN DE ORO
23-Jul-10	06.749	123.597	595	4.9	5.9	5.5	
23-Jul-10	06.684	123.584	568			7.1	INT II- BUTUAN; SURIGAO CITY; CAGAYAN DE ORO
23-Jul-10	06.574	123.340	638			7.1	INT II - CAGAYAN DE ORO
24-Jul-10	06.214	123.672	563	5.2	6.1	6.0	
26-Jul-10	06.859	123.669	595	4.2	5.2	5.0	
26-Jul-10	06.696	123.137	648	4.6	5.6	5.4	
29-Jul-10	06.396	123.400	616			6.6	
29-Jul-10	06.584	123.379	601	3.9	4.9	5.5	
24-Aug-10	06.638	123.588	629	4.6	5.6	5.0	
05-Oct-10	06.757	123.762	602			5.0	
06-Oct-10	06.671	124.800	8	4.8	5.7	5.2	

Date	North Latitude	East Longitude	Depth (km)	Ml	Mb	Ms	Intensity Reports Near Villanueva
24-Jan-11	06.346	123.595	596	4.7	5.7	5.0	
03-Mar-11	09.510	125.900	3	5.1	6.0	5.7	INT I - CAGAYAN DE ORO
24-Jun-11	06.743	123.745	593	4.5	5.5	5.0	
07-Jul-11	06.228	124.245	576	4.8	5.8	5.2	
10-Jul-11	09.490	122.136	31	4.8	5.7	5.2	
11-Jul-11	09.506	122.023	4	5.5	6.4	6.2	INT II - CAGAYAN DE ORO
11-Jul-11	09.693	122.566	101	5.1	6.0	5.7	
01-Oct-11	07.446	123.926	621	4.8	5.8	5.2	
05-Nov-11	06.706	123.870	573	4.6	5.6	5.0	
07-Nov-11	07.993	125.013	1	4.7	5.7	5.2	INT III - QUEZON LIBONA MANOLO FORTICH, BUKIDNON; INT II -CAGAYAN DE ORO; INT I - HIBOK-HIBOK
12-Jan-12	08.394	125.867	1	4.6	5.6	5.0	
17-Jan-12	06.518	125.877	90	4.7	5.7	5.1	
06-Feb-12	09.968	123.165	5	6.0	6.9	6.9	INT III - BUTUAN; CAGAYAN DE ORO; INT II - MAMBAJAO, CAMIGUIN
06-Feb-12	09.915	123.172	1	5.6	6.5	6.3	
06-Feb-12	09.917	123.111	6	5.0	6.0	5.5	
06-Feb-12	09.929	123.075	8	4.8	5.8	5.2	
16-Mar-12	09.977	125.599	17	5.3	6.2	5.9	INT III - CAGAYAN DE ORO; INT I - HIBOK-HIBOK
03-Jun-12	06.575	124.020	631	4.9	5.9	5.3	
11-Jun-12	06.650	123.853	604	4.7	5.7	5.1	
03-Sep-12	06.539	123.580	1	5.3	6.2	5.9	
03-Sep-12	07.914	124.883	5	5.1	6.1	5.7	INT III - MALAYBALAY; CAGAYAN DE ORO; MISAMIS ORIENTAL
02-Oct-12	08.192	123.081	24	4.8	5.8	5.2	INT II - LUGAIT MISAMIS ORIENTAL; INT I - CAGAYAN DE ORO CITY
24-Nov-12	06.516	123.625	630	4.7	5.7	5.0	
17-Apr-13	07.296	124.795	6			5.3	INT III - CAGAYAN DE ORO; INT II - LIBONA BUKIDNON; BUTUAN, ILIGAN
01-Jun-13	07.285	124.793	1			5.7	INT III- CAGAYAN DE ORO; INT II- MALAYBALAY; CAMIGUIN ISLAND
02-Jun-13	07.360	124.794	12			5.7	INT II - MISAMIS ORIENTAL
15-Jul-13	07.338	124.814	3	4.8	5.8	5.2	INT III- CAGAYAN DE ORO; INT II- BUKIDNON

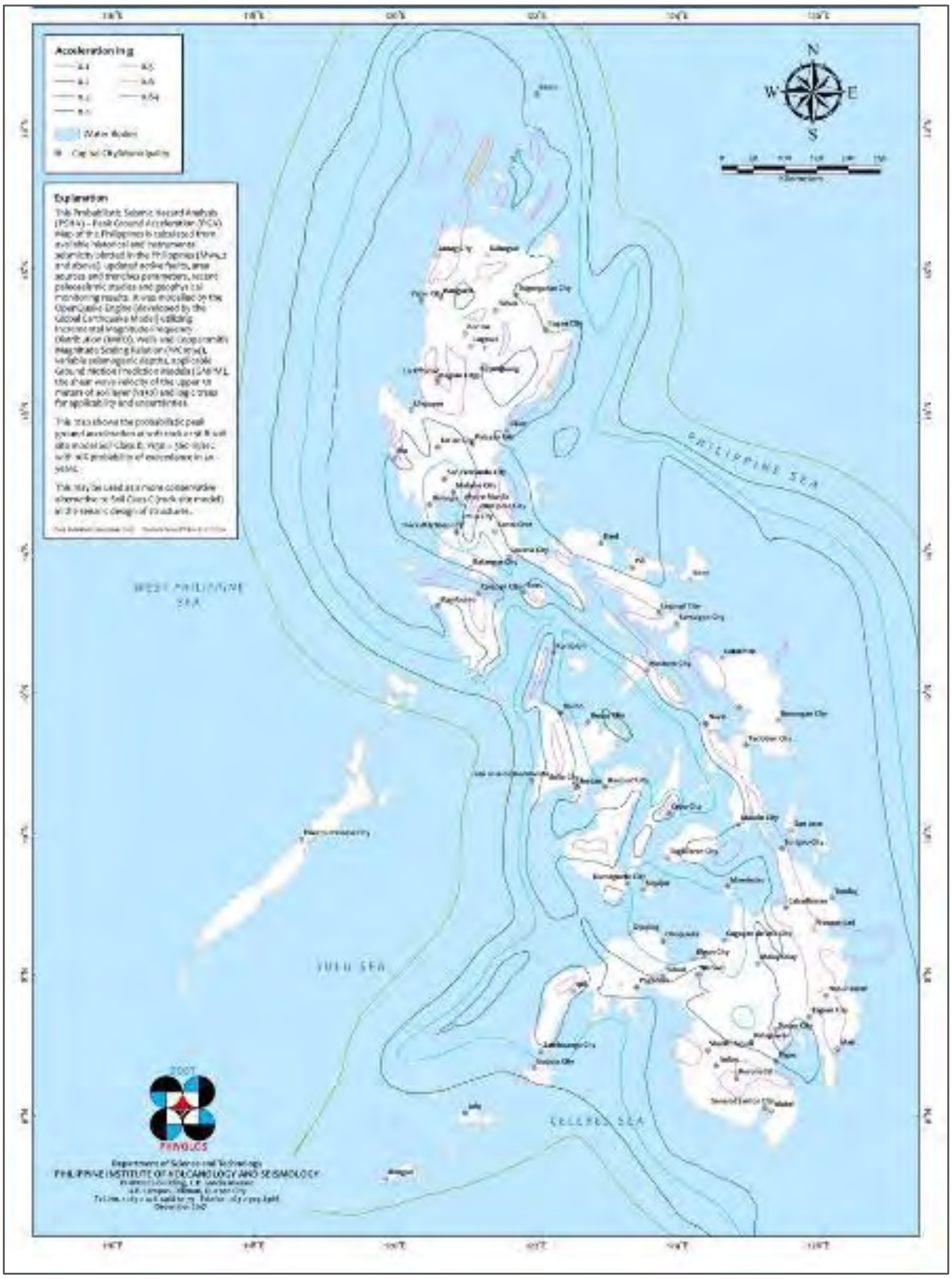
Date	North Latitude	East Longitude	Depth (km)	Ml	Mb	Ms	Intensity Reports Near Villanueva
18-Aug-13	06.327	124.698	385	5.1	6.0	5.6	
15-Oct-13	09.848	124.044	12	6.2	7.0	7.2	INT V - CAMIGUIN ISLAND; GINGOOG; CAGAYAN DE ORO
15-Oct-13	09.873	124.009	9	4.7	5.7	5.1	
15-Oct-13	09.825	123.688	3	5.0	5.9	5.5	
15-Oct-13	09.909	124.009	5	4.7	5.7	5.1	
15-Oct-13	09.769	123.664	7	4.7	5.7	5.1	
16-Oct-13	09.745	123.615	1	5.8	4.8	5.2	INT II - MAMBAJAO CAMIGUIN - AFTERSHOCK
16-Oct-13	09.908	124.070	7	5.7	4.7	5.0	
20-Oct-13	09.891	124.028	7			5.4	
29-Oct-13	07.517	125.207	123	4.6	5.6	5.0	
01-Nov-13	09.849	124.123	5	4.8	5.8	5.2	INT I - HIBOK-HIBOK
17-Mar-14	09.458	125.281	10	4.9	5.9	5.4	
11-Jun-14	09.706	125.786	20	4.6	5.6	5.0	
19-Sep-14	06.875	125.104	1	4.7	5.7	5.0	
20-Sep-14	06.747	124.979	15	5.5	6.4	6.2	
20-Oct-14	06.801	125.056	3	4.6	5.6	5.0	
22-Oct-14	06.730	125.006	4	4.7	5.7	5.0	
25-Oct-14	08.424	125.882	14	4.7	5.7	5.0	
20-Jan-15	06.238	123.890	623			5.2	
26-Jan-15	09.817	122.262	16			5.1	
13-Apr-16	07.834	121.965	27	5.4	6.3	6.0	
26-Jul-16	09.672	125.466	12	4.9	5.9	5.3	INT I- GINGOOG CITY
06-Aug-16	06.202	125.313	74	4.9	5.9	5.4	
02-Sep-16	06.352	123.772	1	4.6	5.6	5.0	
04-Sep-16	08.389	125.805	6	5.3	6.3	6.0	INT III - GINGOOG, MEDINA, BALINGASAG, SALAY, JASAAN, & BALINGOAN, MISAMIS ORIENTAL; INT II - CAGAYAN DE ORO
14-Oct-16	09.096	125.469	34	4.9	5.8	5.3	INTENSITY V - NASIPIT & CARMEN AGUSAN DEL NORTE; BUTUAN CITY; INTENSITY III - SURIGAO CITY; GINGOOG CITY MISAMIS ORIENTAL; MAMBAJAO CAMIGUIN; INTENSITY II - CAGAYAN DE ORO CITY

Source: PHIVOLCS 2019
Notes:
RF - Rossi-Forel Intensity Scale PEIS - PHIVOLCS Earthquake Intensity Scal

2.1.2.3.1.1 Ground Shaking/Acceleration

Ground acceleration caused by earthquakes may result to great damage and destruction to property and infrastructure accompanied by loss of life. Factors that influence the intensity of ground shaking include the magnitude of the earthquake, distance of the site in relation to the earthquake generator, characteristics of the underlying rocks, and the soundness of the building. The Philippines is located near or along the so called “earthquake belt” and is prone to seismic hazards. The reason why the PHIVOLCS and the United States Geological Survey (USGS) conduct ground motion hazard mapping in terms useful to engineering design using modern probabilistic methodology. In the study, the peak horizontal ground accelerations that have a 10 % probability of being exceeded in 50 years have been uniformly estimated for rock, medium soil, and soft soil site condition. Result of the study shows an estimate on rock ranging from a low of 0.11g in Visayas to a high of 0.30g in the vicinity of Casiguran fault zone in eastern Luzon. Estimates for soft soil conditions are considerably higher and range between 0.27g for Visayas and 0.80g along the Casiguran fault zone.

The project site which, is underlain mainly by alluvium, fall under “stiff soil”. **Figure 2.1-14** is the latest (2017) Peak Ground Acceleration Map released by PHIVOLCS with “g” on stiff soil at 0.3 for 500-year return period.



Source: PHIVOLCS, 2017

Figure 2.1-14. Peak Ground Acceleration Map, 500-Y Return Period on Stiff Soil

In the seismic design provisions of the National Structural Code of the Philippines (NSCP), the three geotechnical inputs are the “near source factors”, “soil profile type” and “seismic zone factor”. These inputs are used to shape and proportion the response spectrum given in the code.

The Philippines (except Palawan) is classified as seismic zone 4 since it is located in a Plate Boundary Zone formed by the subduction of the Philippine Plate and the Sundaland-Eurasian Plate. Since the ground is generally underlain by sands and silts having average field SPT N-values greater than 15, the soil profile type may be taken as SD--stiff soil profile.

The last seismic design provision required in the NSCP is the near source factor which seeks to amplify seismic design forces for structures located less than 15-km from a type A seismic source and less than 10-km from a type B seismic source.

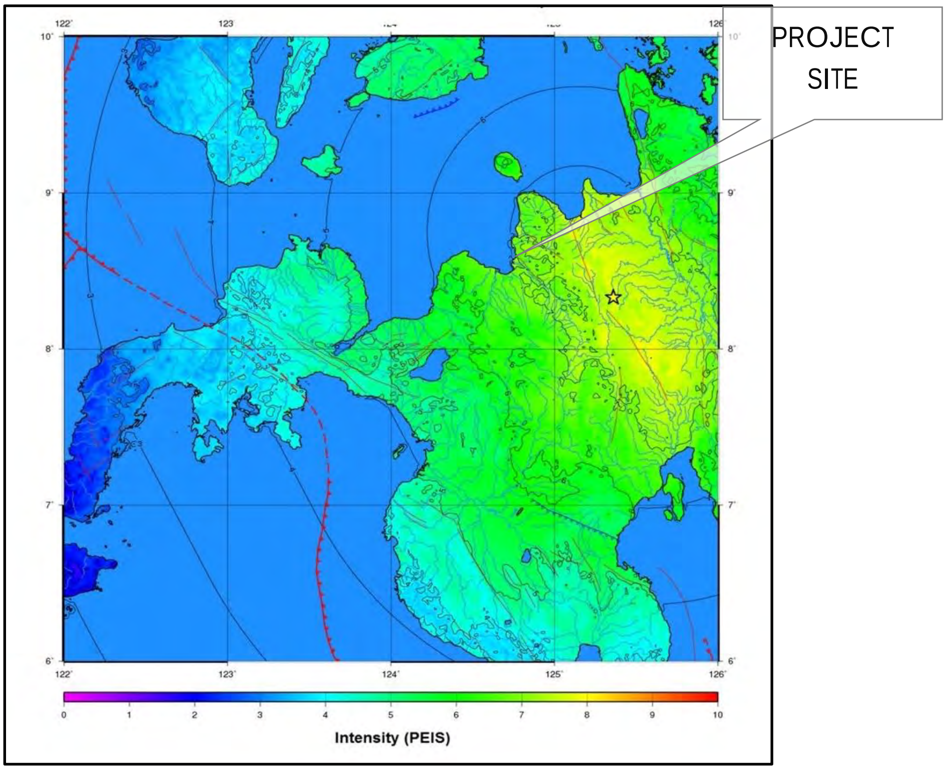
The other earthquake generators listed on the table are said to be more active. Nonetheless, the PGA values computed for these sources are lower because of their much greater distance from the project site.

Table 2.1-2. Peak Ground Acceleration Map, 500-Y Return Period on Stiff Soil Types of Faults near the Area

Earthquake Generator	Magnitude	Distance	Fault Type
Tagaloan River Fault	5.5	4.2	Type C
Cabanglasan Fault	5.4	30	Type B
Central Mindanao Fault	7.6	40	Type A
Philippine Fault Zone	8	60	Type A

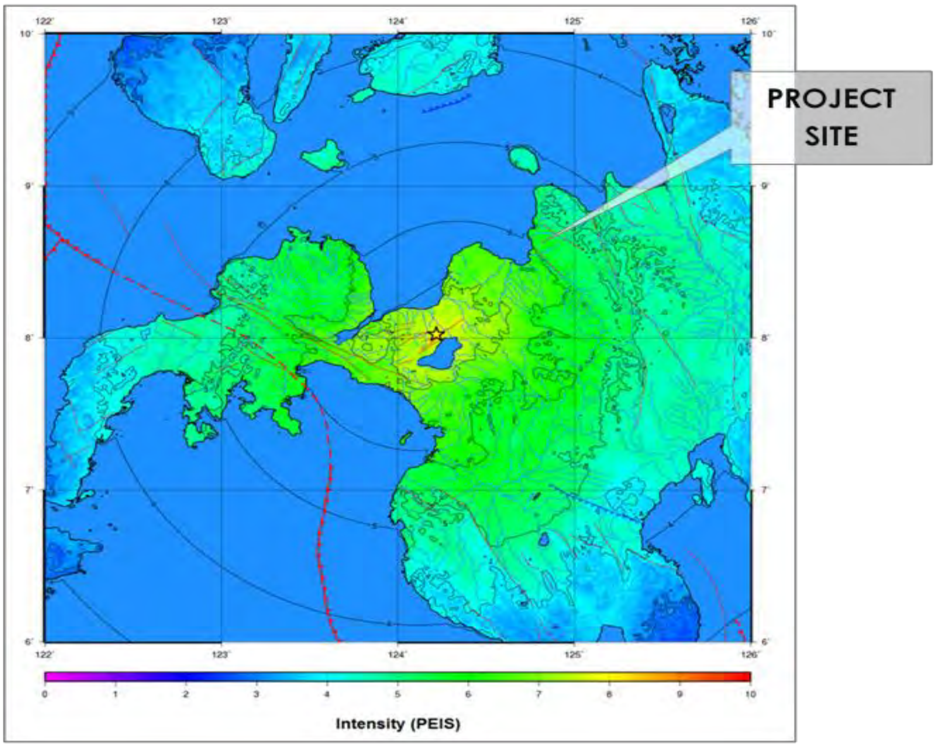
It can be seen from the table that the type A and B faults are more than 20-km from the site, which means the near source factors need not be applied.

It is recommended that the codal design parameters be used to design the structures. Furthermore, the codal parameters should supersede any peak ground acceleration (PGA) measured using deterministic methods since the codal design spectrum already incorporates the PGA amplification effect of the soil and near source effects.



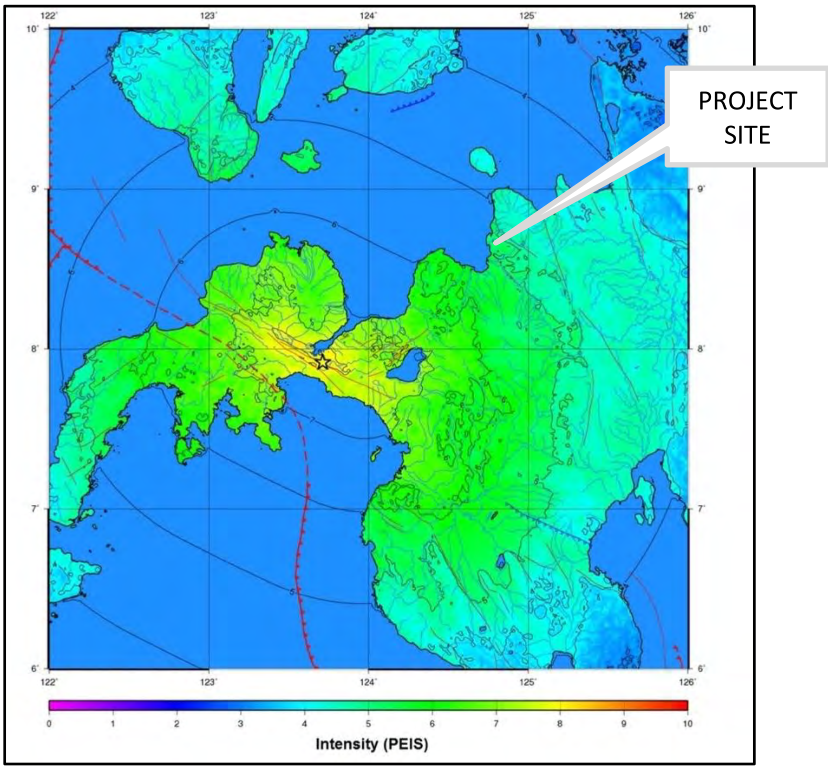
Source: PHIVOLCS, n.d.

Figure 2.1-15. M7.6 Central Mindanao Fault Scenario Earthquake



Source: PHIVOLCS, n.d.

Figure 2.1-16 M6.9 Lanao Fault System Scenario Earthquake



Source: PHIVOLCS, n.d.

Figure 2.1-17. M7.3 MF Western Mindanao Fault Scenario Earthquake

2.1.2.3.1.2 Ground Rupture

This hazard is seemingly absent in the project area since the nearest active fault, the Tagoloan Fault, is about 4.2km NE from the project. PHIVOLCS's recommended buffer zone for ground rupture hazard is 5 meters on both sides of the fault.

2.1.2.3.1.3 Liquefaction

Liquefaction is the process that transforms the behavior of cohesionless water-saturated unconsolidated sediments from a solid to a liquid state usually caused by seismic stresses (Torres et al, 1994) that create ground shaking. Water saturated soils loose strength and liquefy and thus the material tends to flow causing buildings to sink and rotate or lean into the soil (Keller, 1985).

Reyes et al, of UP-Engineering Research and Development Foundation, Inc., in their soil study of areas that liquefy during the 16th July 1990 Luzon earthquake came out with the following soil conditions for the potential liquefiable layers:

1. loose soil classification;
2. upper layers of the surveyed areas;
3. water table near the ground surface;
4. N-value of less than 30 using the American Association of State Highway and Transportation Officials (AASHTO) method and less than 35 using the Japan Society of Civil Engineers (JSCE) method; and
5. 50% passing (D50) of approximately 0.001-1.8mm.

Based on the Liquefaction Hazard Map, the project area is susceptible to liquefaction hazard (**Figure 2.1-17**).

Impact Analysis

The planned expansion will not induce liquefaction susceptibility of the area but the project itself is susceptible. Since loose sands and a shallow water table are present at the site, the liquefaction potential of the site will have to be assessed. The presence of potentially liquefiable soils would necessitate the use of a deep foundation system to support the critical structures of the power plant.

Source: 2020 HazardHunterPH (data from PHIVOLCS)

Figure 2.1-18. Liquefaction Hazard Map in Region X

Key Results of the Soil Investigation at Site (*by Central Southern China Electric Power Design Institute of China Power Engineering Consulting Group, 2014*).

The study team based their investigation work upon full collection and analysis of preliminary documents of the power plant as well as the investigation document handover sheet submitted by the power generation company of the institute and the geotechnical investigation instruction issued by the chief engineer of the investigation company. The main means of investigation is drilling. Meanwhile, cone penetration tests (CPT) and geologic investigation is adopted as auxiliary means, mainly including drilling, in-situ test (SPT), and indoor test, etc. Besides, preliminary investigation results are studied and utilized, and relevant local geologic data and construction experience are collected to accomplish the data summary and analysis.

Maximum drilling depth was 46.5m, and one SPT is conducted in every 1.0-1.5m. The field investigation started on November 18, 2013, and completed on December 25, 2013 with 40 drillholes for a total of 1,827.8 meters.

Considering the shallow groundwater level at the project site and the proximity of a seismic source capable of generating high-magnitude earthquakes, it is evident that the loose to medium dense sands within the site subsurface are susceptible to liquefaction.

According to the practical conditions of this project, within the depth scope of 20m, Layer ② silt, Layer⑤ silty fine sand, Layer ⑦ silty fine sand with silt interbed, and Layer ⑧ silt should be subject to liquefaction evaluation.

With the depth of 20m underground, the critical value of SPT blow counts for liquefaction evaluation shall be calculated as per the following formula:

$$N_{cr} = N_0 \beta [\ln(0.6 d_s + 1.5) - 0.1 d_w] \sqrt{3/\rho_c}$$

Where:

N_{cr} - Critical value of SPT blow counts for liquefaction evaluation;

N_0 - Reference value of SPT blow counts for liquefaction evaluation, $N_0 = 19$ if determined as per 1st Group of Magnitude IX;

d_s - Depth of standard penetration point for saturated soil (m);

d_w - Groundwater level (m);

ρ_c - Percentage of clay content; considered as 3 if the value is less than 3 or it is sand;

β - Adjustment coefficient; 0.80 for 1st Group of design earthquake, 0.95 for 2nd Group, and 1.05 for 3rd Group.

Judgment of liquefied soil, when

$N' < N_{cr}$, it can be judged as liquefiable soil.

Where:

N' - Measured SPT blow counts;

N_{cr} - critical value of SPT blow counts for liquefaction evaluation, calculated as per the formula above.

According to this investigation and the test data, preliminary liquefaction evaluation is conducted for the soil layers that are distributed in various building sections. After analyzing as per the calculation results, the liquefiable soil layers in various building sections of the plant site include: Layer ② silt; Layer ⑤ silty fine sand; Layer $^{7\text{-}1}$ silty fine sand with silt interbed; and Layer $^{8\text{-}1}$ silt.

The liquefaction grade is moderate-severe.

The Annex provides the Geotechnical Engineering Investigation Report by The First Northeast Electric Power Engineering Corp of China Energy Engineering Group, 2014."

2.1.2.3.1.4 Landslide

The project site's susceptibility to earthquake-induced landslides is none to low as it is sitting on a flat terrain.

Impact Analysis

The planned expansion will not induce landslide hazard in the area.

2.1.2.3.1.5 Tsunami

In the Tsunami Hazard Map of the Philippines, the area is said to be prone to tsunami due to offshore earthquakes or submarine landslides.

Impact Analysis

The planned expansion will not induce tsunami hazard in the area.

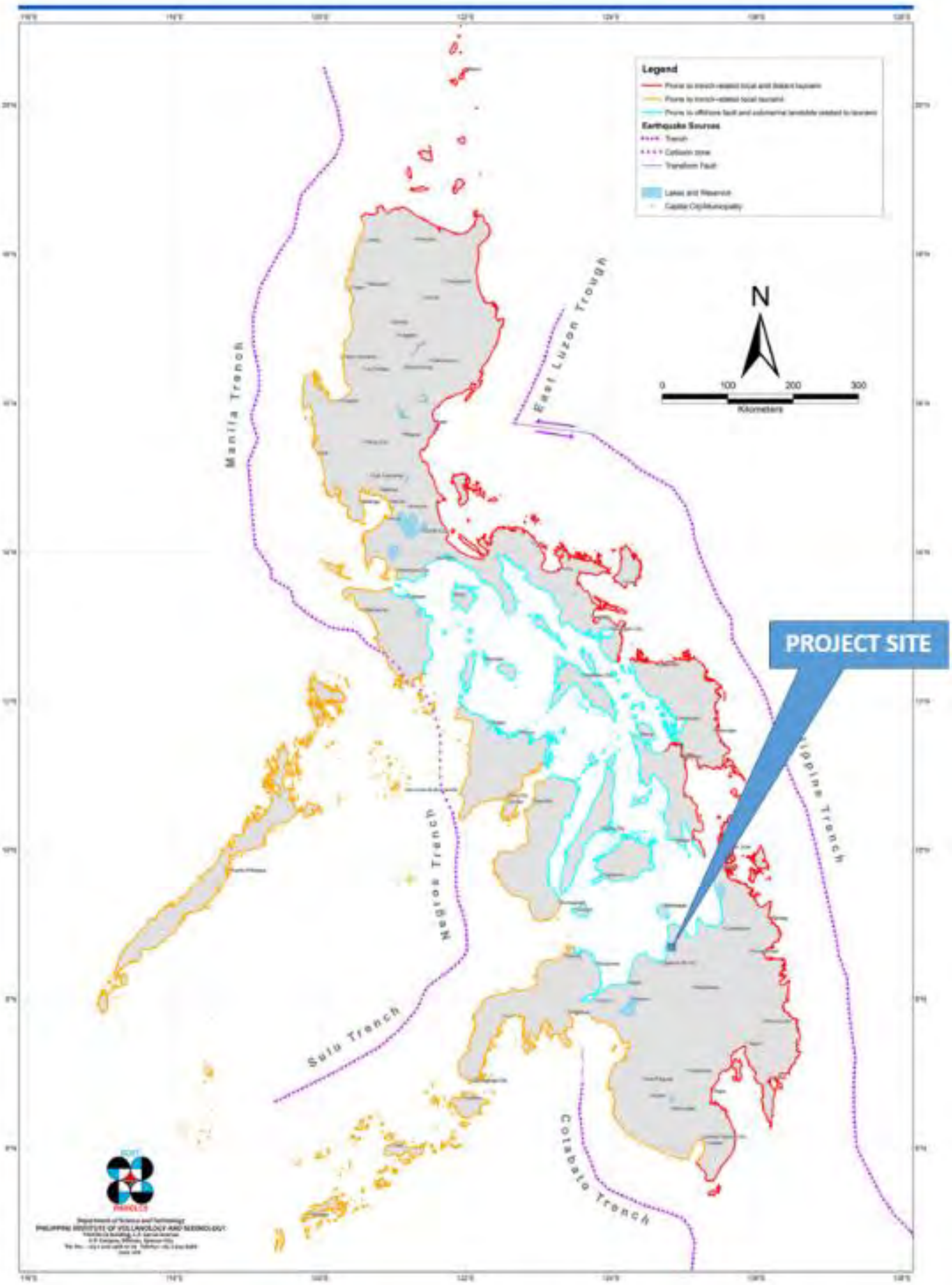
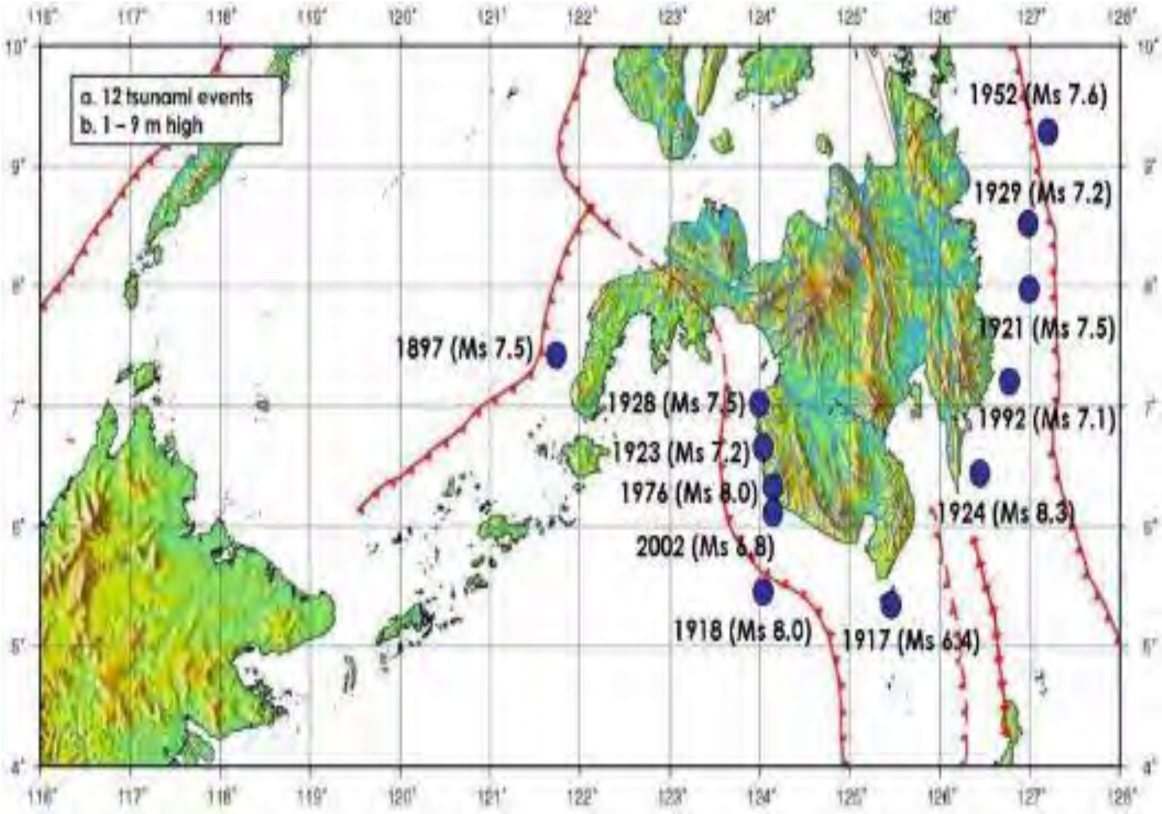


Figure 2.1-19. Tsunami Prone Areas in the Philippines

Figure 2.1-20 below shows the tsunamigenic earthquakes that occurred in Mindanao. It is noted that none of these have affected the project site and its vicinities.



Source: MLP Bautista, et al., 2014. PHIVOLCS

Figure 2.1-20. Tsunamigenic Earthquakes that Affected Mindanao

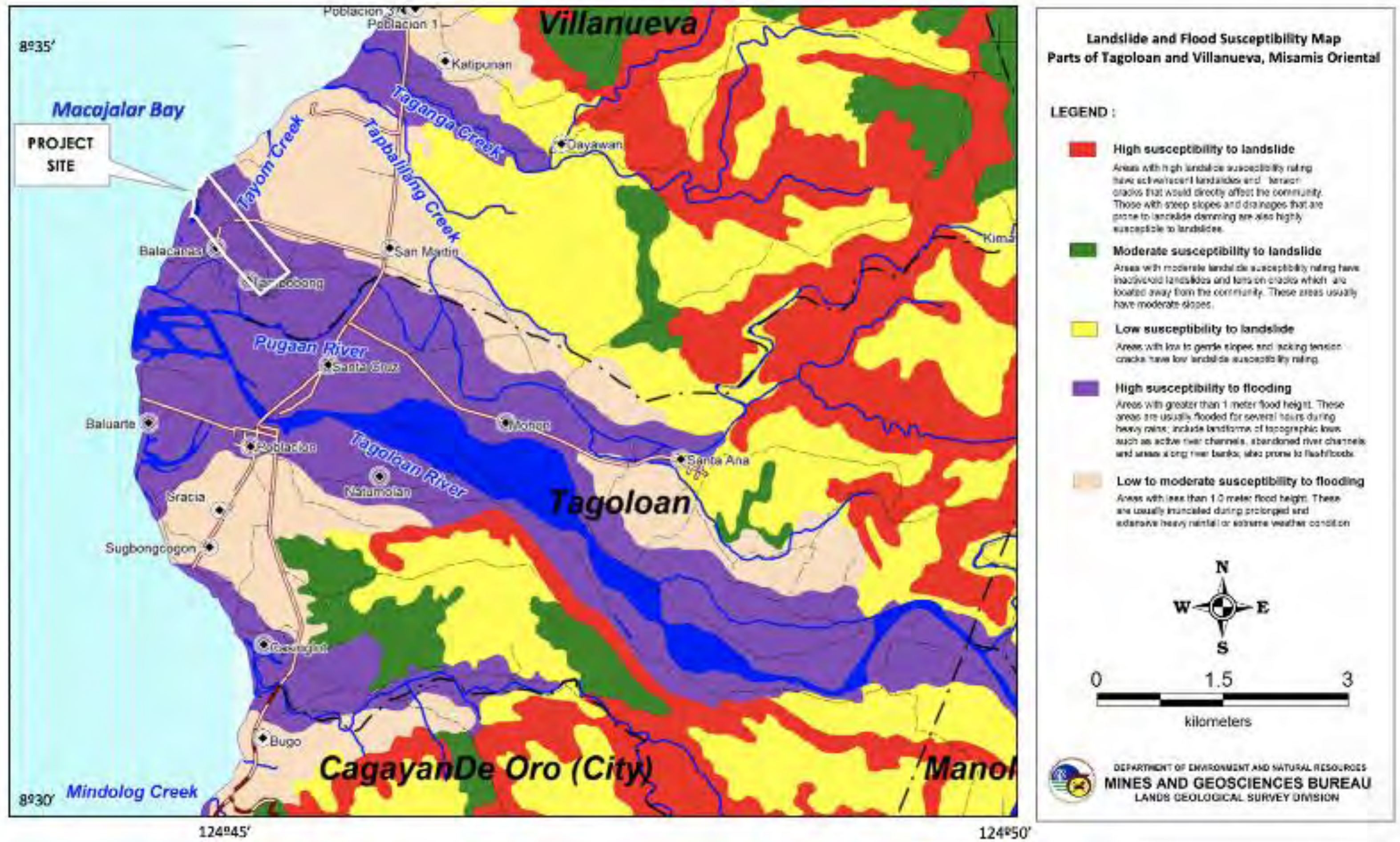
2.1.2.3.2 Mass Movement

2.1.2.3.2.1 Landslide (Rain-induced)

Based on **Figure 2.1-21** or the Landslide and Flood Susceptibility Map of Tagoloan-Villanueva Area, the plant site, which sits on a flat lying area, has low susceptibility to landslide hazard.

Impact Analysis

The planned expansion will not induce landslide hazard in the area.



Source: MGB-10, 2012

Figure 2.1-21. Landslide and Flood Susceptibility Map of Tagoloan-Villanueva Area

2.1.2.3.3 Hydrological Hazard

2.1.2.3.3.1 Flood Hazard

Floods usually occur during or after heavy rainfall wherein the river channels are saturated with water resulting to river swelling and overflowing of floodplains. The low-lying areas with poor drainage system are susceptible to flood hazard.

The susceptibility of the project site to flooding is from low to high, depending on which data source to consider. The project site elevation ranges from 0m to <10m.

According to the Flood Hazard Map of MGB-10 (**Figure 2.1-22**), the plant site is highly susceptible to inundation with flood height greater than 1m. It is also prone to flash floods. It's very close proximity to Tagoloan River, which is a major drainage system that has experienced a lot of flooding events in the past, makes it prone to this hazard. In **Figure 2.1-23** (HazardHunterPH Map), the area is within Moderate to Very High Susceptibility to flooding.

Tagoloan River emanates from Malaybalay, Bukidnon and drains northward, towards Macajalar Bay. Flooding along this river is limited to the low-lying areas in the lower reaches. River bank erosion associated with sediment deposition in the lower reaches seems to be one of the problems in the Tagaloan River. The flood prone area of Tagaloan, which extends to about 1,300 ha, covers the said developing industrialization areas including the municipalities of Tagoloan and Villanueva.

During floods, low-lying areas adjoining the Tagoloan River are frequently inundated due to the inadequacy of channel flow capacity. Inundation and damages in the Tagoloan River Basin are concentrated in the lower reaches due to the topographic features.

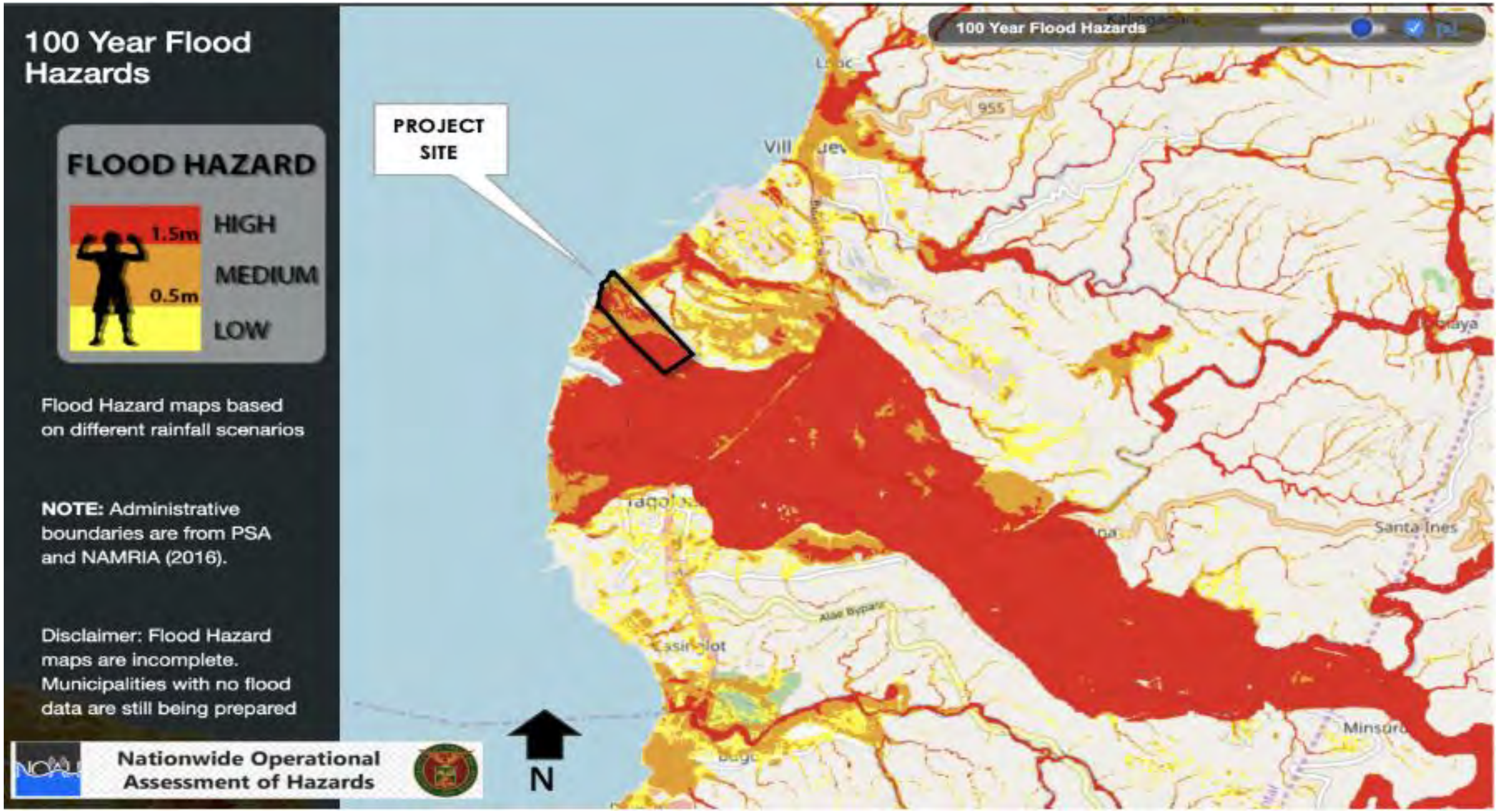
In 1984, the Municipality of Tagoloan was not spared by catastrophic typhoon “Nitang” which caused inundation from the Tagoloan river bank sweeping away the northern section of the PHIVIDEC Industrial Estate and the town proper of Tagoloan. Properties were damaged and numerous lives were lost. Another devastating typhoon in 1990 ravaged the river bank and left approximately 100 families homeless.

In December 2014, TS Seniang (Jangmi) hit the Philippines and delivered intense to torrential rains over a prolonged period and caused widespread floods and landslides in Northern Mindanao and the Visayas.

Sensors in Tagoloan River in Misamis Oriental registered a water level of up to 8m. The swelling of the river generated floods that could have turned out into a disaster. However, the timely delivery of information to these communities, relayed through social media and direct calls to DRMM officers, may have helped avert a possible catastrophe. In Tagoloan, with a population of 63,850, an alert of incoming floods was communicated in the morning of December 29, 2014. By the time floods rushed in the afternoon at 3:10 PM, people were already out of harm's way, except for one person who drowned. The flood hazard in Tagoloan was there, but no disaster in terms of mass casualties happened. (UP-NOAH, 2014)

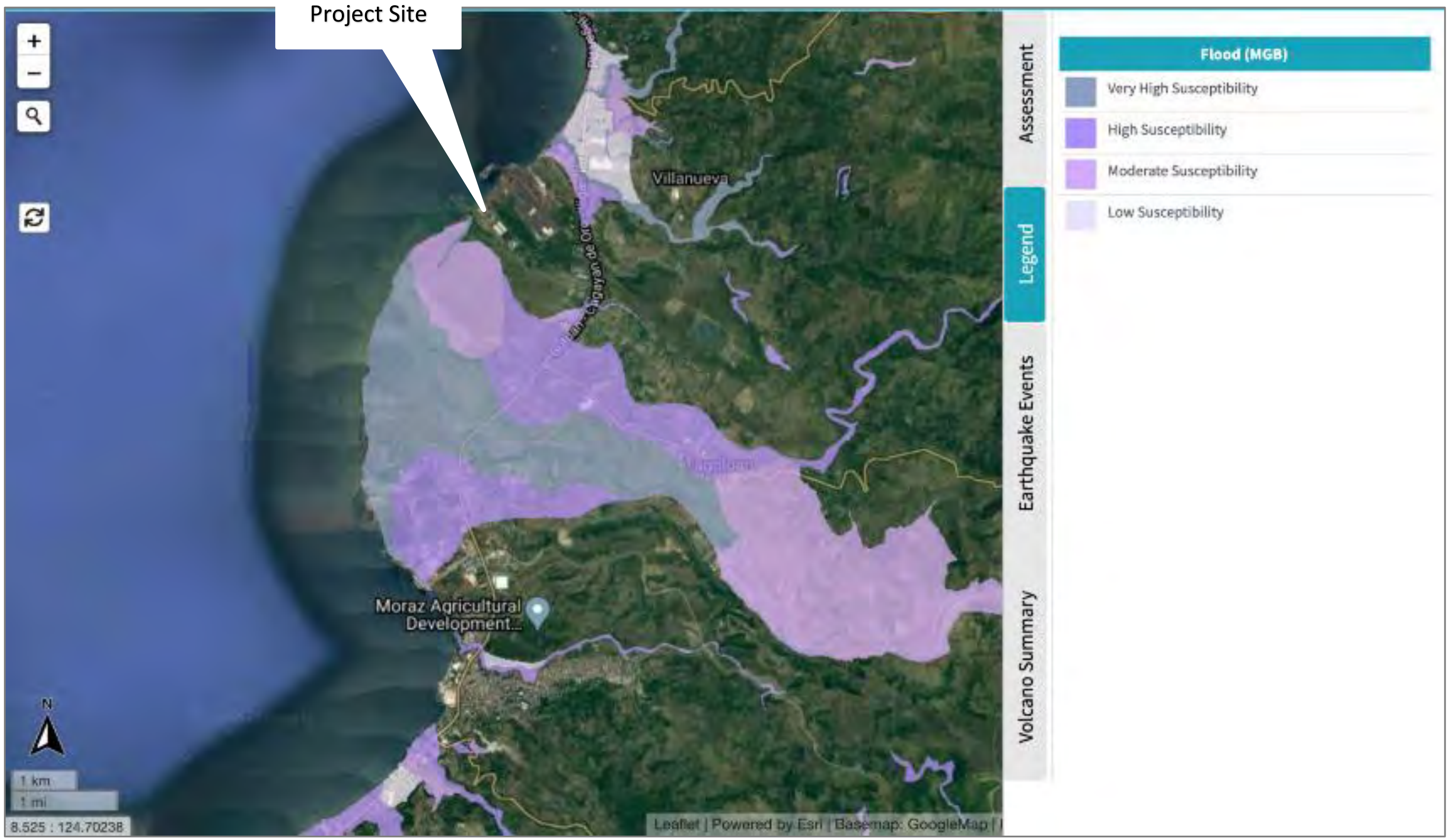
Impact Analysis

The construction of the plant expansion and its ensuing operations will not impact on the existing flood susceptibility of the area. However, the project is also prone to flooding. Proper engineering interventions such as elevating the site and sufficient drainage system are some mitigation measures.



Source: UP NOAH, screen-captured June 2019

Figure 2.1-22. 100 Year Flood Hazard Map of Tagoloan-Villanueva Area



Source: *HAzardHunterPH, screen grabbed March 2020 (data from MGB)*

Figure 2.1-23. Flood Hazard Map of Project Site and vicinities

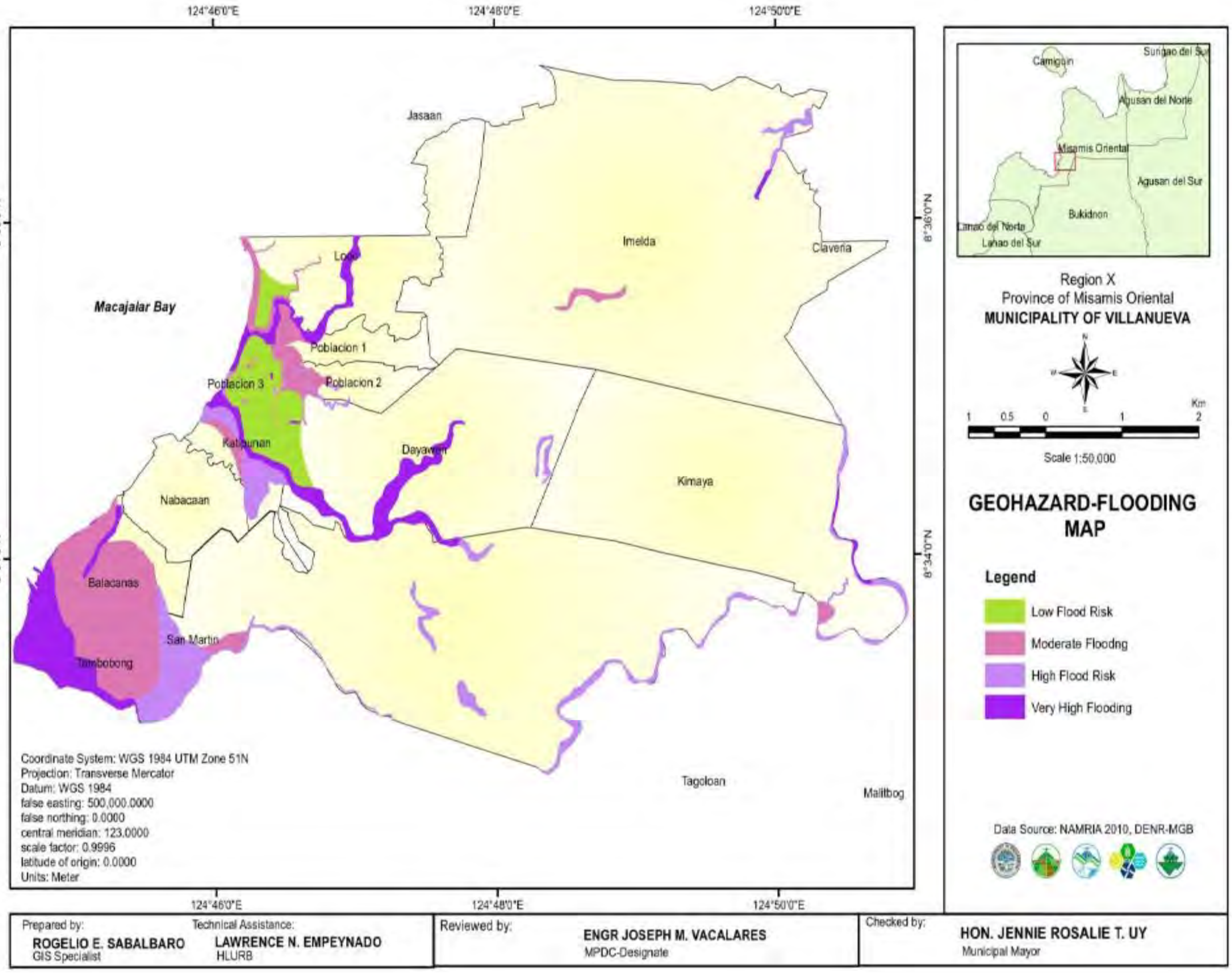


Figure 2.1-24. Geohazard-Flooding Map of the Municipality of Villanueva

2.1.2.3.3.2 Storm Surges / Storm Waves

Storm surge is an abnormal rapid rise of sea level resulting from strong winds pushing water towards the shore (NOAA, 2013). This can cause severe destruction and damage in its surrounding areas. High winds push the ocean's surface that causes water pile up higher than the ordinary sea level. Storm surges have known to damage nearby coastal structures, resulting from the wave impacts and debris carried by the surge. Other effects include flooding of low-lying coastal areas and intense wave erosion of beaches, dunes and other structures.

The maximum storm surge height map of the Philippines was presented in the report, "Identification of storm surge vulnerable areas in the Philippines through the simulation of Typhoon Haiyan-induced storm surge levels over historical storm tracks" (Lapidez, JP, et al., 2014). It "calculates the maximum probable storm surge height for every coastal locality by running simulations of Haiyan-type conditions but with tracks of tropical cyclones that entered PAR from 1948–2013" (Lapidez, JP, et al., 2014). Hypothetical typhoons were created using the tracks of the selected typhoons and the central pressure, maximum sustained wind speed values, and radii to the 50 and 30 knot winds of Haiyan. A total of 861 hypothetical typhoons were generated for this study. Storm surge simulations for these typhoons were generated using the JMA Storm Surge Model. (Lapidez, JP, et al., 2014). This model is a numerical code that is used to simulate and predict storm surges generated by tropical cyclones (Higaki, 2006). The numerical scheme of the model is based on 2D shallow water equations. Other governing equations include the equation of motion and the continuity equation with air pressure and wind fields used as external forcings.

Based on this study, the project site in Villanueva is within the zone of 1-2m maximum height. This indicates that the conservative storm surge advisory level to be adapted in the area is Advisory 1 (SSA 1). Figure 2.1-24 shows the storm surge hazard in the vicinity of the project site, which indicates that the site itself but its adjacent sites have low to moderate susceptibility. Nevertheless, the pier area should have adequate protection from strong waves.

Project NOAH's Compilation of Storm Surge Occurrences in the Philippines (2014), lists 57 events. Of these, there is only one event during Ty. Sening/Kate on October 14-15, 1970, which indicates that 12 provinces on north islands of Mindanao were affected. However, the affected areas were not specified in the list.

Climate change (global warming) has potential impacts on the frequency and strength of typhoons, and hence, on storm surge and storm waves. Rise in sea levels, spurred by climate change, will increase water depths and, by extension, wave heights in stormy weather. Even if the rise in sea level during storms does not flood the coastal areas, the resulting waves probably will. Storm surges can also be enhanced by tidal fluctuations and can be difficult to prepare for unless one has an hour-by-hour estimation of the weather situation.

As sea levels rise due to climate change, low-lying coastal areas are permanently flooded by the sea. The likelihood and severity of storm surges also rises since weaker winds will also be able to increase the sea level enough to flood coastal areas. In addition, as the sea level rises, the water depth increases and the wave base becomes deeper; waves reaching the coast have more energy and therefore can erode and transport greater quantities of sediment.

Impact Analysis

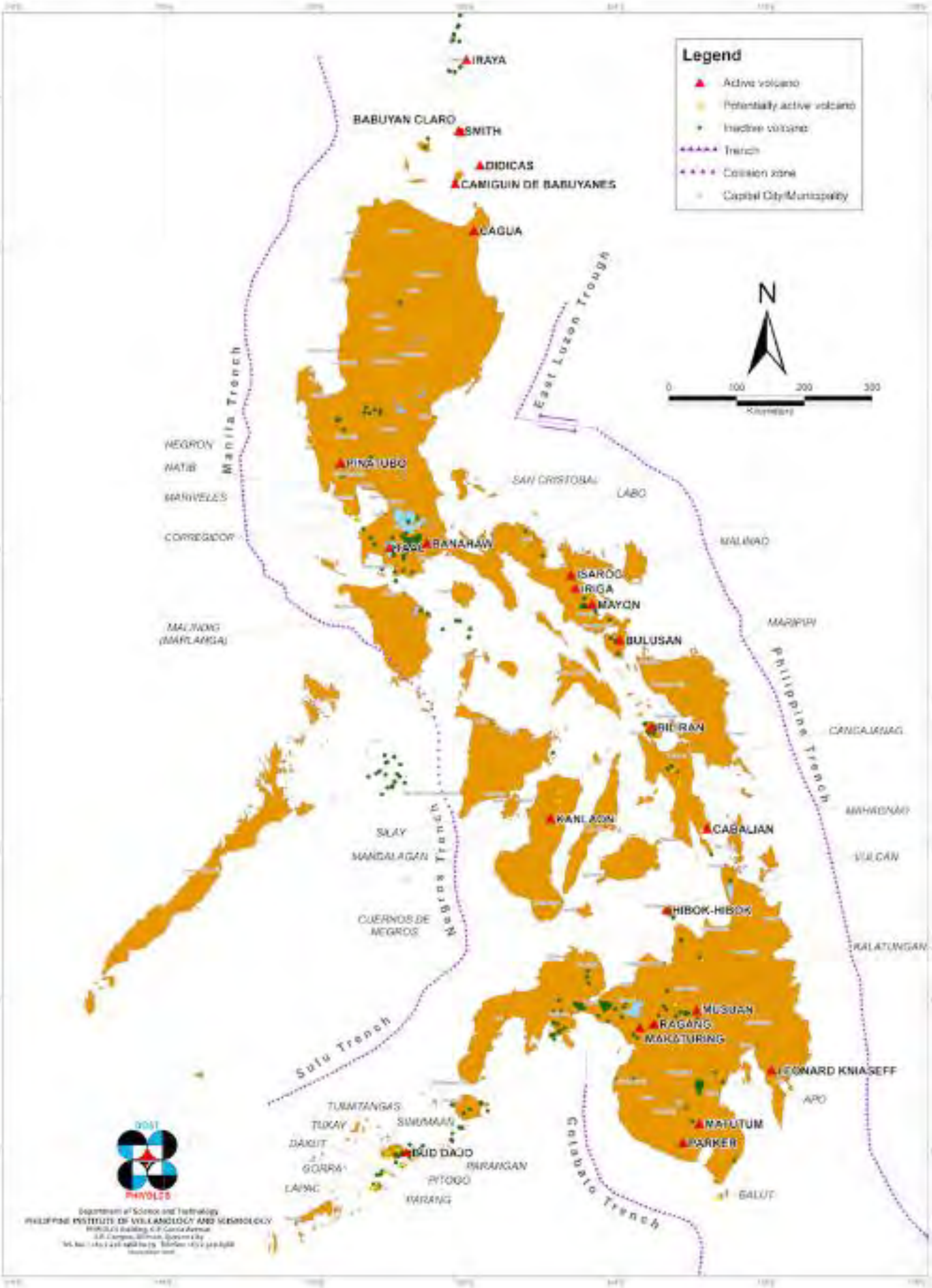
The construction for the plant expansion and its ensuing operations will not impact on the existing storm surge susceptibility of the area.

Source: UP-NOAH interactive hazard maps

Figure 2.1-25. Storm Surge Map of the Project Site and vicinities (SSA 1)

2.1.2.3.4 Volcanic Hazards

There are no active volcanoes near Villanueva, and hence, volcanic hazards are absent at the project site. The nearest known active volcano is Mt. Hibok-Hibok in Camiguin Island, which is about 72 km to the north of the project site. In an event of eruption, the hazard that may affect the site is from possible ash fall.



Source: PHIVOLCS 2015

Figure 2.1-26. Distribution of Active Volcanoes in the Philippines

Impact assessment and options for mitigation and/or enhancement

The development and operation of the proposed plant capacity expansion at full capacity is not seen to induce liquefaction, landslides, or mudflows based on the above discussion; rather, the project has low to moderate susceptibility risks to these natural hazards.

However, investigation of the regional geological setting as well as the results of the geotechnical and soil investigation reveal that the proposed site is near one active fault and is underlain by layers of sand with varying degrees of consistencies.

To mitigate the potential effects of the geologic nature to the project and vice-versa, the following recommendations are to be considered:

- For auxiliary buildings in plant area, shallow foundation can be adopted for ordinary building and underground pipelines and pipe ducts, which have lower load and lower deformation requirements. During design, it's required to consider as much as possible the deep burial of foundation, and take the Layer ⑥ "hard shell", which is located in the upper part of ground surface, as the bearing stratum.

- Pile foundations should be adopted for power house, stack, main substation, transfer station, dry coal shed, hydraulic structure, bucket wheel machine, coal belt conveyor gallery, and auxiliary buildings that have higher load.

- According to the composition of foundation soil on construction site, the engineering experience for adjacent operating power plant (Mindanao Power Plant), and the construction experience of Cagayan in Mindanao, it's better to select the Precast driven pile for this project.

- On the one hand, precast driven pile can enhance the bearing capacity of the foundation, on the other hand, in the process of hammer construction through the foundation soil compaction, the impact on the saturated sand and silt foundation liquefaction resistance good treatment effect. At the same time, according to our construction experience in Indonesia's 3 x 142 mw coal-fired power plant project in Bali Island, PHC pipe pile also can be used, pile diameter 400 mm to 600 mm.

- Therefore, it's recommended to adopt the precast driven pile. Besides, based on the construction experience for Mindanao Power Plant and Cagayan de Oro City, square precast driven pile can be adopted on the site, which has the sectional dimension of 300mm-500mm.

- **Lateral Load Resistance (Ground shaking)** Lateral loads developed as an inertial force due to earthquake and wind load acting on the sides of the building. This lateral load must be evaluated during the design phase using the National Building Code and the Structural Code of the Philippines as minimum guide. This lateral load will be resisted by the passive and frictional resistance of the foundation. Area of foundation shall be designed to have larger lateral resistance against the total base shear triggered by seismic load or wind load.

- **Excavation and Fill.** Excavation shall be braced by using sheet piles with water beams. Excavation is prone to collapse and could affect adjacent structures. Filling materials necessary to elevate the building floors of the proposed steel plant shall use base course type of fill materials. Compaction shall be done at optimum water content.

2.1.3 Pedology

Baseline:

The geotechnical program conducted in 2013 in the plant site consists of 20 boreholes. The results of this subsurface investigation show that the site subsoil generally consists of sands of varying relative condition, which intersperse with stiff to very stiff silt. The succeeding table present the subsurface condition at each borehole location based on the results of field and laboratory testing.

The loose sands with N-values less than 10 are mostly found within the upper 1-2m depth only, after which it is underlain by medium dense, to dense, to very dense soils.

Table 2.1-3. Subsurface Conditions in 20 Boreholes

Hole No.	Depth, m	USCS Classification	SPT N-value	Consistency / Relative Condition
BH-1	0.0 – 1.0	SC-CM	7	Loose
	1.0 -27.0	SP / SW / ML / SC-SM	11-29	Medium dense
	27.0 - 37.5	SM / SP-SM	30-40	Dense
	37. 5 - 40.0	(MH) SW-SM	51-56	Very dense
BH-2	0.0 - 1.0	MH	14	Stiff
	1.0 - 12.0	SM / SP / SP-SM / SC	10-24 (34)	Medium dense
	12.0 - 15.0	SM	31-32	Dense
	15.0 - 18.0	SC-SM / SM	16-20	Medium dense
	18.0 - 39.0	SM / SC-SM / ML	31-48	Dense
	39.0 - 40.5	SW-SM	50-73	Very dense
BH-3	0.0 - 2.0	SM / SC-SM	6	Loose
	2.0 - 7.5	SP / GW / SM	11 – 27	Medium dense
	7.5 - 22.5	SM / SP / SP-SM / SC	33 – 46 [51]	Dense
	22.5 - 30.0	[MH] SM / SP-SM	20 – 29	Medium dense
	30.0 - 34.5	SP-SM	41 – 46	Dense
	34.5 - 40.0	SP-SM / SM	51 – 59	Very dense
BH-4	0.0 - 2.0	SM	8 – 10	Loose
	2.0 - 10.5	SM / SP / ML / SP-SM	17 – 29	Medium dense
	10.5 - 24.0	SP-SM / SP	[28] 30 – 50	Dense

Hole No.	Depth, m	USCS Classification	SPT N-value	Consistency / Relative Condition
	24.0 - 40.0	SP / SM / SP-SM / ML	[41] 53 – 99	Very dense
BH-5	0.0 - 2.0	SC-SM / SP-SM	7–9	Loose
	2.0 – 13.5	GW / SW-SM / SM	11 – 23	Medium dense
	13.5 – 18.0	SW-SM / SP-SM / SM	31 – 40	Dense
	18.0 – 22.5	SP-SM / SP	14 – 29 [31]	Medium dense
	22.5 – 28.5	SC-SM / SM	[24] 45 – 49 [56]	Dense
	28.5 – 31.5	MH	39 – 47	Hard
	31.5 – 33.0	SM	19	Medium dense
	33.0 – 36.0	SC / SC-SM	37 – 53	Dense to very dense
	36.0 – 40.0	CH / SP-SM	61 – 75	Hard / Very dense
BH-6	0.0 – 1.0	SM	3	Very loose
	1.0 – 3.0	SW-SM / SP-SM	18 – 30	Medium dense
	3.0 – 6.0	SP	32 – 36	Dense
	6.0 – 21.0	SM / SP-SM / SC-SM	13 – 28 [37]	Medium dense
	21.0 – 27.0	ML / SC-SM / SM	37 – 46	Dense
	27.0 – 34.5	ML / MH / CH	18 – 28	Very stiff
	34.5 – 40.0	SP-SM	[31] 54 – 58	Very dense
BH-7	0.0 – 1.0	SC	8	Loose
	1.0 – 22.5	SM / SP / SW / SW-SM / SP-SM	11 – 29 [32]	Medium dense
	22.5 – 28.5	SW-SM / SP-SM	36 – 50	Dense

Hole No.	Depth, m	USCS Classification	SPT N-value	Consistency / Relative Condition
	28.5 – 40.0	SP-SM / SM	51 – 67	Very dense
BH-8	0.0 – 1.0	SW-SM	8	Loose
	1.0 – 4.0	SW / SP	14 – 30	Medium dense
	4.0 – 7.5	SP	37 – 48	Dense
	7.5 – 15.0	GP / SP-SM / SM	17 – 29	Medium dense
	15.0 – 30.0	SC-SM / SM / ML / SC	33 – 43 [52]	Dense
	30.0 – 33.0	MH	19 – 23	Very stiff
	33.0 – 40.0	SM / SC	[37] 51 – 64	Very dense
BH-9	0.0 – 5.0	SC-SM / SM / SP	4 – 10	Loose
	5.0 – 12.0	SP / SM / SP-SM	12 – 29	Medium dense
	12.0 – 19.5	SP-SM / SP / SM	39 – 46 [54]	Dense
	19.5 – 24.0	SC-SM	18 – 22	Medium dense
	24.0 – 40.0	SC / SP-SM / SP / SM	50 – 97	Very dense
BH-10	0.0 – 10.5	SM / SW-SM / SP / SW	10 – 26	Medium dense
	10.5 – 18.0	SP / SM	33 – 41	Dense
	18.0 – 22.5	SP / SW-SM / SP-SM	22 – 27	Medium dense
	22.5 – 28.5	SP-SM / SP / SW	33 – 45	Dense
	28.5 – 33.0	SP / SW	[48] 51 – 54	Very dense
	33.0 – 39.0	CH	[16] 20 – 22	Very stiff

Hole No.	Depth, m	USCS Classification	SPT N-value	Consistency / Relative Condition
	39.0 – 42.0	GP / SP	59 – 62	Very dense
BH-11	0.0 – 2.0	SM / SW-SM	8 [14]	Loose
	2.0 – 15.0	GP / SP / SW / SM / SP-SM	11 – 30	Medium dense
	15.0 – 18.0	SP-SM	34 – 39	Dense
	18.0 – 25.5	SM / ML / SW-SM	20 – 24 [36]	Medium dense
	25.5 – 30.0	SM / SP-SM	37 – 45 [52]	Dense
	30.0 – 33.0	MH	14 – 20	Stiff to very stiff
	33.0 – 36.0	SM	32 – 47	Dense
	36.0 – 40.0	SC-SM / ML	52 – 59	Very dense
BH-12	0.0 – 2.0	MH / ML	6 – 10	Medium stiff to stiff
	2.0 – 6.0	SM / SP	40 – 48 [51]	Dense
	6.0 – 12.0	SC-SM / SM	15 – 21	Medium dense
	12.0 – 15.0	MH / CH	9 – 10	Stiff
	15.0 – 18.0	ML	20 – 34	Very stiff to hard
	18.0 – 21.0	SC / SC-SM	32 – 36	Dense
	21.0 – 27.0	SM / SP-SM / SC-SM	27 – 29	Medium dense
	27.0 – 39.0	MH	[16] 17 – 30 [40]	Very stiff
	39.0 – 43.0	SM / SW-SM	[48] 64 - 66	Very dense

Hole No.	Depth, m	USCS Classification	SPT N-value	Consistency / Relative Condition
BH-13	0.0 – 1.0	SM	2	Very loose
	1.0 – 13.5	SP / SM	[10] 11 – 28	Medium dense
	13.5 – 18.0	SM / SC	38 – 46	Very dense
	18.0 – 30.0	SM / SC-SM / SC / SP-SM / SP	22 – 30 [32]	Medium dense
	30.0 – 33.0	CH	24 – 26	Very stiff
	33.0 – 36.0	SW-SM / SP-SM	45 – 50	Dense
	36.0 – 40.0	SW-SM / SP-SM	51 – 59	Very dense
BH-14	0.0 – 2.0	MH	5–8	Soft to medium stiff
	2.0 – 21.0	SP / SP-SM / SM / SP	11 – 30 [34]	Medium dense
	21.0 – 33.0	SP / SP-SM / SM	[30] 31 – 47	Dense
	33.0 – 36.0	MH	24 – 27	Very stiff
	36.0 – 37.5	SP	40	Dense
	37.5 – 40.0	SM / SW-SM	61 – 70	Very dense
BH-15	0.0 – 1.0	MH	6	Medium stiff
	1.0 – 2.0	SP	8	Loose
	2.0 – 12.0	SP / SC	[9] 11 - 22	Medium dense
	12.0 – 22.5	MH	7 – 14	Medium stiff to stiff
	22.5 – 28.5	SP	10 – 18 [36]	Medium dense
	28.5 – 40.0	SM / GW / SP	[22] 59 – 69	Very dense
	0.0 – 1.0	MH	22	Very stiff

Hole No.	Depth, m	USCS Classification	SPT N-value	Consistency / Relative Condition
BH-16	1.0 – 2.8	SP	59 – 'refusal'	Very dense
	2.8 – 5.4	Andesite / SP	[32] [coring]	Very dense
	5.4 – 7.5	SP	17	Medium dense
	7.5 – 16.0	MH	[2] 10 – 20	Stiff to very stiff
	16.0 – 20.5	SC	16 – 26	Medium dense
	20.5 – 25.0	SM	39 – 45	Dense
	25.0 – 40.0	SW / SP / SM	[50] 52 – 82	Very dense
BH-1	0.0 – 15.0	SC / SP	26 – 29 [37]	Medium dense
	15.0 – 19.5	MH	20 – 26	Very stiff
	19.5 – 36.0	SM / SP / SW	[27] 31 – 50 [52]	Dense
	36.0 – 40.0	SM / SP	54 – 75	Very dense
NBH-1	0.0 – 6.0	SP / SP-SM	7 – 10 [11]	Loose
	6.0 – 9.0	MH	8–9	Medium stiff
	9.0 – 21.0	SC-SM / ML / SM / SC	12 – 28 [32]	Medium dense
	21.0 – 25.5	MH	18 – 28	Very stiff
	25.5 – 30.0	SC-SM / SC	25 – 30 [42]	Medium dense
	30.0 – 37.5	SC / SC-SM / SM	33 – 44	Dense
	37.5 – 40.0	SP-SM / SM	52 – 54	Very dense
NBH-	0.0 – 7.5	CH	RW - 5	Very soft to soft
	7.5 – 12.0	MH	6–7	Medium stiff

Hole No.	Depth, m	USCS Classification	SPT N-value	Consistency / Relative Condition
	12.0 – 28.5	SC / SM / SW-SM / SP / GW	[9] 10 – 29	Medium dense
	28.5 – 37.5	SP-SM / SP	32 – 48	Dense
	37.5 – 40.0	SM / SP-SM	57 – 61	Very dense
NBH-3	0.0 – 4.0	SM / GP-GM [MH]	7 – 8 [13]	Very loose
	4.0 – 10.5	[MH] SM	22 – 30	Medium dense
	10.5 – 15.0	SM	31 – 46	Dense
	15.0 – 19.5	ML / MH	13 – 18	Stiff to very stiff
	19.5 – 25.5	ML / SP-SM	22 – 28 [40]	Medium dense
	25.5 – 33.0	ML / SP-SM	31 – 40	Dense
	33.0 – 40.0	SW-SM	60 – 80	Very dense

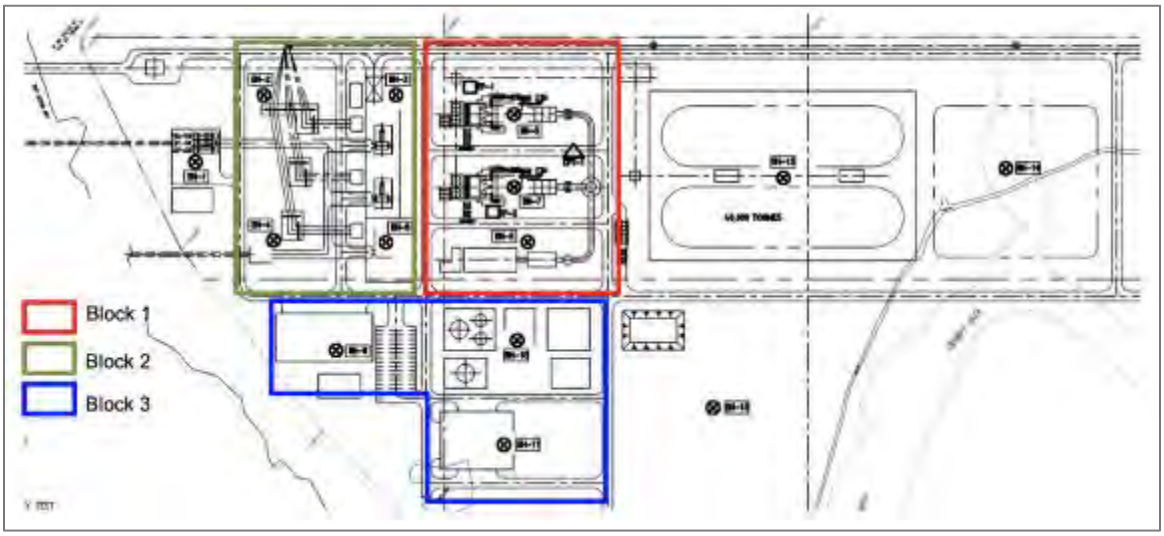


Figure 2.1-27. Partial Borehole Location Map Showing the Blocks.

Inasmuch as the project involves expansion in the same project site/area, baselines are more suitably reckoned from CHANGES and which are deemed more relevant than absolute existing baseline parameters.

Moreover, in the case of baselines for pedology and terrestrial ecology, the pertinent parameters are not measured and reported in the SMRs and neither are they required by the MMT.

These changes are appropriately recognized by comparing the previous and proposed project site, shown in the maps below.

Shown in Table 2.1-4 below are the coordinates of the soil sampling stations for the original project.

Table 2.1-4. The Coordinates of the soil sampling station for the original project.

Station Sample	Coordinates
1	N 8°33’54.8” S 124°44’46.7”
2	N 8°33’38.5” S 124°44’42.3”
3	N 8°33’38.4” S 124°44’55.1”
4	N 8°33’28.1” S 124°45’13”
5	N 8°32’59.9” S 124°45’25.4”
6	N 8°32’51.8” S 124°45’21.5”

The maps of the Soil Sampling Stations are shown below.

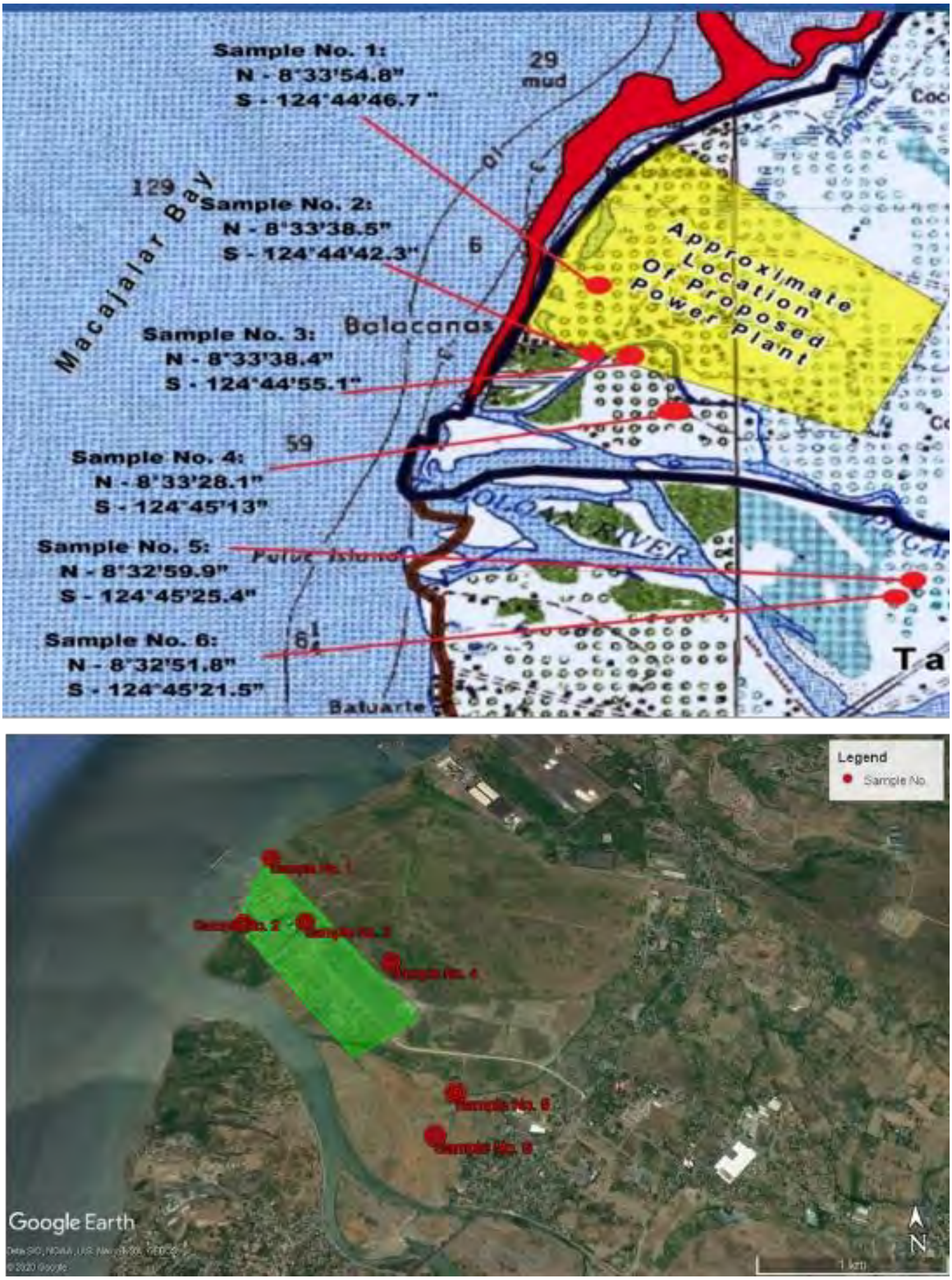


Figure 2.1-28. Maps of the Soil Sampling Stations for the Original Project (Top in NAMRIA, Bottom in google earth)

A typical photograph of the expansion site is shown below.

Plate 2.1-7. Photograph of the Site

2.1.3.1 Soil Erosion/ Loss of Topsoil/ Overburden

Erosion is not as prevalent within the municipality with majority of the barangays assessed as having low susceptibility to erosion associated risks. Only Barangay Imelda (part of Napapong Spring) shows indications of possible severe/high threats to soil erosion although these threats are quite low as it does not pose very significant risk to the community and human lives. In Barangay Kimaya, Looc, Dayawan, Poblacion 1 and Poblacion 2 show indications of moderate threats to soil erosion incidents.

Slight Erosion incidents may be observed in the part of Barangay Katipunan and San Martin. While **no apparent erosion may be observed in the Barangays of Balacanas, Tambobong,** parts of San Martin & Katipunan and Poblacion 3 since these areas are situated in flat terrain.

High to slightly high risk in the occurrence of soil erosion may take place on highly sloped areas like Barangay Imelda, Kimaya and Dayawan. Generally, the area is located within a flat terrain. The site has no apparent erosion according to the generated soil erosion map of the municipality (**Figure 2.1-29**). Erosion in the project area is might be very minimal and temporary and will be encountered only during wet season and during construction activities. As construction and development progress, disturbance of the top soil and subsoil will occur. The exposed top soil will be prone to erosion if left unprotected. Steep cuts will be unstable and become prone to erosion.

Surface and gully erosion will be managed using erosion controls. These controls include the installation of drainage networks to channel surface run-off away from cleared or work areas and installation of erosion control devices when needed.

However, with respect to the specific project site, soil erosion is deemed not significant for the expansion project because:
The construction activities that could potentially lead to soil erosion are confined to the land which is already developed.

Only a small 3 hectare additional land will be required. Inasmuch as this additional land will undergo major soil works, this being for the additional ash pond, no erosion is expected in this additional land.

Key Results of the Soil Investigation at Site (*by Central Southern China Electric Power Design Institute of China Power Engineering Consulting Group, 2014*).

The key results of the soil investigation of the site are presented in Section 2.1-zz; the full report is given in Annex 7, The soil types are shown in Table 2.1-4.

Table 2.1-5. Soil Type of the Project Site/Land

No. of soil layer	①	②	3-1	3-2	⑤	⑥	7-1	7-2
Name of soil layer	Filling soil	Silt	Silty clay	Silty clay	Silty fine sand	Moderate coarse sand with gravel	Silty fine sand with silt interbed	Silty fine sand with silt interbed
Status and compaction	Loose	Loose	Soft plastic	Plastic	Loose	Loose-slightly dense	Loose-slightly dense	Moderate dense
Type of soil	Soft soil	Soft soil	Soft soil	Moderate soft soil	Soft soil	Moderate soft soil	Soft soil	Moderate soft soil
No. of soil layer	7-3	8-1	8-2	8-3	⑨	10-1	10-2	
Name of soil layer	Silty fine sand with silt interbed	Silt	Silt	Silt	Moderate coarse sand with gravel	Silty clay	Silty clay	
Status and compaction	Dense	Slightly dense	Moderate dense	Dense	Moderate dense-dense	Plastic	Hard plastic	
Type of soil	Moderate hard soil	Soft soil	Moderate soft soil	Moderate hard soil	Moderate hard soil	Moderate soft soil	Moderate hard soil	

The maps below shown provide a good appreciation and adequate assessment of the project impacts due to soil erosion.

Plate 2.1-8. Aerial Photograph of the project facilities

Plate 2.1.-9. Additional aerial photographs

Additional Discussions:

Water and wind erodibility potential, sediment sources, etc.

The erosional aspects are those associated with soil movements which principally occur during the construction phase.

The soil, water (rainfall) and wind as factors of erosion

Erosion Potential Assessment Parameters

Table 2.1-6. Composite Erosion Susceptibility Decision Rule

Individual Susceptibilities (Rainfall-Land use-Slope-Soil)	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
S – Slight susceptible M – Moderately susceptible H – Highly susceptible	

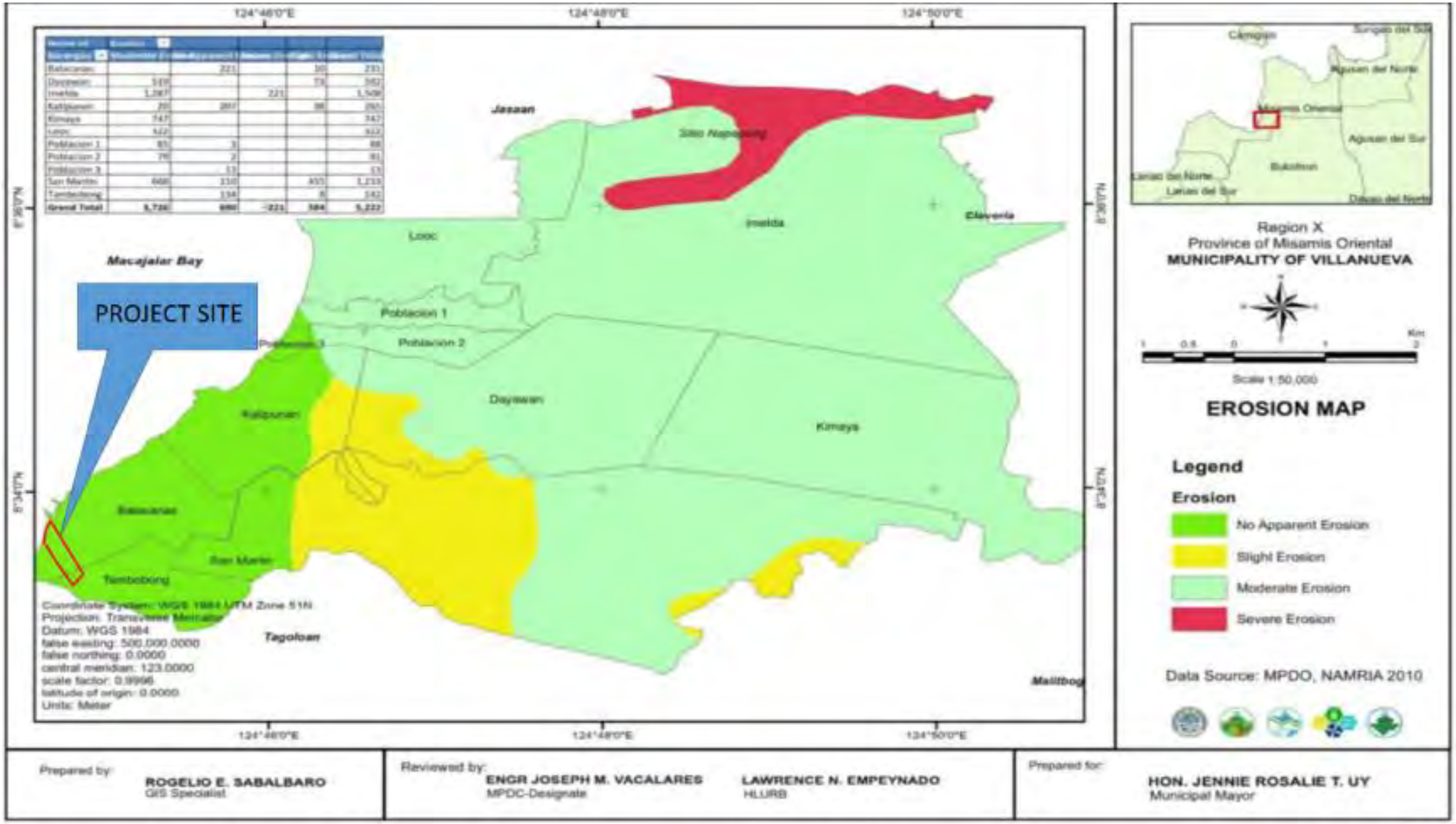
Table 2.1-7. The Rainfall Factor

Degree of Susceptibility	Rainfall Characteristics
Slight	5 to 6 dry months/ 3 to 4 wet months
Moderate	2 to 6 dry months/ 5 to 6 wet months
High	5 to 6 dry months/ 5 to 6 wet months with at least one month with precipitation of 500mm or more

Table 2.1-8. Erodibility and Slope

Erodibility	Rainfall Characteristics
Slight	Level to nearly level (0-3% slope)
Moderate	Undulating and rolling (3 to 18% slope)
High	Rolling to moderately steep (18% and above)

From the referenced (The CLUP of the Municipality of Villanueva) the following information/data are extracted.



Source: Villanueva CLUP, 2017-2027

Figure 2.1-29. Soil Erosion Map of Municipality of Villanueva

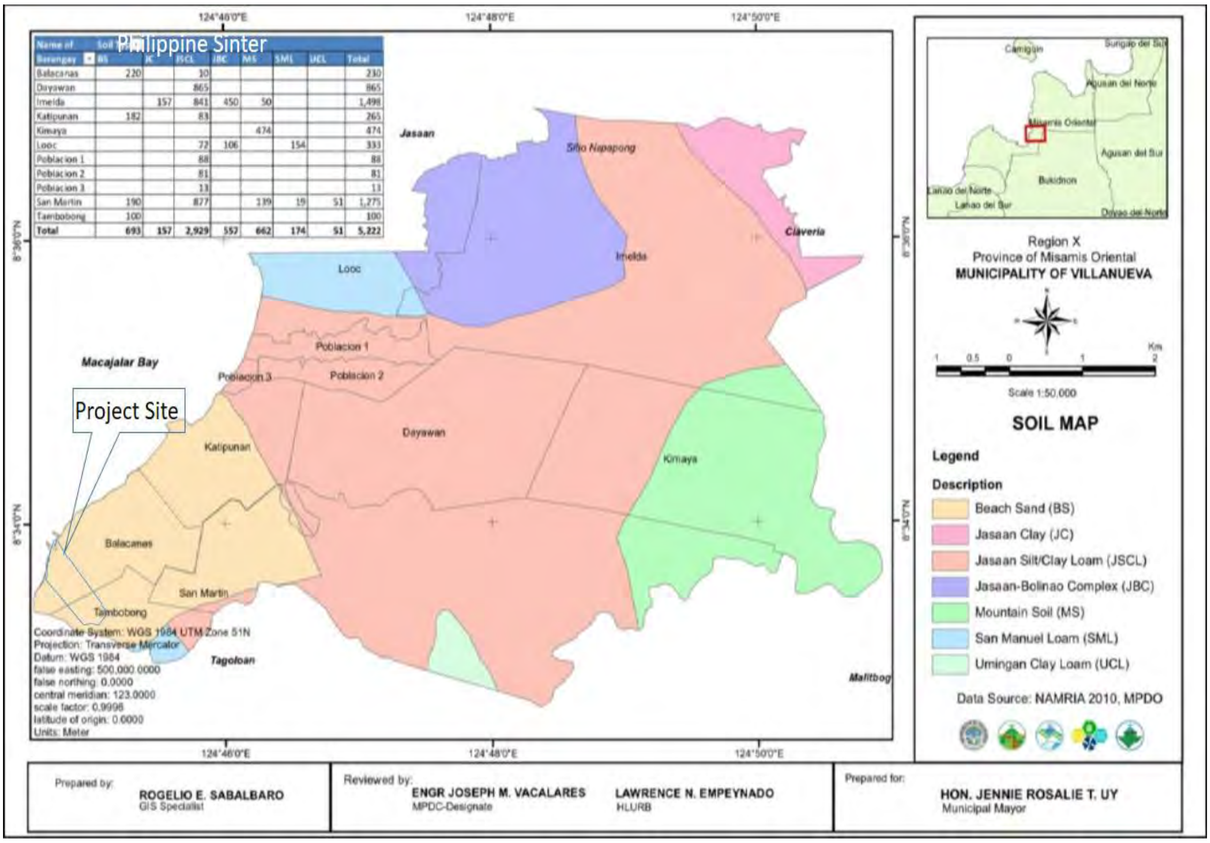


Figure 2.1-30. The Soil Map of Villanueva

Table 2.1-9. Erodibility Potential of the Barangays in Villanueva (Reference: CLUP)

Barangay	Erosion Potential				
	Moderate	No Apparent	Severe	Slight	Grand Total
Balacanas		221		10	231
Dayawan	519			73	592
Imelda	1287		221		1508
Katipunan	20	207		38	265
Kimaya	747				747
Looc	322				322
Poblacion 1	85	3			88
Poblacion 2	79	2			81
Poblacion 3		13			13
San Martin	668	110			1233
Tambobong	3,276	134			142
Grand Total	3 276	690	221	584	5,222

Assessments

Based on "macroscopic" level (i.e., the Municipality) the involved Barangays (Bacalanas and Tambobong) are of **moderate** erosion potentials.

At the "microscopic" level, i.e., **at the project site**, the project area is deemed to fall under the classification of "No apparent" to "slight" erosion potential; for the following reasons:

There has not been experienced significant erosion problems even with the original project;
The expansion project covers essentially the same areas as the original project;

The expansion site is not only flat in topography (a factor to erosion) but more importantly there will be no major construction works with the expansion project.

With respect to "sediment sources" there are essentially no significant sediment transport/movement with the expansion project. Earthworks will be minor because the construction site is already developed. During the operations phase there will be no sediment discharges from the power plant complex. The generated ash will either be landfilled (for the bottom ash) and thus "encapsulated" in the repository pond or transported to a third-party user (for the fly ash).

From these maps it is evident that the expansion area is in a developed flat land. The original project has not resulted in erosion problems. The project expansion area which will be located within the original area except for some expansion facilities which will also be in the developed flat land will therefore not result in erosion problems/issues. The original project has not created or resulted in water and wind erodibility potential, sediment sources, etc. The same can be said and assessed for the expansion areas.

2.1.3.1.1 Loss of Top Soil/Overburden

Unlike extractive activities such as mining, the site needs earth movement for the following purposes only:

a. To achieve desired grading/finished elevation
b. To prepare portions of the site for foundation works and underground pipings for electrical and piping systems
c. To provide drainage system

For the above purposes (of earthworks) the estimated gross amount of soil movement is not expected to be substantial due to the partial development already undertaken at the site of flat terrain. Further, the soil moved will not be exported to outside the site and instead be used for backfilling the net loss of top soil is essentially nil.

Erodibility potential is considered insignificant because of the site flat terrain and the minimum amount of earthworks. **Bank stability** is not germane because of the absence of immediately adjacent banks which have to be protected.

Potential land contamination due to project operations and relation to soil characteristics. The potential for land contamination is determined by the following factors:

a. Concentration of toxic metallic substances in the generated ash
b. Ash management system

In any coal power plant, bottom and fly ash will be generated from the boilers and the electrostatic precipitator, respectively.

On the basis of typical good quality coal used in Philippine coal power plants it may be expected that the ash will not fall within the classification of "Hazardous Wastes" under the "Procedural Manual Title III of DAO 92-29" shown in Annex 14.

Soil characteristics is referenced in respect of ability to cause leachate transport to the Macajalar Bay. Leaching is not deemed to be a serious concern for the expansion project because (a) hazardous leachates are not expected to be generated (b) historical record of underground water based on the SMRs show compliance to key parameters for underground water quality. A typical report is shown in

Table 2.1-10 and (c) the Ash Repository Facility is engineered to prevent leachates penetrating to the soils.

Table 2.1-10. Typical Results of Ground Water Quality Monitoring (Basis SMRs)

Ground Water Quality Monitoring

Outlet No. 3	Ash Yard 3 Lat: 8.33250 Long: 124.45114								
DATE	Effluent Flow Rate (m^3)	pH	Temperature (°C)	Color (TCU)	TSS (mg/L)	Chorides, Cl (mg/L)	Nitrate, No_3 (mg/L)	Phosphates, PO_4^3 (mg/L)	Fecal Coliform (MPN/100mL)
DENR Standard	NA	6.5-8.5	26-30	50	65	250	7	0.5	100
October 16, 2019	NA	7.4	28	5	17	16.5	0.02	0.04	2
November 20, 2019	NA	7.4	31	5	26	15	0.42	<0.01	$24x10^2$

Outlet No. 3	Ash Yard 3 Lat: 8.33323 Long: 124.45054								
DATE	Effluent Flow Rate (m^3)	pH	Temperature (°C)	Color (TCU)	TSS (mg/L)	Chorides, Cl (mg/L)	Nitrate, No_3 (mg/L)	Phosphates, PO_4^3 (mg/L)	Fecal Coliform (MPN/100mL)
DENR Standard	NA	6.5-8.5	26-30	50	65	250	7	0.5	100
October 16, 2019	NA	7.5	28	5	18	24.5	0.15	0.06	2
November 20, 2019	NA	7.8	32	5	59	9.2	0.42	<0.01	79

Impact Assessment

Key Features of the Project Site and of the Expansion Activities

- The expansion site is already well developed and is largely a flat terrain.
- The construction and expansion activities will involve only a small portion of the project site.

- Soil erosion/Loss of topsoil/overburden

Given the above site features and the activities that will involve soil or earth works are confined to foundation works, these aspects are not deemed highly significant vis a vis impacts. The existing site consists of built-up areas which involve only the existing power plant. The entire PHIVIDEC estate/land is featured by built up areas.

Streams, Riverbank stability

There are no construction or operations activities that will impact on the riverbank or stream stability of the Tagoloan River. The pumphouse at Tagoloan is already constructed and its improvement has no impact on river stability or on water, wind erodibility potential.

Neither the construction works nor the operation of the expanded power plant will result in sediment transport.

Overall the site will be accommodate the impact of the construction activities for the expansion project.

Soil map showing soil types, sampling stations, topography, streams, built-up areas and planned project features

- Water and wind erodibility potential
- Sediment sources
- Riverbank Stability

The USLE is deemed not relevant in the absence of soil loss. Earth excavated will be reused as foundation fill materials or to fill up any low lying areas, hence no soil loss is expected.

2.1.3.2 Change in Soil quality/fertility

In terms of chemicals and substances such as N, P, K, organic matter, micronutrients and trace metals, e.g., Pb, Hg, As, Cd and Cr + 6 are deemed not significant because parameters are more relevant for agricultural or similar usage of land. The site is not intended for these purposes.

Possibility of spills on soil quality and fertility

This possibility is deemed not highly significant for the same reasons as above given. Concern for ash leachates is more relevant to underground quality and not to soil quality. The SMRs for underground water in the ash pond areas show compliances with underground water quality.

The impacts on soil quality are reckoned from:

- The baseline data and
- The beneficial use of soil to determine the applicable quality and fertility data.

There has been no monitoring of soil quality/fertility inasmuch as such monitoring not required for the SMRs/CMVRs and by the MMT. This is because the soil/ land involved is not intended for agricultural purposes which with otherwise required soil quality analysis and trending.

Thus “changes” in soil quality/fertility cannot be assessed accurately.

However, the beneficial use of the land/soil is for industrial projects, i.e. not for agricultural purposes.

For the project the relevant parameters vis-à-vis soil relate to ash leaching. Shown below is a recent soil analysis (August 10 2020)

The SMRs/CMVRs do not include similar soil tests.

Sample Descriptions	Parameters	Results	Units
Soil Samples			
Soil 1	Hexavalent Chromium (Cr^{+6})	<0.10	mg/kg
309° NW	Mercury (Hg) [a]	<0.004	mg/kg
Lat: 8°33'29"N	Arsenic (As)	2.39	mg/kg
Long: 124°44'50"E	Lead (Pb)	<0.10	mg/kg
	Cadmium (Cd)	<0.03	mg/kg
Soil 2	Hexavalent Chromium (Cr^{+6})	<0.10	mg/kg
122° SE	Mercury (Hg) [a]	<0.004	mg/kg
Lat: 8°33'38"N	Arsenic (As)	2.81	mg/kg
Long: 124°45'2"E	Lead (Pb)	<0.10	mg/kg
	Cadmium (Cd)	<0.03	mg/kg
Soil 3	Hexavalent Chromium (Cr^{+6})	<0.10	mg/kg
61° NE	Mercury (Hg) [a]	<0.004	mg/kg
Lat: 8°33'34"N	Arsenic (As)	2.79	mg/kg
Long: 124°44'55"E	Lead (Pb)	<0.10	mg/kg
	Cadmium (Cd)	<0.03	mg/kg

The potential impacts on the project with respect to soil may arise from ash leachates. However, the above test results do not suggest adverse impacts given the low values of the metallics. The above results are compared to the Dutch Intervention Values (DIVs)

Parameter	Test Results	Dutch Intervention Values
Soil Sample 1		
Hexavalent Chromium (Cr+6)	<0.10 mg/kg	380 mg/kg
Mercury (Hg)	<0.004 mg.kg	10 mg/kg
Arsenic (As)	2.39 mg/kg	55 mg/kg
Lead (Pb)	<0.10 mg/kg	530 mg/kg
Cadmium (Cd)	<0.03 mg/kg	12 mg/kg
Soil Sample 2		
Hexavalent Chromium (Cr+6)	<0.10 mg/kg	380 mg/kg
Mercury (Hg)	<0.004 mg.kg	10 mg/kg
Arsenic (As)	2.81 mg/kg	55 mg/kg
Lead (Pb)	<0.10 mg/kg	530 mg/kg
Cadmium (Cd)	<0.03 mg/kg	12 mg/kg
Soil Sample 3		
Hexavalent Chromium (Cr+6)	<0.10 mg/kg	380 mg/kg
Mercury (Hg)	<0.004 mg.kg	10 mg/kg
Arsenic (As)	2.79 mg/kg	55 mg/kg
Lead (Pb)	<0.10 mg/kg	530 mg/kg
Cadmium (Cd)	<0.03 mg/kg	12 mg/kg

Based from the above, it is evident that there has been no soil quality degradation brought about by the project. Although there is only one sampling/test date, had there been leachates from the ash these would have accumulated over time and the results thereby reflected in the current tests.

2.1.4 Terrestrial Ecology

The assessment of flora and fauna is deemed to be more appropriate reckoned from the “changes” in the original project and the expansion project. It is noted that monitoring of the terrestrial species is neither undertaken for the SMRs nor is required by the MMT. Of further note is there has not been any complaints from any party nor entity on the current project that relate to terrestrial ecology.

Accordingly the Report for the original project (May 2013) is taken as the baseline and is hereunder given verbatim.

SAMPLING STATIONS OF THE STUDY AREA

The vegetation of the area consists of relics of mangrove swamp, open or grassland areas, patches of trees and well-developed plantation. **Table 2.1-11** and **Figure 2.1-31** below shows the location of the sampling stations for fauna and flora assessment.

Table 2.1-11. Location of Sampling Stations and Types of Vegetation

SAMPLING STATIONS	GEOGRAPHICAL COORDINATES	TYPE OF VEGETATION
Station 1	8°33'43.98"N 124°44'43.31"E	Grassland facing sea shore
Station 2	8°33'40.24"N 124°44'42.36"E	Swamp patch
Station 3	8°33'36.59"N 124°44'44.23"E	Swamp patch associated with shrubs and trees
Station 4	8°33'34.93"N 124°44'44.51"E	Grassland/shrubland
Station 5	8°33'33.61"N 124°44'45.70"E	Grassland/shrubland
Station 6	8°33'32.30"N 124°44'46.99"E	Swamp patch associated with shrubs and trees
Station 7	8°33'33.38"N 124°44'50.05"E	Grassland/shrubland
Station 8	8°33'35.52"N 124°44'56.93"E	Grassland/shrubland
Station 9	8°33'41.11"N 124°44'58.34"E	Grassland/shrubland

The maps below provide glimpses of the land cover of the terrestrial ecology.

Map showing the project facilities relative to the surrounding vegetative cover

Plate 2.1-10. The ash pond area below showing sparse vegetative cover

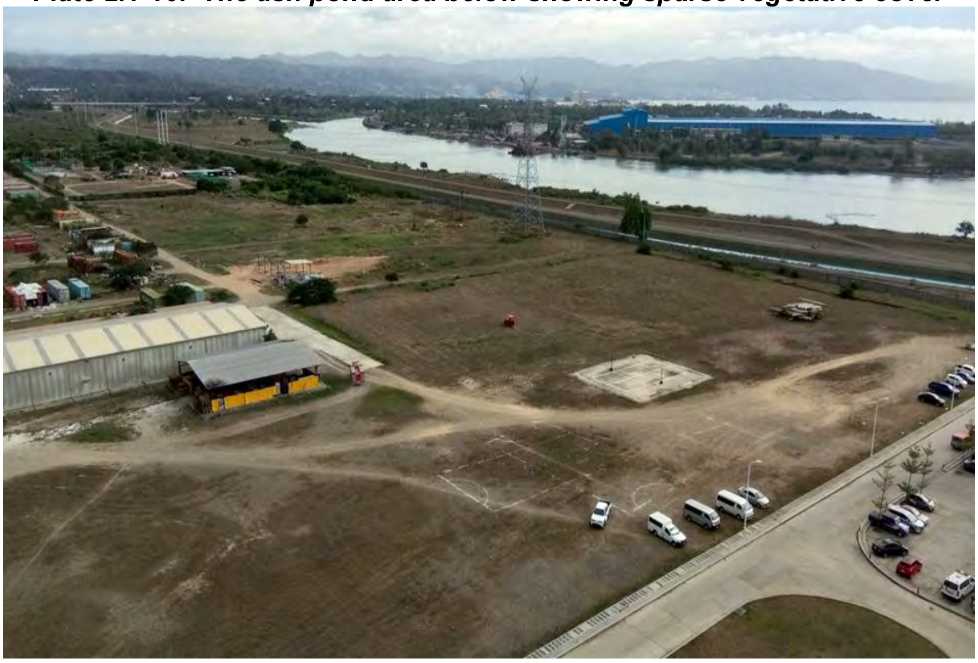


Plate 2.1-11. The project facilities including the covered coal storage

Figure 2.1-31. Map showing the land cover on the project site

It is thus evident from the above maps that:

(a) The vegetative/floral species are sparse and
(b) These are outside the project facilities wherein construction works and operations will be undertaken.

It may be concluded that the impacts on terrestrial (floral) ecology are considered insignificant.

Plate 2.1-12. Photo showing mangrove swamp within the project site

(Photo: BENJAMIN R. CUEVAS, Terrestrial Ecologist)

Plate 2.1-13. Photo showing the strips of forest trees along the perimeter area of the project site

(Photo: BENJAMIN R. CUEVAS, Terrestrial Ecologist)

2.1.4.1 FLORA/ VEGETATION ASSESSMENT for the Original Project

Methodology

Prior to actual assessment, available secondary data were gathered relevant to the study area from the proponent to initially study the expansion area and be able to develop with a working map. Secondary data obtained includes location map and land use map.

Reconnaissance survey was conducted to get an initial impression of the study area in terms of homogeneity and/or heterogeneity of the plant communities and habitat type (ecosystem) as well as the overall condition of the area--topography, terrain, soil characteristics, presence of creeks and gullies, and other physical features relevant to floral assessment. This was done to observe the overall physical characteristics of the area and be able to determine the appropriate actions/methods to be used for primary data gathering.

Primary data gathering of arboreal vegetation was conducted using Rapid Resource Assessment (RSA) to estimate the present condition of floral species found within the direct impact areas. Terrestrial floral survey and assessment follows the Quadrat Sampling Method (QSM) with 10m x 10m (100m^2) dimensions established on the ground using Global Positioning System (GPS) along the transect walk/line with either ridges, trails, creeks, and gullies as access point. Floral inventory involves characterizing and assessing floral assemblages (i.e. open/grassland and second growth forest) to approximate the relativities of densities, frequencies, dominance, and importance values of each species and plant community (habitat) found within the proposed expansion area. Other relevant information such as locations/coordinates and the biophysical condition of each sampling stations were recorded as well as land-use and type of vegetation. Plant species and plant form/habit were identified and recorded in-situ following the scientific standard of taxonomic nomenclatural and classification system. Endemicity, conservation and ecological status, economic importance and uses were also provided in the report.

For computing the various indices, measures of absolute and relative abundance were used to assess the distribution of each species to a community. These measures include the relativities of density, frequency, dominance, and importance values which illustrates how the indices changes relative to the number species in a given sampling station. Below are the formulas used to determine the indices of each species in a given sampling stations:

1) Density = total number of plants of a certain species / total area sampled
2) Frequency = total number of quadrats in which a species occurs / total number of quadrats
3) Dominance = total basal area of a species / total area sampled
4) Relative Density = 100 x density of a particular species / sum of the densities of all species
5) Relative Frequency = 100 x frequency of a particular species / sum of the frequencies of all species
6) Relative Dominance = 100 x dominance of a species / sum of the dominance of all species
7) Importance Value = Relative Density + Relative Frequency + Relative Dominance

For diversity measurements, the Shannon-Weiner Diversity Index was used to estimate habitat quality of each sampling stations. This method is one of the most widely used for computing species diversity index for examining the overall community characteristics comparing two or more distinct habitats. Measurement of diversity is significant and important in determining the quality of every ecological system. Shannon-Weiner Biodiversity Index was used to compute the biodiversity levels of each ecosystem. The Shannon Index is a measure of the average of “uncertainty” in predicting to what species an individual chosen at random from a collection of *S* species and *N* individuals will belong (Magurran, 1998). The indices could later be used as an indicator of biodiversity loss or gain when used as monitoring tools. Below is the formula for Shannon-Weiner Biodiversity Index:

$H' = -[\sum(p_i)(\ln p_i)]$, where, "H'" - represents the symbol for the amount of diversity in an ecosystem;
"p_i" - represents the proportion or relative abundance of each individual species to the total (measured from 0 to 1)
"ln p_i" - represents the natural logarithm of p_i

The uncertainty of occurrence increases both as the number of species increases and as the individuals are distributed more and more evenly among the species already present. Using Fernando Biodiversity Scale (1998), Shannon Biodiversity Index may result in diversity value (H) ranging from zero indicating low community complexity to 3.5 an above which indicates very high community complexity. Table 3.1.4 presents the Fernando Biodiversity Scale (1998) which indicates the level of community complexity.

The maximum possible species diversity (H_{max}) for a community of species would be the condition where the individuals composing the community were **evenly distributed** among all ***S*** species.This is the condition of maximum evenness. Species evenness can be calculated by dividing the species diversity of the community (**H'**) by the maximum possible diversity for the community denoted by $\mathbf{J=H/H_{max}}$ when$\mathbf{H=H_{max}}$ the community has reached its maximum diversity. The value of **J** will approach zero (0) as the community becomes dominated by a single species. This means that diversity is decreasing. The formula for species evenness then, $\mathbf{J = H/H_{max} = -\sum(p_i)\ (\ln p_i)\ /\ \ln S}$, where ***S*** is the number of species in the community. Table 3.1.2 shows the Fernando Biodiversity Scale following the Shannon-Weiner Biodiversity Index and Pielou Evenness Index indicating the level of community complexity.

Table 2.1-12. The Fernando Biodiversity Scale, 1998

Relative Values	Shannon Biodiversity (H') Index	Pielou (J') Evenness Index
Very High	3.5 and above	0.75-1.00
High	3.0 – 3.49	0.50-0.74
Moderate	2.5 – 2.99	0.25-0.49
Low	2.0 – 2.49	0.15-0.24
Very Low	1.9 and below	0.05-0.14

2.1.4.2 Threat to existence and/or loss of important local species

2.1.4.2.1 Summary of endemicity / conservation status

The study area recorded a total of 49 species of flora representing 47 genera belonging to 27 families were identified. In terms of number of representative species, families ASTERACEAE and FABOIDAE were well represented with five species each. A total of 295 plant individuals were recorded in the project site. The species of *Sorghum halapense*(POACEAE) has the most number of populations with 25 representing 8.47% of the total population followed by *Acmellauliginosa*, *Lantana camara*, *Chromolaenaodorata*, all of which belongs to family Asteraceae with 22 or 7.46% each. Other ranking individuals are *Thysonolaenalatifolia* of family Poaceae with 20 or about 6.78% of the total individual. **Table *2.1-13*** below presents the total number of species population of the study area prior to the implementation of the original project, and given as a baseline backgrounder only. However, using the current site conditions as baselines these information are deemed no longer relevant.

Table 2.1-13. Percent Total of Species Population

Spp. No.	Scientific Name	Common Name	Family Name	Total No. of Individual	% of Total
1	*Coryphautan*	Nipa	Arecaceae	22	7.46
2	*Agathisanthemumglobosum*	Agathisanthemum spp.	Rubiaceae	3	1.02
3	*Albiziaprocera*	Akleng-parang	Mimosoidae	5	1.69
4	*Melanolepismultiglandulosa*	Alim	Euphorbiaceae	5	1.69
5	*Antherotomaphaeothrica*	Antherotoma spp.	Melastomataceae	6	2.03
6	*Acacia farnesiana*	Aroma	Mimosoidae	7	2.37
7	*Ficusbenjamina*	Balite	Moraceae	2	0.68
8	*Solanumbiflorum*	Bagan-bagan	Solanaceae	5	1.69
9	*Musa sapientum*	Banana	Musaceae	7	2.37
10	*Morindacitrifolia*	Bangkoro	Rubiaceae	5	1.69
11	*Pongamiapinnata*	Bani	Faboidae	2	0.68
12	*Psidiumguajava*	Bayabas	Myrtaceae	2	0.68
13	*Voacangaglobosa*	Bayag-usa	Apocynaceae	4	1.36
14	*Stylophorumdiphyllum*	Celandine poppy	Papaveraceae	3	1.02
15	*Chamaecristamimosoides*	Chamaecrista spp.	Mimosoidae	1	0.34
16	*Cocosnucifera*	Coconut	Areceae	2	0.68
17	*Lantana camara*	Coronitas	Asteraceae	22	7.46
18	*Muntigiacalabura*	Datiles	Elaeocarpaceae	4	1.36
19	*Ectadiopsisoblongifolia*	Ectadiopsis spp.	Asclepiadaceae	1	0.34
20	*Gomphrenacelosioides*	Gomphrena spp.	Amaranthaceae	3	1.02
21	*Elusineindica*	Goose grass	Poaceae	10	3.39
22	*Ficusseptica*	Hauili	Moraceae	6	2.03
23	*Dysoxylumgaudichaudianum*	Igyo	Meliaceae	5	1.69
24	*Ficusasper*	Is-is	Moraceae	2	0.68
25	*Gmelinaarborea*	Yemane/ Gmelina	Verbenaceae	5	1.69
26	*Sorghum halapense*	Johnson grass	Poaceae	25	8.47
27	*Gliricidiasepium*	Kakawate	Faboidae	3	1.02
28	*Ptecelebiumdulce*	Kamatchile	Caesalpiniodae	1	0.34
29	*Clerodendrummacrostegium*	Kasupangil	Lamiaceae	2	0.68
39	*Triumfettarhomboidea*	Kolot-kolotan	Malvaceae	10	3.39
31	*Urenalobata*	Kollo-kullot	Malvaceae	18	6.10
32	*Mimosa pudica*	Makahiya	Mimosoidae	7	2.37
33	*Pterocaprpusindicus*	Narra	Faboidae	2	0.68
34	*Tabernaemontanapandacaqui*	Pandakaki	Apocynaceae	2	0.68
35	*Pandanustectorius*	Pandandagat	Pandanaceae	3	1.02
36	*Pogostemoncablin*	Patchouli	Lamiaceae	16	5.42
37	*Flemingiastrobilifera*	Payang-payang	Faboidae	2	0.68
38	*Pennisetumnodiflorum*	Pennisetum	Poaceae	2	0.68
39	*Echinacea purpurea*	Prairie dropseed	Asteraceae	3	1.02
40	*Samaneasaman*	Rain tree	Mimosoidae	1	0.34
41	*Blumeabalsimefera*	Sambong	Asteraceae	3	1.02
42	*Terminaliacatappa*	Talisay	Combretaceae	3	1.02
43	*Daturametel*	Talumpunay	Solanaceae	2	0.68

Spp. No.	Scientific Name	Common Name	Family Name	Total No. of Individual	% of Total
44	*Thysonolaenalatifolia*	Tambo	Poaceae	20	6.78
45	*Ficus nota*	Tibig	Moraceae	2	0.68
46	*Zebrinapendula*	Wandering jew	Commelinaceae	3	1.02
47	*Garuga floribunda*	Bogo	Burseraceae	1	0.34

2.1.4.2.2 Summary of Relative Density, Relative Frequency, Relative Dominance, and Importance Value of All Species

Measures of absolute and relative abundance are used to assess the contribution of each species to a community. These measures include **density**, the number of individuals within a chosen area; **relative density**, the density of one species as a percentage of total density; **frequency**, the percentage of total quadrats or points that contains at least one individual of a given species; **relative frequency**, the frequency of one species as a percentage of total frequency; **dominance**, the total basal area of a given species per unit area within the community; **relative dominance**, the dominance of one species as a percentage of total dominance; and **importance value**, expressed as the relative contribution of a species to the entire community expressed as a combination of relative density, relative frequency, and relative dominance.

Each measures offer a different insight into the abundance of the species composing a community. Density tells us the number of individuals per unit area but density is not necessarily proportional to dominance because dominance for a given species expresses the area occupied by the species per unit area. A species composed of primarily large individuals can have high dominance but it will likely have low density, and unless regularly distributed, it will also have low frequency. Frequency, which is often independent of density, expresses one measure of the distribution of individuals within the community. A clumped species can have high density but also low frequency because it occurs in a limited portion of the community. In contrast, a species that is individually and regularly distributed over the landscape will have a high frequency but can have low density. Relative importance, as a combination of relative values for density, frequency, and dominance, is used as a summary of the influence that an individual species may have within the community. Recognize that two species with the same relative importance can have markedly different values for relative density, frequency, or dominance as any differences can be overshadowed by the addition process. Table 3.1.4 provides the summary of relativeness in terms of density, frequency, dominance, and importance value of all species recorded in the study area.

Relative Density of All Species

The relative density of a species is expressed as the percentage of the total number of individual species per unit area. Of the 49 species identified in the study area, the most abundant species in terms of relative density is *Sorghum halapense* (POACEAE) with a total of 25 individuals occupying about 8.47% of the total area sampled followed by *Acmellauliginosa*, *Lantana camara*, *Chromolaenaodorata*, all of which belongs to family Asteraceae with 22 or 7.46% each. Most of these species are sun loving species extensively distributed in open area with saline soils in the lowland and coastal areas.

Relative Frequency of All Species

Relative frequency is defined as the percentage of a number of times of a species occurred in all samples of a given area. As mentioned in the preceding paragraph, frequency is independent of density. It expresses one measure of the distribution of individuals within the community. A clumped species can have high density but also low frequency because it occurs in a limited portion of the community. In contrast, a species that is individually and regularly distributed over the landscape will have a high frequency but can have low density. The importance of determining the relative frequency is we may be able to find out the distribution of an individual species and the range of its succession in an ecosystem. The study area consists of a combination of clustered or aggregated and randomly or highly scattered individuals of floral species and composition. Species occurred in all sampling stations are *Lantana camara* and *Chromolaenaodorata* of the family Asteraceae with 5.76% each. These species are known to be invasive, thus, it is not surprising that they are present in all sampling stations.

Relative Dominance of All Species

Relative dominance is defined as the percentage of the total basal area of all species per unit area with the community. In the study area, the most dominant species in the study area are as follows (descending order); *Acacia farnesiana*(12.82%), *Terminaliacatappa*(9.89%), and *Dysoxylumgaudichaudianum* (9.16%). This means that their presence in the area indicates a tendency to dominate in terms of occupying the space both horizontal and vertical in the future.

Importance Value of All Species

Importance value is expressed as the relative contribution of a species to the entire community expressed as a combination of relative density, relative frequency, and relative dominance. This is used to determine the species' level of biodiversity and other influences of the ecosystem of a given area. As expected, the species with the highest IV belongs to *Acacia farnesiana* (16.92%), *Lantana camara, Chromolaenaodorata,* and *terminaliacatappa* with 12.63% apiece followed by *Dysoxylumgauduchaudianum* (12.58%) and *Ficusseptica* with 12.08%. This means that their presence indicates a tendency to dominate the area and their contribution to biodiversity may manifest influence to the overall species composition of the ecosystem in the future.

Table 2.1-14. List of species observed and recorded in the project site and their relative indices

Spp. No.	Scientific Name	Common Name	Family Name	Total No. of Individual	% of Total	Rel Density	Rel Frequency	Rel Dominance	Importance Value (IV)
1	*Coryphautan*	Nipa	Arecaceae	22	7.46	7.46	1.72	0	9.18
2	*Agathisanthemumglobosum*	Agathisanthemum spp.	Rubiaceae	3	1.02	1.02	1.72	0	2.74
3	*Albiziaprocera*	Akleng-parang	Mimosoidae	5	1.69	1.69	3.45	0	5.14
4	*Melanolepismultiglandulosa*	Alim	Euphorbiaceae	5	1.69	1.69	1.72	5.49	8.91
5	*Antherotomaphaeothrica*	Antherotoma spp.	Melastomataceae	6	2.03	2.03	1.72	0	3.76
6	*Acacia farnesiana*	Aroma	Mimosoidae	7	2.37	2.37	1.72	12.82	16.92
7	*Ficusbenjamina*	Balite	Moraceae	2	0.68	0.68	1.72	1.47	3.87
8	*Solanumbiflorum*	Bagan-bagan	Solanaceae	5	1.69	1.69	1.72	0	3.42
9	*Musa sapientum*	Banana	Musaceae	7	2.37	2.37	1.72	0	4.1
10	*Morindacitrifolia*	Bangkoro	Rubiaceae	5	1.69	1.69	1.72	5.49	8.91
11	*Pongamiapinnata*	Bani	Faboidae	2	0.68	0.68	1.72	4.4	6.8
12	*Psidiumguajava*	Bayabas	Myrtaceae	2	0.68	0.68	1.72	2.93	5.33
13	*Voacangaglobosa*	Bayag-usa	Apocynaceae	4	1.36	1.36	1.72	0	3.08
14	*Stylophorumdiphyllum*	Celandine poppy	Papaveraceae	3	1.02	1.02	1.72	0	2.74
15	*Chamaecristamimosoides*	Chamaecrista spp.	Mimosoidae	1	0.34	0.34	1.72	0	2.06
16	*Cocosnucifera*	Coconut	Areceae	2	0.68	0.68	1.72	2.2	4.6
17	*Lantana camara*	Coronitas	Asteraceae	22	7.46	7.46	5.17	0	12.63

Spp. No.	Scientific Name	Common Name	Family Name	Total No. of Individual	% of Total	Rel Density	Rel Frequency	Rel Dominance	Importance Value (IV)
18	*Muntigiacalabura*	Datiles	Elaeocarpaceae				1.72		
19	*Ectadiopsisoblongifolia*	Ectadiopsis spp.	Asclepiadaceae				1.72		
20	*Gomphrenacelosioides*	Gomphrena spp.	Amaranthaceae	3	1.02	1.02	1.72	0	2.74
21	*Elusineindica*	Goose grass	Poaceae	10	3.39	3.39	1.72	0	5.11
22	*Chromolaenaodorata*	Hagonoi	Asteraceae	22	7.46	7.46	5.17	0	12.63
23	*Ficusseptica*	Hauili	Moraceae	6	2.03	2.03	3.45	6.59	12.08
24	*Dysoxylumgaudichaudianum*	Igyo	Meliaceae	5	1.69	1.69	1.72	9.16	12.58
25	*Ficusasper*	Is-is	Moraceae	2	0.68	0.68	1.72	2.93	5.33
26	*Gmelinaarborea*	Yemane/ Gmelina	Verbenaceae	5	1.69	1.69	3.45	3.66	8.81
27	*Sorghum halapense*	Johnson grass	Poaceae	25	8.47	8.47	3.45	0	11.92
28	*Gliricidiasepium*	Kakawate	Faboidae	3	1.02	1.02	1.72	6.59	9.33
29	*Ptecelebiumdulce*	Kamatchile	Caesalpiniodae	1	0.34	0.34	1.72	2.93	4.99
30	*Clerodendrummacrostegium*	Kasupangil	Lamiaceae	2	0.68	0.68	1.72	0	2.4
31	*Triumfettarhomboidea*	Kolot-kolotan	Malvaceae	10	3.39	3.39	1.72	0	5.11
32	*Urenalobata*	Kollo-kullot	Malvaceae	18	6.1	6.1	1.72	0	7.83
33	*Mimosa pudica*	Makahiya	Mimosoidae	7	2.37	2.37	3.45	0	5.82
34	*Pterocaprpusindicus*	Narra	Faboidae	2	0.68	0.68	1.72	8.79	11.19
35	*Tabernaemontanapandacaqui*	Pandakaki	Apocynaceae	2	0.68	0.68	1.72	0	2.4

Spp. No.	Scientific Name	Common Name	Family Name	Total No. of Individual	% of Total	Rel Density	Rel Frequency	Rel Dominance	Importance Value (IV)
36	*Pandanustectorius*	Pandandagat	Pandanaceae	3	1.02	1.02	1.72	0	2.74
37	*Pogostemoncablin*	Patchouli	Lamiaceae	16	5.42	5.42	1.72	0	7.15
38	*Flemingiastrobilifera*	Payang-payang	Faboidae	2	0.68	0.68	1.72	0	2.4
39	*Pennisetumnodiflorum*	Pennisetum	Poaceae	2	0.68	0.68	1.72	0	2.4
40	*Echinacea purpurea*	Prairie dropseed	Asteraceae	3	1.02	1.02	1.72	0	2.74
41	*Samaneasaman*	Rain tree	Mimosoidae	1	0.34	0.34	1.72	5.13	7.19
42	*Blumeabalsimefera*	Sambong	Asteraceae	3	1.02	1.02	1.72	0	2.74
43	*Caesalpinianuga*	Sapinit	Caesalpiniodae	3	1.02	1.02	1.72	0	2.74
44	*Terminaliacatappa*	Talisay	Combretaceae	3	1.02	1.02	1.72	9.89	12.63
45	*Daturametel*	Talumpunay	Solanaceae	2	0.68	0.68	1.72	0	2.4
46	*Thysonolaenalatifolia*	Tambo	Poaceae	20	6.78	6.78	1.72	0	8.5
47	*Ficus nota*	Tibig	Moraceae	2	0.68	0.68	1.72	5.86	8.26
48	*Zebrinapendula*	Wandering jew	Commelinaceae		1.02	1.02			2.74
49	*Garuga floribunda*	Bogo	Burseraceae	1	0.34	0.34	1.72	0.73	2.8
TOTAL				**295**	**100**	**100**	**100**	**100**	**300**

2.1.4.3 Threat to abundance, frequency and distribution of important species

2.1.4.3.1 Summary of Endemicity, Conservation Status, and Economic Importance

Endemicity and Conservation Status

The Philippines harbors about 8,000+ species of flowering plants distributed in about 1,600 genera and 191 families. There are more than 6,490 species of non-flowering plants (i.e. algae, fungi, mosses, ferns, etc.) and combined with vascular plants the total number of plants is about 14,490+ species. Of this number, between 30 to 40% are said to be endemic to the country and nowhere else can be found *(Source: Herbarium Digital Library, 2008)*.

Of the 49 species identified in the study area, only 1 species *(Pterocarpusindica)* is listed and categorized as endemic to the Philippines and classified as endangered under IUCN and DENR Administrative Order 2007-01 while the others are either common or introduced/exotic and can be found anywhere in the world. Exotic species is an introduced species outside its natural habitat. *Acacia farnesiana, Lantana camara*, and *Chromolaenaodorata* are among the representative species of this category and they are regarded as "invasive" species.

With respect to conservation status, no single species were recorded to be threatened critically endangered, endangered, vulnerable, and data deficient based on the International Union for the Conservation of Nature (IUCN) and DENR Administrative Order 2007-01 "Establishing the National List of Threatened Philippine Plants and their Categories and the List of Other Wildlife Species" dated January 22, 2007. Threatened species is defined as a general term to denote species or subspecies that is considered as critically endangered, endangered, vulnerable or other accepted categories of wildlife whose population are at risk of extinction. The 2007 IUCN categories of threatened species or subspecies are as follows:

Critically Endangered	-	refers to the species or subspecies facing extremely high risk of extinction in the wild in the immediate future due to extraction;
Endangered	-	refers to a species or subspecies that is not critically endangered but whose survival in the wild is unlikely if the causal factors continue operating;
Vulnerable	-	refers to a species or subspecies that not critically endangered nor endangered but is under threat from adverse factors throughout its range and is likely to move to the endangered category in the future;
Least Concern	-	refers to the species or subspecies which have been evaluated but not qualify for any other category;
Data Deficient	-	applied to a species or subspecies when the available information is not sufficient for a proper assessment of conservation status to be made. This does not necessarily indicate that the species has not been extensively studied; but it does indicate that little or no information is available on the abundance and distribution of the species.

Ecological and Economic Importance

The predominance of Asteraceae and Poaceae indicates a type of adaptation to poor acerbic soil – nitrogen fixation. This is a symbiotic association of roots of plants with nitrogen-fixing bacteria like *Rhizobium sp*. Moreover, one explanation for the proliferation of the pioneer species is another type of functional biological adaptation. These types of adaptation will play a very significant role in the consideration and rehabilitation of degraded soils in the future.

On economic aspect, trees represent one of the most important components of each and every terrestrial ecosystem. There are tangible and intangible benefits that can be derive from floral ecosystem. For tangible, trees plays an important role in addressing climate change and global warming while for intangible benefits are timber and implements to support heavy construction. On the other hand, other plant forms such vines, grasses, shrubs, and herbs also provides important role in the ecosystem. Grasses are commonly used as ground cover to lessen the impact of the raindrops to soil;

bamboos are effective in soil stabilization of riverbanks while vines are primary source of raw materials for weaving and handicraft industry. Majority of the plant species that were identified have economic values to support the economic activity in the community. Although many of the brush species are considered weeds, they can be utilized for medicinal purposes, as food, construction materials, and ornamental plants. Others can be utilized for handicrafts, agricultural implements, fibers, ground cover, dyes, and forage. Some edible species in the project sites include the common food and cash crops introduced or planted by the owners or trustees and other naturally growing species in the area.

Biodiversity Level and Species Richness
Biodiversity or biological diversity refers to variety or variability among living organisms and the ecological complexes in which they occur, and encompasses ecosystem, species, and genetic diversity (D.B. Jensen, M. Torn, and J. Harte., 1990). Having a variety of livings in an area is important in the health of the environment or biological systems. In general, the higher or the more diversity of life in the environment, the better the environment is. On the other hand, species richness occurring within a specific area or community measures a unique level of ecological organization which reflects the biological structure of a community. A community with high species richness and diversity will likely have a complex network of trophic pathways. In contrast, a community with low species richness and diversity likely have a fewer species and trophic interactions. Interactions among species within the food web of communities with high species diversity are theoretically more complex and varied than in communities of low species diversity. Indices of species richness and species diversity are often used in a comparative manner, that is, to compare communities growing under different environmental conditions or to contrast seral stages of succession.

Measurement of biodiversity is important given the obvious declines on habitat quality in almost every ecological system. For this purpose, the Shannon-Weiner Biodiversity Index, the most practical and popular biodiversity measurement were used to examine the overall community characteristics and quality of two or more distinct habitats and to describe the degree of uncertainty of predicting the species of an individual picked at random from the community. The uncertainty of occurrence increases both as the number of species increases and the individuals are evenly distributed among all species in a given community. Using the Fernando Scale (1998), Shannon Biodiversity Index may result in diversity value (H) ranging from zero indicating low community complexity to 3.5 and above which indicates very high community complexity. This is the condition where maximum possible species diversity composing the community is evenly distributed among all species. It is also a condition where biodiversity is high and have reached its maximum evenness while a community composed of single species or being dominated by a single species will have low biodiversity as its evenness reaches zero.

Overall, the computed Shannon-Weiner Biodiversity Index (H’) is 3.45 which indicate high level of biodiversity reflecting a complex network of trophic pathways capable of producing substances from an energy sources. On the other hand, Pielou’s (J’) Evenness Index of the study area is 0.88. This reflects that a community of species composing the individual is evenly distributed among all species. It also reflects a community with a high species evenness wherein interaction among species within the community is complex and varied.

For the Expansion Project and the EPRMP

Methodology

The above quoted report for the original project is used as baseline and is compared with the current/expanded project scenario.

The sampling stations are overlaid in the map of the expansion project facilities as shown in Figure 2.1-29 below.

Figure 2.1-32. Sampling Stations Overlaid in the Footprint of the Project Facilities

The presence of significant floral communities under the present scenario or the lack of these are clearly depicted for the expansion project in the photographs below:

Photographs of the expansion project site

The Access Road

An Impact Assessment

Impact Parameters

1. Habitat loss or degradation-Land clearing, river damming, etc. resulting in loss of habitat.
2. Activities that may lead to alteration of habitat, composition, structure or function.
3. Habitat fragmentation. Break-up of the natural landscape into small patches isolated from one another.

4. Effect on the number of species present, movement of species, and transfer of materials among habitats.
5. Loss of Species e.g. keystone, endangered and endemic species
6. Threat to existence and/or loss of important local species
7. Wetlands, are critical to ecological processes or endangered species.

The following considered:

1. The floral communities, e.g. vegetation types are listed in the table below:
2. With respect to conservation status, no single species were recorded to be threatened critically endangered, endangered, vulnerable, and data deficient based on the International Union for the Conservation of Nature (IUCN) and DENR Administrative Order 2007-01 "Establishing the National List of Threatened Philippine Plants and their Categories and the List of Other Wildlife Species" dated January 22, 2007. Threatened species is defined as a general term to denote species or subspecies that is considered as critically endangered, endangered, vulnerable or other accepted categories of wildlife whose population are at risk of extinction.
3. No plantation or replantation activities were undertaken at the project site
4. The fact that the sites of the project components, principally, the power plant, the ash pond, the additional conveyor system and the access road are clear of important floral species except for grass and cogon communities,

TYPE OF VEGETATION
Grassland facing sea shore
Swamp patch
Swamp patch associated with shrubs and trees
Grassland/shrubland
Grassland/shrubland
Swamp patch associated with shrubs and trees
Grassland/shrubland
Grassland/shrubland
Grassland/shrubland

IT IS CONCLUDED THAT THE EXPANSION PROJECT WILL NOT HAVE ANY ADDITIONAL IMPACTS ON THE FLORAL ECOLOGY INASMUCH AS THESE IMPACTS HAVE BEEN EXPERIENCED DURING THE IMPLEMENTATION OF THE ORIGINAL PROJECT. THE SITES AT WHICH THE FLORAL SPECIES WERE PRESENT BEFORE THE IMPLEMENTATION OF THE ORIGINAL PROJECT ARE NOW THE LAND ALREADY DISTURBED AND OCCUPIED BY THE ORIGINAL PROJECT AND TO BE OCCUPIED BY THE EXPANSION PROJECT. AS SEEN IN THE ABOVE TABLE ON "TYPE OF VEGETATION" THE FLORAL SPECIES THAT WILL BE FURTHER DISTURBED BY THE EXPANSION PROJECT ARE BASICALLY GRASSLANDS.

Moreover the standing trees at the project site under current conditions are Ipil-ipil (Leucaena leucocephala)/ Leguminosae Aratiles or Datiles (Muntigia calabura)/ Muntigiaceae andGmelina

(Gmelina arborea)/ Lamiaceae which call under the Least Concern category under IUCN conservation status

For the existing operations the undertaking of SMRs and CMVRs was not undertaken nor is required by the MMT. As explained in the foregoing discussion there have been no significant concerns on disturbances of floral and faunal species inasmuch as the site for the expansion project is already well developed and devoid of significant forest covers, important vegetation and wildlife communities.

Prospectively, however the monitoring of terrestrial species is included in the EMoP Section 6.

2.1.4.3.2 Impacts on GHG emissions and carbon sequestration program

For similar reason, the expansion project will not have major impact on carbon sequestration inasmuch as the trees responsible for sequestration are already absent.

It is notable, however, that the FDCMPC is undertaking a Carbon Sink Programme, provided in Annex 14. The following table shows the type and number of trees planted from which estimated the rate of sequestration of GHGs.

Period Covered	Area Coverage	Species	Quantity Planted	Current Mortality	No. of Surviving Seedlings	Survival Rate	CO_2 Sequestration Potential*
May 2018 – December 2019	20 hectares	Hybrid Eucalyptus	4,000	172	3,828	96%	4,502 tCO_2/ha
		Giant Eucalyptus	4,000	187	3,813	96%	4,502 tCO_2/ha
		Gmelina	4,000	313	3,687	92%	2,114 tCO_2/ha
		Mangium	4,000	338	3,662	92%	1,005 tCO_2/ha
Jan – Dec. 2020	20 hectares	Mangium	16,000	227	15,773	99%	1,083 tCO_2/ha

Pollution impact on species e.g. dust, noise, chemicals, eroded sediments and increased Temperatures.

Pollution impacts are not deemed significant in the absence of species to be impacted on and additional because (a) dust, noise and air pollution criteria are within the standards of the DENR as shown in the Air Dispersion Model and in the SMRs (b) toxic and hazardous chemicals are essentially absent based on the SMRs and (c) temperature increases refer to the increase in the temperature of the cooling water outfall which obviously does not reach the onshore sites.

2.1.4.3.3 TERRESTRIAL FAUNA

Similar to the case for the terrestrial fauna assessment the referenced baselines are taken from the original report in the EIS for the original project, quoted verbatim hereunder:

FAUNA/ WILDLIFE ASSESSMENT

Methodology

The survey of fauna resources was conducted thru ocular/aural observation, field diary, and interview with key informants. Ocular and aural observations were employed along the trails of each sampling stations from 08AM until 10AM. Birds were systematically surveyed (diurnal only) for it is being considered as proxy for assessing the faunal composition of the study area. The reason is that birds can easily be observed unlike other wildlife group which requires trapping or mist-netting. Bird observation over an established transect line is a widely used standard in conducting rapid site assessment (Herzog et.al 2002). Data collected from the field includes listing of species and the number of individuals both from visual and aural observations. Bird species nomenclature follows Kennedy et.al 2000. Aside for standardized line transect counts (Bibbyet.all 1992), other fauna which includes non-volant mammals, bats, reptiles, and amphibians were included on the assessment through opportunistic observations. Wildlife identification was conducted based on physical and unique features, markings, sounds and remains (i.e. feathers, fecal remains, tracks and other remnants). Wildlife survey techniques employed during the survey are described as follows:

1. Transect method – an imaginary line following accessible roads or trails or ridges within the covered area. It is commonly used in order to observe and record the presence of wildlife species occurring in the area;

2. Ocular survey/ observation – actual observation of wildlife along the imaginary transect line based on the physical and unique features, markings, sounds/ aural, and remains i.e. feathers, fecal, tracks and other remnants;

3. Field Diary – recording all observations encountered during the survey; and

4. Key Informant Interview/ Ethnobiological Survey – gathering information from key informants or residents with regard to the historical accounts of wildlife species that were not encountered during the actual survey, human activities such as hunting and trapping in each of the study areas; and

5. Secondary information/ sources on wildlife study of the project site.

Results and Discussions

Species Richness, Composition and Conservation Status

Various species of wildlife recorded in the area are summarized in the Table 2.1-8 below:

Table 2.1-15. List of different species of birds observed in the area.

Scientific Name	Family Name	Common/Local Name	Geographical Distribution
Centropusbengalensis	Cuculidae	Lesser Coucal	A widespread and common resident in all countries of Southeast Asia.
Laniusschach	Laniidae	Long-tailed Shrike	Oriental Region; Philippines, Singapore, Hong Kong
Lonchuramalacca	Estrildidae	Chestnut Munia	Resident breeding bird in Bangladesh, Brunei, Cambodia, China, India,Indonesia, Laos, Malaysia, Burma, Nepal, Philippines, Singapore, Taiwan, Thailand, Vietnam and Hawaii.
Lonchuraleucogastra	Estrildidae	White-bellied Munia	Southeast Asia
Geopeliastriata	Columbidae	Zebra Dove	Southeast Asia; introduced and common in the Philippines and Borneo
Streptopeliachinensis	Columbidae	Spotted Dove	Common resident breeding bird across its native range on

Scientific Name	Family Name	Common/Local Name	Geographical Distribution
			the Indian Sub continent and Southeast Asia
Chalcophapsindica	Columbidae	Emerald Dove	Resident breeding bird in the tropical and sub-tropical parts of the Indian Subcontinent and east through Myanmar, Thailand, Malaysia and Indonesia, to northern and eastern Australia.
Hirundorustica	Hirundinidae	Barn Swallow	Throughout SE Asia.
Cisticolajuncidis	Sylviidae	ZittingCisticola	A common resident and winter visitor throughout SE Asia except Borneo.
Megalurus sp.	Locustellidae	Grassbird	Southeast Asia
Halcyon chloris	Alcinidae	Collared Kingfisher	Oriental region; Australasia
Pycnonotusgoiavier	Pycnonotidae	Yellow-vented Bulbul	Southeast Asia; common in the Philippines, Singapore and Brunei
Passer montanus	Passeridae	Eurasian Tree Sparrow; Maya	Eurasia; common in all countries
Collocalia sp.	Apodidae	Swiflet	Southeast Asia
Rhipidurajavanica	Muscicapidae	Pied fantail	Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailan d, and Vietnam
Nectariniajugularis	Nectariinidae	Olive-backed Sun Bird	Oriental Region and east into northern Australia. A widespread and common resident throughout the region; vagrant in Hongkong
Tytolongimembris	Tytonidae	Grass Owl	Australia, Bangladesh, China, Fiji, Hongkong, India, Indonesia, Japan Myanmar, Nepal, New Caledonia, Papua NewGuinea, Philippines Taiwan and Vietnam
Butoridesstriatus	Ardeidae	Little Heron	A non-breeding visitor throughout all countries and territories within the region.
Egrettaintermedia	Ardeidae	Intermediate Egret	Africa, the Oriental Region; Australasia; partly migratory. A non-breeding visitor throughout all countries and territories within the region.

Table 2.1-16. List of Herpeto-fauna and Amphibians observed in the area.

Scientific Name	Family Name	Common/ Local Name	Geographical Distribution
Python reticulatus	Pythonidae	Reticulated Python/Sawa	Southeast Asia; All over the Philippines
Elaphe sp.	Colubridae	Common Brown Snake	Common in Southeast Regions
Naja sp.	Elapidae	Cobra	Africa, SE Asia, South Asia

Scientific Name	Family Name	Common/ Local Name	Geographical Distribution
Varanus sp.	Varanidae	Monitor Lizard/Bayawak	Philippines; Southeast Asia
Gekko gecko	Gekkonidae	Tokay Gecko/Tuko	Southeast Asia
Mabuya sp.	Scincidae	Mabuya	All over the Philippines
Hemidactylusfrenatus	Gekkonidae	Common House Lizard	Worldwide
Draco sp.	Agamidae	Flying Lizard	
Ranaerythraea	Ranidae	Common Green Frog	SE Asia
Bufomarinus	Bufonidae	Marine Toad/Giant Toad	Common in all countries

Table 2.1-17. List of mammals observed in the area

Scientific Name	Family Name	Common/ Local Name	Geographical Distribution
Cynopterusbrachyotis	Pteropodidae	Common Short-nosed Fruit Bat	Southeast Asia
Ptenochirusjagori	Pteropodidae	Musky Fruit Bat	Endemic to the Philippines
Musmusculus	Muridae	House Mouse	Widespread in SE Asia

The survey assessment recorded thirty two (32) different wildlife species, 19 avi-fauna, 10 herpeto-fauna and amphibians, and 3 mammals.

All of the birds noted in the area are common resident of the country categorized as least concerned by the International Union for Conservation of Nature (IUCN) and are not listed under the Convention on International Trade in Endangered Species of Fauna and Flora (CITES). Due to the swamp areas and proximity to the sea, migratory birds were observed in the area.

Herpeto-fauna observed during the survey include three (3) CITES Appendix II species, *Python reticulatus, Naja sp.* and *Varanus sp.*, which means the species are not necessarily now threatened with extinction but may become so unless trade is closely controlled. It also includes so-called "look-alike species," i.e. species of which the specimens in trade look like those of species listed for conservation reasons (cites.org). Other species are comparatively common, non-CITES and least concern of IUCN.

The three (3) mammalian species observed in the area are common, least concern of IUCN and are Non-CITES. Presence of fruit trees and *Ficus sp.* (Balete) served as food source and dwelling place for Bats.

Photos showing some of the wildlife species observed in the area are given in **Plates 2.1-14** below.

Plates 2.1-14. Photographs of typical Faunal Species at Project Site

Diversity and Evenness
Having different types of habitat and presence of fruit-bearing trees comprising the survey area, different species of common birds and bats which mainly rely their survival on the said resources were recorded numerous. Birds and fruit bats made their existence due to availability of food and dwelling place. However, this wildlife also serves as food to carnivorous animals inhabiting the area. Nearby vegetation has the same type of ecosystem, thus, wide range of food source are being provided by the area.

Ecological and Economic Importance
Ecologically speaking, all organisms play important role in the balance of ecosystem yet, some bring economic importance that poses threat to their existence in the wild.

Despite the fact that birds and fruit bats aid in seed dispersal being the natural seed dispersing agent of nature, humans hunt them for food consumption and pet purposes. Though wildlife noted in the area are relatively common and are not listed as threatened species, it does not necessarily mean that their collection and hunting may be rational.

Meat of snakes and large lizards are similarly being consumed by humans for food. Though poses great threat in the lives of humans, snakes bring therapeutic significance, same with Geckos which are said to cure asthma and other respiratory ailments.

The foregoing discussions are based on baselines in 2013 for the original project. No monitoring was undertaken nor required by the MMT on terrestrial aspects.

For an assessment of the impacts and mitigating measures for the planned expansion project, the current conditions are referred to.

Current baselines and conditions:

These are appropriately reflected in the recent photo documentations shown below:

Plate 2.1-15 Photographs of the already developed project site

The above plates indicate that the trees/vegetation are generally outside the expansion project site

Plate 2.1-16 Photographs of the typical trees and vegetation present in the project site

Typical trees and vegetation (grasslands) are depicted above

The typical standing trees at the project site are:

- Ipil-ipil (Leucaena leucocephala)/ Leguminosae
- Aratiles or Datiles (Muntigia calabura)/ Muntigiaceae
- Gmelina (Gmelina arborea)/ Lamiaceae

These species were classified as Least Concern under IUCN conservation status

GENERAL SUMMARY

On the basis of the above comprehensive and survey for the original project and the existing site conditions, following conclusions and mitigation measures are made and recommended.

- **Vegetation Removal and Loss of Habitat**

Site preparation/clearing could result in disturbance of small number of trees and vegetation (grass).

Threat to Existence and/or Loss of Important Local Species

There are no important local species to be affected. Patches of mangroves are present outside the project site.

- **Threat to Abundance, Frequency and Distribution of Important Species**

There are no threat to the abundance, frequency and distribution of important species.

- **Hindrance to Wildlife Access**

There are no important wildlife at the project site; hence wildlife access is not materially significant.

Impact Assessment for the Expansion Project

The expansion project will not significantly impact on the terrestrial fauna because:

1. **Significant impacts were relevant only for the original project.**
2. **The clearing of vegetation and floral communities have caused the migration of faunal species at the project site.**

Moreover, in recognition that cutting of all species of mangroves is prohibited pursuant to RA 7161 as well as Section 43 of PD 705 which states that all mangrove swamps set aside for coast protection purposes shall not be allowed for clear-cutting operation, it may be noted that there are no mangrove communities in the project site

2.1.4.3.3.1 Effects on wildlife referenced to various public domain publications, e.g. (https://blog.arcadia.com/7-ways-coal-impacting-wildlife/)

The baselines on wildlifes specific to the project are initially identified to provide assessment of potential effects of the expansion project. These baselines are dated **2013** embodied in the EIS Report for the original project and on **May 2021** for the expansion project, the latter reflected in the photographs below.

Photographs showing current baselines

Plates 2.1-15 Photographs of the already developed project site (the land) and on the wildlife observed or not observed.

Photograph of the existing trees within the project site (provide also WGS 84 coordinates), the ash pond area, the area for the proposed additional conveyor system occupying 3 hectares.

The concerns on wildlife enumerated below are duly considered:

Habitat destruction

The habitats of concern are forests, vegetation, grasslands and plains. These are essentially absent and thus concern for destruction is deemed not significant.

Coal ash spills
Coal ash is the toxic waste generated by coal-burning power plants. This toxic sludge can be stored in coal ash ponds that are too often improperly safeguarded against leaks and breaches. This negligence has resulted in numerous spills that have devastated natural wildlife habitat

"Toxic sludges" refer to the ash generated. Bottom ash is stored in a repository ash pond and is considered "encapsulated" i.e. will not leak out or breach to the land/terrestrial environment. On the other hand fly ash will be disposed outside of the project site through agreements with fly ash offtakers.

Air pollution
Emissions from coal-fired power plants are the leading source of smog, acid rain, and toxic air pollution. Sulfur dioxide, nitrogen oxides, particulate matter, mercury, carbon monoxide, and arsenic are just a

few of the harmful pollutants emitted by coal plants on a daily basis. These pollutants cause a variety of respiratory and cardiovascular diseases that impact not only humans, but wildlife as well.

As noted from the SMRs and CMVRs provided in Annex 10, there have been no significant exceedances to the NAAQGV which could impact not only on humans, but also on wildlife, noting further the absence of wildlife in the developed area for the project site.

Water pollution

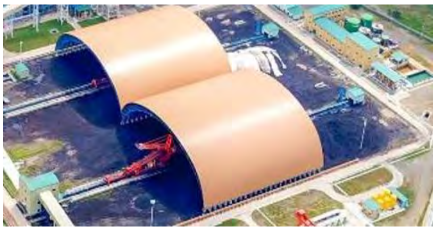
Coal mining impacts aquatic wildlife in several ways. As noted above, both mountaintop removal and coal ash spills can result in harmful pollutants entering our waterways. Coal-fired power plants are also responsible for dumping millions of toxic metals into our surface water each year. One of the most noticeable effects of coal mining on water is acid mine drainage, or the outflow of acidic water from coal mines into nearby rivers and streams. Acid mine drainage disrupts the growth and reproduction of aquatic plants and animals and can result in the loss of aquatic life.

Although an important aspect, for this particular project there will be no discharges of coal or coal ash to the water environment, principally the Macajalar Bay and the Tagoloan River. Discharges for the project are the return cooling water which is coal and coal ash free because the cooling water will not come in contact with the coal and the coal ash.

Coal dust

The dust created by the crushing and processing of coal causes a host of problems for wildlife. In addition to potentially severe heart and respiratory problems, coal dust can impair the ability of leaves to photosynthesize and oxidizing coal particles can settle in waterways, reducing the oxygen available for aquatic wildlife.

Coal dust is an important aspect relating to wildlife. However for the project, coal dust is deemed not an important consideration because the feed coal is stored in covered (partially) systems shown herein again.



Moreover, the fly ash to be transported to 3rd party offtakers will be carried in dump trucks to be properly covered such as by tarpaulin to prevent fugitive coal dust dispersion.

Mercury deposition

Coal-fired power plants are one of the largest source of toxic mercury contamination. Fish are particularly susceptible to mercury poisoning, but scientists have also found mercury accumulation in birds, mammals, reptiles, and amphibians. The primary consequences of mercury poisoning are reproductive and neurological problems. According to the National Wildlife Federation, “fish have difficulty schooling and decreased spawning success, birds lay fewer eggs and have trouble caring for their chicks, and mammals have impaired motor skills that affect their ability to hunt and find food

Mercury is regarded as an important consideration in the project. However the wildlife related thereto and of concerns refer to the marine species in Macajalar Bay and the fish communities in Tagoloan River. As stated in the foregoing coal and coal dust will not be discharged to these water systems because the cooling water to be discharged is coal and coal ash free.

On GHG emissions, it is seriously and responsibly recognized that notwithstanding the small contribution of the Philippines and of its coal power plants to the global GHG inventories, the Proponent will nevertheless continue to exercise initiatives that are climate change friendly such as the carbon sink programme.

SECTION 2. ASSESSMENT OF KEY ENVIRONMENTAL IMPACTS

2.2 WATER

This module is significant because:

a. It identifies and assesses project impacts on the critical water infrastructures, i.e., the drainage morphology/local drainage system, which, if adversely affected, may result in flooding not only in the proposed project area but also in the surrounding area.
b. This module also identifies and assesses the impact of the proposed project on stream, lake, and on the bay, fronting the site. The potential impacts on the bay cover water depth, bathymetry and current circulation.
c. This section also includes discussion on oceanography that is vital in terms of identifying and assessing the possible disruption of circulation pattern and the potential for coastal erosion.
d. Baseline in terms of water quality is also provided and discussed. Additionally the existing freshwater and marine ecology and the impacts of the proposed project.

Methodology and Limitations

Primary data and survey were initially conducted during the preparation of the EIS Report for the original project and subsequently revalidated with more recent surveys. With respect to marine ecology, principally corals and to river ecology, i.e. fishes, trends cannot be gleaned from the SMRs nor from the MMTs because regular reports on these parameters are not required.

Secondary data were derived from the latest Comprehensive Land Use Plan (CLUP) of the Municipality of Villanueva and Biodiversity Management Bureau website.

Focus is made on the impact areas in Macajalar Bay which are the domain of the thermal effects from the cooling water discharge. With respect to Tagoloan River assessments and the corresponding methodology are made in the vicinity of the point of water abstraction and with respect to water competition.

2.2.1 Hydrology/Hydrogeology

The hydrology impacts/aspects of the project are relevant in respect of the drainage systems especially for storm drainage and in connection with the abstraction of from the Tagoloan River for process use. It is noted that the drainage systems are already in place and the abstraction from Tagoloan River has been ongoing. Also, the surface waters are either absent (perpetual creeks and springs) or not affected (underground water) since these are absent at the project site.

The regional geologic map, which includes the project site, is shown **in Figure 2.2-1** below, indicating that the site is within the following classification:

Age – **Recent Epoch**

Hydrogeologic Characteristics – **Quaternary Alluvium, Swamps, Flood Plains, River and Beach Deposits**

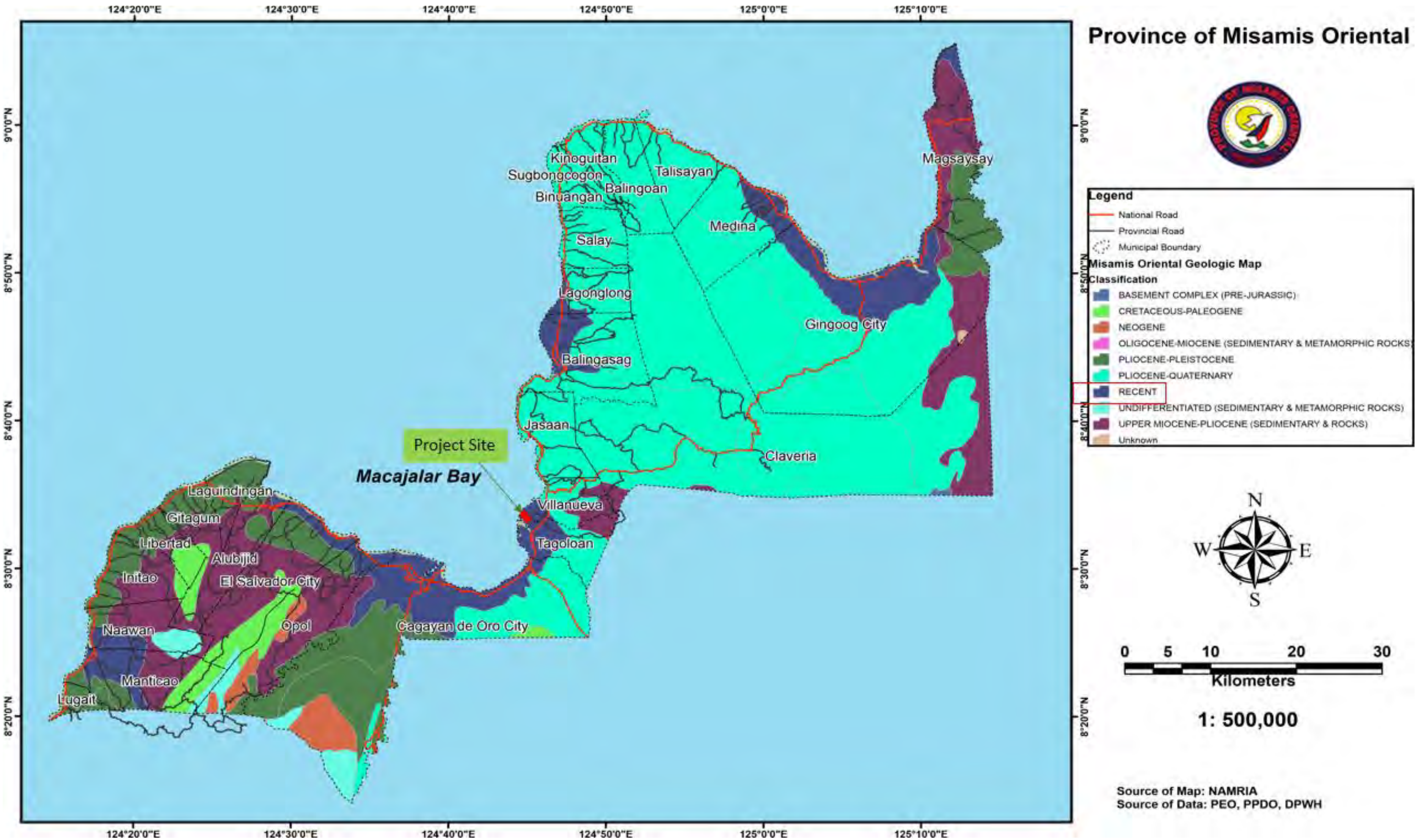


Figure 2.2-1a. The Geologic Map Classification of Misamis Oriental

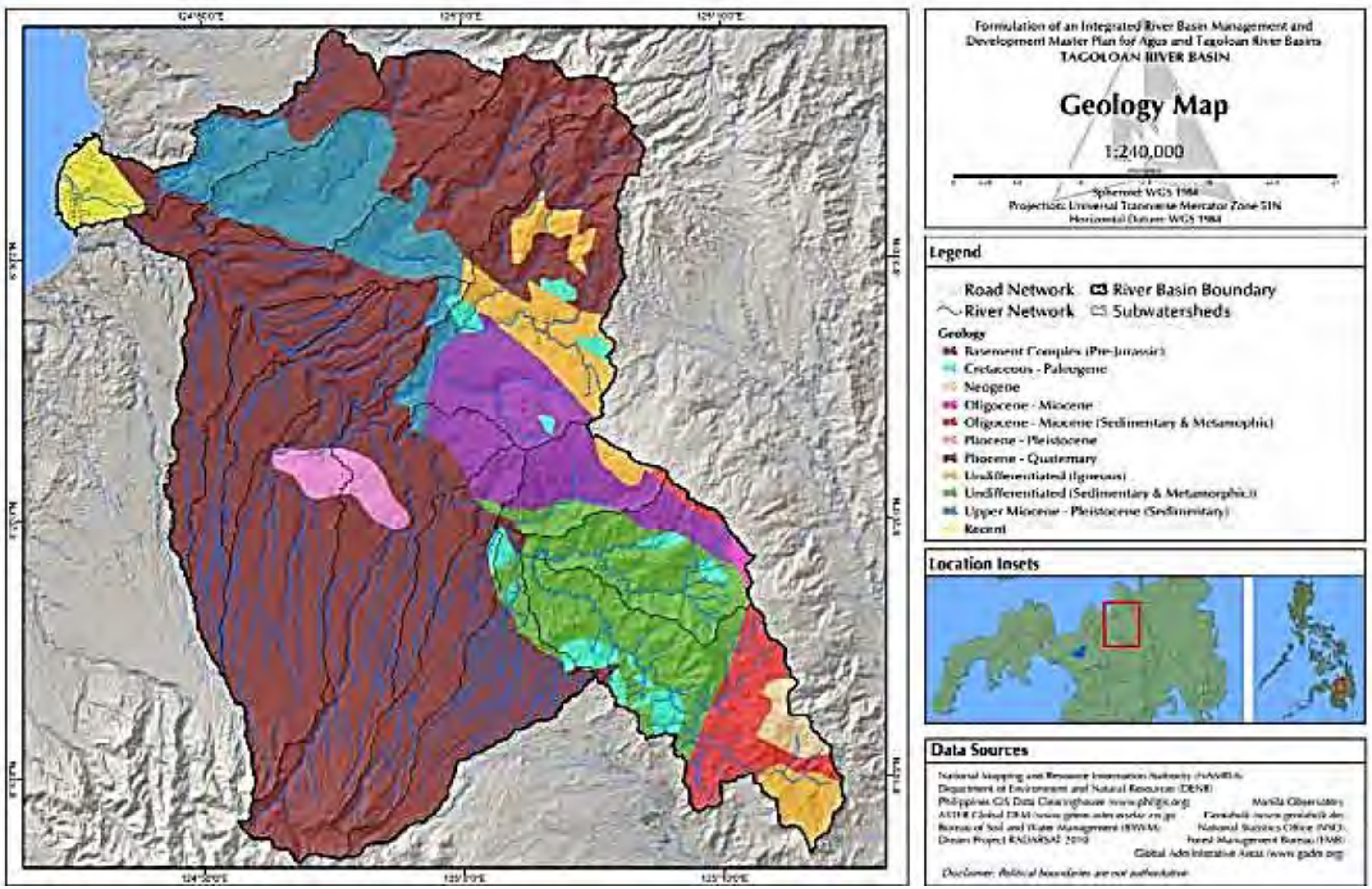
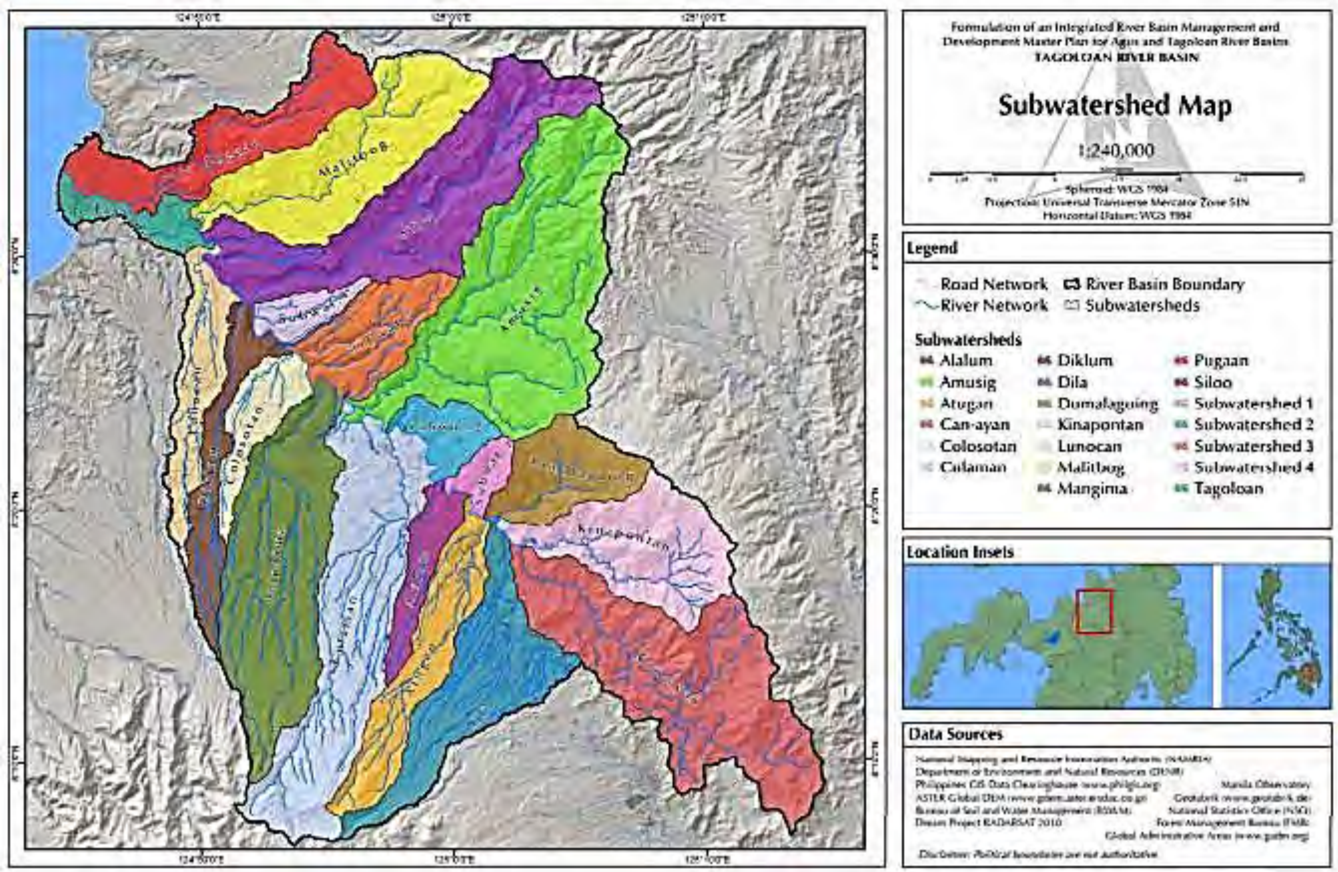


Figure 2.2-1b. Geology Maps

(Top Map : The Geologic Classification Map of Misamis Oriental; Bottom : Geology Map)

In terms of hydrology/hydrogeology the map of the Tagoloan River Subwatershed is shown in Figure 2.2-2



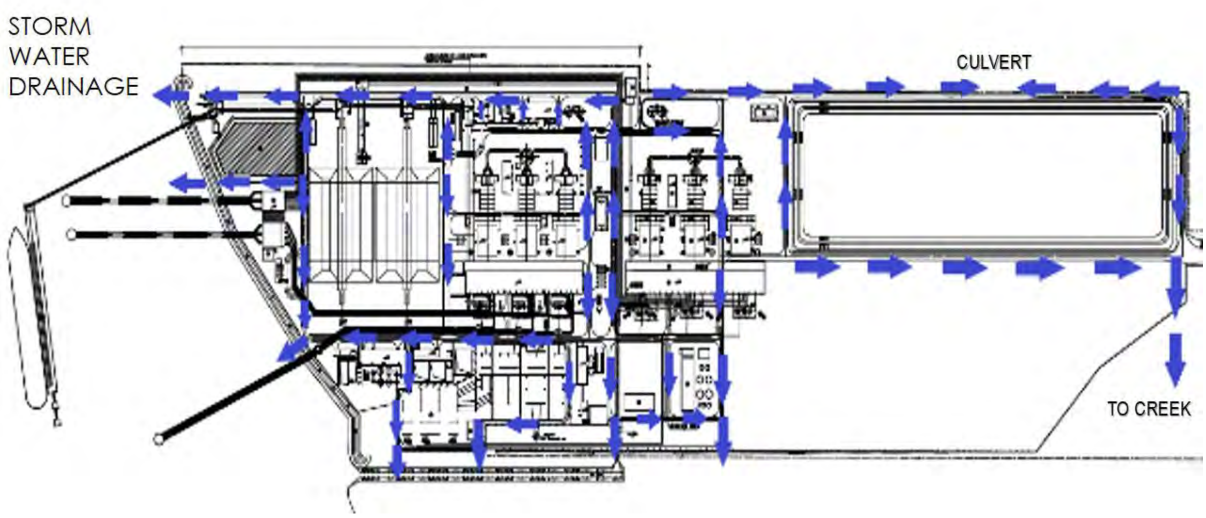
http://now.minda.gov.ph/wp-content/uploads/2014/06/TRB.Vol5_.MapAtlas.pdf

Figure 2.2-2. Subwatershed Map of Tagoloan River Basin

2.2.1.1 Change in Drainage morphology/ Inducement of flooding/ Reduction in stream volumetric Flow

Relevant baseline data/parameters.

The drainage system of the Project is shown in **Figures 2.2-3.**



Figures 2.2-3. Initial Drainage System/Concept of the Project

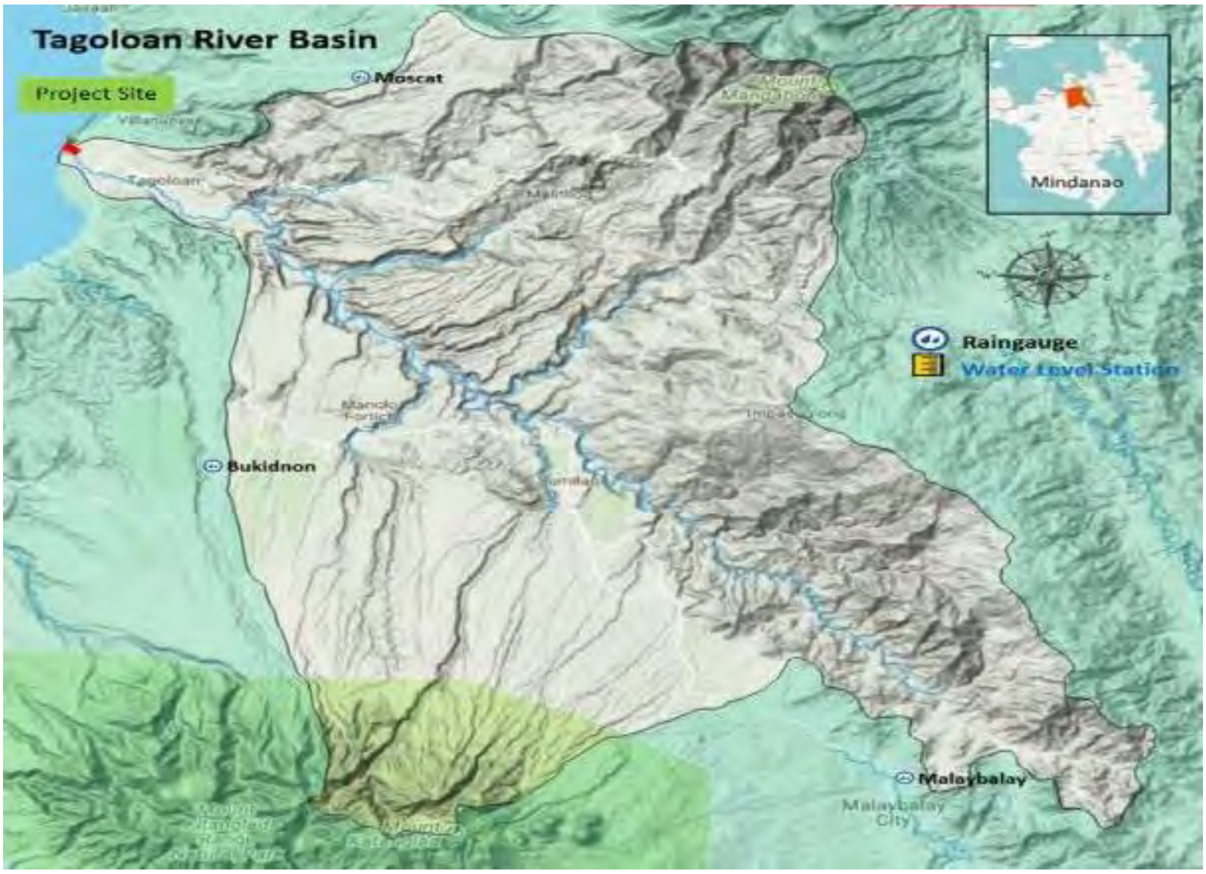


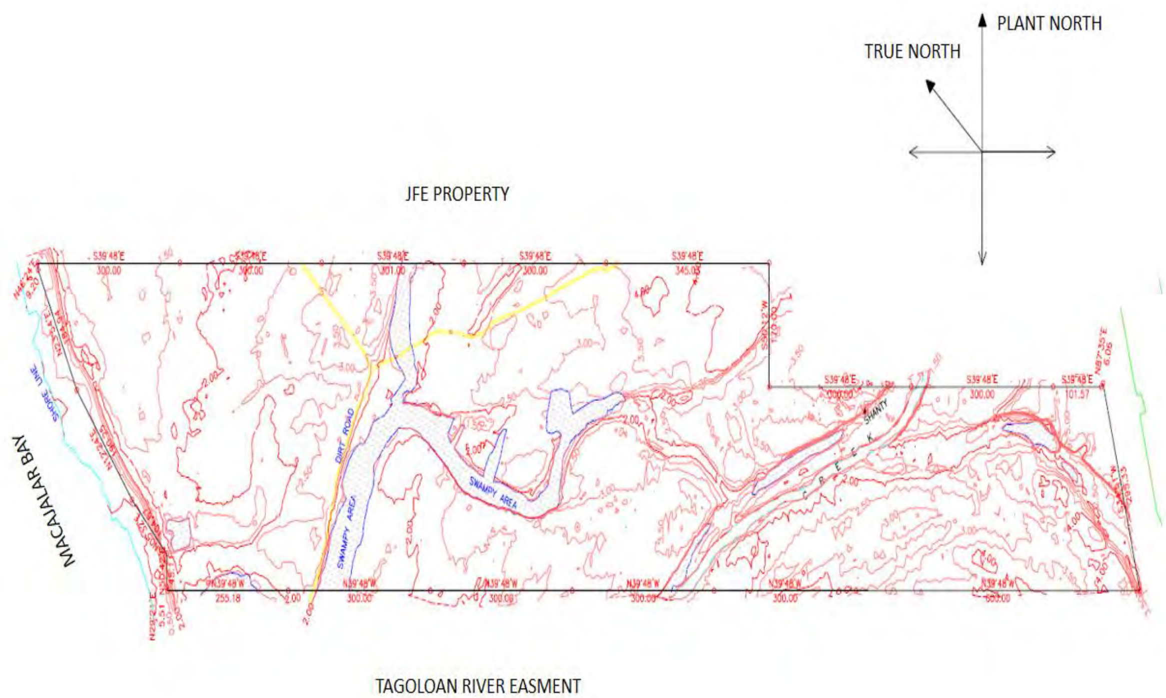
Figure 2.2-4. The Local Drainage System (source:PAGASA)

As seen in **Figure 2.2-2** top figure, the plant drainage process and storm waters flows to Pugaan creek, and Macajalar Bay. The bottom figure shows that the plant perimeter and the middle section of the project area are provided with drainage canals.

Figure 2.2-3 showing the local drainage indicates that storm water flows to Macajalar Bay through the Tagoloan River and Pugaan creek.

Site Topography

Figure 2.2-5 shows the topographic map of the project area.



Source : FDC Misamis Power Corporation
Figure 2.2-5. The Topographic Map of the Project Site.

Historical Flooding/Drought Occurrences

The following are from the Comprehensive Land Use Plan of Villanueva; cited faithfully to avoid misinterpretation.

Watershed/Subwatershed

The Tagoloan River Basin watershed system with an estimated drain area of one thousand seven hundred-four (1,704) square kilometers covering the provinces of Bukidnon and Misamis Oriental extends one hundred six (106) kilometers from Malaybalay City to the estuary of Tagoloan River in Macajalar Bay. Villanueva lies along the northern coastal portion of this river basin bordering barangay Balacanas and Tambobong. This watershed system plays a very critical role in the maintenance of ecological balance along its tributaries. If left unchecked, the water quality that flows along its waterways shall adversely impact on the lowland areas with pollution, siltation, garbage and very high risk of flooding.

A sub-watershed area with springs in Sitio Lagatac and in Tuburan 1, Barangay Poblacion 1, has been the traditional source of water in the host municipality until this was augmented by the Napapong Spring in Barangay Imelda that significantly boosted the water pressure potentially serving all lowland

barangays with level three household water system. There are, three main sub-watershed systems have been identified in the municipality where Lagatac is just one of its major tributary.
Shown in **Table 2.2-1** below is the Natural Drainage System by Sub-watershed

Table 2.2-1. Natural Drainage System by Sub-watershed of the Municipality of Villanueva

WATERSHED	AREA (has)	Percent (%)
Baloc – Tuburan Sub-watershed	1,680	32.17
Tubigan – Tag-anga Sub-watershed	1,952	37.48
Pugaan – Tagpayao Sub-watershed	1,590	30.45
TOTAL	**5,222**	**100.00**

At the immediate vicinity of the project site and adjoining areas, since its operation in 2016 there has not been any documented evidence that the Project has caused any significant floodings. The experienced episodes of floods could attributable to the overflowing of the creek waters of Raganga which overflowed its bank during the 2009 flood incidents and the seasonal rise of floodwaters in Barangay Balacanas which at certaine periods reached heights of three (3) meters destroying several houses as well as resulting in deaths of few animals.

Flood Hazard is cited below in respect of flooding in the vicinity of Tagoloan River.

According to the Flood Hazard Map of MGB-10, the plant site is highly susceptible to inundation with flood height greater than 1meter. It is also prone to flash floods. It's very close proximity to Tagoloan River, which is a major drainage system that has experienced a lot of flooding events in the past, makes it prone to this hazard.

Tagoloan River emanates from Malaybalay, Bukidnon and drains northward, towards Macajalar Bay. Flooding along this river is limited to the low-lying areas in the lower reaches. River bank erosion associated with sediment deposition in the lower reaches seems to be one of the problems in the Tagaloan River. The flood prone area of Tagaloan, which extends to about 1,300 ha, covers the said developing industrialization areas including the municipalities of Tagoloan and Villanueva.

During floods, low-lying areas adjoining the Tagoloan River are frequently inundated due to the inadequacy of channel flow capacity. Inundation and damages in the Tagoloan River Basin are concentrated in the lower reaches due to the topographic features.

In 1984, the Municipality of Tagoloan was not spared by catastrophic typhoon "Nitang" which caused inundation from the Tagoloan river bank sweeping away the northern section of the PHIVIDEC Industrial Estate and the town proper of Tagoloan. Properties were damaged and numerous lives were lost. Another devastating typhoon in 1990 ravaged the river bank and left approximately 100 families homeless.

In December 2014, TS Seniang (Jangmi) hit the Philippines and delivered intense to torrential rains over a prolonged period and caused widespread floods and landslides in Northern Mindanao and the Visayas.

Stream flow measurements/estimates; Delineation of watershed / sub watersheds/floodplain; and identification of aquifers if any.

Stream flow measurements/estimates are relevant with respect to the abstraction of process water from the Tagoloan River. However, with the granting of Water Permit by the NWRB, this matter is deemed as being of inconsequential.

Watershed/Sub water sheds/floodplain

The sub water shed map of Tagoloan River is shown in **Figure 2.2-2.**

Aquifers.

Groundwater and aquifers considerations are not deemed relevant in the absence of (a) ground water extraction and (b) subsurface activities. In the case of the latter only foundation works will be involved which do not require deep soil works.

Assessment

On the drainage system

The engineered project drainage system provides for unobstructed flow of process and storm waters. There will be no flooding to the adjacent areas of the plant.

On local drainage.

The local drainage does not cross the project area and therefore is not blocked nor diverted or disturbed.

On impacts to the project, for this same reason, overflows from the local drainage system will not flood the project.

On Topography

Since the project site is already developed land, and the expansion project will be located in the same area as the existing site, topography is deemed not to be impacted by nor impact on the Project.

Climate Change Effects

On flooding, rainfalls constitute the most important natural factor which is not related to the Project. Baselines on rainfall may be gleaned from the projections such as discussed hereunder.

The **PAGASA Precis Model-based** rainfall projections are given below:

Table 2.2-2. Seasonal rainfall change (in %) in 2020 and 2050 under medium-range emission scenario in provinces in Region 10

	OBSERVED BASELINE (1971-2000) mm				CHANGE in 2020 (2006-2035)				CHANGE in 2050 (2036-2065)			
	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON
Region 10												
BUKIDNON	329.7	335.6	653.8	559.5	2.9	-10.3	-4.4	-0.3	-5.1	-13.0	-9.7	-5.8
LANAO DEL NORTE	337.5	350.3	662.5	621.1	9.6	-0.6	-2.2	6.9	2.5	-1.9	1.4	7.1
MISAMIS OCCIDENTAL	392.1	323.4	633.1	728.3	9.1	1.4	6.1	6.1	5.2	0.3	5.1	4.6
MISAMIS ORIENTAL	442.5	296.0	615.7	581.1	4.6	10.4	3.7	2.9	1.8	17.8	5.2	0.1

Source: "Climate Change in the Philippines", February 2011. PAGASA

It may be seen in the above that the climate-change induced changes in rainfalls are in the decreasing rainfalls thus climate change impacts on flooding may be considered insignificant. The positive trend in December, January and February results in small rainfall change of 7.9 mm (1.8% of 442.5) or 450.4

mm total compared to projected **583.68 mm** (-5.2 % of 615.7 decrease or 32 mm decrease from 615.7 mm) for June July August for the 2050 scenario.

On the other hand **Table 2.2-3** provides the projections based on the PAGASA Climate Information Risk Analysis Matrix (**CLIRAM**) tool. (*Ref: Climate Trends and Projected Climated Change in the Philippines", DOST PAGASA 2018. Emal exchange with Dr Rodel Lasco, Oscar M. Lopez Center, 04 May 2020*)

From this table may be seen the high emission projected value of **678.4 mm** (SON) for 2036-2065.

Table 2.2-3. Projected Rainfalls for 2036-2065 (Based on "CLIRAM" tool)

Region	Province	Observed (1971-2000)				Projected (2036-2065)									
		DJF	MAM	JJA	SON	Scenario	Range*	DJF (Dec-Jan-Feb)		MAM (Mar-Apr-May)		JJA (Jun-Jul-Aug)		SON (Sep-Oct-Nov)	
								Percent change	Projected value	Percent change	Projected value	Percent change	Projected value	Percent change	Projected value
Region 10	Bukidnon	329.7	335.6	653.8	559.5	Moderate Emission (RCP4.5)	Lower Bound	-18.9	267.4	-21.0	265.0	-27.3	475.4	-41.1	329.8
							Median	-3.2	319.2	-9.7	303.1	-16.3	547.4	-26.5	411.2
							Upper Bound	17.3	386.8	12.8	378.5	12.6	736.5	-7.7	516.2
						High Emission (RCP8.5)	Lower Bound	-18.4	269.1	-14.5	287.0	-19.6	525.9	-22.4	434.1
							Median	-7.4	305.3	-6.7	313.1	-4.4	625.1	-10.9	498.6
							Upper Bound	25.7	414.4	5.4	353.6	17.0	765.0	10.1	616.0
	Lanao del Norte	337.5	350.3	662.5	621.1	Moderate Emission (RCP4.5)	Lower Bound	-9.5	305.4	-22.9	270.1	-8.5	606.4	-30.5	431.9
							Median	2.4	329.3	7.5	324.2	-1.8	650.5	8.4	569.0
							Upper Bound	21.4	409.6	87.3	656.2	69.4	1,122.0	61.4	1,002.2
						High Emission (RCP8.5)	Lower Bound	-10.0	303.6	-16.0	294.3	-10.0	596.5	-15.4	525.4
							Median	1.3	342.0	1.2	354.4	1.9	675.0	-2.3	606.9
							Upper Bound	13.2	382.0	27.6	447.1	19.7	793.0	9.8	682.2
	Misamis Occidental	392.1	323.4	633.1	728.3	Moderate Emission (RCP4.5)	Lower Bound	-5.5	370.3	-11.0	288.0	-11.8	558.1	-19.8	583.8
							Median	1.1	396.2	-5.6	305.2	3.5	655.2	-1.4	718.2
							Upper Bound	42.3	557.8	10.1	356.1	16.8	739.6	14.7	835.6
						High Emission (RCP8.5)	Lower Bound	-6.6	366.2	-7.2	300.1	-8.1	581.5	-6.4	681.4
							Median	8.2	424.2	3.6	335.0	3.2	653.1	-1.0	720.9
							Upper Bound	27.9	501.4	14.9	371.6	21.1	766.7	9.0	794.0
	Misamis Oriental	442.5	296.0	615.7	581.1	Moderate Emission (RCP4.5)	Lower Bound	-21.4	347.6	-19.1	239.5	-22.2	478.8	-37.3	364.6
							Median	-6.8	412.3	-6.4	277.1	-14.1	529.0	-21.2	457.8
							Upper Bound	37.0	606.4	7.1	317.0	8.5	668.0	-0.7	576.8
						High Emission (RCP8.5)	Lower Bound	-27.2	322.0	-20.0	236.7	-15.9	518.0	-33.2	387.9
							Median	-0.7	439.3	-5.6	279.4	-2.8	598.2	-10.9	517.6
							Upper Bound	28.1	567.0	2.8	304.3	14.6	705.9	16.7	678.4
	ey					Moderate	Lower Bound	-21.2	589.4	-17.8	459.6	-32.6	368.7	-37.5	386.6

2.2.1.2 Change in stream, lake water depth

Hydrogeology

In simple and general terms **"Hydrogeology"** is the aspect of geology that deals with the distribution and movement of **groundwater** in the soil and rocks of the Earth's crust i.e.in **aquifers**

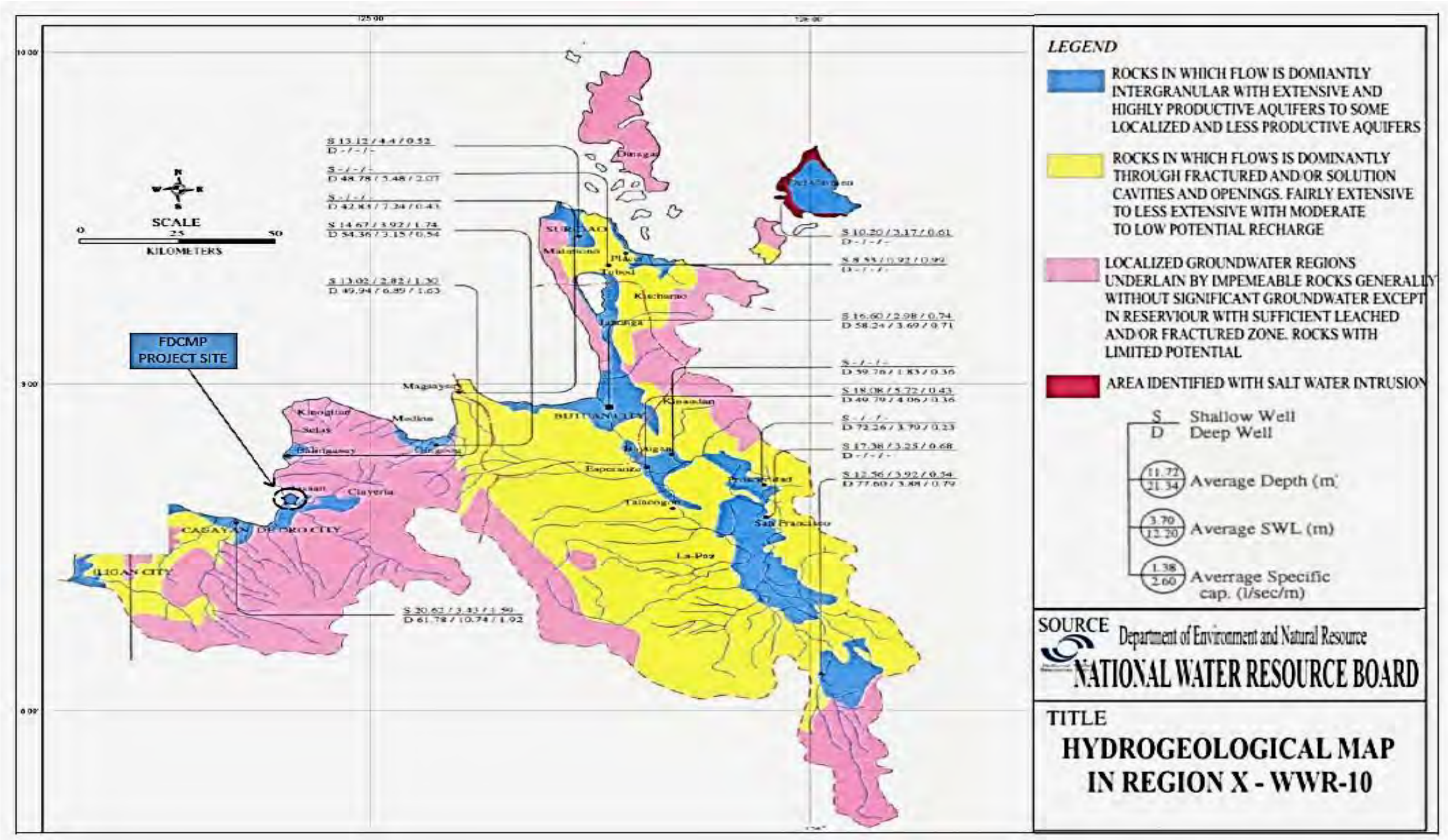
For this particular project :

On underground water abstraction. This activity is absent inasmuch as process water will be drawn from Tagoloan River

Underground works that could cause potential damage to aquifers and underground waters are absent since these are confined to the construction of foundations which involve shallow ground diggings.

Potential seepage of leachate from the ash repository pond. This is deemed as highly unlikely because the ash pond is lined with membranes thus preventing leachate seepage. This is evident based on the SMR findings on the quality of underground water in the vicinity of the ash pond.

Notwithstanding the above the hydrogeological maps of the region is provided in **Figure 2.2-6** while the Tagoloan River Basin Groundwater Distribution Map is given in **Figure 2.2-7.**



Source: National Water Resource Board
Figure 2.2-6. Hydrogeological maps of the region

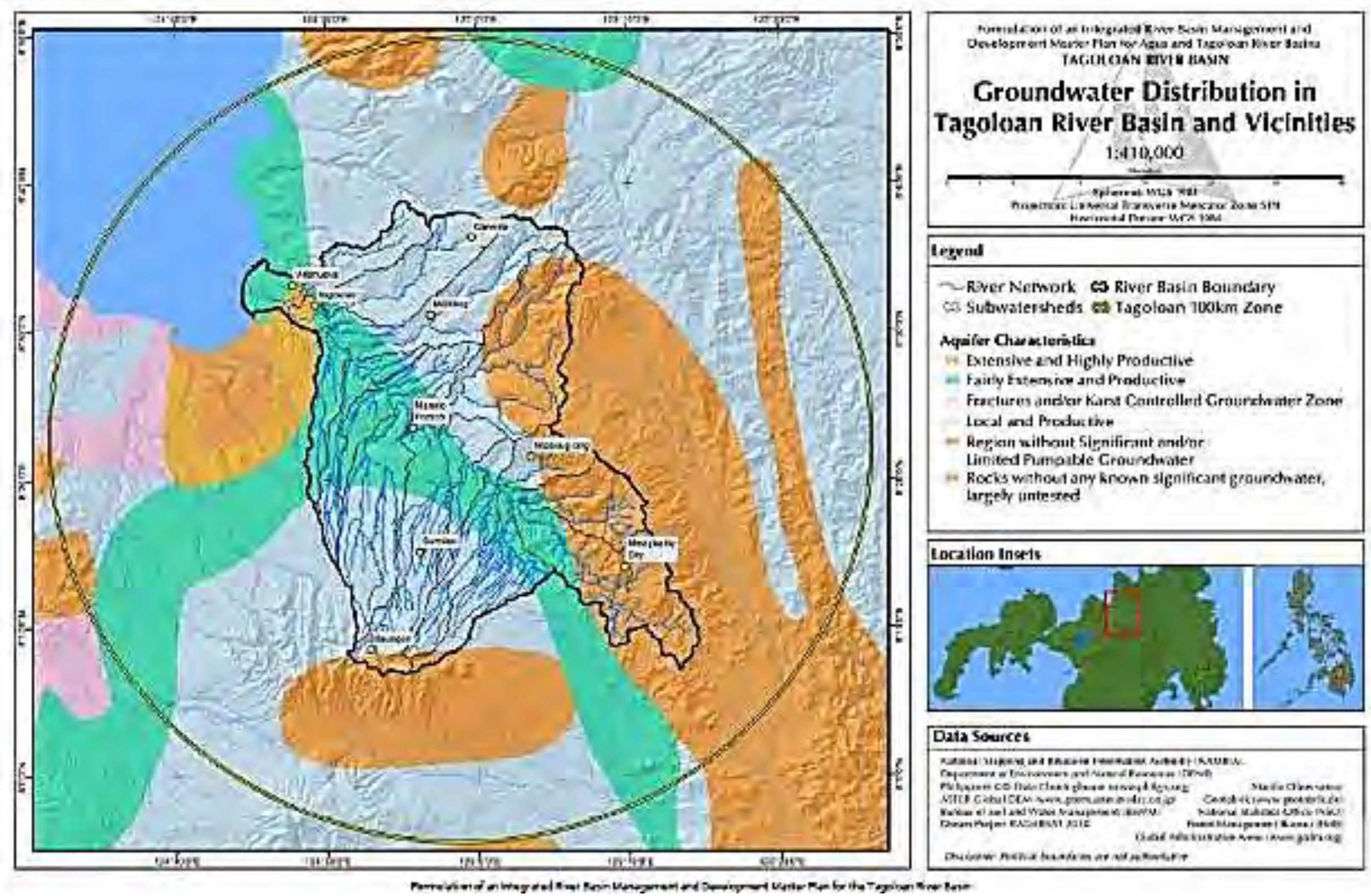


Figure 2.2-7. The Groundwater Distribution Map in Tagoloan River

Moreover, on groundwater which is a vital environmental resource, quality monitoring is among the regular parameters in the SMRs. Additional discussions are made in **Section 2.2.3.**

Assessment of impacts in terms of change in stream, lake water depths.

The granting by the NWRB of a Water Permit signifies that there are no concerns with respect to changes in stream depths and also in respect of competition in water use. It is noted that in the technical evaluation of Water Permits, the NWRB evaluates the dependable flow of rivers, which is 80% of flow duration and an environmental flow of 1 0% of the depenctable flow shall be retained.

Lake water depth is not relevant in the absence of lake water bodies in the project site and adjacent areas.

2.2.1.3 Depletion of water resources / competition in water use

Current / projected water use (groundwater / surface water) in the area and adjacent areas

Inventory of water supply source including spring and wells.

Assessment of project impact on the existing water resources and the resulting competition in the water use using analysis/ estimation of water availability.

Include discussions taking into consideration the PAGASA medium to long term projections.

Updated water balance.

Figure 2.2-8 shows the fresh water balance (figures in m3/hr.)

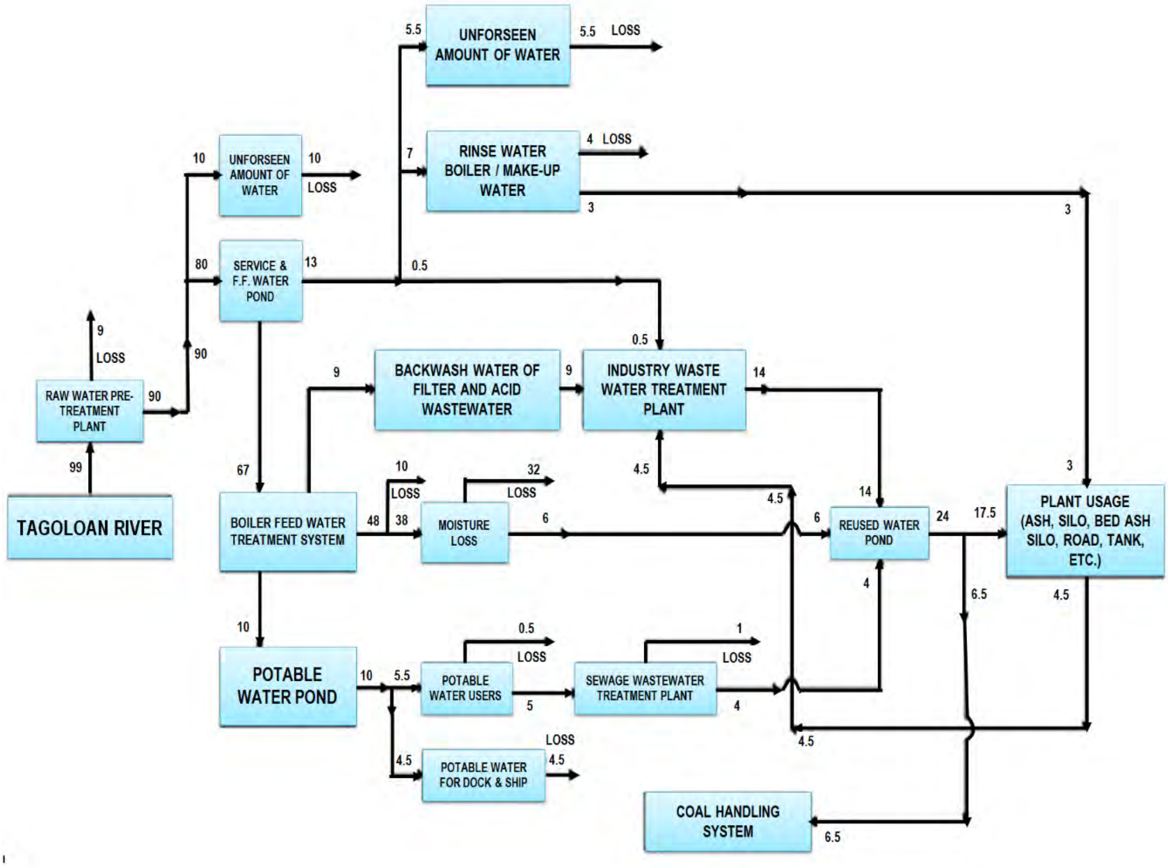


Figure 2.2-8. The Updated Fresh Water Balance

The above water balance does not account for all other activities (agricultural, domestic and industrial activities) that require water from the Tagoloan River. It is deemed adequate and compliant with regulations to abide by the permits, clearances and requirements of the National Water Regulatory Board (NWRB) which has jurisdiction over all these other activities.

The sea water balance (values in m3/hr) is shown in **Figure 2.2-9.**

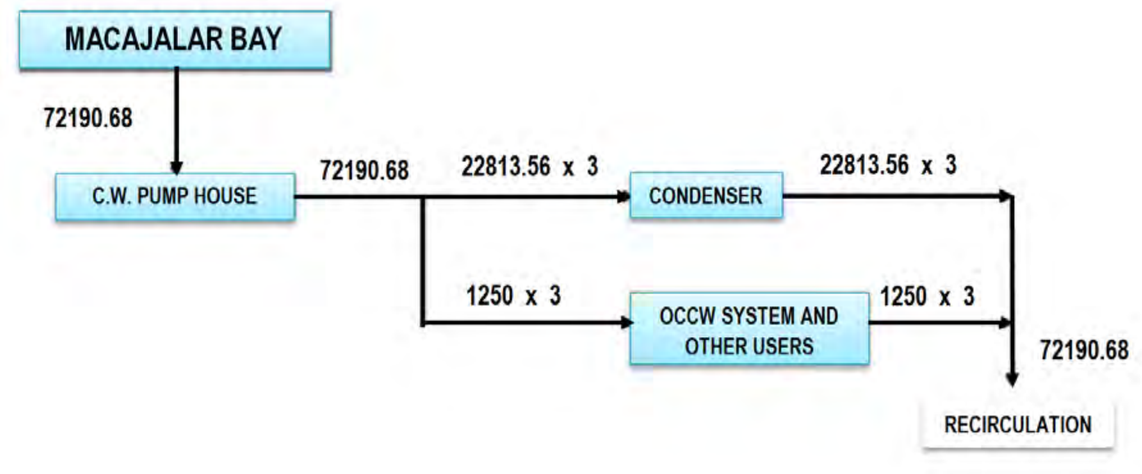


Figure 2.2-9. The Sea Water Balance

Water Requirements

The estimated rate of river water abstraction at full (6 x 135 MW) operations is seen in the water balance **Figure 2.2-8**.

It is worthy reiterating that the NWRB Water Permit carries with it the clearance/approval for the extraction of this river water volume.

<u>Assessment Methodology/Approach</u>

Identification and assessment of project impacts on the change in drainage morphology/local drainage system and resulting effects of flooding pattern in the project area and surrounding. Include climate projections effects on flooding.

The project will not cause significant impacts on the local drainage morphology because (a) the local drainage systems which are the Tagoloan river and the canal are neither disturbed or diverted by the project. (b) The project's drainage system is self-contained, i.e. it is designed to handle process and storm waters from both the plant and from rainfalls.

The canal is normally dry but will receive flows from the Cooling Water return stream. During extreme events of rainfalls, the Pugaan creek could be over flown and the cooling water discharge may add to the water flows. It is noted again that the Pugaan creek extends to the canal. The canal improvement is a project of the DPWH, thus coordination with FDCMP in the design of the canal will be made.

On Climate Change Projections

An assessment of water availability in the context of climate change projections by PAG-ASA.

The **PRECIS** and **CLIRAM** projections shown in **Table 2.2-2 and 2.2-3** suggest that projected rainfalls can decrease at certain months during the life of the Project.
Inasmuch as the NWRB Water Permit is subject to renewal, it is deemed incumbent on NWRB to assess if renewal of permit will be made in the future with consideration of climate change.

Potential Impact of the Plant Operation on Flooding
The plant process is dry except for the use of once-through cooling water and raw water for boiler and miscellaneous services; thus there will be no inducement of flooding from plant water usage. The

cooling water will be returned to the Bay while the process water will be primarily used for steam generation and partly for miscellaneous services including domestic needs.

"Risk" situation associated with the use of water in relation to flooding:

In an event, although remote, that the cooling water and process water lines will break thus causing water to "flood" the project area, this situation is readily corrected by automatic shutdown of the intake pump(s). The plant drainage will flow to the Bay and not to population centers

"Risk" of pipeline rupture.

In the event that a pipeline ruptures, although remote would occur, the Cooling Water stream will discharge naturally to the Macajalar Bay and not to the shore; thus, no flooding would result.

Scenario of High Volumetric Rate of Storm Water from Strong Typhoons

The construction of perimeter walls could cause a concern that the natural discharge of stormwater would be impeded.

The plant drainage system will be able to handle the flow of the stormwater to the ultimate basin, the Macajalar Bay.

Impacts of Flooding on the Project ("Vice-Versa" Scenario)

In a scenario, although unlikely that the plant is flooded, the potential consequences on the environment are:

Submergence of the ash repository in water with potential scenario of leaching

This can be mitigated by the use of geomembranes which effectively isolate the various layers of deposited coal ash leaving only the top/exposed layer to flood

A water impounding pond will be considered near the repository to control flow of water to the Bay. Prior the ultimate discharge of the impounded water, analysis will be conducted to test for hazardous elements/substances.

Washing away of stored coal to the Bay

Containment of the stored coal, such as by bund walls or buildings, will be considered in the design of the coal storage farm/facility.

Aggravation of flooding in nearby areas

This will be addressed for the expansion project as it is done for the current plant operations by the proper design of the plant drainage system.

It is noteworthy that the plant operations from the original project to date have not resulted in any impacts and risks discussed in the foregoing.

2.2.2 Oceanography

2.2.2.1 Change/disruption in water circulation pattern, littoral current, coastal erosion and deposition

Hydrodynamic Modeling

Assessment of project impact on the degree of change/disruption of circulation pattern and potential for coastal erosion

Thermal Plume Modeling

Change in Bathymetry

Result of the expansion project vis a vis the original project

The Delft3D model was set up and used to provide assessments of predictive information on the regional water movements, flow velocities, driven by winds and tides, which will then be used as inputs for thermal plume modelling. Delft3D-Flow simulates the flow of ocean currents within a model region due to forcing by astronomical tides, wind stress, and friction at the sea bed.

2.2.2.1.1 Tidal Water Levels

To determine the type of tides prevailing in the area, the predicted time series of tidal water levels of various tidal stations nearest Macajalar Bay were then subjected to harmonic analysis to quantify the equivalent representative tidal constituents. **Table 2.2-6** summarizes the amplitudes and phases of the major tidal constituents for Cogtong IHO Tidal Station and Bilabil IHO Station in Surigao del Norte using the Delft Dashboard Tide Prediction Tool.

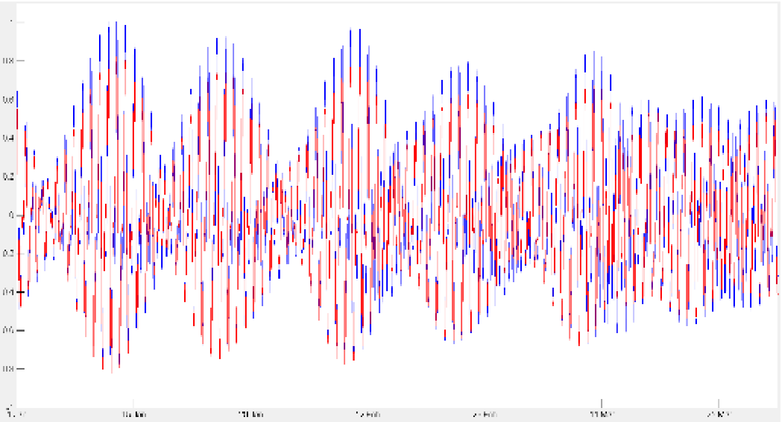


Figure 2.2-10 Predicted tidal water levels in the project area derived tidal harmonics from Cogtong IHO (in blue line) and Bilabil IHO (in Surigao, red line) through Delft Dashboard

The Form Number (F) or the amplitude ratio, is a convenient way to determine the type of tide (diurnal, semi-diurnal, or some combination of the two). It is computed as the sum of the main two diurnal amplitudes (K1+O1) divided by the sum of the main two semidiurnal amplitudes (M2+S2). Based on computation, the Form Number is about 1.19 in Cogtong IHO. This value can be interpreted that since the Form Number is in the range of 0.25 to 1.50, the area is experiencing mixed semidiurnal tide cycle (i.e., meaning that there are two unequal low and high tides each day), see Table below for reference. For the other nearest tidal station, Bilabil IHO in Surigao, the From Number computed is 1.62, which means that for Surigao del Norte farther up north of the project area, the prevailing tidal cycle is mixed diurnal.

Table 1. Tidal types defined by Form Number

Tidal Type	Form Number	Typical Form
Semidiurnal Tides	Less than 0.25	
Mixed, Semidiurnal	0.25 – 1.5	
Mixed, Diurnal	1.5 – 3.0	
Diurnal Tides	More than 3.0	

Table 2.2-4 Summary of Tidal Constituents for the Predicted Tide Stations nearest the project area, in Cogtong IHO and Surigao (Bilanbilan IHO)

Tidal Constituent	COGTONG IHO		SURIGAO (BILANBILAN IHO)	
	Amplitude	Phase (deg)	Amplitude	Phase (deg)
M2 (principal lunar)	0.2812	308.777	0.2051	311.877
S2 (principal solar)	0.1660	356.014	0.1209	4.959
N2 (elliptical lunar)	0.0492	288.366	0.0271	298.360
K2 (declination lunar-solar)	0.0442	354.214	0.0321	3.557
K1 (declination lunar-solar)	0.2725	329.497	0.2595	317.504
O1 (principal lunar)	0.2616	284.622	0.2695	272.620
P1 (principal solar)	0.0902	329.960	0.0852	317.949
Q1 (elliptical solar)	0.0506	259.562	0.0516	248.545

2.2.2.1.2 Predicted Water Circulation Patterns and Movement

To help quantify the effect of coastal circulation and thermal dispersion on the downstream coastal study area, the hydrodynamic model was used to simulate the effect of the representative tidal events occurred from January 1 - February 1, 2020. The first 5 days of the simulation period is used to ensure that the model reaches its steady state thus preventing the effect of numerical oscillations as a result of the initial conditions of the model run. The thermal dispersion simulation started from the 5th of January up to the 1st of February 2020, using the first 5-days of hydrodynamic simulation as the initial condition in the computations. The modelling performed off the coast of the study area was more of a limited analysis, as a comprehensive data set (e.g., historical time series of water quality data, actual discharge rates, etc.) in order to fully model the coastal circulation was not available at the time of preparing this report.

a) Predicted Water Circulation under the Baseline Condition

Both winds and tidal forces significantly influence current circulation inside the Macajalar Bay. The results of the hydrodynamic simulation demonstrated tidal ebbing and flooding dictating current movement and mass transport within and out of the area. This may have been brought by the complicated topography and coastal configuration and shallow depth of the area of the proposed site development.

The next two figures below show the depth-average current for *habagat* wind conditions (wind speed of 4 m/s from the southwest) during tidal flooding for the first one while the second one shows the detailed flow patterns for tidal 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.

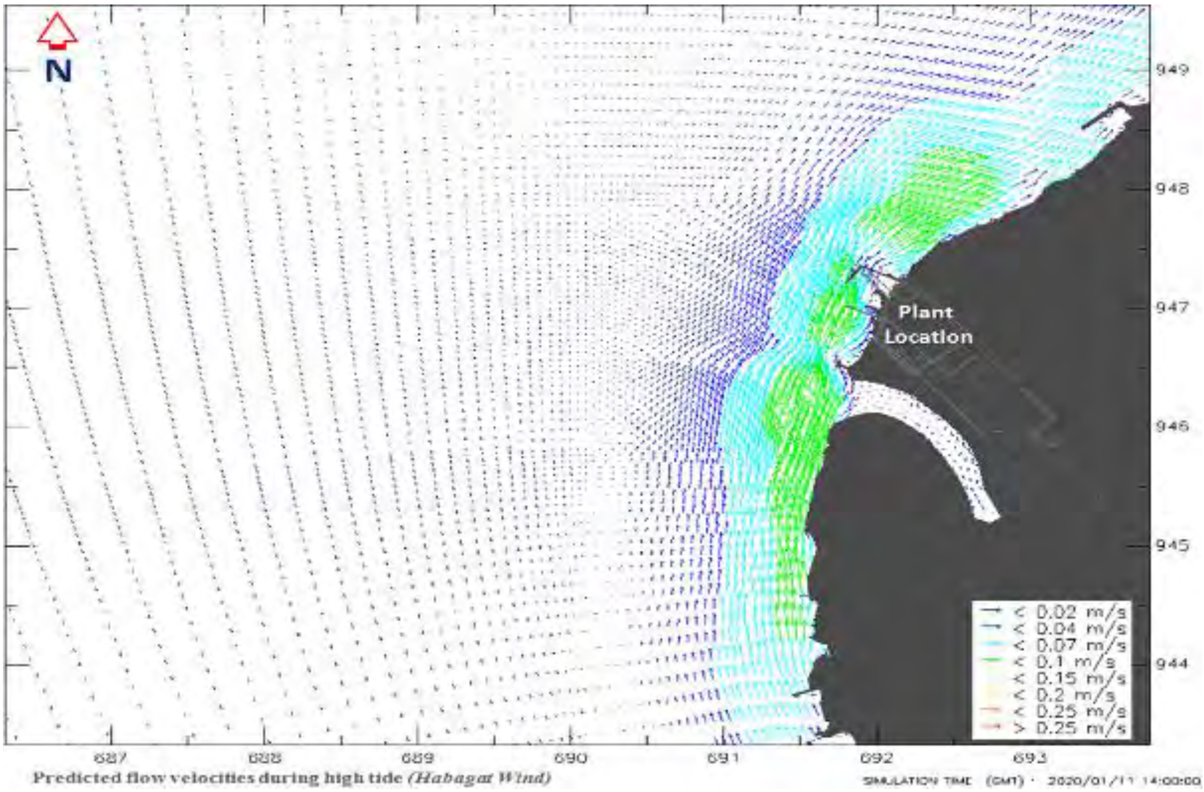


Figure 2.2-11 Predicted currents in the project area during tidal flooding (habagat wind condition).

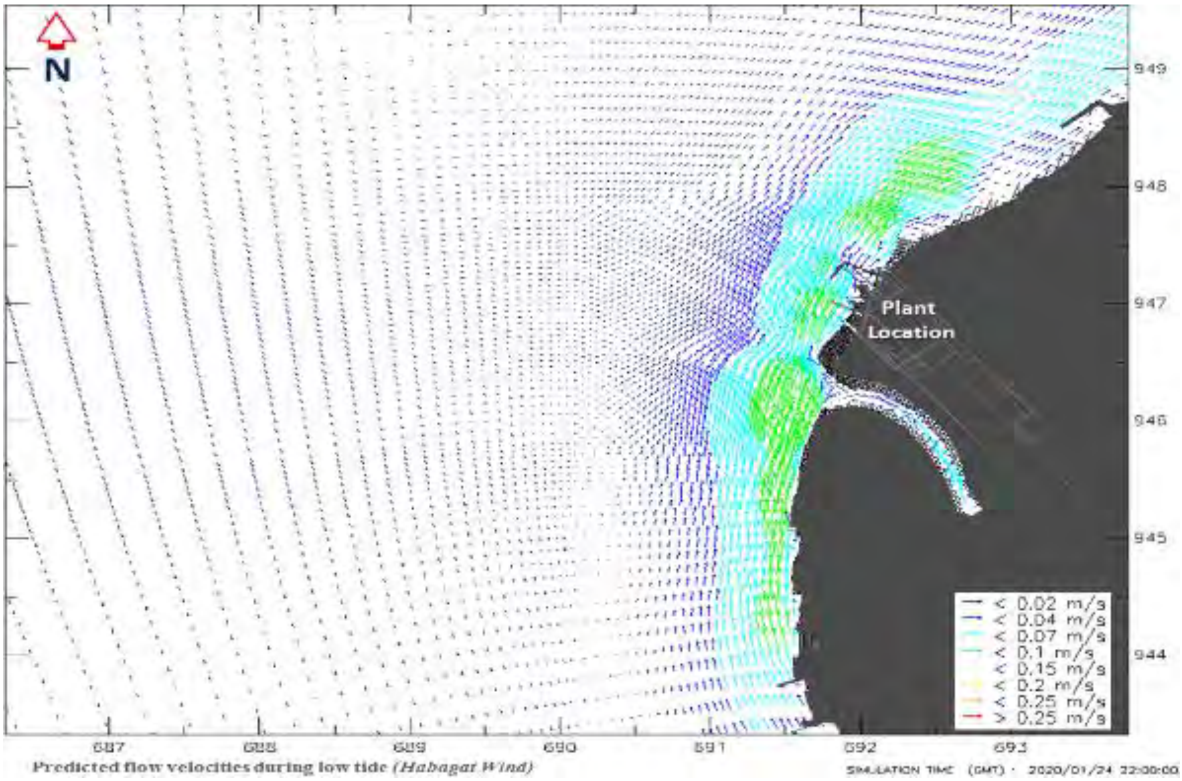


Figure 2.2-12 Predicted currents in the Bay during low tidal event (habagat wind condition).

The next figures show the typical flow patterns in the project area during high tides and low tides under the influence of wind blowing from the northeast direction (*amihan* wind).

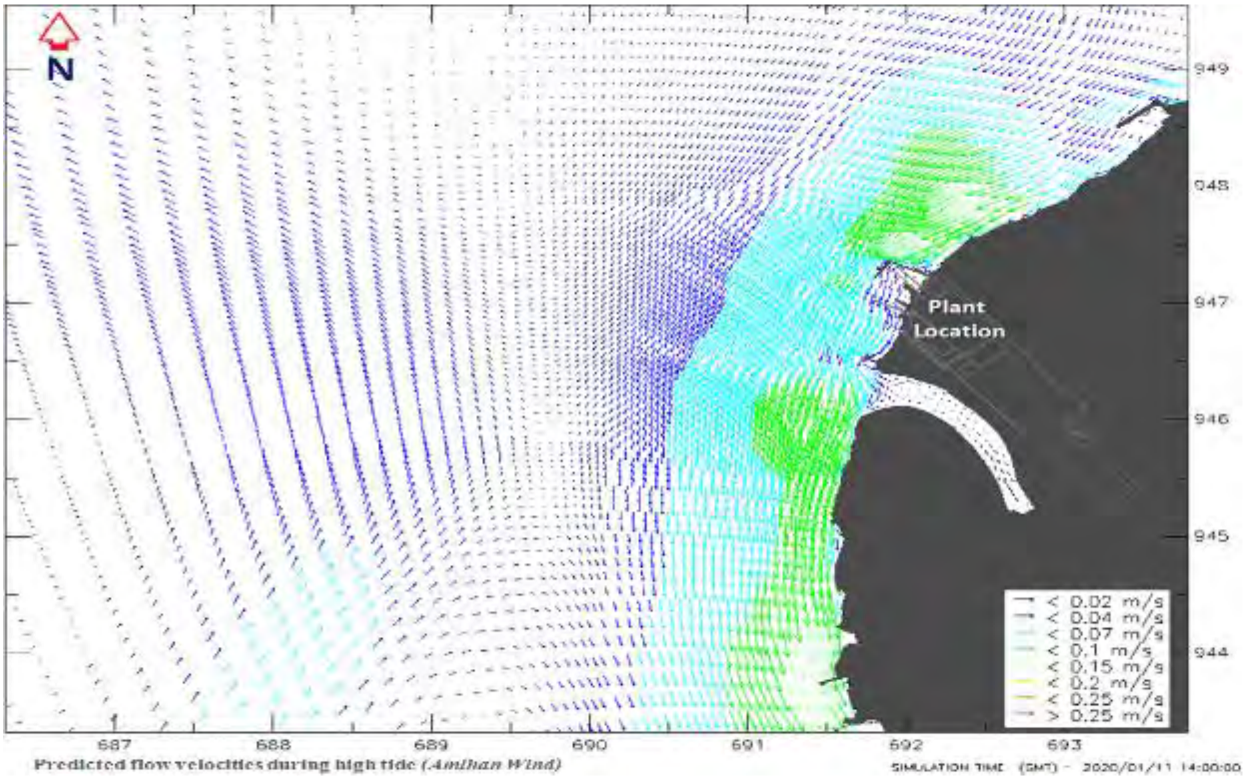


Figure 2.2-13 Predicted currents in the Bay during high tidal event for amihan wind condition.

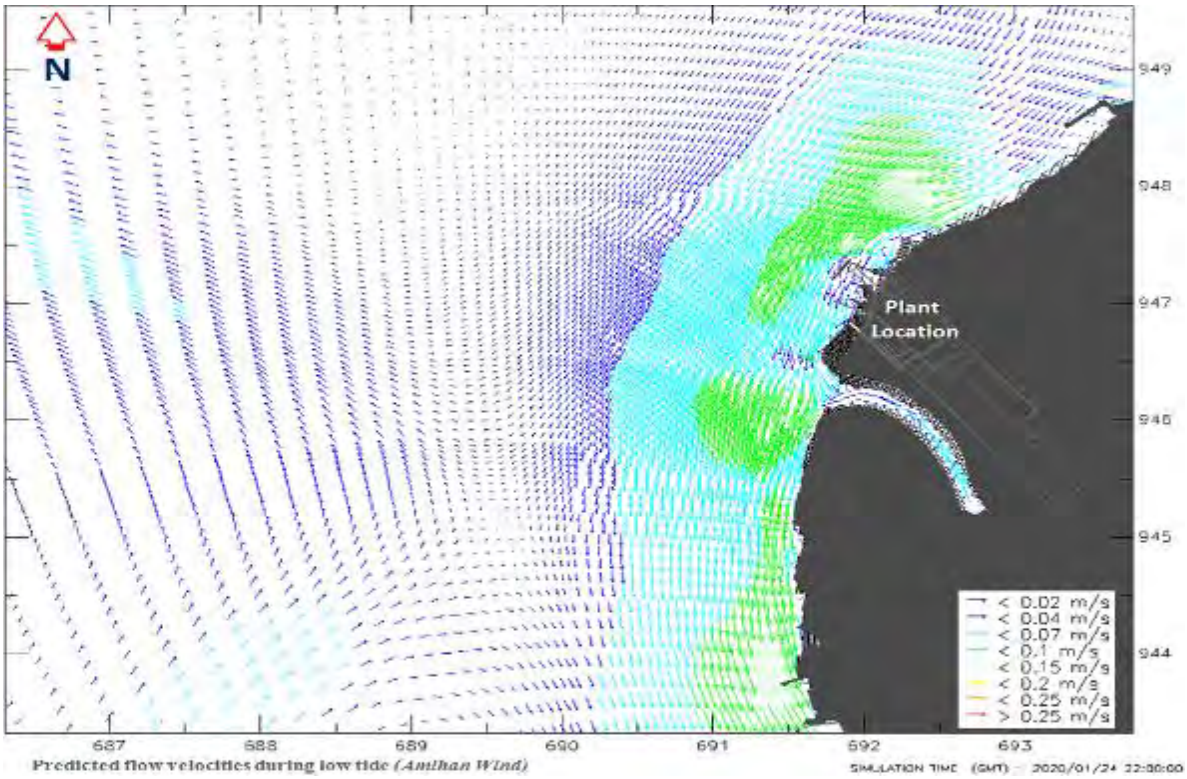


Figure 2.2-14 Predicted currents in the Bay during low tidal event for amihan wind condition.

From the examination of the predicted currents in the Bay during these two wind conditions, it follows that the wind shear had a significant influence in steering the currents. During habagat conditions, the currents exhibit a bias towards the northeast, due to the prevailing southwesterly winds. The high tidal event induces current speeds reaching a maximum of more than 0.2 m/s while the currents during tidal ebbing were generally weaker, reaching a maximum of ~0.1 m/s near the coast. Far offshore, the predicted currents are generally less than 0.05 m/s for both *amihan* and *habagat* wind conditions.

b) Predicted Changes in Water Circulation due to the Project

Due to the rather large volumes of seawater used for cooling (about 20.05 m3/s for each of the two plants, original and expansion projects), and the subsequent release of the same volume of water may affect the existing water movement and flow patterns in the area immediate of the project site. Thus, the abstraction rates of 20.05 for each of the intakes, as well as the release of the same discharge at each of the two outfalls were considered in the simulations which were then compared to the baseline scenario simulations (i.e., without project).

Using the results of Delft3D model, the potential changes in the hydrodynamics in the project area were assessed by comparing the results of the baseline conditions with what is predicted ‘with the project in place’ scenario. The ‘with project’ or post-development scenario were setup using the same model inputs as the baseline scenario, except the inclusion of the abstraction and discharge rates as a result of the future operation of the plant.

The succeeding figures show the predicted circulation patterns in the area (shown as arrows) and comparative estimates in the changes in flow magnitudes (as colored contours) as a result of the project for varying tidal and wind events. The changes in flow magnitudes are determined by taking the difference of the results of the simulations of ‘with’ and ‘without’ project. Negative values in the legend indicate the reductions in the flow magnitudes while a positive value indicates increase in flow magnitudes. The general layout of the proposed plant is also shown as gray areas in these figures.

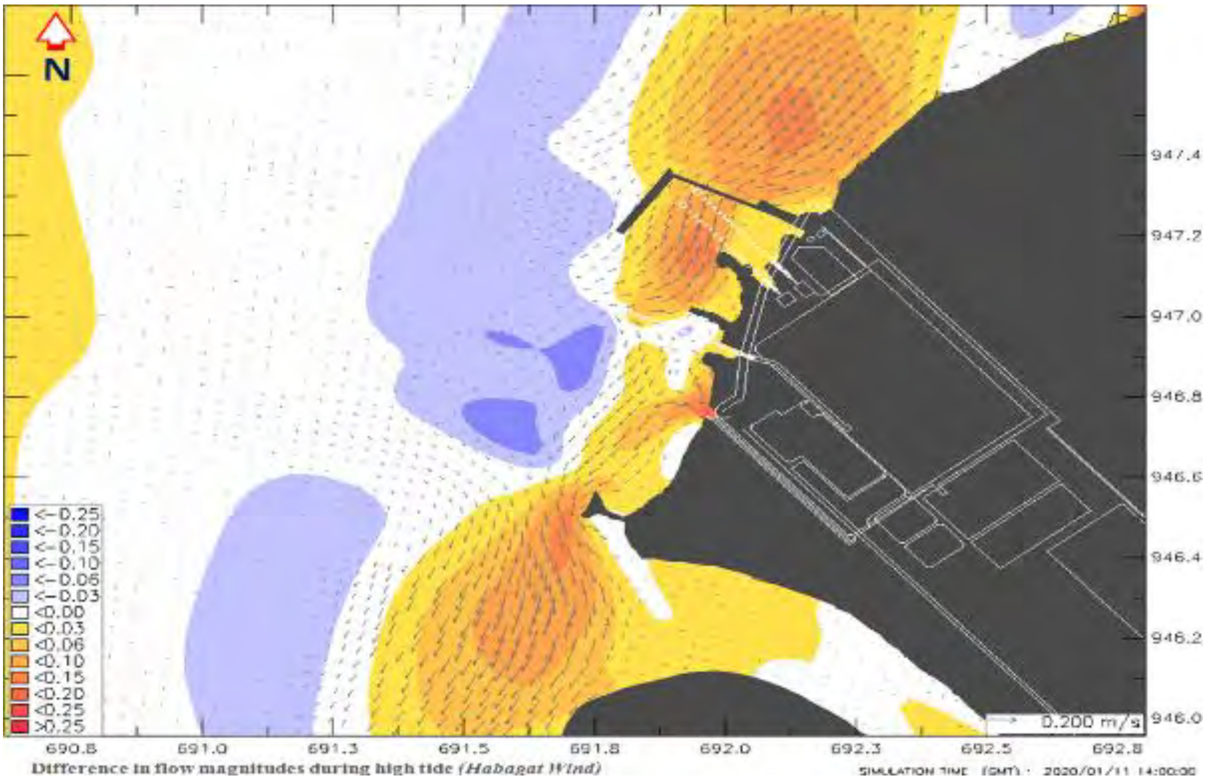


Figure 2.2-15 Predicted changes in flow magnitudes near the plant during high tidal event for habagat wind condition.

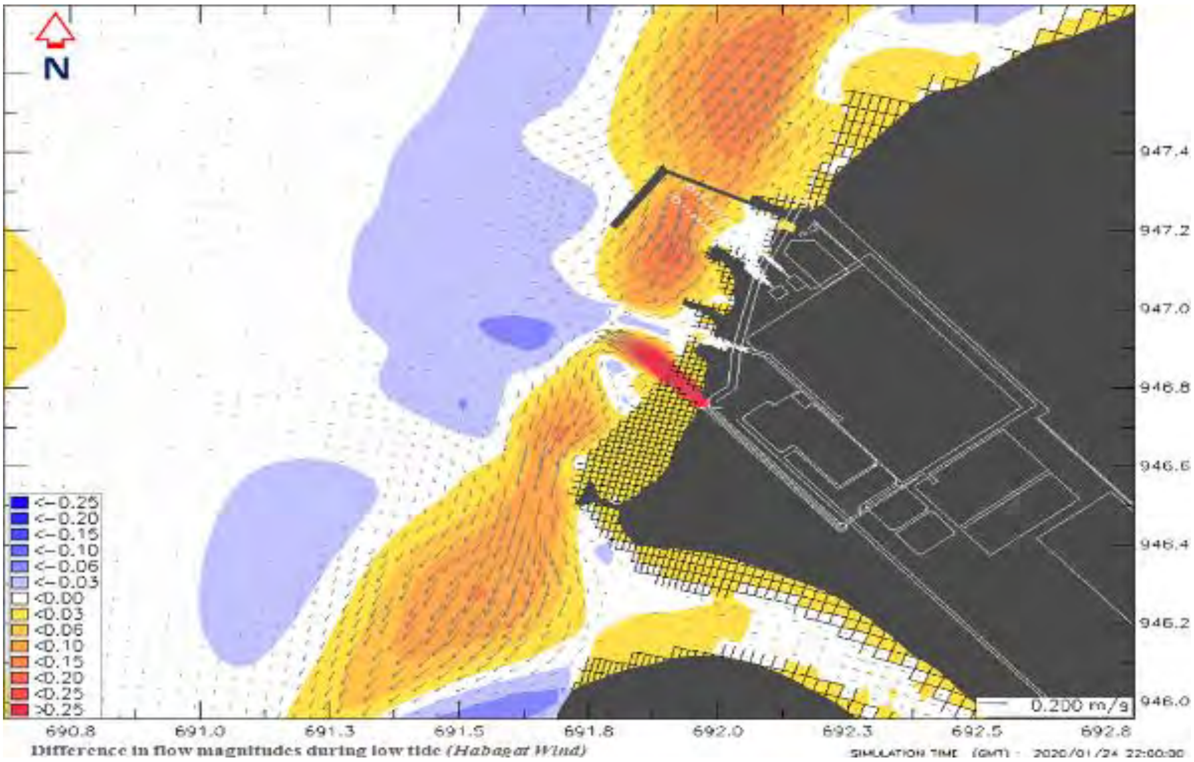


Figure 2.2-16 Predicted changes in flow magnitudes near the plant during low tidal event for habagat wind condition.

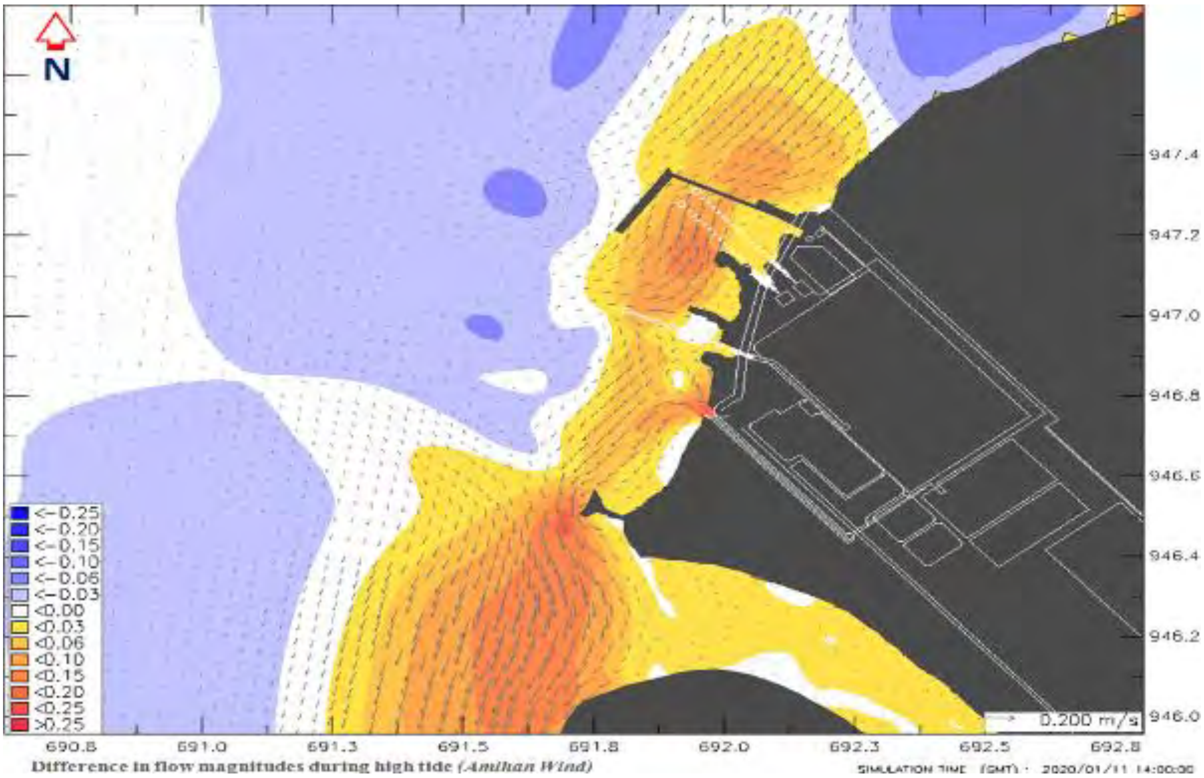


Figure 2.2-17 Predicted changes in flow magnitudes near the plant during high tidal event for amihan wind condition.

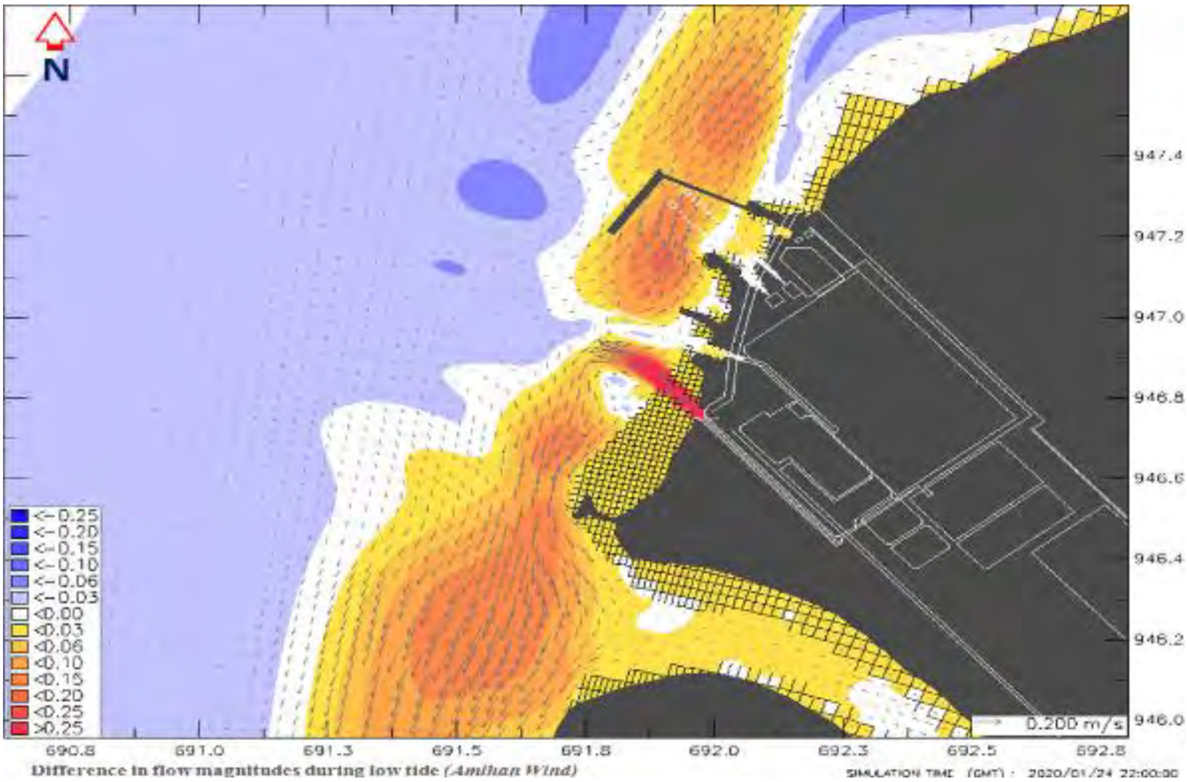


Figure 2.2-18 Predicted changes in flow magnitudes near the plant during tidal ebbing for amihan wind condition.

In general, regardless of tidal conditions and wind patterns, it appears that near the intakes and outfalls, an increase in flow magnitudes in the range of 0.03 to 0.15 m/s is predicted due to the operations of the plant. Farther offshore and a few hundreds of meters alongshore from the plant, changes in flow magnitudes is predicted to be minimal as a result of the mixing of the outfall/return water with the sea water.

The relatively high increase in flow magnitudes is near the canal of the expansion project. Due to the shallow waters during low tidal events, the increase in flow magnitudes is higher than what is predicted during high tides. The increase in magnitudes in the vicinity of said outfall is about 0.25 m/s but reduced to less than 0.10 m/s as the discharge mixes with the ambient coastal waters.

2.2.2.2 Thermal Plume Modelling

This sub section assesses the movement and dispersal patterns of thermal plume in the study area as a function of the general hydrodynamics around the development site. In particular, dispersal, dilution and accumulation patterns of the thermal plume as transported by the ambient current circulations were investigated to give a very good indicator for potential impacts arising from the plant's operation on overall water quality, specifically focusing on resulting water temperature.

It is assumed that the ambient temperature of the model domain coastal zone is constant at 28°C. This is to ensure that the resulting thermal concentrations as predicted by the model are attributed exclusively from the source. Scenarios were developed to incorporate the effects of southwesterly and northeasterly winds, as well as calm wind conditions, to investigate the propagation and dispersal of the warm water plume as current is forced by the wind, particularly near the surface.

Warm water discharges were simulated operating continuously for at least 25 days in the model, to allow the build-up of the far-field thermal plume over many tidal cycles. Results were examined over a spring cycle using tidal data from January 2020.

The model outputs the temperature, and excess temperature (delta T) can be calculated easily by subtracting 28°C from the predicted temperature, allowing temperature prediction for all ambient conditions. The predicted excess temperatures would be largely unaffected by the ambient water temperature, even if the model was run with a different ambient conditions.

The following figures show the results of the model runs. Some of the results of the 27-day simulation of warm water plume 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 movements.

The various considered Modelling Scenarios are summarized hereunder and discussed separately:

Scenarios	Wind Condition	Parameter	Time Duration	Remarks
Scenario 1	Amihan North Easterly	Temperature plume	3, 6, 12 hours	The time (hours and days) are the lapsed time from start of simulation period Excess max temperature is defined as maximum differences in temperature of the composite values
			3,708, 5.542, 8,458 days	
			11.167, 14.417, 16.625, 18.333 days	
			21.25, 23.792, 26.875, 18.33273 days	
		Excess Max Water Temperature	27 days	
Scenario 2	Habagat- South Westerly			
		Temperature plume	2, 7 hours	
			1.208, 4.75, 6.583, 9.458 days	
			12, 14.58, 15.667, 17.375 days	
			20.292, 23.833, 25.917, 27 days	
		Excess Max Water Temperature	27 days	
Scenario 3	Calm Condition	Temperature plume	1,4,8,12 hours	
			1.042, 4.667, 6.375, 9.417 days	
			10.125, 12.292, 14.583, 16.50 days	
			19.208, 22..75, 25.833, 27 days	

Scenario 1 – Thermal Dispersion under a North-easterly Wind (Amihan) Condition

This scenario setting incorporated the influence of wind on coastal current circulation and transport and movement of thermal plume in the study area. This was accomplished with the use of a uniform wind speed forcing of 4 m/s (amihan wind, 25 to 50 degrees from the north), representative of the northeast monsoon conditions.

Using the design discharge data of 72,190.68 m3/hr (equivalent to 20.05 m3/s) for each of the outfall pipes of the original and expansion projects, and temperature of 28°C for both discharge rates, the results of the model runs are explained further below.

For *Amihan* wind conditions, the plume was predicted to oscillate and change direction with each flood and ebb tide event. While the general orientation of the high-concentrated thermal plume is geared towards the south-western direction, part of the plume was pulled in a north-easterly direction during flood tide, momentarily paused and then forced towards the southwest during the ebb tide. As a result of the change in directions and current velocities, the concentrations would be variable over time. Lower concentrations (higher dilution rates) were occurring during stronger currents. In contrast, patch of moderately higher concentration (lower dilution rates) tended to build up at the turn of the tide or weaker current events. The lower concentration patch, with a rise in temperature of less than 0.5°C, would move as the current speeds increased again and tended to be present within the wider plume at any one time.

However, the maximum limit of 3°C rise in ambient temperature (shown as red areas with >3°C in the figures) is quite visible, which were highlighted with black contour in the figures. Notice also the low-concentrated plumes (shown as sky blue and yellow green areas), wherein its coverage area moderately shrinks or spreads consistent with the rise and fall of the tide. As the flow along the shore is directed southwest during Amihan, the thermal plume likewise moved parallel to the shore. In the case of low flow velocities during slack water, the plume spread further in different directions, though at lower thermal concentrations of less than 0.5°C rise in ambient temperature.

The next figures show a sample series of the plume movements, causing a build-up in concentration during Amihan wind events. This patch of higher delta T would then be advected away from the release site as current speeds increase and further reduced in concentrations due to transport and mixing.

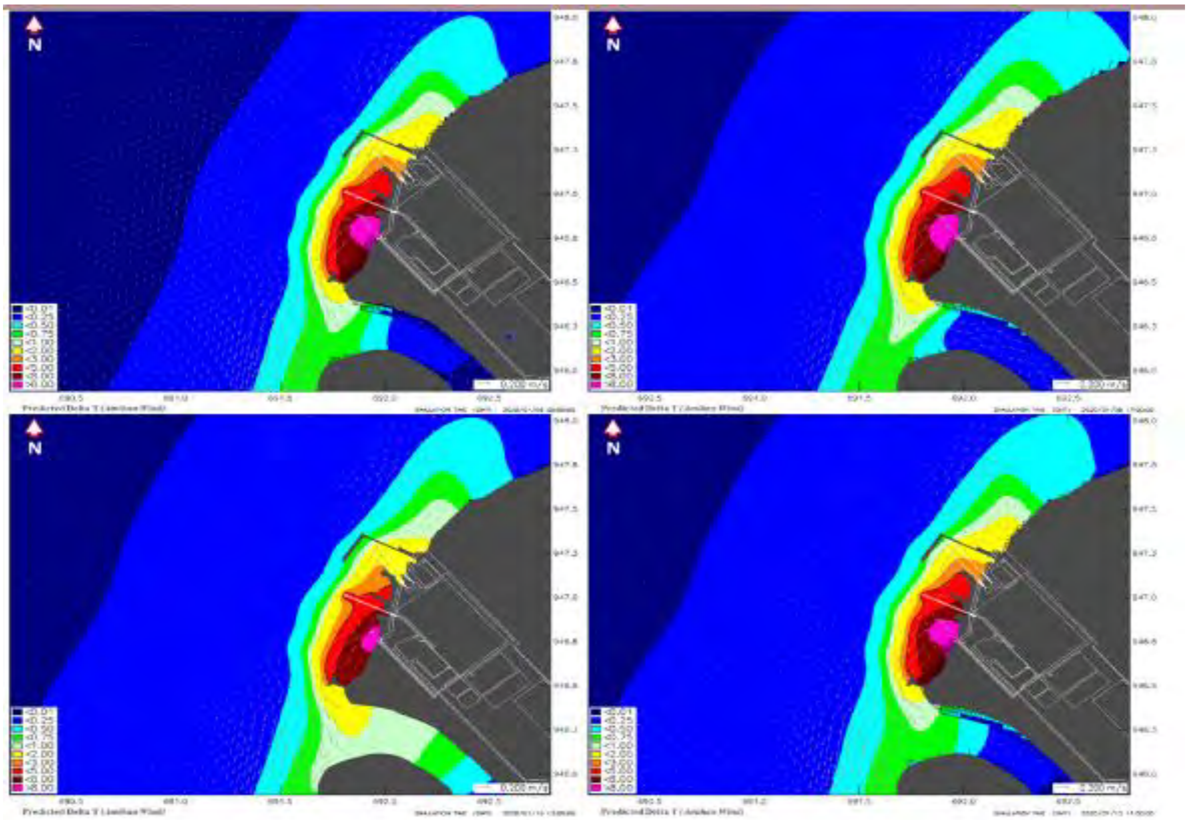


Figure 2.2-19 Predicted transport of thermal plume after one hour (upper left), 3 hours (upper right), 6 hours (lower left) and 12 hours (lower right) of continuous warm water releases, under amihan wind condition.

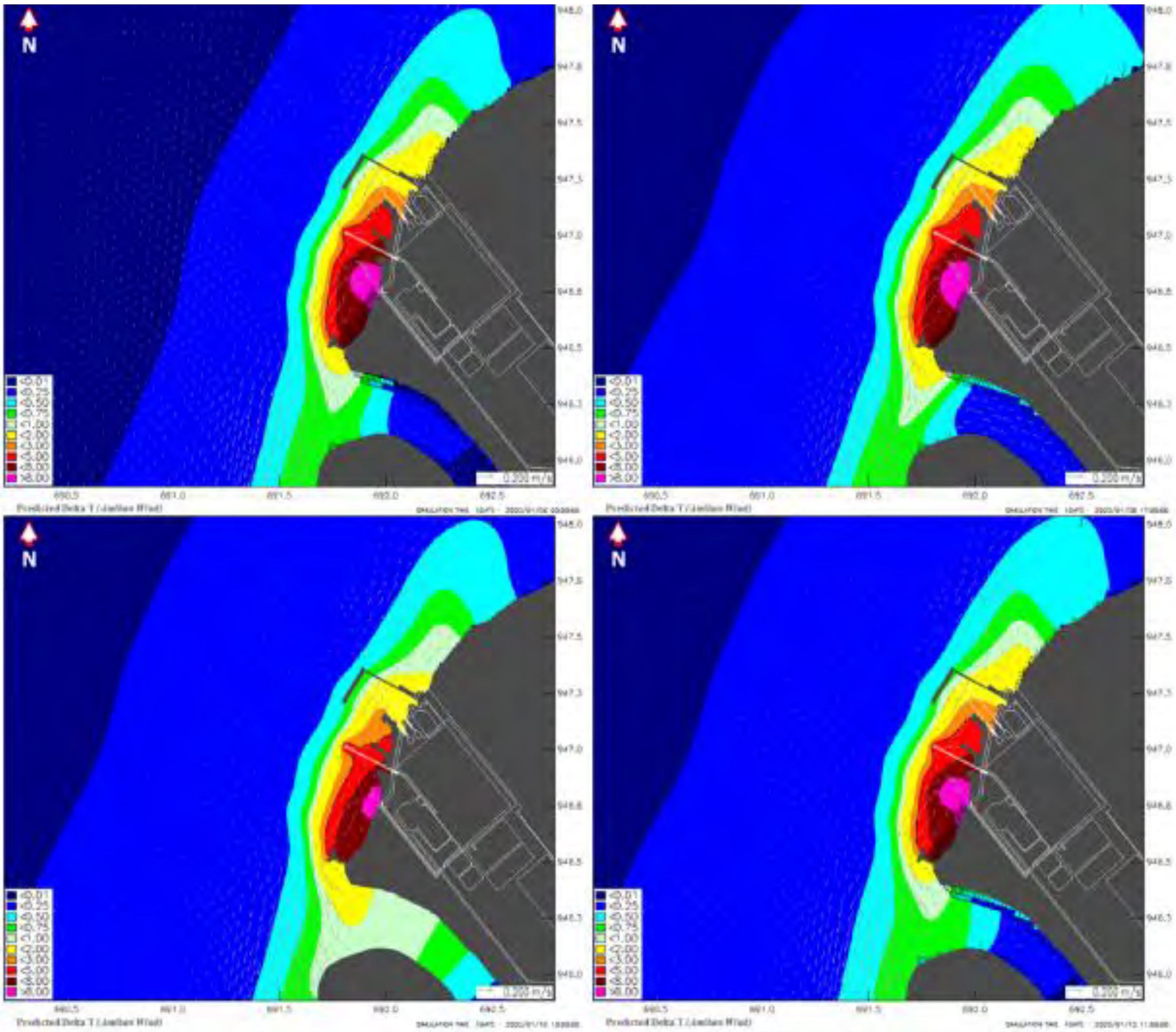


Figure 2.2-20 Predicted transport of thermal plume after 24 hours (upper left), 3.708 days (upper right), 5.542 days (lower left) and 8.458 days (lower right) of continuous warm water releases, under amihan wind condition.

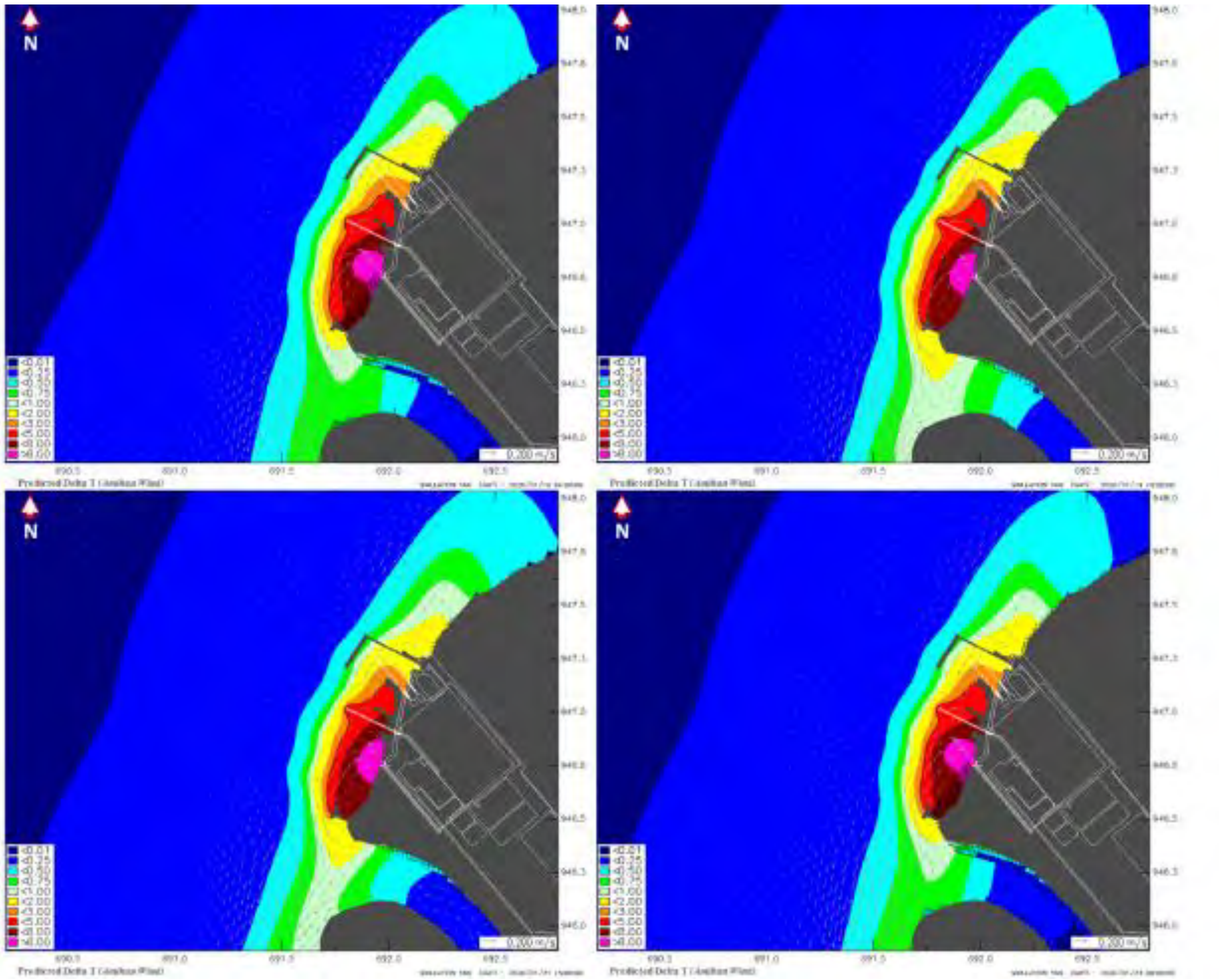


Figure 2.2-21 Predicted transport of thermal plume after 11.167 days hours (upper left), 14.417 days (upper right), 16.625 days (lower left) and 18.333 day (lower right) of continuous warm water releases, under amihan wind condition.

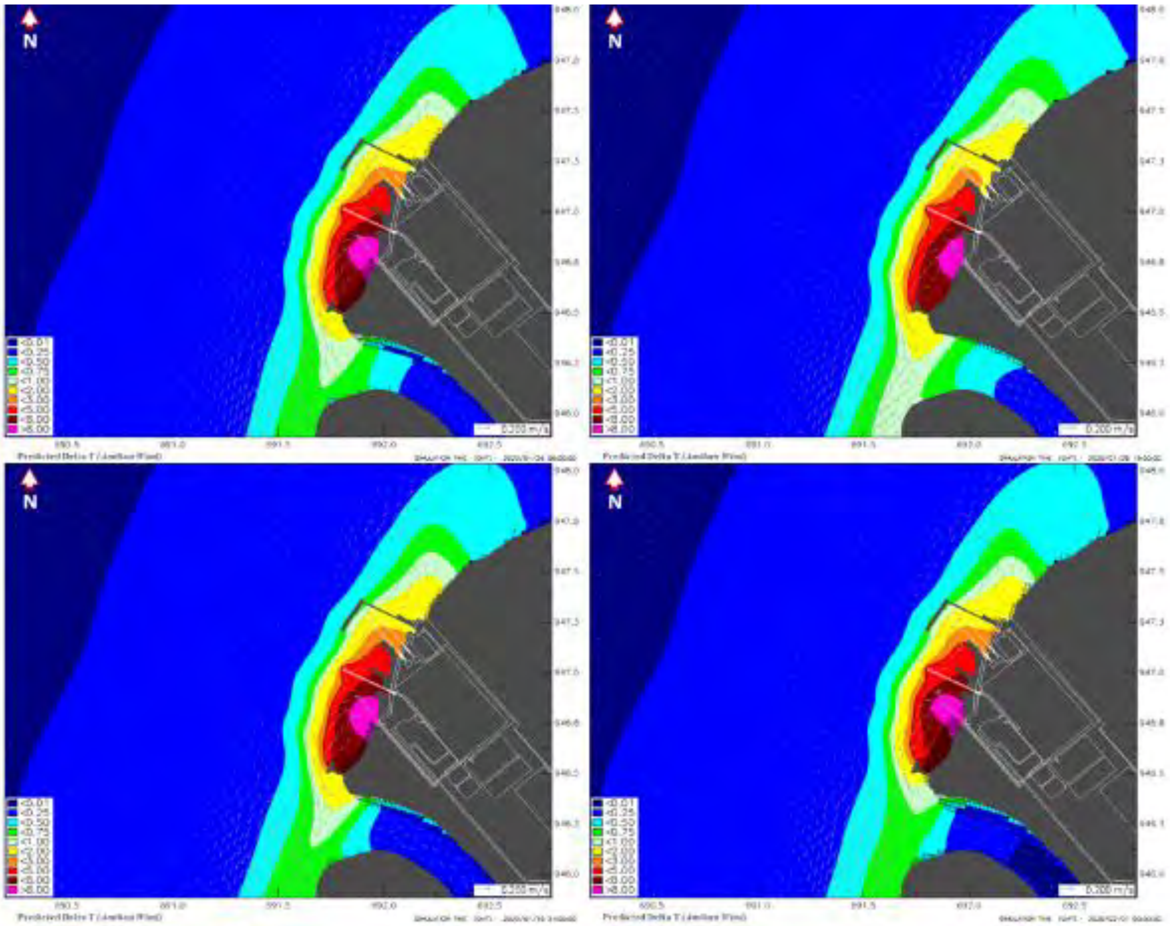


Figure 2.2-22 Predicted transport of thermal plume after 21.25 days hours (upper left), 23.792 days (upper right), 25.875 days (lower left) and 18.33273 day (lower right) of continuous warm water releases, under amihan wind condition.

To define the extent of excess temperature due to warm water release at the outfalls, considering the design discharge rates and outfall temperature concentrations as well as the ambient concentrations, the composite of the maximum values were calculated at each grid of the entire 27-day simulations and given in the figure below.

The simulation run predicts that the maximum thermal concentration at the vicinity of the two outfalls will exceed the allowable DENR standard of not more than 3°C rise in background concentration, which is visible in the composite map shown by the red contour plot (<5.0 in legend). The simulation calculated a maximum rise in temperature is to be more than 5 °C within the vicinity of the original project outfall and about 8°C in the coastal area close to the expansion project outfall. Farther offshore, the ambient temperature marginally increases by less than 0.50°C. Also, as the outfall of the expansion project is located near the shore, it contributes a higher warm water temperature level as compared to the existing outfall. This result is mainly due to its shallow location where dilution and mixing is limited.

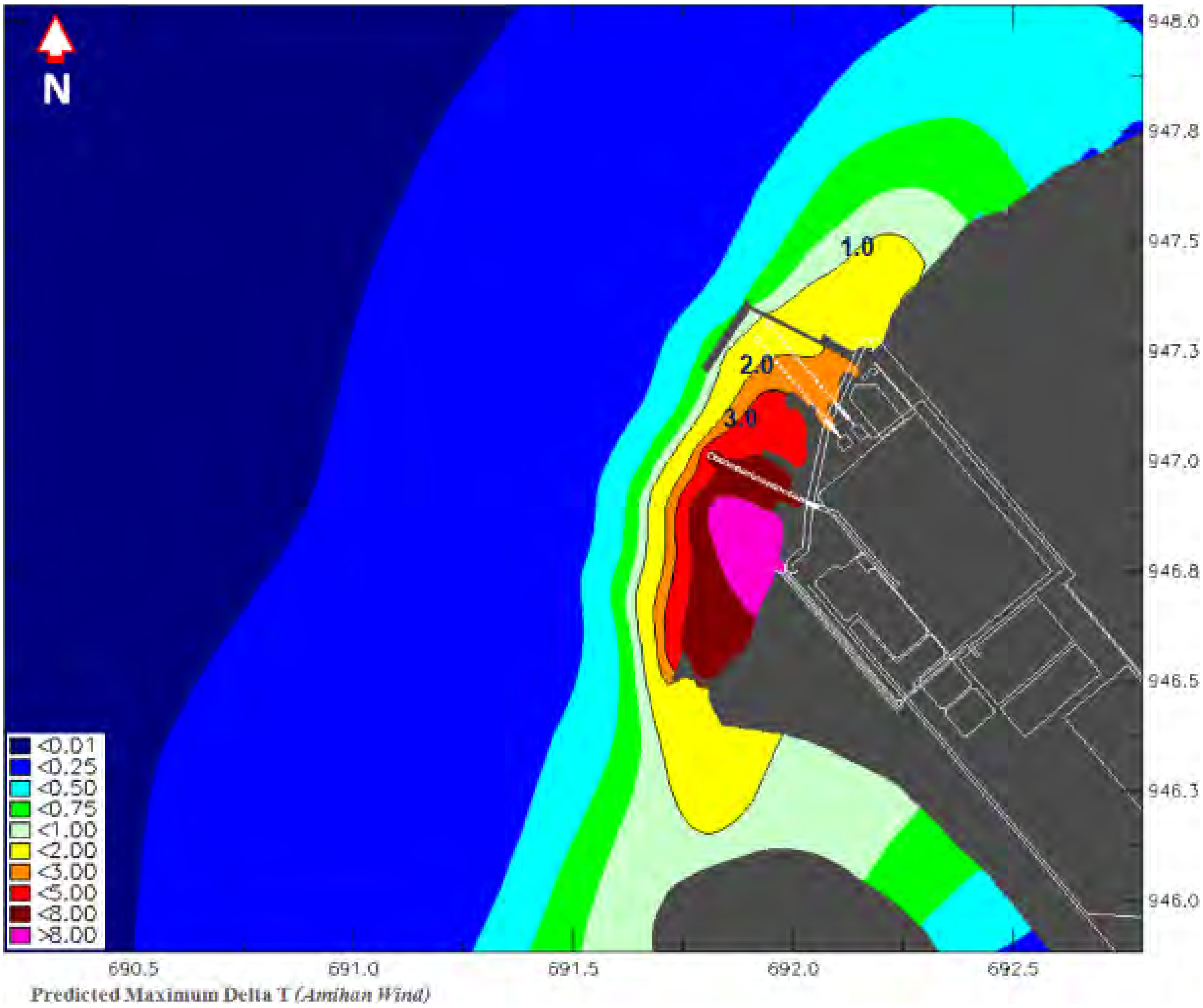


Figure 2.2-23 Predicted maximum variations in excess water temperature for the 27-days thermal plume simulation under amihan wind condition. Black contour line represents incremental increase of 1 degree C in ambient temperature level.

Scenario 2 – Thermal Dispersion under a South-westerly Wind (Habagat) Condition

The next scenario sets describe the fate and transport of warm water temperature during the prevailing *Habagat* wind condition in the project area. The model results presented in this section are based on a continuous 27-day release of the thermal plume at the outfalls. One is located just at the shore (i.e., expansion project), and the other one about 100 m offshore (existing plant).
For the *Habagat* scenario, the model used a wind speed of 4 m/s blowing from the south-westerly direction. The model predicts that the spatial dispersion of the thermal plume is directed towards the northern direction, running parallel to the coast. After a few hours of continuous release of thermal water, the plume distributes in an elliptic pattern generally directed towards the northeast. After a few days, lower concentration plumes are predicted to flow in the south, south-westerly direction partly due to the transition of tides (from high to low and vice versa) where weak circular eddies and gyres are formed affecting transport and movement of the thermal plume.

As with the *Amihan* wind model results, a significantly higher excess temperature of more than 5°C is predicted in areas near the outfall of the existing plant, and more than 8°C at the expansion project (see visible red and pink areas in the figures). Thus, similar to the results of the *Amihan* wind scenario, the temperature level rise of 3°C is predicted to occur during the *Habaga*t wind.

The composite map of this particular simulation scenario predicts the maximum thermal concentration in the vicinity of the two outfalls. It is noted the maximum delta T patch has a concentration of more than 5°C as shown by maroon contour plot (< 8 in legend) near the original project outfall and more than 8°C (pink patch, >8.0 in the legend) at the outfall of the expansion project.

Scenario 3 – Thermal Dispersion under Calm (No wind) Condition

One potential combination of oceanographic and meteorological conditions that may produce low dispersion of the thermal effluent is a period of low ambient currents which would correspond to the period of lowest transport and mixing, thereby allowing the plume to maintain its character for longer than it would under normal conditions. Thus, calm wind speed were also considered in this study to drive the dispersal patterns using the same design discharge rate and temperature rise conditions.The results of this model simulation are shown in the succeeding figures.

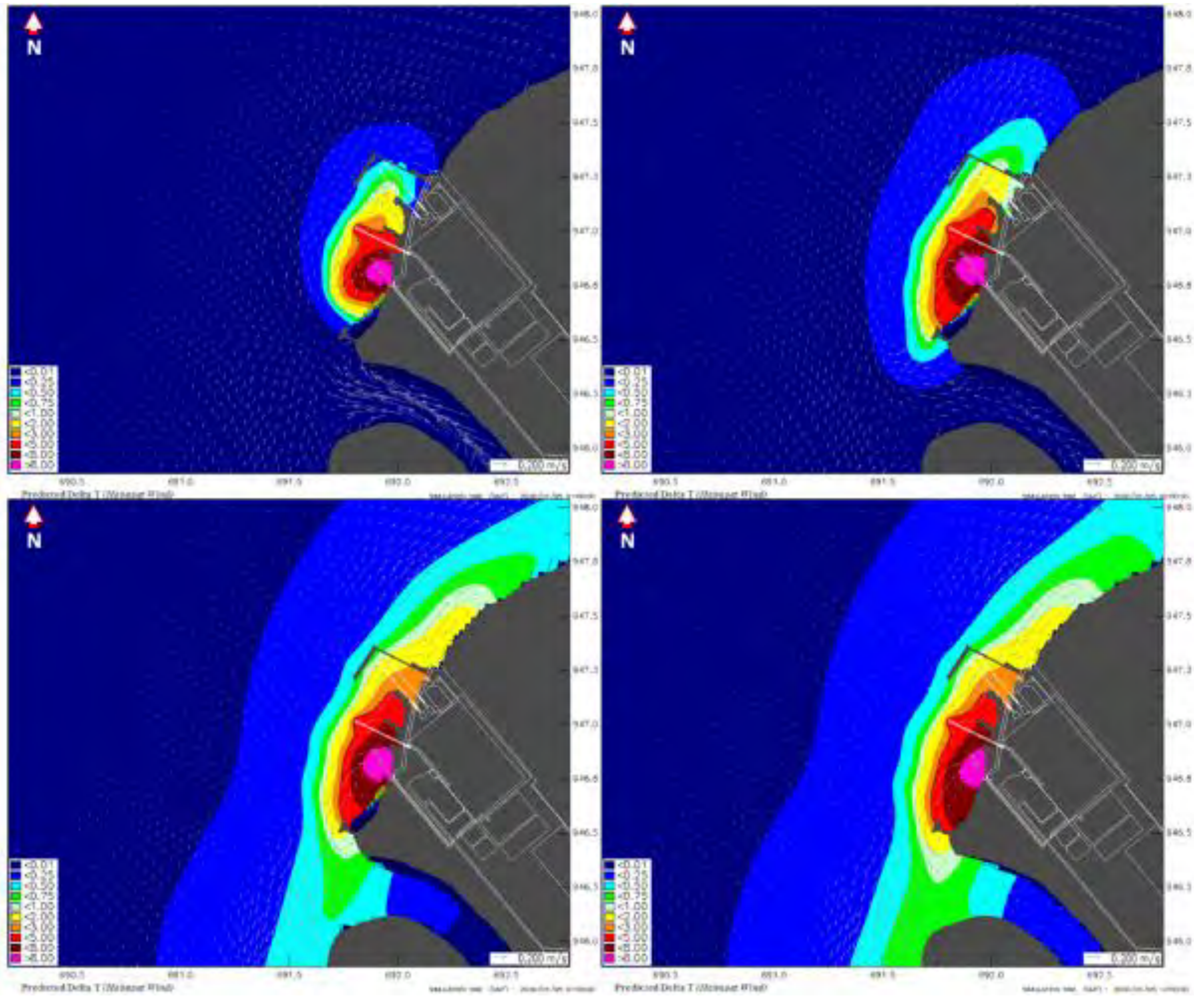


Figure 2.2-24 Predicted transport of thermal plume after one hour (upper left), 2 hours (upper right), 7 hours (lower right) of continuous warm water release, under Habagat wind condition.

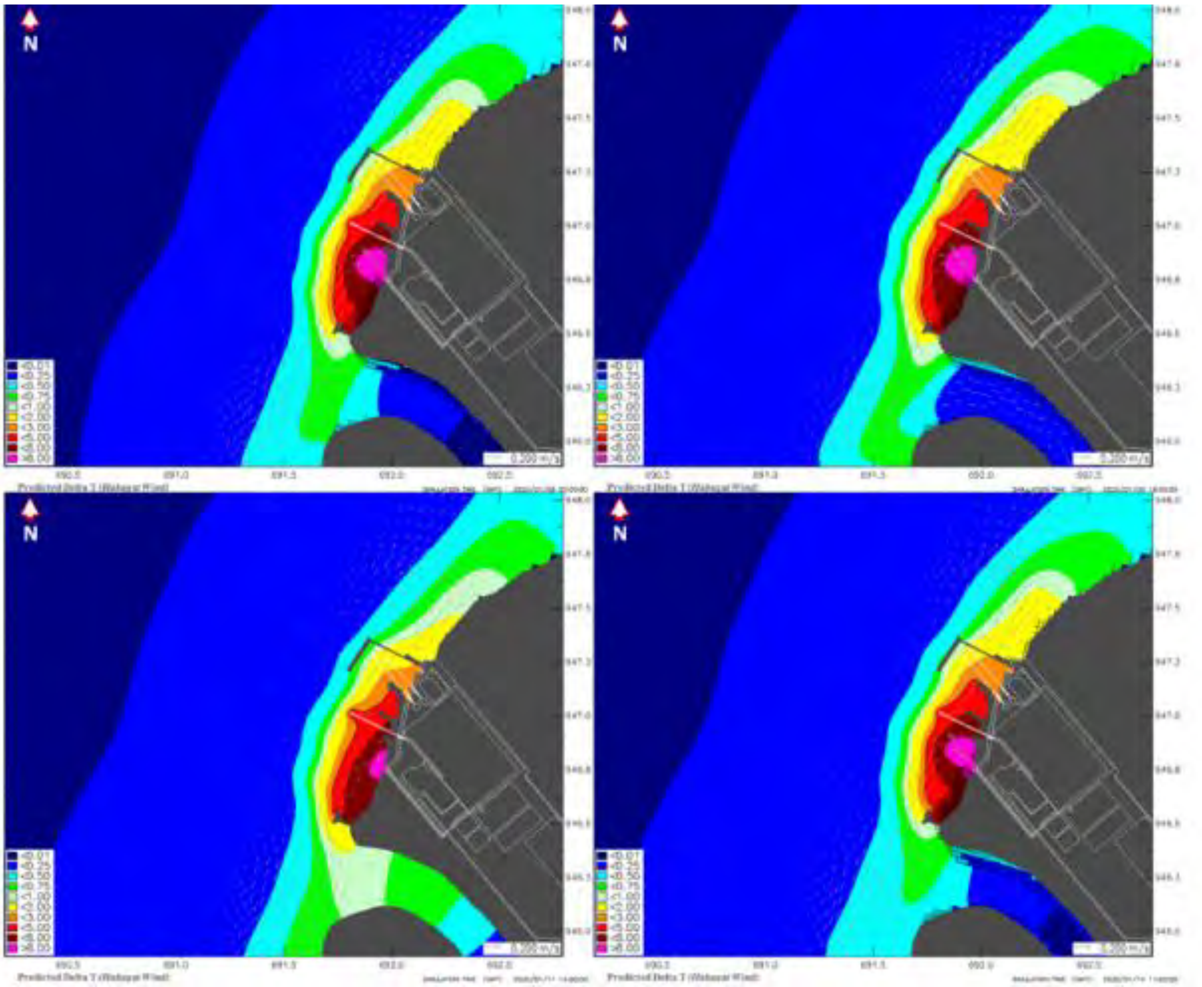


Figure 2.2-25 Predicted transport of thermal plume after 1.208 days (upper left), 4.75 days (upper right), 6.583 days (lower left) and 9.458 days (lower right) of continuous warm water releases, under Habagat wind condition.

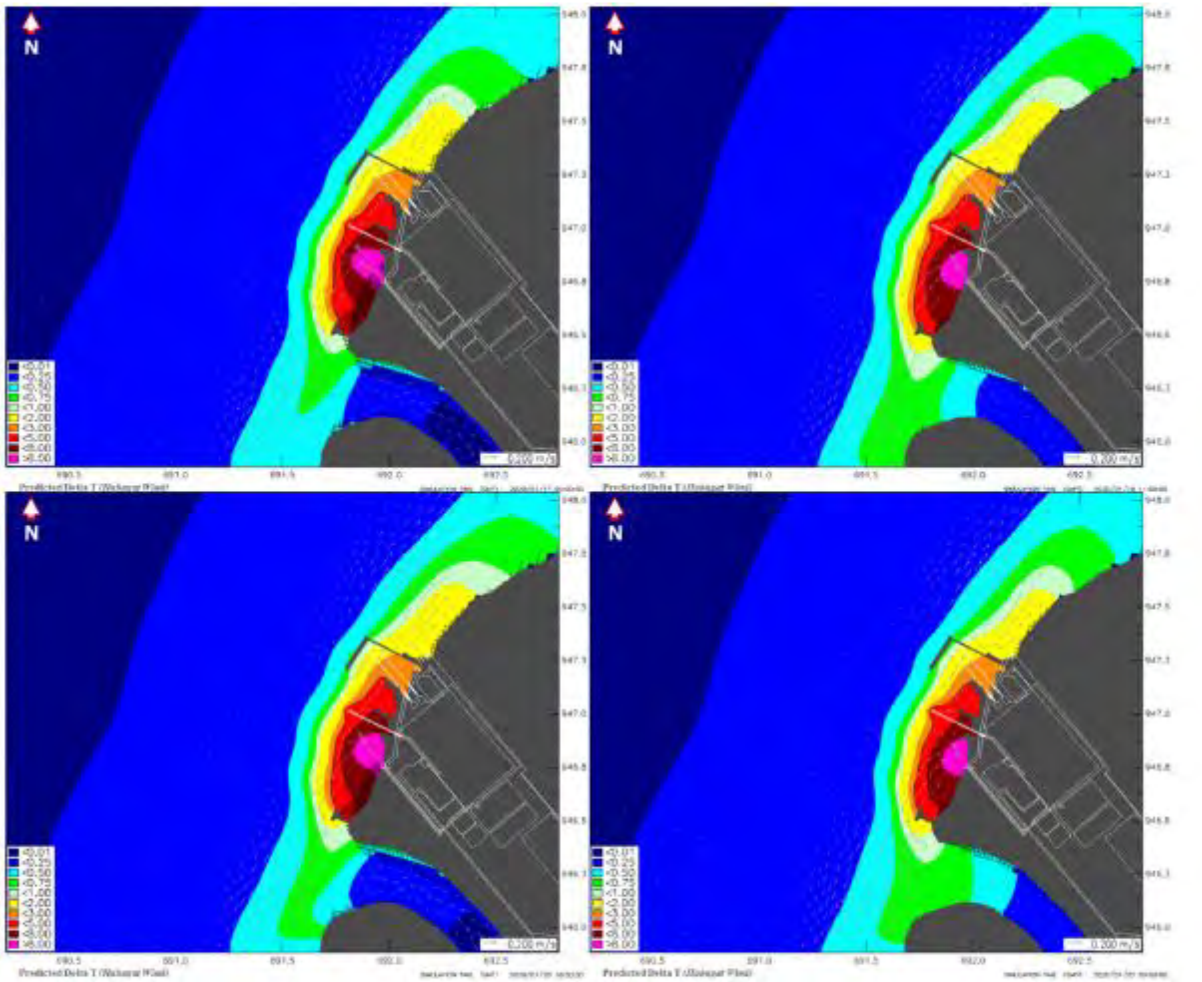


Figure 2.2-26 Predicted transport of thermal plume after 12 days (upper left), 13.458 days (upper right), 15.667 days (lower left) and 17.375 days (lower right) of continuous warm water releases, under Habagat wind condition.

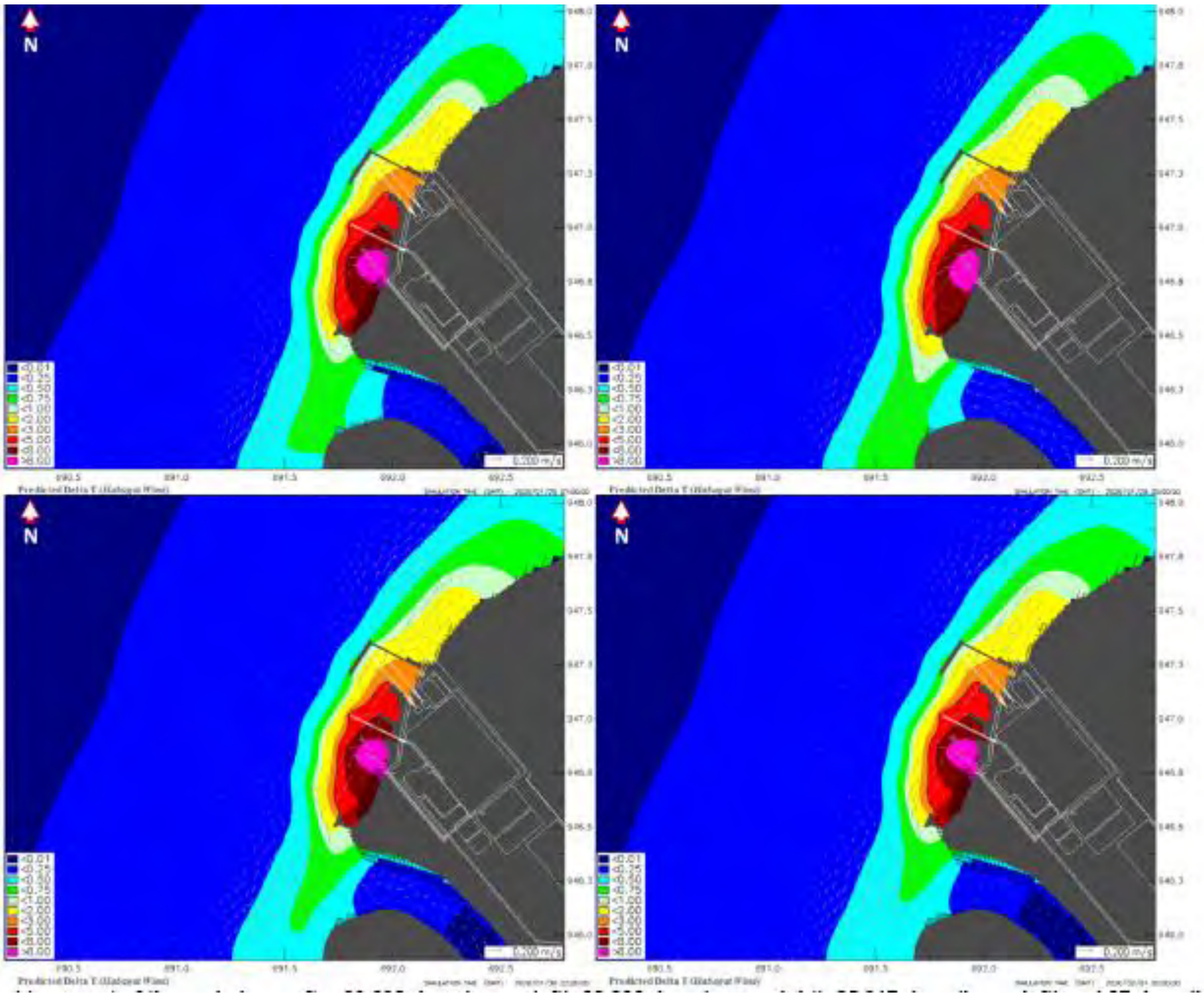


Figure 2.2-27 Predicted transport of thermal plume after 20.292 days (upper left), 23.833 days (upper right), 25.917 days (lower left) and 27 days (lower right) of continuous warm water releases, under Habagat wind condition.

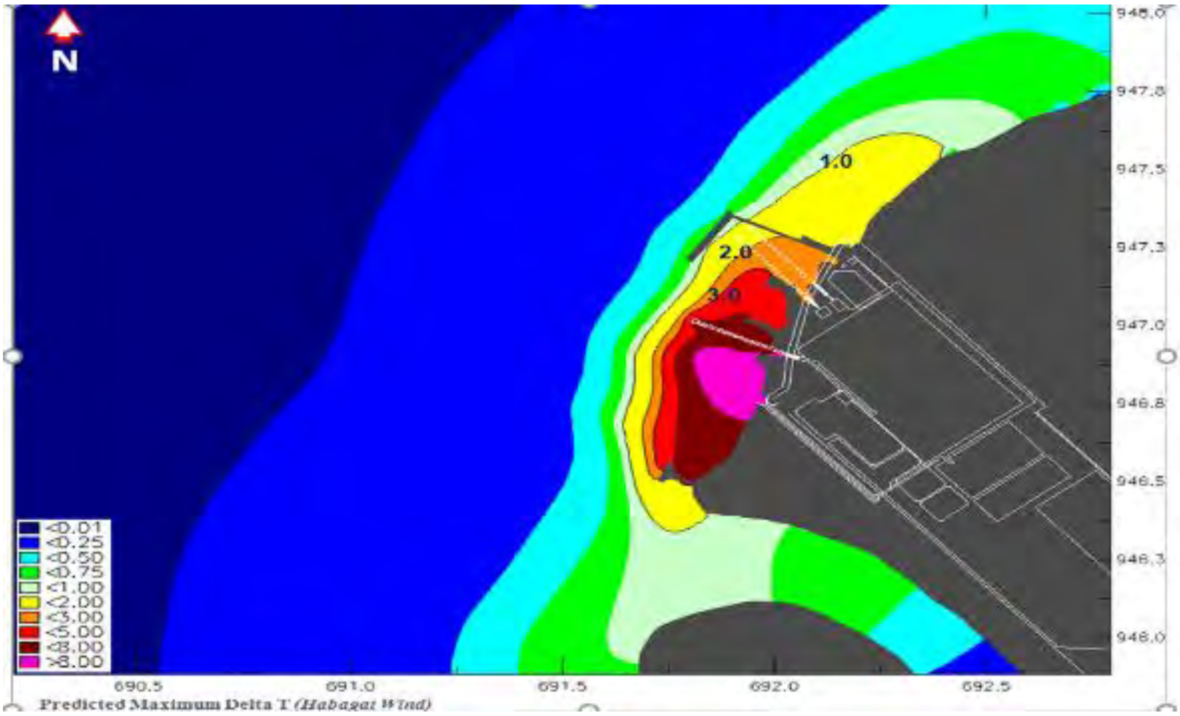


Figure 2.2-28 ***Predicted maximum variations in excess water temperature for the 27-days thermal plume simulation under Habagat wind condition. Black contour line represents incremental increase of 1 degree***

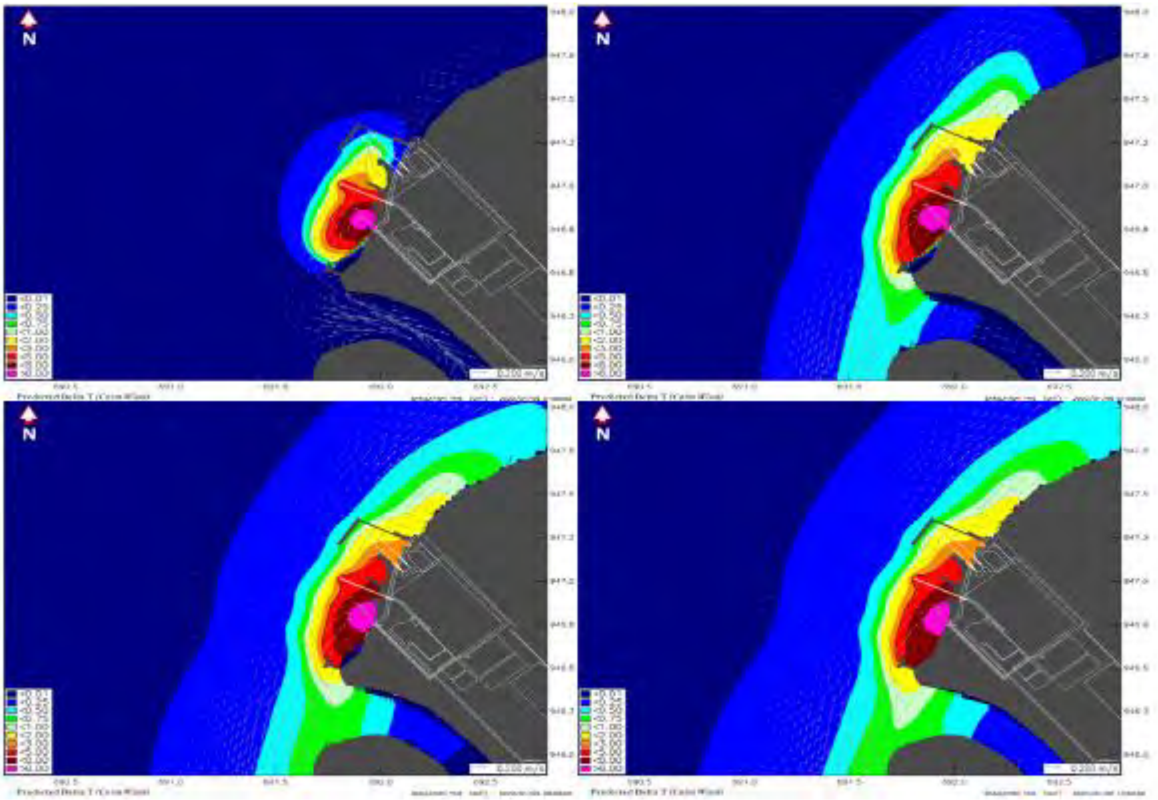


Figure 2.2-29 ***Predicted transportation of thermal plume after one hour (upper left), 4 hours (upper right), 8 hours (lower left) and 12 hours (lower right) of continuous warm water releases, under calm wind condition.***

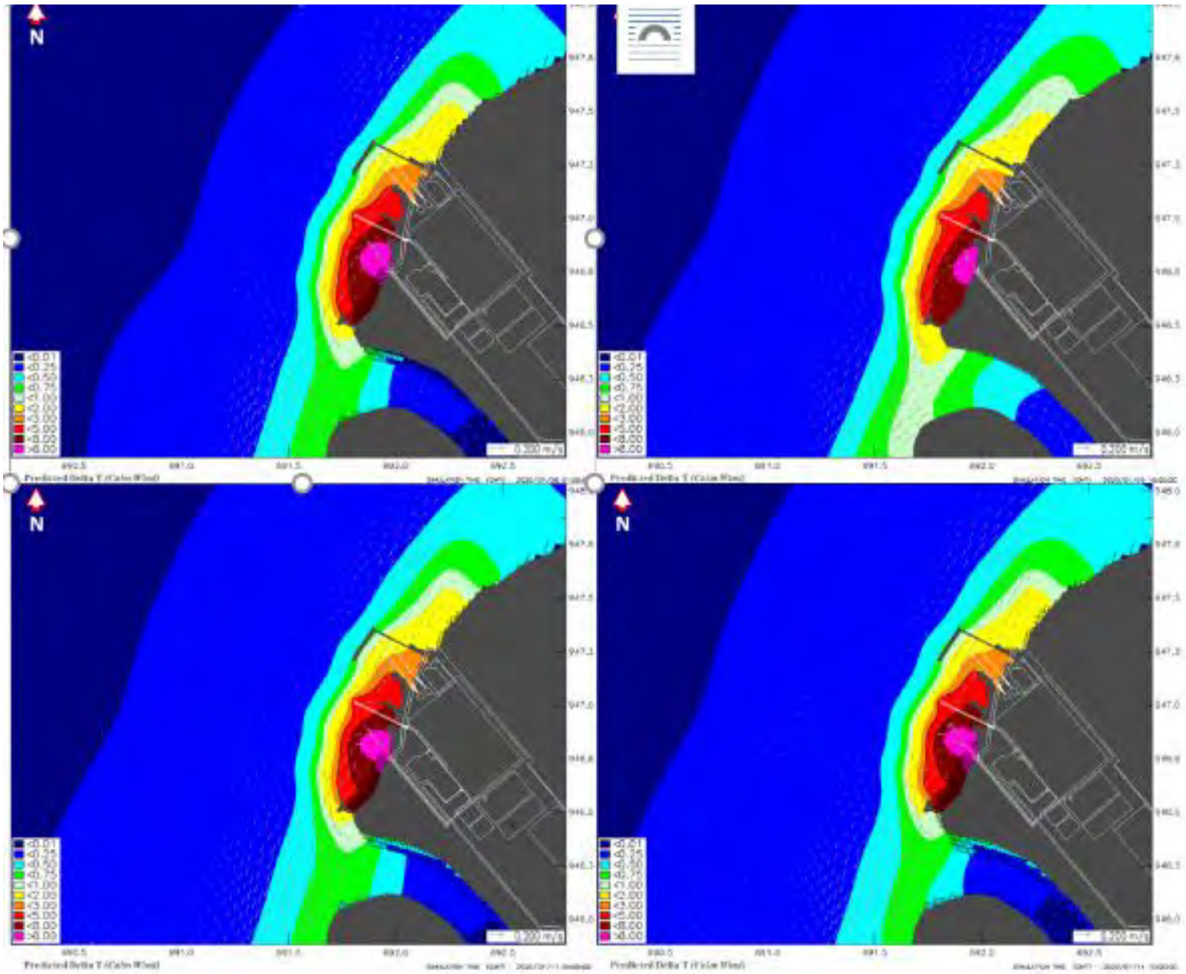


Figure 2.2-30 Predicted transport of thermal plume after 1.042 days (upper left), 4.667 days (upper right), 6.375 days (lower left) and 9.417 days (lower right) of continuous warm water releases, under calm wind condition.

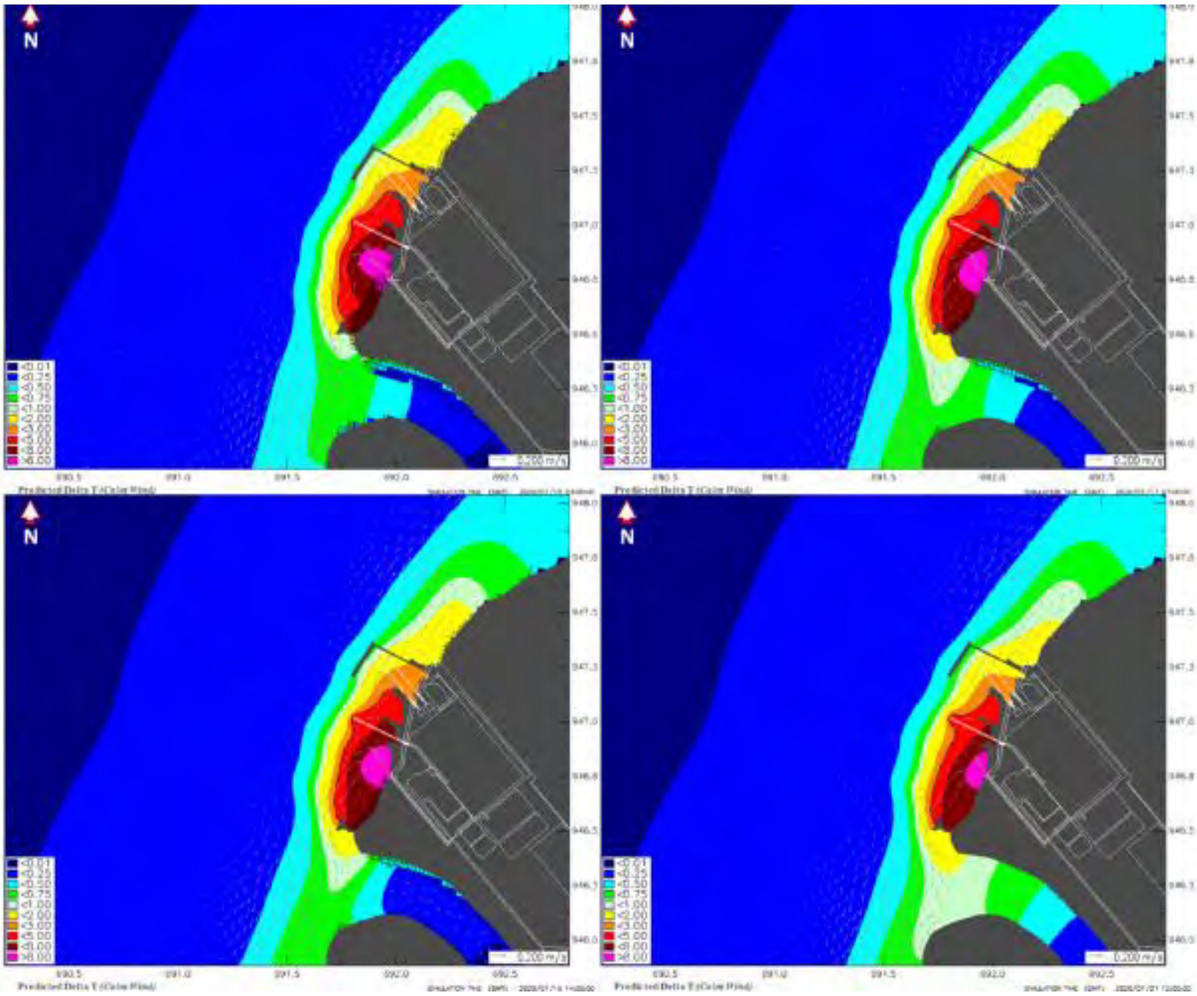


Figure 2.2-31 Predicted transport of thermal plume after 10.125 days (upper left), 12.292 days (upper right), 14.583 days (lower left) and 16.50 days (lower right) of continuous warm water releases, under calm wind condition.

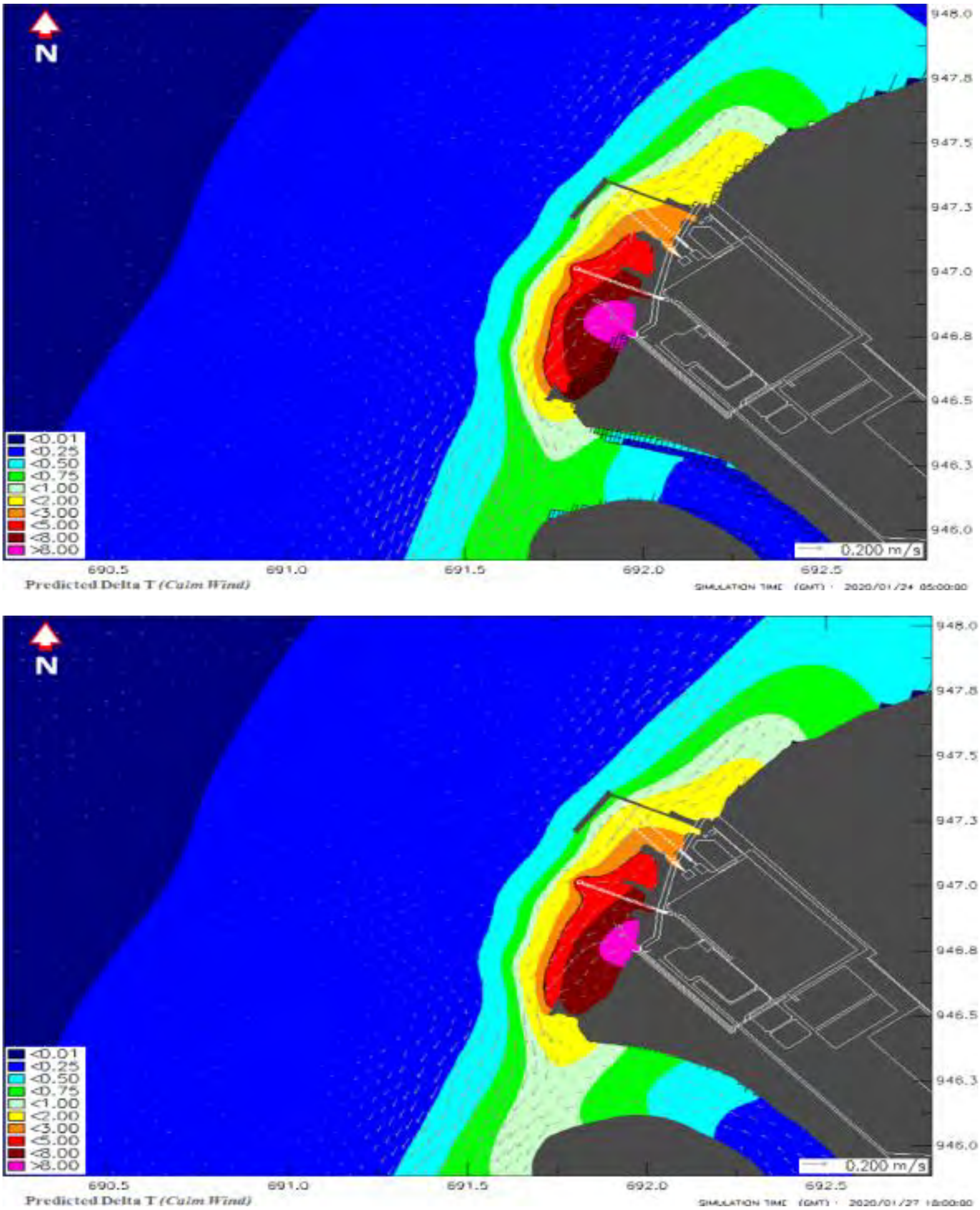


Figure 2.2-32 Predicted transport of thermal plume after 19.208 days (upper left), 22.75 days (upper right), 25.833 days (lower left) and 27 days (lower right) of continuous warm water releases, under calm wind condition.

The results show that at the beginning of the thermal release, the spreading of the plume flows in a approximately semi-circular pattern due to the limited influence of wind that transports the plume away from the outfalls. After several hours, the plume then starts to spread alongshore in response to the low ambient current generated by the tidal oscillations in the Bay.

For this scenario, the map shows that the maximum thermal concentration at the vicinity of the existing plant outfall increases by more than 5°C; while temperature rise for the outfall of the expansion project is more than 8°C. The map below represents the composite map of the simulation with predicted maximum rise in temperature of less than 3°C, as shown by the red contour plot (<5.0 in legend).

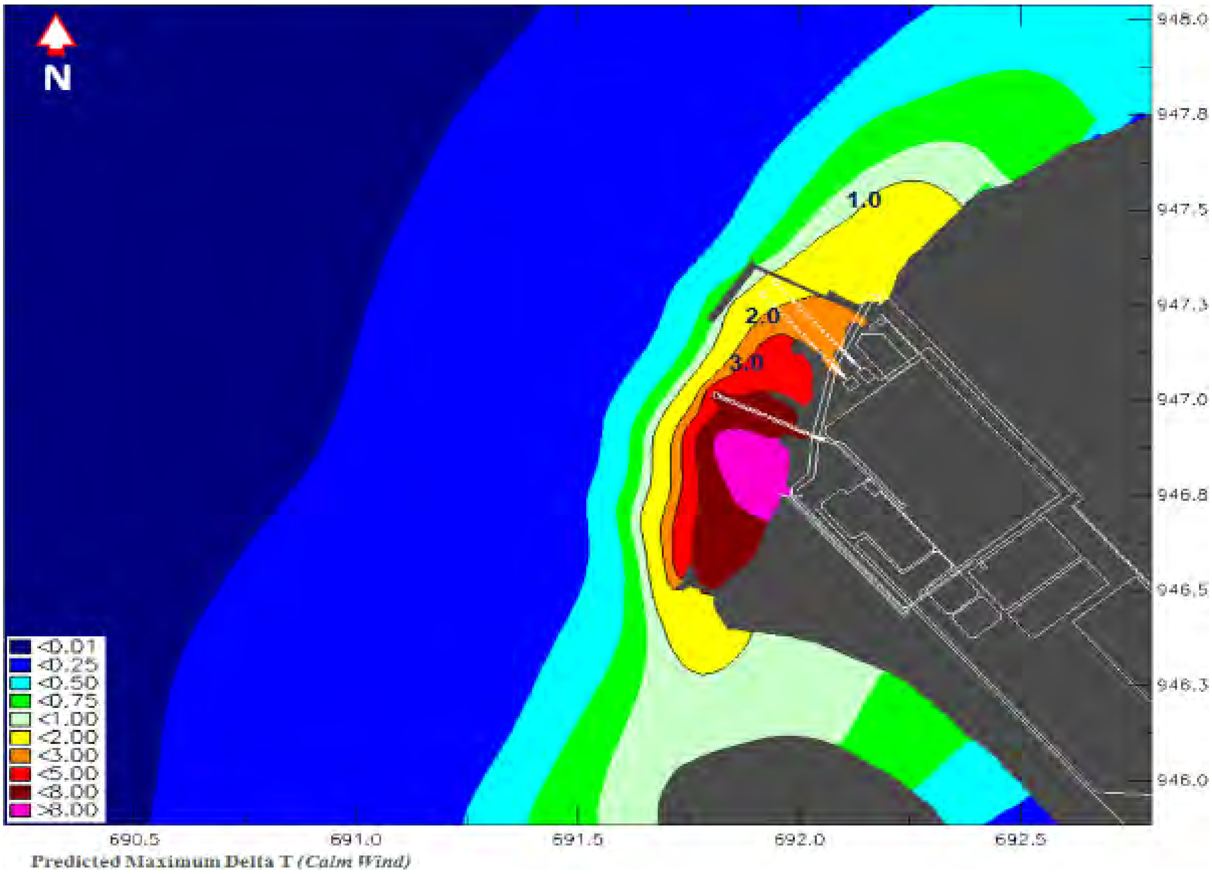


Figure 2.2-33. Predicted maximum variations in excess water temperature for the 27-days thermal plume simulation under calm wind condition. Black contour line represents incremental increase of 1 degree C in ambient temperature level.

Impact Analysis based on Thermal Dispersion

A dispersion modelling study was carried out to simulate the discharges of warm water streams taking into consideration the two separate locations of the outfall for the existing plant and the expansion project. For both location of the outfalls, the corresponding increase in ambient temperature conditions of 10 degrees were likewise considered, incorporating different prevailing wind conditions (*habagat, amihan*, and calm wind) in the analyses.

The numerical modeling includes some key components and assumptions. The model equations represent the actual hydrodynamic processes; river discharge, evaporation and direct rainfall are neglected; uniform wind field condition, etc. The bathymetry of the areas covered in the model schematization is based on available NAMRIA bathymetry map complemented with limited depth measurements conducted near the project area.

The plume dispersion modeling simulations under the worst-case condition provides a scenario with a period of low wind incorporating the effects of tidal oscillations. Also, the intake and release of seawater are assumed to be at its maximum design discharge rates for 24/7 for the 27-day simulations, which may not be the case during the actual plant operations.

From the results of the three scenarios, the model results revealed that the water temperature fluctuates depending on the rise and fall of the tides. Higher thermal concentration is predicted to occur during low tidal level event. The extent of maximum temperature for the three wind condition scenarios does not vary that much over time. This implies that the equilibrium state has been reached regardless of the duration of the simulation, the extent of the coverage of the spreading of the plume will remain more or less the same.

The figure below shows the extent of maximum thermal plumes simulated by the model for the 27-days period, under the worst case (no wind) and windy conditions (*amihan* and *habagat*). The extent of maximum temperature map was derived by taking the maximum predicted values at each grid cells for the three scenarios for the entire 27-day simulation period given the design discharge and temperature rates.

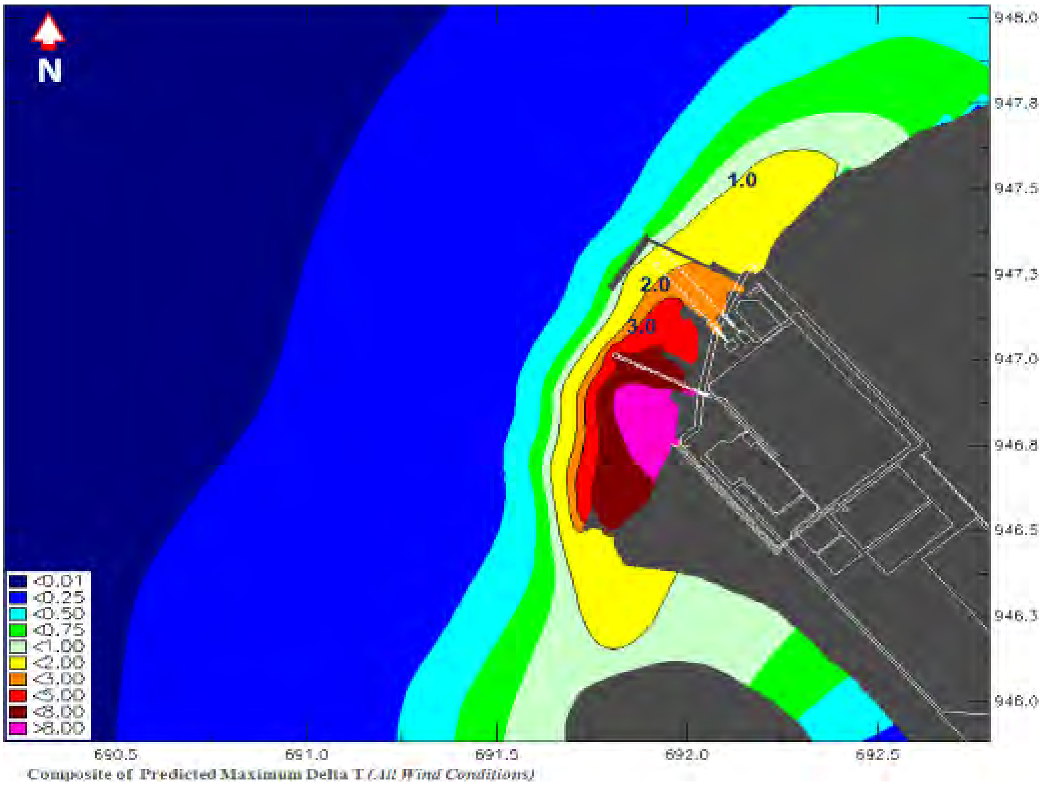


Figure 2.2-34 Predicted maximum variations in water temperature for the 25-days thermal plume simulation, for a given discharge rates and varying wind conditions. The model predicts a maximum rise in warm water of more than 5°C (shown as red area) near outfall of the original project, and more than 8°C (pink area) near the outfall of the expansion project.

The composite map of these simulation runs predict that the maximum thermal concentration at the vicinity of the existing plant outfall will increase by more than 5°C; while near the shore where the outfall of the expansion project will be located, the maximum rise in ambient temperature is predicted to increase by more than 8°C. The red contour plot representing the maximum limit is visible in the figure (<5.0 in legend). The area exceeding the 3°C threshold is about 13.597 hectares.

Table 2.2-5. Estimated area off the coast affected by the temperature rise due to release of warm water.

Temperature Rise	1 degree C	2 degree C	3 degree C
Area (in has)	37.297	17.863	13.597

Higher ambient temperature is expected at the outfall near the shore (i.e., the expansion project), which is not surprising given that this area is shallow, of which limited dilution and mixing is expected. A much better dilution rate is likely at the other outfall located about 200 meters offshore as this area is rather deep compared to the other outfall, not to mention that it is somewhat exposed to the open sea where tidal influences and wind effects greatly contribute to the mixing and transport of warm waters released thru this particular outfall. Thus, as outfall of the expansion project is located at the shore, it contributes higher warm water temperature level as compared to the other outfall. This is mainly due to its shallow location where dilution and mixing is rather limited.

The area of the two intakes where the existing plant and expansion projects draw their cooling water is predicted to increase its temperature by more than 1°C. Given this increase in temperature of the cooling water which may re-circulate back through the seawater intake, reduction of the thermal efficiency of the plant may need to be considered.

It may be construed that the maximum rise in temperature can reach up to 8^0C which may be deemed as being significantly higher than the allowable DENR standard of not more than 3^0C. On this point which is duly recognized, the following notes are deemed relevant:

That the temperature rise should be more appropriately related to the environmental resources that could be affected. The following regulatory guidelines are thus noted:

Based on the previous DAO 35, “mixing zone” is delineated as “ a place where the effluent discharge from a point source mixes with a receiving body of water”. Further the general conditions governing the location and extent of the mixing are include:

a. No mixing zone or combination of mixing zones shall be allowed to significantly impair any of the designated uses of the receiving body of water.
b. A mixing zone shall not include an existing drinking water supply intake if such mixing zone would significantly impair the purposes for which the supply is utilized.
c. A mixing zone for rivers, streams, etc., shall not create a barrier to the free migration of fish and aquatic life.
d. A mixing zone shall not include a nursery area of indigenous aquatic life nor include any area designated by the Department of Environment and Natural Resources for shellfish harvesting, tourist zones and national marine parks and reserves, coral reef parks and reserves and declared as such by the appropriate government agency.
e. In general, the length of the mixing zone or plume in rivers or similar waterways shall be as short as possible and its width shall be preferably not more than one-half of the width of the waterway.
f. **In discharging hot effluents from power plants**, mineral ore milling and similar generators of large volume of liquid wastes **the permissible size of the mixing zone shall be determined through modeling taking into consideration the size, hydraulic and hydrological data of the receiving body of water and the design and siting of the wastewater outfall**.

(The foregoing guidelines on the mixing zone was not declared as being repealed under DAO 2016-08.}

On the other hand, the US EPA recognizes the use of mixing zone (*Ref: National Service Center for Environmental Publications (NSCEP) under the title “Compilation of EPA Mixing Zone Documents” 2006)*. Its definition of mixing zone The US EPA defined a mixing zone as an area where an effluent discharge undergoes initial dilution and is extended to cover the secondary mixing in the ambient waterbody. A mixing zone is an allocated impact zone where water quality criteria can be exceeded as acutely toxic conditions are prevented. Water quality criteria must be met at the edge of a mixing zone.

Additionally, the State of Oregon Department of Environmental Quality recognizes "best practicable treatment" in its "**Regulatory Mixing Zone Internal Management Directive Part One: Allocating Regulatory Mixing Zones May 2012"**

"State requirement for highest and best practicable treatment OAR 340-041-0007(1) requires highest and best practicable treatment and/or control of wastes, activities, and flows to maintain the overall water quality at the highest possible levels and deleterious factors (e.g., temperature, toxics) at the lowest possible levels. While this is evaluated on a case-by-case basis, and additional state or federal regulations may apply, the department generally uses EPA technology-based effluent limitations to make this evaluation."

Under the NPDES (National Pollutant Discharge Elimination System of the USEPA) permitting authorities allow an allocated impact zone for dischargers—an area near the outfall where higher pollutant concentrations, temperatures, or suspended solids are allowed before water quality standards must be met. Permit conditions are established through mixing zone analysis that considers the size, position within the receiving stream, constituents of concern, dilution capabilities, and sensitive ecological communities.

Mixing zone analyses allow dischargers to confidently evaluate receiving water effects based on different discharge/treatment scenarios, defining the appropriate balance between water quality protection and necessary level of treatment.

Nonetheless the final Design and Engineering will firm up the engineering or mitigating interventions for which the following will be considered (a) establishment of efficiengt water cooling system (b) temporary reservoir.

In summary, the modelling study provides the basis for the Detailed Engineering and Design (DED), which by the basic principle of an EIS being a planning tool, will necessarily be undertaken post ECC.

2.2.2.3 Change in Bathymetry

The latest bathymetric survey was undertaken by FDCMP, (seen in the figure below.) For the 80.87 hectares of this surveyed area offshore of the project, the volume of water is about 23.81 million cubic meters and has an average depth of 29.45 meters.

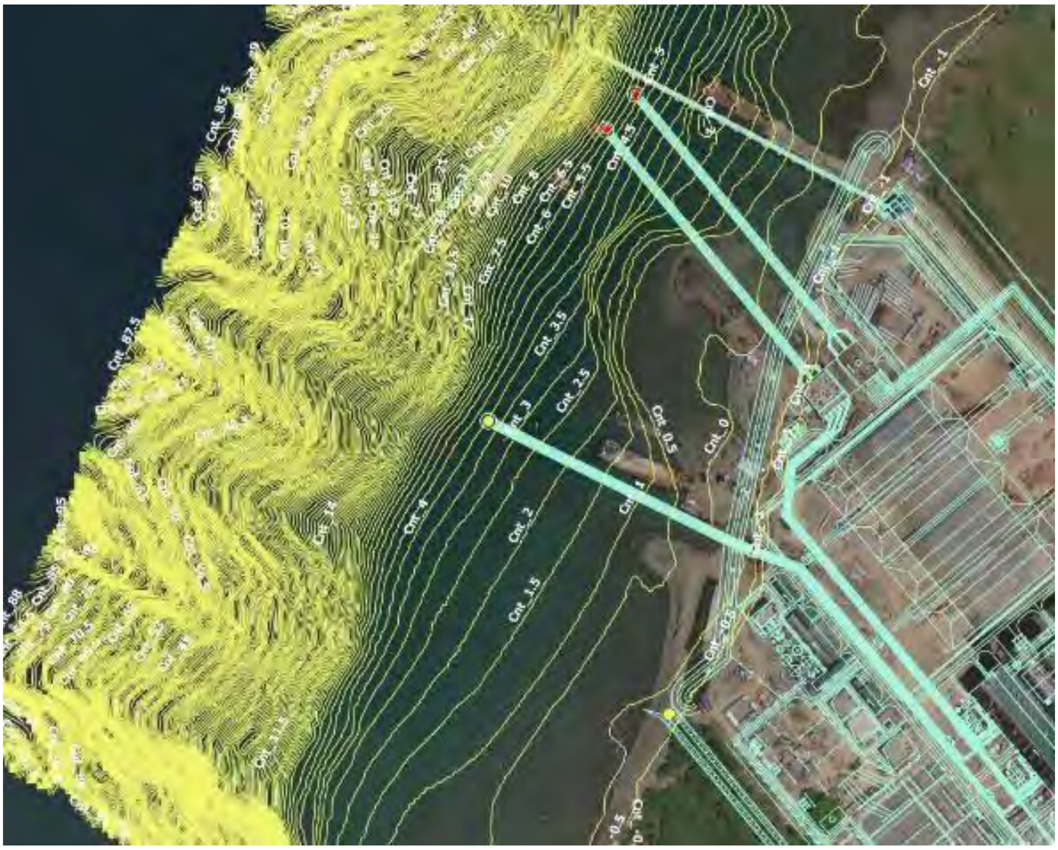


Figure 2.2-35. Generated bathymetry contour offshore of the project area.

Particle trajectories released at the proposed outfall locations were observed to moved and stayed longer around the shallowest portion of the Bay as they are transported along the coast and away from the project area. The projected route of the sediments (represented by these particles) may cause changes, although deemed minimal, on the bathymetry of the discharge points. Even without the project, however, alongshore transport of sediment and hence bathymetry changes is evident, as can be seen at the mouth of nearby Tagoloan River where sediment deposition can be seen.

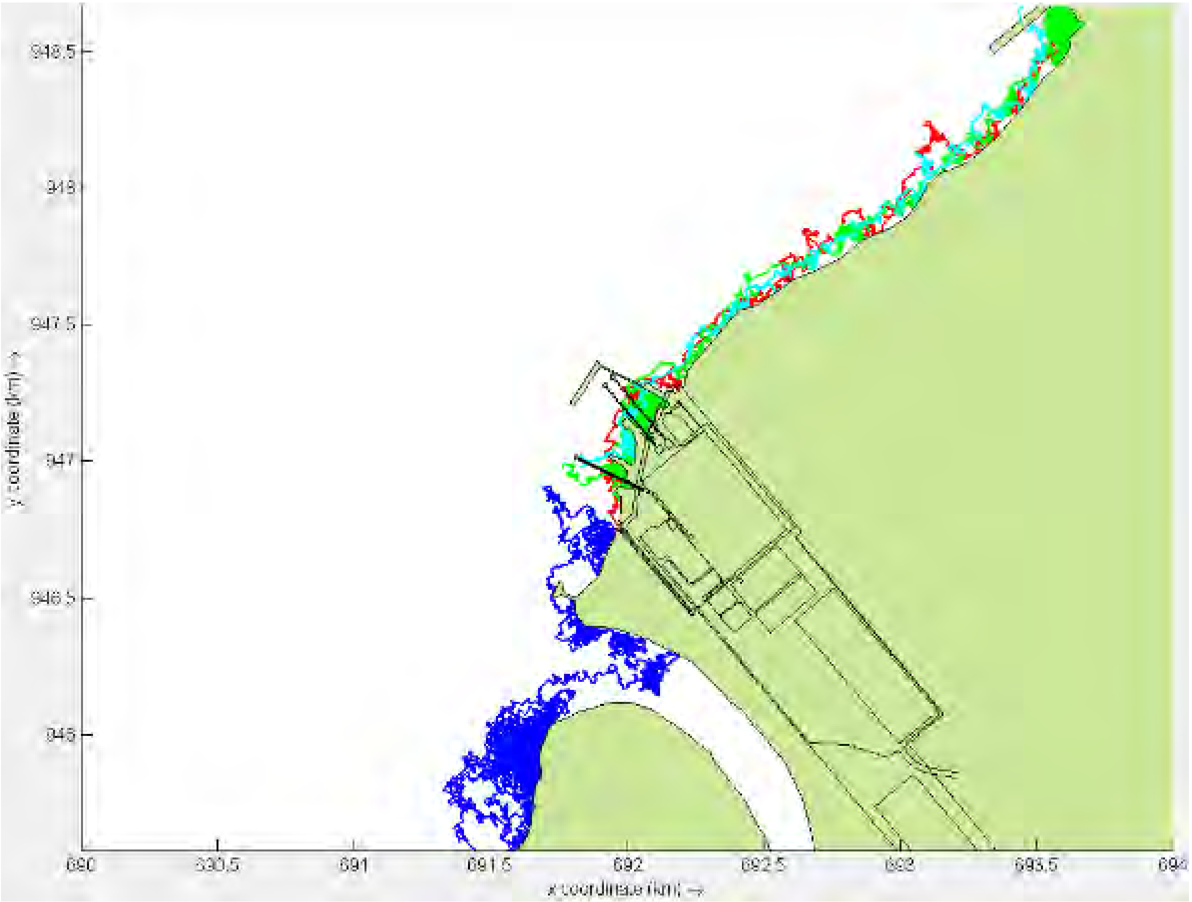


Figure 2.2-36. Predicted trajectories of four (4) particles released at the two outfalls using a Particle Tracking Model

Discussion on the Particle Dispersion Modelling.

The above discussions focuses on an assessment of how particles may impact on the seabody bathymetry.

For a more macroscopic assessment, i.e. on how particles may impact on water quality and on the properties of onshore based on a particle dispersion modelling, the following discussions are made.

Basic premises for a mathematical modeling for particle dispersion:

i. *Knowledge of well-known point sources of pollutants*
(https://www.hindawi.com/journals/ism/2013/424572/#abstract)

The pollutant of relevance to the modelling is Total Suspended Solids (TSS). However, TSS is neither a concern for the Macajalar Bay nor in the waste water effluent discharge as gleaned for example in the SMR for the 4th Q 2019.
Waste water effluents TSS : 4 – 21 mg/L vs DENR Standard of 100 mg/L

Macajalar Bay 8 – 72 mg/L vs DENR Standard of 100 mg/L

ii. The discharge to the Macajalar Bay is principally the return cooling water. The water system involves the drawing of water from the Bay and the discharging of the same also to the Bay. The cooling water is a once-through system and does not undergo any chemical reaction nor comes in contact with substances that would carry over particles or pollutants.

iii. The basic equation for modelling is the continuity equation illustrated below for tides, a parameter for oceanographic modelling.

$$\frac{\partial u}{\partial t} = f v - g \frac{\partial \zeta}{\partial x} + \frac{1}{\rho_w}\left[\tau_{sx} - \tau_{bx}\right] \quad (1)$$

$$\frac{\partial v}{\partial t} = -f u - g \frac{\partial \zeta}{\partial y} + \frac{1}{\rho_w}\left[\tau_{sy} - \tau_{by}\right] \quad (2)$$

$$\frac{\partial \zeta}{\partial t} = -\frac{\partial (uh)}{\partial x} - \frac{\partial (vh)}{\partial y} \quad (3)$$

where x and y are the horizontal Cartesian coordinates in the plane of the chosen map projection of the undisturbed sea surface, u and v are the current components along x and y directions, respectively, ς is the sea surface elevation, h is the still water depth, f is the coriolis parameter, τ_{sx} and τ_{sy} are the components of surface wind stress, τ_{bx} and τ_{by} are the components of bottom frictional stress, ρ_w is the density of water (assumed constant) and g is the gravitational acceleration.

iv. Most basic assumption in a mathematical modeling is "steady state" condition. This condition is not met in the case of particle dispersion modelling.

Thus it is deemed that a particle dispersion modelling is not only inapplicable but more importantly particles are not key parameters in the measurement or monitoring of marine water quality.

2.2.2.4 Monitoring Plan

During Operation Phase

Monitoring of thermal discharge will be done semi-annually in five (5) stations within the area identified in these modelling works as exceeding the 3°C threshold. The monitoring protocol will be subject to the guidelines of the MMT.

Mitigation Measures

Mitigating measures for thermal pollution is the release of cooling effluents offshore where the water is deep (i.e., during high tides), and there is substantial water mixing. Impacts towards biotic components can be prevented by locating the outfall offshore, away from coral reef areas. Options for mitigation include: (a) Cool down the cooling water return before ultimate discharge to the Macajalar Bay (b) If necessary, translocate the corals within the domain of the 3°C rises, and (c) deepening of the area fronting the offshore facilities through dredging.

2.2.2.5 Discussion of how the impacts may be affected by climate change especially sea level rise

The climate change scenarios and projects are discussed in the foregoing (page 2.2-9).

Impacts on the expansion project are reckoned from t**emperature** and **rainfall** predictions. Ambient temperature is a key input to the thermal plume modeling while rainfalls impact flooding. A 4 °C change for JJA in the long term is predicted. This is deemed minimal noting that the assumed ambient temperature of 28 °C will, at worst scenario, increase to 30.4 deg C. Mitigating measures can be planned in advance e.g. by pre cooling of the discharge Cooling Water temperature

On the other hand the downward trend in rainfalls is favorable to flooding concerns.

On the Climate Change Induced Sea Level Rise

The 5th Assessment of the Intergovernmental Panel for Climate Change (IPCC, 2014)
(References: "Sea Level Change" Annex 3 IPCC WG1ARS Chapter 13 Final and "Projections of Sea Level Rise" Climate Change 2013: The Physical Science Basis Working Group 1 Contribution to the Fift IPCC Assessment Report)

This assessment details the issues, approaches, models, and current state of affairs for Sea Level Rise**.** From this it is noted that **SLR should not be taken** as a local phenomenon as it is the effect of global warming, studies for which have been the subject of the 29-year old UN-led organization.

Ocean thermal expansion and glacier melting have been the dominant contributors to 20th century global mean sea level rise. *Observations since 1971 indicate that thermal expansion and glaciers (excluding Antarctic glaciers peripheral to the ice sheet) explain 75% of the observed rise (high confidence). The contribution of the Greenland and Antarctic ice sheets has increased since the early 1990s, partly from increased outflow induced by warming of the immediately adjacent ocean. Natural and human-induced land water storage changes have made only a small contribution; the rate of groundwater depletion has increased and now exceeds the rate of reservoir impoundment.*

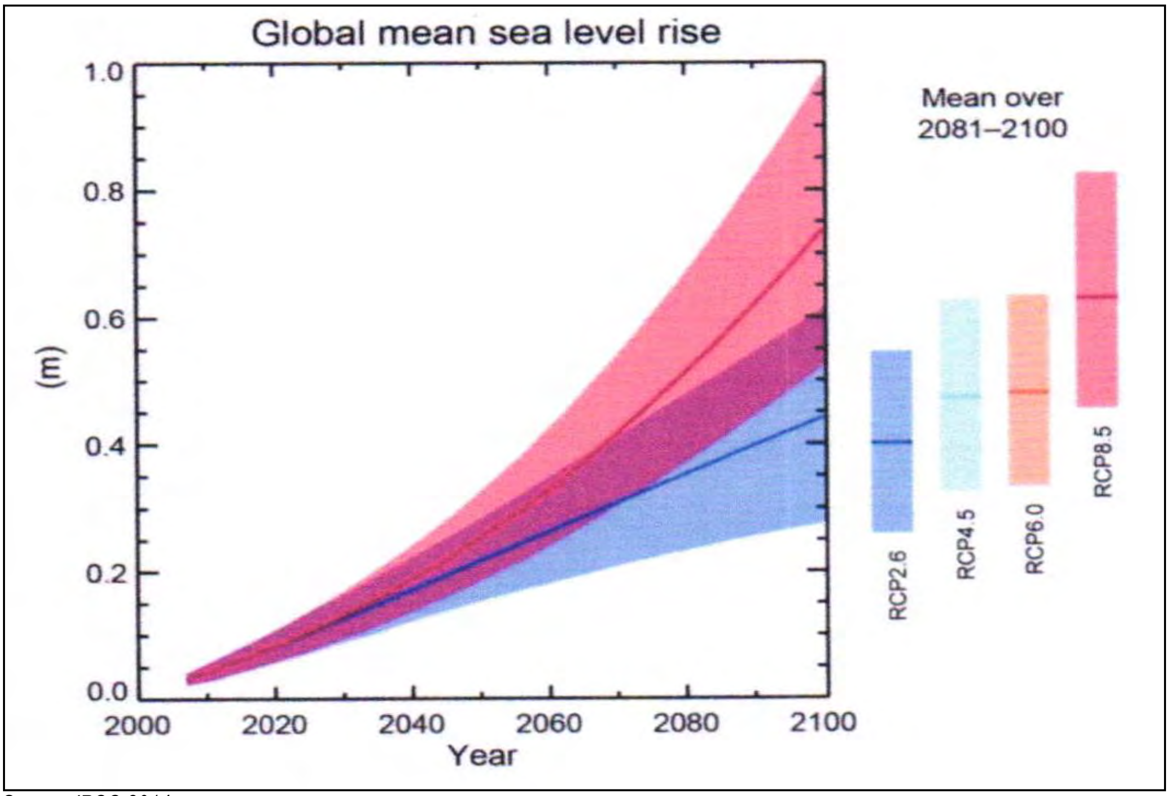
There is high confidence in projections of thermal expansion and Greenland surface mass balance, and medium confidence in projections of glacier mass loss and Antarctic surface mass balance. *There has been substantial progress in ice-sheet modelling, particularly for Greenland. Process-based model calculations of contributions to past sea level change from ocean thermal expansion, glacier mass loss and Greenland ice-sheet surface mass balance are consistent with available observational estimates of these contributions over recent decades. Ice-sheet flowline modelling is able to reproduce the observed acceleration of the main outlet glaciers in the Greenland ice sheet, thus allowing estimates of the 21st century dynamical response (medium confidence). Significant challenges remain in the process-based projections of the dynamical response of marine-terminating glaciers and marine-based sectors of the Antarctic ice sheet. Alternative means of projection of the Antarctic ice-sheet contribution (extrapolation within a statistical framework and informed judgement) provide medium confidence in a likely range.*

The sum of thermal expansion simulated by Coupled Model Intercomparison Project phase 5 (CMIP5) Atmosphere–Ocean General Circulation Models (AOGCMs), glacier mass loss computed by global glacier models using CMIP5 climate change simulations and estimates of land water storage explain 65% of the observed global mean sea level rise for 1901–1990 and 90% for 1971–2010 and 1993–2010 (high confidence). When observed climate parameters are used, the glacier models indicate a larger Greenland peripheral glacier contribution in the first half of the 20th century such that the sum of thermal expansion, glacier mass loss and changes in land water storage and a small ongoing Antarctic ice-sheet contribution are within 20% of the observations throughout the 20th century. Model-based estimates of ocean thermal expansion and glacier contributions indicate that the greater rate of global mean sea level rise since 1993 is a response to radiative forcing (RF, both anthropogenic and natural) and increased loss of ice-sheet mass and not part of a natural oscillation (medium confidence)

The other factor to SLR is the reduction of liquid water storage on land such as due to underground water abstraction.

The high emission scenario (RCP8.5 scenario) from the IPCC 5rh Assessment Report suggests an absolute global mean sea level rise of 0.52 m to 0.98 m by 2100 relative to the 1986-2005 period, with a median value estimate at 0.74 m by 2100, see below. For the future e.g. Year 2075,a value **of 0.45 m** may be assumed for the sea level rise (calculated from the design water level for 2015), based on the median IPCC estimates tor the high emission scenario for the global sea level rise.

Figure 2.2-38 is an IPCC chart of global mean sea level rise projections.



Source: IPCC 2014

Figure 2.2-37. Chart of Global Mean Sea Level Rise

The local factor that could give rise to sea level rise is ground water extraction which results in land subsidence and ultimately to sea level rise.

The following conclusion is thus drawn from the above discussions:

That the Project will not cause sea level rise

2.2.2.6 Storm surge hazard exposure, vulnerability, risk maps

Risks and hazards are adequately discussed in Section 2.1.

2.2.3 Water Quality

Baseline Data Parameter Requirement:

Physio-Chemical characterization of water:

- *pH*
- *BODs*
- *COD*
- *DO*
- *Oil and grease*
- *TSS*
- *Temperature*
- *Heavy Metals: Hg, Cd, As, Cr, Pb*
- *Fecal / total coliform*
- *Sampling site map as applicable from DAO 2016-08*

The baseline data are reported in **Section 6 Environmental Compliance Monitoring (ECM) and also in this Section 2.2.3.**

Assessment of impacts of siltation on surface and coastal/marine waters.

Siltation is not deemed to be a highly significant impact because of minimal earthworks, a major source of silts, inasmuch as the project site is already well developed and soil/earthworks which can cause siltation are considered minimal. Moreover the earthworks are short term and not undertaken duringthe operations phase.

The results provided in the SMRs show general compliances to the DENR standards. Note is made on reported high TSS for Tagoloan River with values of greater than the standard of 65 mg/L. This is however, deemed, not a concern noting that the Suspended Solids could have presumably been contributed by sediments discharged from other sources which are not the project.

2.2.3.1 Degradation of ground water quality

Strictly, ground water is not relatively as significant a resource as surface waters because
(a) There are no activities such as water abstraction that involve ground water
(b) The only potential contamination of ground water may be occasioned by seepage of leachates from the ash pond.

Nevertheless, ground water monitoring works have been conducted as part of the SMR and MMT reports. Below are typical results of the recent SMR.

The current report shows that all parameters tested within the sampling area are all within the standard set by DENR.

Table 2.2-6. Monitoring Results for Ground water Quality for the last 4 years

pH																
Location of Monitoring Station	**Year 2017**				**Year 2018**				**Year 2019**				**Year 2020**			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
DENR Standard	**6.5 - 8.5**				**6.5 - 8.5**				**6.5 - 8.5**				**6.5 - 8.5**			
Ash Yard 1 N -8181447.245441; E 11793422.205953	7.20	7.20	0.00	0.00											6.40	6.90
Ash yard 2 N -8181787.993760; E 11792130.886342	7.00	7.00	7.27	7.30	7.60	7.20			6.80	6.50	7.10	7.00	6.60	7.30	6.40	6.80
Ash yard 3 N -8181509.213071; E 11792766.605580	7.60	7.60	7.43	7.50	7.50	7.40			7.10	7.10	7.50	7.40	7.10	7.10	6.80	7.30
Ash yard 4 N -8181867.558214; E 11793454.082825	7.93	7.93	8.20	7.83	8.20	7.50			7.50	6.80	7.70	7.80	7.00	7.10	6.60	7.20
Ash yard 5 N -8181867.558214; E 11793454.082825	7.03	7.03	7.37	7.30	7.30	7.00			6.90	6.50	7.10	7.30	6.60	6.80	6.80	7.10
Ash Yard 6 N -8181867.558214; E 11793454.082825	7.47	7.47	7.33	7.07	7.30	7.60			6.90	6.80	7.30	7.30	7.60	7.20	6.80	7.10

Temperature (°C)																
Location of Monitoring Station	**Year 2017**				**Year 2018**				**Year 2019**				**Year 2020**			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
DENR Standard	**26 - 30**				**26 - 30**				**26 - 30**				**26 - 30**			
Ash Yard 1 N -8181447.245441; E 11793422.205953	28.00	30.00	0.00	0.00											32.00	32.00
Ash yard 2 N -8181787.993760; E 11792130.886342	28.00	30.67	32.67	23.07	30.00	31.00			31.00	32.00	27.00	32.00	31.00	34.00	32.00	32.00
Ash yard 3 N -8181509.213071; E 11792766.605580	27.95	31.33	31.33	12.53	30.00	30.00			31.00	31.00	27.00	31.00	31.00	32.00	32.00	31.00
Ash yard 4 N -8181867.558214; E 11793454.082825	28.10	31.00	31.00	30.67	30.00	30.00			30.00	31.00	26.00	32.00	31.00	32.00	31.00	30.00
Ash yard 5 N -8181867.558214; E 11793454.082825	27.95	32.00	31.00	30.00	30.00	30.00			30.00	31.00	26.00	31.00	30.00	33.00	31.00	31.00
Ash Yard 6 N -8181867.558214; E 11793454.082825	28.30	32.33	32.67	31.67	31.00	32.00			31.00	32.00	27.00	32.00	31.00	34.00	31.00	31.00

Color (TCU)																
Location of Monitoring Station	Year 2017				Year 2018				Year 2019				Year 2020			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
DENR Standard	50				50				50				50			
Ash Yard 1 N -8181447.245441; E 11793422.205953	10.00	4.00	0.00	0.00											5.00	5.00
Ash yard 2 N -8181787.993760; E 11792130.886342	7.50	4.67	3.00	5.00	5.00	5.00			5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Ash yard 3 N -8181509.213071; E 11792766.605580	7.50	2.00	2.00	4.00	5.00	5.00			5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Ash yard 4 N -8181867.558214; E 11793454.082825	7.50	4.00	5.00	5.00	5.00	5.00			5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Ash yard 5 N -8181867.558214; E 11793454.082825	10.00	3.67	6.67	6.67	5.00	5.00			5.00	5.00	5.00	5.00	5.00	5.00	10.00	5.00
Ash Yard 6 N -8181867.558214; E 11793454.082825	10.00	13.33	57.33	11.67	30.00	10.00			100.00	20.00	5.00	5.00	5.00	20.00	5.00	5.00

Total Suspended Solid (mg/L)																
Location of Monitoring Station	Year 2017				Year 2018				Year 2019				Year 2020			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
DENR Standard	65				65				65				65			
Ash Yard 1 N -8181447.245441; E 11793422.205953	8.00	11.00	0.00	0.00											12.00	65.00
Ash yard 2 N -8181787.993760; E 11792130.886342	6.00	62.00	66.00	62.00	242.00	272.00			339.00	858.00	116.00	420.00	318.00	280.00	3.00	8.00
Ash yard 3 N -8181509.213071; E 11792766.605580	5.00	18.00	30.67	10.00	51.00	21.00			20.00	69.00	33.00	26.00	37.00	49.00	10.00	109.00
Ash yard 4 N -8181867.558214; E 11793454.082825	6.00	26.00	93.00	62.00	108.00	11.00			100.00	60.00	152.00	59.00	136.00	247.00	31.00	62.00
Ash yard 5 N -8181867.558214; E 11793454.082825	7.00	188.67	321.00	200.67	493.00	227.00			6.00	216.00	541.00	1252.00	745.00	2014.00	6.00	18.00
Ash Yard 6 N -8181867.558214; E 11793454.082825	36.00	41.33	28.33	24.33	44.00	18.00			26.00	27.00	83.00	12.00	76.00	39.00	7.00	15.00

Chorides, Cl (mg/L)

Location of Monitoring Station	Year 2017				Year 2018				Year 2019				Year 2020			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
DENR Standard	250				250				250				250			
Ash Yard 1 N -8181447.245441; E 11793422.205953	41.10	112.40	0.00	0.00											16.00	17.00
Ash yard 2 N -8181787.993760; E 11792130.886342	28.25	32.77	35.33	23.00	37.00	35.00			25.00	9.00	3.00	8.20	10.10	32.20	23.00	18.50
Ash yard 3 N -8181509.213071; E 11792766.605580	12.55	25.87	25.00	18.67	45.00	45.00			40.00	11.00	12.00	15.00	11.90	39.70	21.00	18.00
Ash yard 4 N -8181867.558214; E 11793454.082825	31.30	32.27	31.00	28.00	34.00	30.00			60.00	7.00	17.50	9.20	10.40	39.20	33.00	22.00
Ash yard 5 N -8181867.558214; E 11793454.082825	11.95	21.17	14.00	18.67	40.00	25.00			81.00	6.00	10.00	132.40	8.80	80.70	12.00	11.00
Ash Yard 6 N -8181867.558214; E 11793454.082825	108.20	72.33	22.00	21.00	50.00	48.00			75.00	9.00	13.00	19.70	19.90	101.00	97.00	68.00

Nitrate, No_3 (mg/L)

Location of Monitoring Station	Year 2017				Year 2018				Year 2019				Year 2020			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
DENR Standard	7				7				7				7			
Ash Yard 1 N -8181447.245441; E 11793422.205953	0.44	0.82	0.00	0.00											0.09	0.09
Ash yard 2 N -8181787.993760; E 11792130.886342	0.09	0.08	0.14	0.09	1.58	0.41			0.09	0.60	1.19	0.33	1.43	0.31	0.11	0.01
Ash yard 3 N -8181509.213071; E 11792766.605580	0.10	0.03	0.04	0.33	0.79	0.16			0.03	0.21	0.23	0.42	0.25	0.30	0.46	1.20
Ash yard 4 N -8181867.558214; E 11793454.082825	0.09	0.08	0.20	0.12	1.35	0.43			0.01	0.18	0.22	0.42	0.60	0.18	0.10	0.04
Ash yard 5 N -8181867.558214; E 11793454.082825	0.03	0.64	0.19	0.22	1.05	0.11			0.07	0.09	0.23	0.40	0.55	0.63	0.90	0.07
Ash Yard 6 N -8181867.558214; E 11793454.082825	0.66	0.02	0.14	0.14	0.81	0.16			0.11	0.04	0.15	0.32	0.32	0.37	0.16	0.01

Phosphates, PO_4^{3} (mg/L)

Location of Monitoring Station	Year 2017				Year 2018				Year 2019				Year 2020			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
DENR Standard	**0.5**				**0.5**				**0.5**				**0.5**			
Ash Yard 1 N -8181447.245441; E 11793422.205953	0.01	0.03	0.00	0.00											0.02	0.05
Ash yard 2 N -8181787.993760; E 11792130.886342	0.02	0.05	0.03	0.02	0.15	0.12			0.13	0.15	0.66	0.02	0.04	0.02	0.01	0.05
Ash yard 3 N -8181509.213071; E 11792766.605580	0.04	0.01	0.05	0.02	0.06	0.05			0.04	0.04	0.01	0.01	0.03	0.03	0.04	0.03
Ash yard 4 N -8181867.558214; E 11793454.082825	0.03	0.04	0.08	0.07	0.08	0.02			0.04	0.04	0.17	0.01	0.04	0.06	0.01	0.06
Ash yard 5 N -8181867.558214; E 11793454.082825	0.09	0.03	0.10	0.22	0.38	0.03			0.20	0.09	0.24	0.09	0.04	0.03	0.02	0.06
Ash Yard 6 N -8181867.558214; E 11793454.082825	0.03	0.11	0.13	0.12	0.09	0.03			0.17	0.08	0.07	0.01	0.09	0.10	0.06	0.08

Fecal Coliform (MPN/100mL)

Location of Monitoring Station	Year 2017				Year 2018				Year 2019				Year 2020			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
DENR Standard	**100**				**100**				**100**				**100**			
Ash Yard 1 N -8181447.245441; E 11793422.205953	1.80	220.00	0.00	0.00											4.50	1.80
Ash yard 2 N -8181787.993760; E 11792130.886342	9.50	1827.00	903.33	136.50	130.00	33.00			240.00	350.00	1.80	17.00	1.80	2.00	6.10	12.00
Ash yard 3 N -8181509.213071; E 11792766.605580	1750.90	19.53	3256.67	191.50	17.00	49.00			350.00	540.00	49.00	24.00	1.80	240.00	17.00	34.00
Ash yard 4 N -8181867.558214; E 11793454.082825	460.90	3078.27	1956.67	445.00	220.00	350.00			540.00	35.00	240.00	79.00	240.00	540.00	11.00	48.00
Ash yard 5 N -8181867.558214; E 11793454.082825	1751.00	5335.50	1080.00	484.50	22.00	79.00			920.00	24.00	130.00	350.00	1.80	540.00	2.00	22.00
Ash Yard 6 N -8181867.558214; E 11793454.082825	1750.90	4867.27	3233.33	181.50	14.00	350.00			240.00	16.00	130.00	2.00	1.80	39.00	170.00	17.00

Figure 2.2-38a. Trends in Ground Water Quality

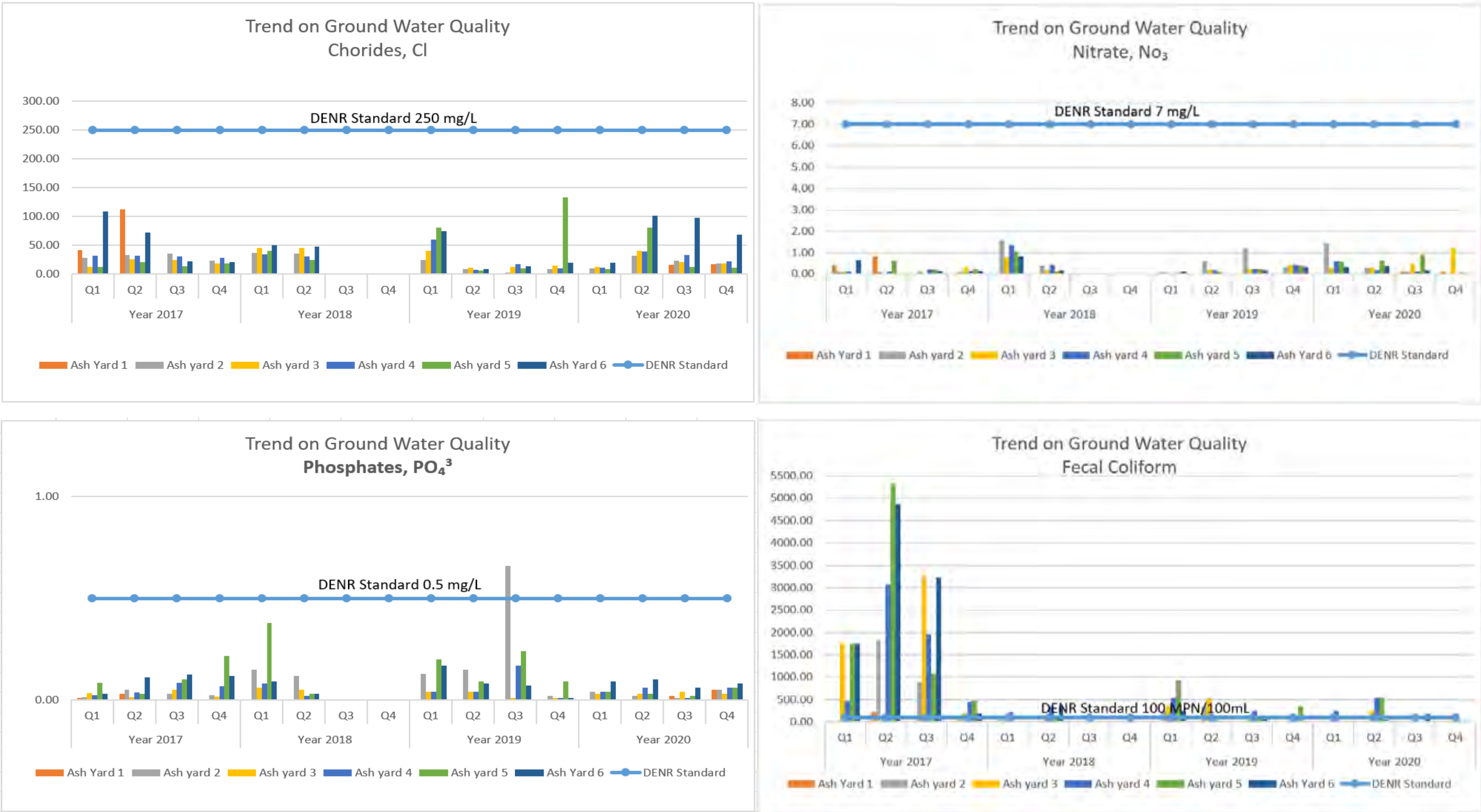


Figure 2.2-38b. Trends in Ground Water Quality

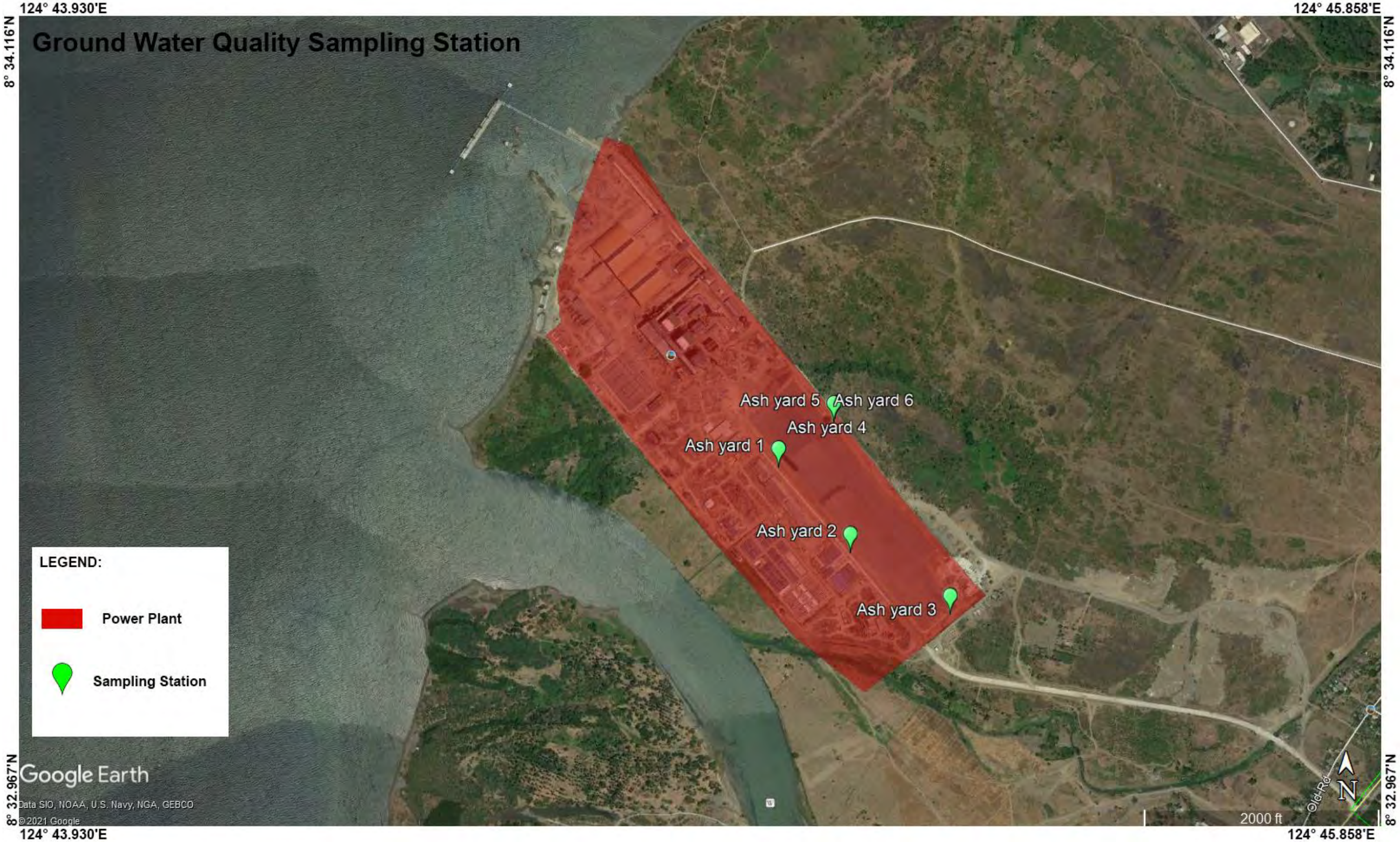


Figure 2.2-39. Ground Water Quality Sampling Stations

2.2.3.2 Degradation of surface water quality
2.2.3.3 Degradation of coastal/marine water quality

Water Quality Baseline

The water quality at the Tagoloan River and Macajalar Bay are shown hereunder and was reported as part of SMRs. See Table 2.2-8 and 2.2-9

The most significant result of the above which relate to a coal power plant project is that the metallic and toxic substances are all insignificant. This statement is made because of perceptions that coal power plants generate metallic and toxic substances.

The sampling stations are shown in Figure 2.2-41.

Potential contamination of the river due to spills/leaks is considered minimal because there are no effluent discharges from the plant site. The operation of the water pump has to be maintained well so that no oil leaks will result from this. Moreover the river pump is not sited in the river body itself.

Tagoloan River

TSS values were observed to exceed standards; however these are not attributable to the power plant but from various discharges from industries and the communities and other industries. Likewise same is the case for Fecal Coliform.

Macajalar Bay

Temperatures were recorded to be well within standards. These are key parameters because of discharge of cooling water return to the Bay at elevated temperature.

Fecal coliform were recorded to exceed standards; but these are attributable to other sources of domestic water discharges.

Table 2.2-7. Monitoring Results for Ambient Water Quality (Tagoloan River)

Location of Monitoring Station	pH					Temperature (°C)					BOD (mg/L)					TSS (mg/L)					Color (TCU)				
	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021
DENR Standard	6.5 - 8.5					26 - 30					5					65					50				
Tagoloan River Upstream N -8181867.558214; E 11793454.082825	7.7	8.5	8.3	7.9	7.9	29	28	27	28	28	2	2	2	1	2	47	64	241	160	152	5	5	10	10	10
Tagoloan River Downstream N -8181600.634597; E 11794107.006988	7.90	7.7	7.7	7.8	7.8	29	30.00	30	28	28	3	2	1	1	1	333	44	264	170	165	5	5	10	10	10

Location of Monitoring Station	Dissolved Oxygen (mg/L)					Chorides, Cl (mg/L)					Nitrate, No$_3$ (mg/L)					Phosphates, PO_4^3 (mg/L)					Fecal Coliform (MPN/100mL)				
	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021
DENR Standard	5					250					7					0.5					100				
Tagoloan River Upstream N -8181867.558214; E 11793454.082825	6	9	8	6	8	11	12	5.2	19	4.5	0.5	0.25	0.61	0.38	0.36	0.12	0.17	0.29	0.11	0.06	35	350	2.4	39	430
Tagoloan River Downstream N -8181600.634597; E 11794107.006988	5	9	9	9	7	3	10	4.7	20	3.5	0.5	0.19	0.62	0.33	0.21	0.08	0.1	0.28	0.13	0.06	35	23	180	180	84

Charts showing the trend of Ambient Water Quality Monitoring at Tagoloan River for the past 4 years up to Q1 of 2021.

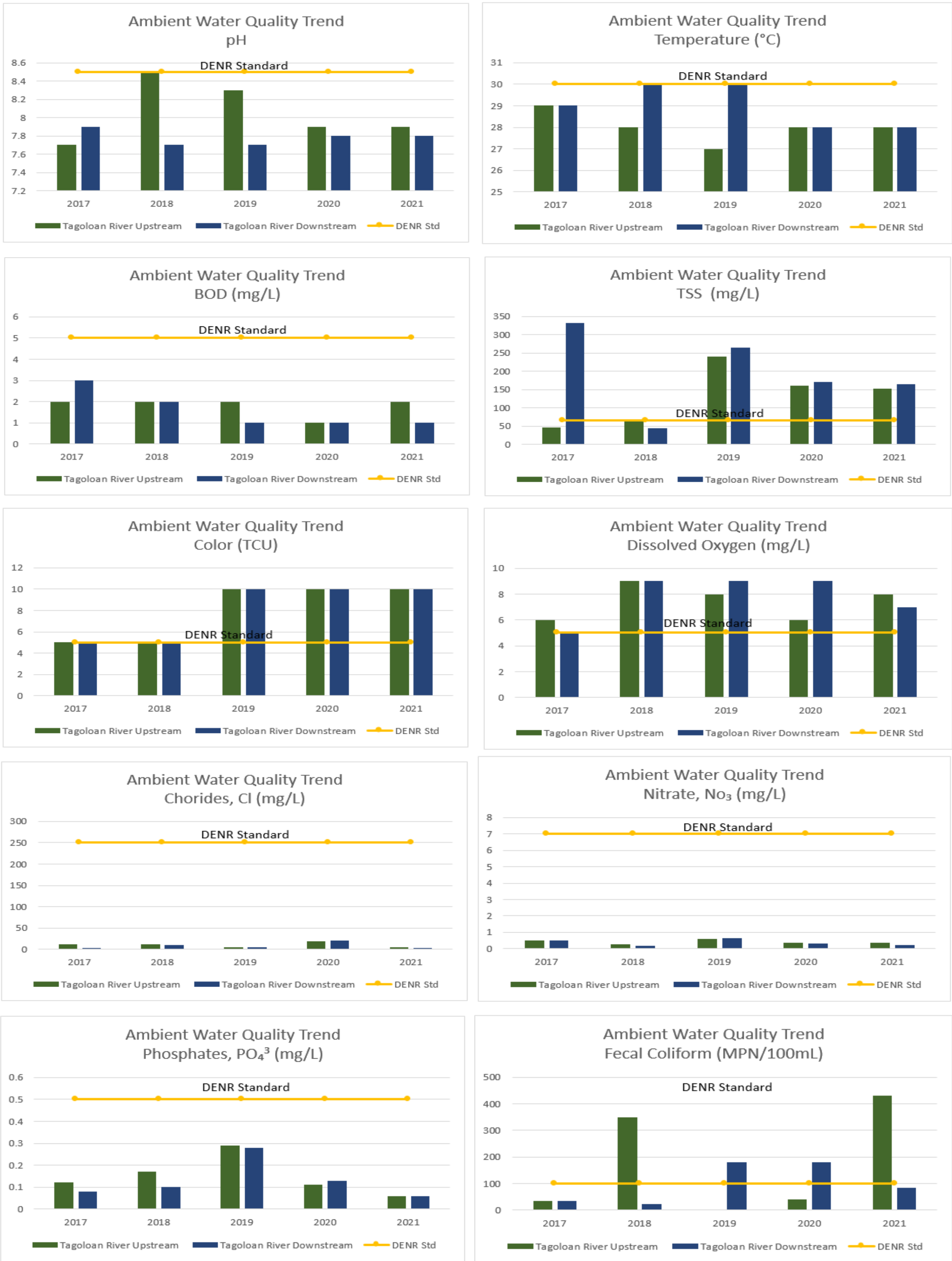


Figure 2.2-40 Trend of Ambient Water Quality Monitoring at Tagoloan River for the past 4 years

Table 2.2-8 Trends of Ambient Water Quality Monitoring at Macajalar Bay for the past 4 years up to Q1 of 2021.

Location of Monitoring Station	pH					Temperature (°C)					COD (mg/L)					TSS (mg/L)					Color (TCU)				
	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021
DENR Standard	6.0 - 9.0					25 - 31					200					100					150				
Macajalar Bay Station No. 1 N -8180612.503774; E 11795600.759068	6.9	8.2	8.6	7.8	7.4	31	30	31	28	27	119	147	70	266	245	13	22	8	42	49	2	5	5	5	10
Macajalar Bay Station No. 2 N -8180612.503774; E 11795600.759068	7.2	8.2	8.7	7.8	7.1	30	30	31	28	26	179	98	140	231	200	13	18	10	45	51	2	5	5	5	5
Macajalar Bay Station No. 3 N -8180612.503774; E 11795600.759068	7.2	8.1	8.2	7.6	7.1	30	30	26	28	26	167	108	72	236	80	8	20	66	52	68	2	5	5	5	10
Macajalar Bay Station No. 4 N -8180980.633559; E 11796204.985285	7.3	7.7	8.5	7.6	6.9	29	30	30	29	25	144	157	120	295	320	11	16	10	40	62	2	5	5	5	5

Location of Monitoring Station	Dissolved Oxygen (mg/L)					Nitrate, No$_3$ (mg/L)					Phosphates, PO_4^3 (mg/L)					Fecal Coliform (MPN/100mL)				
	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021
DENR Standard	NA					20					1					400				
Macajalar Bay Station No. 1 N -8180612.503774; E 11795600.759068	5	8	9	8	6			0.45	0.13	0.28	0.18	0.07	0.02	0.06	0.07	350	7.8	23	1600	39
Macajalar Bay Station No. 2 N -8180612.503774; E 11795600.759068	5	7	8	8	8	0.19	0.11	0.21	0.12	0.3	0.03	0.01	0.01	0.06	0.07	170	2	23	24	540
Macajalar Bay Station No. 3 N -8180612.503774; E 11795600.759068	5	8	8	8	7	0.15	0.1	0.18	0.13	0.29	0.01	0.02	0.01	0.08	0.06	110	1.8	21	24	39
Macajalar Bay Station No. 4 N -8180980.633559; E 11796204.985285	5	8	8	8	7	0.12	0.1	0.32	0.08	0.31	0.01	0.02	0.01	0.04	0.08	35	4.5	12	39	13

Charts showing the trend of Ambient Water Quality Monitoring at Macajalar for the past 4 years up to Q1 of 2021.

Figure 2.2-41 Trends of Ambient Water Quality Monitoring at Macajalar Bay for the past 4 years up to Q1 of 2021.

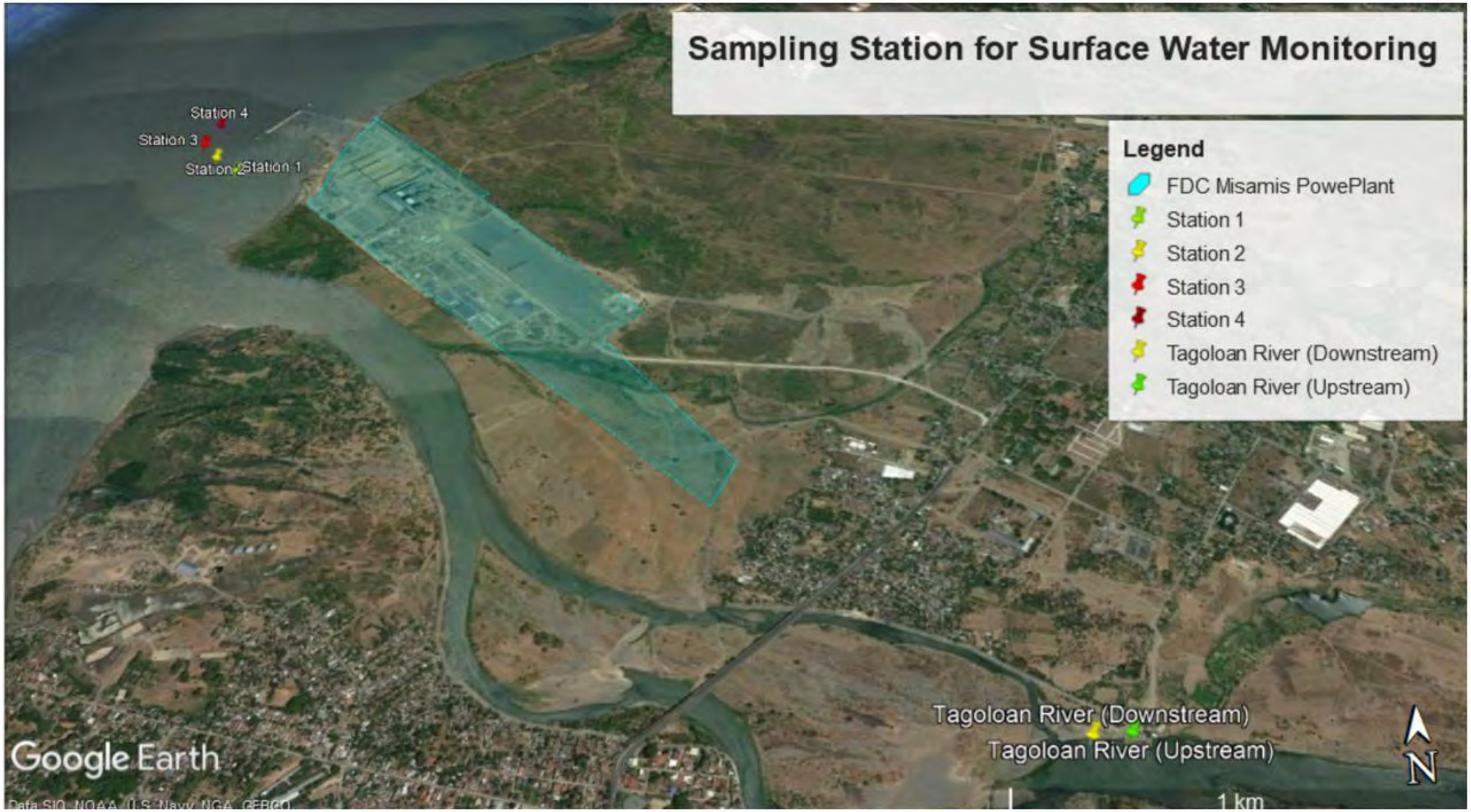


Figure 2.2-42. Map of Sampling Stations for Surface Water Monitoring (Tagoloan River and Macajalar Bay)

2.2.4 Freshwater Ecology

Objectives of the baseline freshwater ecology survey

Freshwater ecology assessment was conducted in the upstream and downstream of two (2) stations focusing on the major impact areas which are where the raw water pumping station of the power plant is located (coordinates N 08.539864°; E 124.768917). This station is located at approximately 2.5 kilometers from the southern periphery of the proposed power plant project site (**Figure *2.2-42***).

Dates of Surveys : October 2018

The primary objective is to determine the presence of important aquatic biota that can be susceptible to extraction of river water during project operations. The key parameters used are plankton community structure, presence of fish biota, macro-invertebrates, and macro-benthos.

The environmental assessment also attempted to document fisheries resource use practices around the general impact area of the pump house intake conduit through observance of actual fishing operations. However, no fishers were encountered during the survey as the inland portions have ceased to be a popular fishing ground due to loss of fisheries productivity. According to key informants, both fish and freshwater bivalve fisheries are already under immense pressure from loss of habitats and dwindling stocks. The river presently has various industrial users, most of which are for additional water use by several industrial establishments, for irrigation and sand and gravel quarrying. The survey employed a cast net to conduct actual fishing in river upstream section in order to document catch composition during *in-situ* documentation of actual fishing results. Moreover, key informants were interviewed to identify species of fish in the river system particularly focusing on the rare species of 'Pigok' and river snapper that allegedly were previously present in the river system. For plankton communities, three (3) stations were subjected to biotic sampling that included phytoplankton, zooplankton, and epibenthic benthos. Macrobenthos community diversity was sampled in two (2) stations; and macro-invertebrates of significant economic value for food and livelihood were also catalogued through core sampling in a one station upstream of the pumping station.

***Figure 2.2.43**. The Tagoloan River showing the 6 x 135 MW coral fired Misamis Power Plant site and location of raw water pump house station.*

Sampling methodology and stations

Sampling stations

- ***River Physical properties***

Parameters describing the basic morphology of the river in two (2) sampling stations were documented *in situ*. Among others, this included riparian width, substrate composition, riverbank vegetation, depth, salinity and river flow measurement. Station 1 was positioned upstream of the pumping station in the boundary of Barangay Mojon and Sta. Cruz, Tagoloan. Station 2 is located downstream of the pumping station in Barangay Sta Cruz, Tagoloan. The coordinates of the survey stations are listed in **Table 2.2-12** and depicted in **Figure 2.2-43.** At the time of the survey, dredging and sand and gravel quarrying were being undertaken in the upstream sampling station and the disturbance of loose soil and sand from quarrying activities were vividly evident, with sediment streams spilling out. Flood control structures were built in many portions of river bends. (Plate 2.2-1). These activities and structures are not related to the power plant project.

Table 2.2-9. Location of river ecology sampling stations in the Tagoloan River bisecting the municipalities of Tagoloan and Villanueva, Misamis Oriental.

WP Code	LATITUDE	LONGITUDE	Remarks
RVR1	N 08.536329°	E 124.781817°	Upstream position along Tagoloan River approximately 3 km from periphery of power plant site. Turbid grayish water with gravel and sand. Actual riverbank width at 88m (from Google Earth).
RVR2	N 08.540616°	E 124.764156°	Downstream of the pumping station about 2.5 km from power plant site; depth 46cm at sampling point. Turbid brown-colored water with sand, mud and gravel substrate. Actual riverbank width at 137m (from Google Earth).

Plate 2.2-1 River ecology sampling stations (with sand quarrying in left photo) in the vicinity of the proposed water pumping station of the Misamis Power Plant in Tagoloan River.

Figure 2.2-44 Survey stations for river characteristics in the vicinity of the proposed pumping station in Tagoloan River surveyed during aquatic biota assessment in the impact area of the proposed 3 x 135 MW coral fired Misamis Power Plant.

- ***Aquatic Biota – Plankton***

Composition, abundance and density of phytoplankton communities was determined using standard methodologies, including plankton net surveys, Shannon-Weaver Diversity/Evenness Indices and bio-assessment metrics. Plankton sampling was conducted in three (3) stations (Figure 2.2-44) where water samples for quantitative and qualitative analysis were collected by vertical towing employing a 20 µm Plankton net (Plate 2.2-2). Morphological characteristics were used as the basis for the identification of the different plankton species. After fixing the samples with Lugol's solution (10mL:1L), the samples were transported to the UP MSI laboratory for counting and identification, where 1 ml aliquot samples were taken for plankton identification and enumeration under a Zeiss Axioskop II Microscope. Identification of the phytoplankton organisms using the taxonomic guide of Tomas (1997) were done up to species level whenever possible. Nannoplankton and piccoplankton were not included in the phytoplankton identification. Cell counts up to 200 cells were made using a Sedgewick Rafter counter chamber. Diversity (H') and evenness (J') index was computed according to Shannon-Weaver (1963) and Pielou (1966) considering only the identified organisms at genus and species level. Counting and identification of organisms was conducted using a Sedgwick-Rafter plate. For zooplankton, a dissecting microscope was used. Phytoplankton were counted and identified to the lowest taxonomic level (genera) possible while zooplankton were identified to major groups using available references. Phytoplankton and zooplankton densities are presented as number of cells or organisms per liter. The coordinates of the plankton sampling stations is presented in Table 2.2-13; map of station locations are presented in Figure 2.2-45 (also please see Plate 2.2-3).

Table 2.2-10 Sampling stations for plankton community diversity during the freshwater ecology survey in Tagoloan River, Tagoloan, Misamis Oriental; 29-30 October 2018.

WP Code	LATITUDE	LONGITUDE	Remarks
PLK1	N 08.536329°	E 124.781817°	Upstream position along Tagoloan River in Barangay Mojon about 2.2 km south of the proposed steel mill site.
PLK2	N 08.540616°	E 124.764156°	Midstream position along Tagoloan River in Barangay Sta Cruz almost 3 km southwest of the proposed project site.
PLK3	N 08.557807°	E 124.743384°	Located in the 330-meter wide estuary of Tagoloan River bordered by Barangay Sto. Niño in Tagoloan and Barangay Balacanas in Villanueva.

Figure 2.2-45. Location of survey stations for plankton community diversity surveyed during freshwater ecology/aquatic biota assessment in the vicinity of the raw water pumping station of the proposed of the 3 x 135 MW coral fired Misamis Power Plant in Tagoloan River.

Macrobenthos and macro-invertebrates of significant value for food and trade

Benthic macrobenthos were collected core sampling of benthic and epibenthic benthos in the same stations as plankton community sampling (**Table 2.2-11**). The location of the benthos sampling stations is shown in **Figure 2.2-46**. Identification of other macro-invertebrates, particularly those with significant economic value for food and trade was supplemented through opportunistic surveys and core sampling along the riverbanks in both stations.

Table 2.2-11. Sampling stations for benthos community diversity during the freshwater ecology survey in Tagoloan River.

WP Code	LATITUDE	LONGITUDE	Remarks
BNT1	N 08.536329°	E 124.781817°	Upstream position along Tagoloan River in Barangay Mojon about 2.2 km south of the proposed steel mill site.
BNT2	N 08.540616°	E 124.764156°	Midstream position along Tagoloan River in Barangay Sta Cruz almost 3 km southwest of the proposed project site.
BNT3	N 08.557807°	E 124.743384°	Located in the 330-meter wide estuary of Tagoloan River bordered by Barangay Sto. Niño in Tagoloan and Barangay Balacanas in Villanueva.

The coordinates of stations for opportunistic surveys of macro-invertebrates of significant value for food and livelihood of local fishers is listed in Table 2.2.15 and shown in Figure 2.2-45.

Table 2.2-12. Sampling stations for macro-invertebrates during the freshwater ecology survey in Tagoloan River, Tagoloan, Misamis Oriental

WP Code	LATITUDE	LONGITUDE	Remarks
MAC1	N 08.535562°	E 124.778452°	About 100 meters downstream of station 1. Core sampling and use of scoop net was undertaken in riverbank strewn with rocks and pebbles.

Plate 2.2-2: Plankton and macroinvertebrate sampling in the vicinity of the proposed pumping station of the Misamis Power Plant in the Tagoloan River.

***Figure 2.2-46.** Location of macrobenthos community sampling stations in the Tagoloan River during the freshwater ecology/aquatic biota assessment conducted in the vicinity of the proposed water pumping station of the Misamis Power Plant Project in the Tagoloan River*

Figure 2.2-47. Location of survey stations for macro-invertebrates of significant commercial vlaue to local fishers in the Tagoloan River during the freshwater eccology/aquatic biota assessment conducted in the vicinity of the proposed water pumping station of the Misamis Power Plant.

The status before the setting up of the coal power plant was reported in the EIS for the original project (i.e., the 3 x 300 MW CFB Coal Power Plant)

The previous status was reported dating back as early as 2001 and reported hereunder:

A survey of the Tagoloan River, the most adjacent and impact area of the project is provided hereunder.

Freshwater Ecology Survey dated as early as 2001. Verbatim but partial quotes from the EIS Report.

… Start of Quote " Fisheries Profile

Results of rapid appraisal of municipal capture fisheries

Municipal Capture Fisheries

Actual fishing was undertaken by the survey team in two stations close to the project site on 11 February 2013 (please see Figure 16 for location of stations). A set gill net of monofilament nylon measuring 30 meters in length was used. Results from actual fishing operations were supplemented by rapid fisheries appraisal through key informant interviews (12 fishers) and observations of actual fishing operations in front of the project site. The information gathered was directed at defining the state of municipal fisheries in the general area of the project site in terms of (i) fishing gears used, (ii) catch composition, (iii) catch rates and issues that may be heightened with the establishment and operation of the project.

In a previous EIA study prepared by HATCH for the 210-MW Mindanao Coal-Fired Power Plant (2001) in Villanueva, a total of the number of 282 fishers were accounted, operating a total of 171 fishing gears dominated by the gill net, hook and line and beach seine (*baling)*. The total annual production in Balacanas was estimated at 122 MT and 227 MT in Looc. It should be noted that the mosquito net – a version of the beach seine (baling) but with finer meshes – is an active gear banned under the Fisheries Code of the Philippines but is being used extensively in Balacanas, with 20 units in 2001 (Table 9; HATCH EIA report, 2001). The gear is set in the shallow portion of the sea and is then dragged towards the shore. The net scrapes the shallow seabed and normally disturbs, or destroys, many benthic life form communities, including seagrass and algae.

Table 2.2-13. Number of fishers and fishing gears in Bgys. Balacanas and Looc, Villanueva in 2001. (Data obtained from the HATCH EIA Report for the Mindanao Coal-Fired Power Plant, 2002)

Barangay	Fishing gear	Local name for Fishing gear	Est. No. of fishers	Est. No. of fishing gear	Est. Average Daily Catch (kg/day)	No. of fishing days/mo	No. of fishing months/year	Estimated Annual Production (mt)
Balacanas								
	gillnet	Kayagkag	25	10	30	24	12	86
	mosquito net	Baling	20	4	20	3	5	1
	cast net	Laya	30	20	1	22	12	5
	hook and line	Pasol	30	30	2	24	12	17
	multiple h/line	Hugos	20	20	2	24	12	12

Barangay	Fishing gear	Local name for Fishing gear	Est. No. of fishers	Est. No. of fishing gear	Est. Average Daily Catch (kg/day)	No. of fishing days/mo	No. of fishing months/year	Estimated Annual Production (mt)
			125	**84**			**sub-Total**	**122**
Looc								
	gillnet	Pukot	58	24	30	24	9	156
	mosquito net	Baling	8	2	40	3	5	1
	bottom set gillnet	Palugdang	45	15	10	15	9	20
	hook and line	Taga	46	46	5	24	9	50
			157	**87**			**sub-Total**	**227**
Total for 2 Barangays			**282**	**171**			**Total**	**348**

In recent years, however, *the Integrated Coastal Management Plan of Villanueva (undated; but according to the MAO, the plan was formulated in 2011) indicates that there are only 93 fishers in the coastal barangays of Looc and Poblacion 3*, majority of which undertake fishing as a part-time livelihood. Slightly over 50% of these fishers operate fishing boats while the rest practice shore-based fishing using cast nets, fish pots and traps. Apart from this, some 41 fishing boats from other municipalities allegedly intrude into the municipal waters of Villanueva to capture small pelagic species. While no figures on fisheries yield estimates were presented in the plan, anecdotal accounts reveal that over the last two decades, destructive fishing practices, largely through the use of dynamite and fine mesh nets, exacerbated by siltation in coastal waters have led to loss of important habitats that nurture demersal fish recruitment. At the present time, key informants alleged that major fishing grounds are situated farther out into Macajalar Bay, with more than one hour of navigation by motorized boat. In deeper waters, the use of fish aggregating devices (FADs-Payao) is being practiced. In principle, FADs attract small fishes into the shelter provided by the FAD and thereafter large pelagic species, such as tuna and jacks, become attracted to the schooling fish. The FAD-aided fishing areas are then fished through hook and line and surrounding nets to almost capture everything within the FAD area. The primary yield consists of Hairtails (Espada) and an assortment of large pelagic species of tuna and tuna-like species (e.g., *Thunnus tonggol*, *Euthynnus affinis, and Katsuwonus pelamis)* dolphinfish (*Coryphaena hipporus)*, spanish mackerel (*Scomberomorus commerson)*, roundscad (*Decapterus macrosoma*) and frigate mackerel (*Auxis thazard)*. For hairtails and its associated by-catch, an average of 20 kg per day is captured.

In nearshore waters, the primary fishing gears employed by small fishers are (i) set gill nets (pukot), hook and line (kawil), beach seine (baling) and cast nets. The primary observation is that fisheries is no longer productive in the near-shore areas around the project site compared to ten years ago and few fishers have continued to fish as their principal livelihood. Lucrative demersal species have diminished from the reefs, replaced by juveniles and the capture of small pelagics has become the dominant practice. There are about six (6) fisher households that have settled on the beach along the Tagaloan River estuary and all practice full time fishing with use of cast nets, gill nets and fish pots. Fishers interviewed on the beach fronting the project site claim there are about 36 fishers, many of which are part time fishers residing far from the shoreline, fishing in the coastal waters around the proposed project site but only about four boats were encountered by the survey team in 3 days of observations. Fishers report that an average of 7 kilograms of assorted fish is harvested from gillnetting with only 4 to 6 hours of gear operation (Plate 11). Even as the catch rates have declined considerably as compared to the yield projections indicated in previous EIA surveys, the present rates declared by the fishers are quite substantial if compared to other heavily-fished areas in say central Visayas. The catch composition of municipal capture fisheries, according to order of yield proportion are as follows:

Catch composition of municipal capture fisheries in Villanueva, Misamis Oriental in order of production importance (top 10; data from key informants and actual fishing operation, February 2013)

Table 2.2-14. Catch composition of small-scale capture fisheries in Villanaueva, Misamis Oriental, in particular, near the Tagoloan River estuary (February 2013).

English name of fish	Local (common) name	Scientific Name
Indian sardines	Tamban	*Sardinella longiceps*
Hairtail	Espada	*Trichiurus lepturus*
Mackerels	Alumahan/Matang baka	*Scomber australasicus* *Selar boops*
Frigate mackerel	Tulingan	*Auxis thazard*
Spanish mackerel	Tanguige	*Scomberomorus commerson*
Lizardfish	Kambabalo	*Saurida micropectoralis*
Eastern little tuna	Tuna/bariles	*Euthynnus affinis*
Moontail bullseye		*Pricanthus hamrur*
Rabbitfish	Dangit	*Siganus spp.*
Gray mullet	Banak	*Mugil cephalus*

Note in the photograph below the presence of the freshwater species *Tilapia sp* caught by the "mosquito net" .

Plate 2.2-3. Photograph showing the presence of tilapia

Survey Results

The actual fishing stations are shown in the figure below.

In the river estuary, an average of 5 to 7 small fishing crafts were observed to operate daily in using cast nets to catch principally 'pasayan' (*Nematopalaemon tenuepsis*), and gill nets to catch mullet (*Mugil sp*), rabittfish (*Siganidae; above*), Snappers (*Lutjanidae*) and Tipalia. The catch rate is exceedingly low, at only 1 to 2 kg per fisher per day, consisting mostly of mullets, shrimps and juvenile rabbitfish. Results of actual fishing operations using gill net in two stations inside the Tagaloan River yielded only 2 fishes per gear setting of 3 hours each. In both cases the species caught was *Mugil cephalus*, or the common mullet.

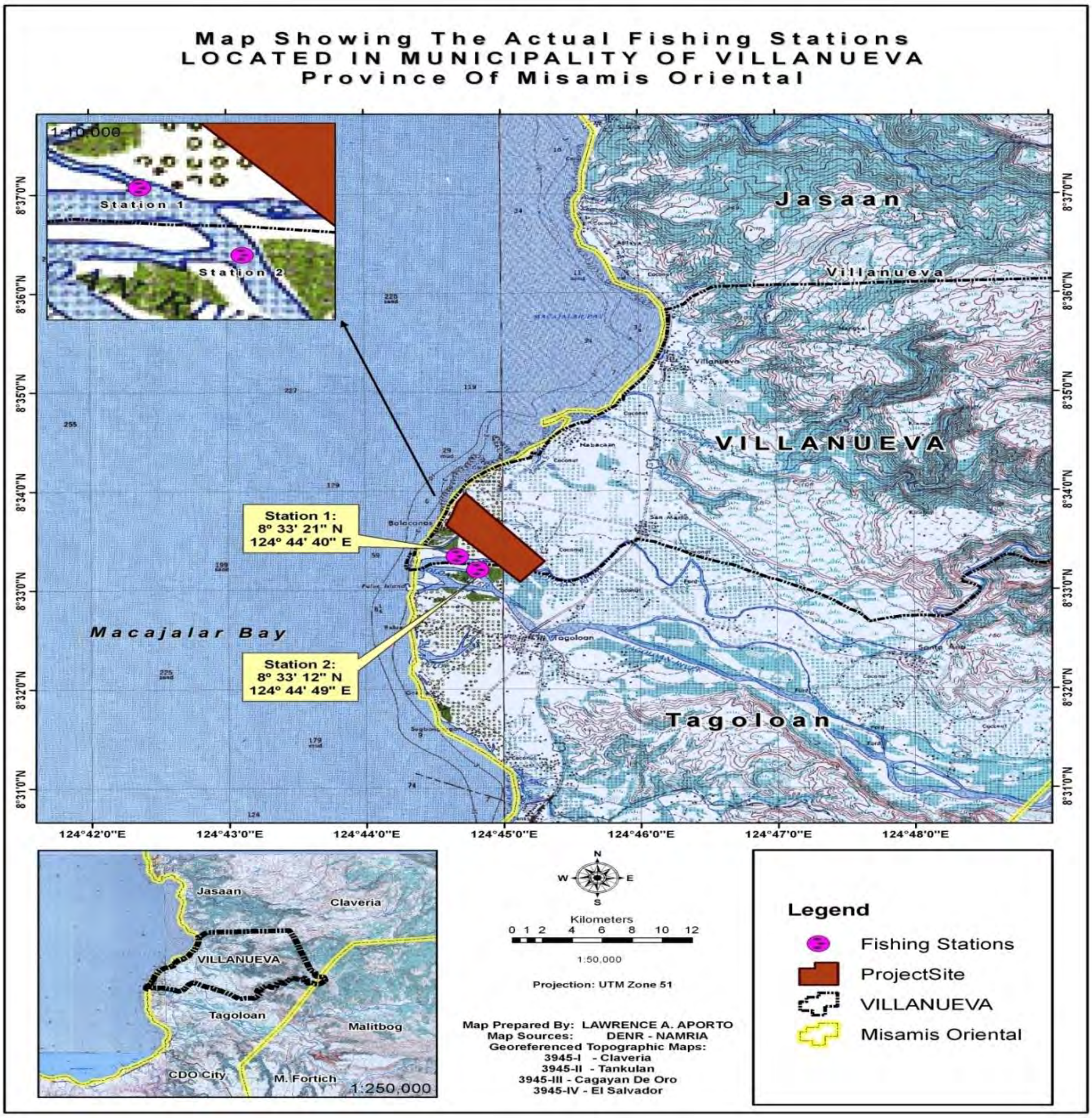


Figure 2.2-48. Map of the Fishing Survey Stations

The survey confirms the claim of fishers in the area that river fisheries productivity has declined considerably due to the extremely intense sedimentation. Previous studies indicate that the most common animals encountered in the river include the penead shrimps (pasayan), the molluscs *Thiara* sp., *Melanoides* and *Vivipara*. A lucrative species of freshwater fish knows as *Pigok*, (first alleged to be *Therapon sp.* in previous studies) was allegedly captured in many of previous sampling stations for the Mindanao Power Plant EIA in 2001. In the present survey, there has been no sightings of the Pigok even as it is a highly sought after fish due to its lucrative price (P 800/kilogram) and rare status. None of the fisher key informants interviewed has caught the fish in the last 3 to 5 months. Research undertaken by the present survey team revealed that the Pigok is a the same as the tapiroid therapon species known as *Pigek* - *Mesopriostes cancellatus* – which was previously thought to be endemic in the Abra River and the Rio Grande de Mindanao. The fish is allegedly captured rarely at the present time and residents suspect that the practice of capturing spawning females as they migrate downstream to lay eggs is the main reason for the disappearance of the fishes. Fishers also alleged that the Pigok does not inhabit the heavily turbid waters near the Tagaloan river estuary.

At present, the only major fishery resource that is found extensively in the Tagoloan river is the freshwater fish Tilapia sp. The species is caught by cast nets thrown by fishers in shallow calm waters in the downstream section of the river. Upstream, few fishers operate as fisheries productivity in this part of the river is lesser than the fisheries in the estuary area where fish species that migrate into brackish water can still be captured, albeit in progressively decreasing yield. In the river estuary, an average of 5 to 7 small fishing crafts were observed to operate daily in using cast nets to catch principally 'pasayan' (*Nematopalaemon tenuepsis*), and gill nets to catch mullet (*Mugil sp*), rabittfish (*Siganidae;*), Snappers (*Lutjanidae*) and Tilapia. Their area of operation is not within the river itself but in coastal waters where brackishwater dominate. The catch rate is exceedingly low, at only 1 to 2 kg per fisher per day, consisting mostly of mullets, shrimps and juvenile rabbitfish. Results of actual fishing operations using gill net in two stations inside the Tagaloan River yielded only 2 fishes per gear setting of 3 hours each. In both cases the species caught was *Mugil cephalus*, or the common mullet (Plate 12). The catch composition consists of mostly juvenile sizes. In the mangrove areas, the capture of Mud Crabs (*Scylla serrata*) is being practiced together with gleaning for bivalves. In three days of actual observations and lookouts for fishing operation, the survey team encountered about 5 fishing crafts in the estuary during various times of the day. No mud crab harvesting activities were observed and neither was there any crab traps encountered.

Presence of pollution indicator species

Freshwater fish species have not been utilized as pollution indicator species but their presence in significant numbers and species diversity will indicate a relatively robust and healthy river ecology. Such numbers do not occur in the portion of the Tagaloan river close to the project site. As a summary, Tagoloan River is partly degraded in view of siltation that has rendered the downstream portions, especially in the river mouth where the project is located, highly unfavorable for long-term fish recruitment and habitation. Thus in this area, there are no ecologically and economically important species apart from the hardy Tilapia and mullet species of fish. Mullets spend part of their life stages in barckishwater environments. Sporadic fishing activities are being undertaken for household and not for commercial purposes. In previous surveys undertaken for the Mindanao Power Plant, many of the freshwater species encountered were found in the upstream portions of the river.

Overall Assessment of Project Impacts

There is no significant overall impact on fresh water ecology because the project is located in the downstream portion of the river where little diversity of freshwater animals has been observed due to the heavily silted estuary.

The use of river waters will not result to any alteration of habitats, either in the estuary or in the upstream portions away from the project site. Neither will upstream migration of fishes, especially of the rare freshwater fish – the Pigok – will not be interrupted as well as there will be no barriers to impede such animal movements. Moreover, the Pigok is no longer hunted by fishers in the river mouth due to its exceedingly scarce occurrence. In the same manner, it is not foreseen that the highly sought after crustacean – the Mud Crab (*Scylla serrata*), will not be affected by the project's water extraction in as much as the crabs do not inhabit midstream environments but occur only in the muddy substrate of *Nypa* and mangrove swamps. Tilapia juveniles normally swim against the current and would therefore be more prominent in upstream waters where salinity is lower. It is unlikely too that fishes that are estuary dwelling, such as gobies, mullets and juvenile snappers, will not be affected by the project's river water extraction. Moreover, molluscan veligers (settlers) have not been found to be densely occurring in this portion of the river as revealed during zooplankton investigations and are therefore too few to be affected significantly.

There are no effluent discharges to the Tagoloan river; water will be abstracted for process and miscellaneous plant usages. The water will be converted into steam and thence ultimately vented to the atmosphere or be discharged as a treated effluent with Macajalar Bay as the discharge basin. The extraction of river waters will not negatively impact or cause dislocation of benthic communities of animals in the estuary. Adequate filters and screens will ensure that no freshwater fishes will be sucked into the intake pipe for river water. In the same manner, the extraction of river water is not expected to result to significant reduction in freshwater outflow into the estuary as the water balance computation show that the flow of river water can support the volume extracted.

2.2.4.1 Threat to existence and or loss of important local species and habitat

River habitats of the freshwater fish Pigek

The habitats of the rare fish *Mesopristes cancellatus* have already been disturbed by intense sedimentation and scouring of riverbanks during heavy rains. The fish is known to migrate upstream in the upper zones of the Tagaloan River where it seeks undisturbed feeding grounds and cleaner shelters. They travel back downstream in periodic events to spawn or mate. During these periods they become highly susceptible to fishing mortality. The capture of spawning males and females has led to a presumption that the species has been reduced to very few individuals (undocumented).

Project operations will not have any impact on the survival and distribution of the fish, nor the loss of its habitats upstream. This is because there will be no contribution of the project to sedimentation and scouring of the riverbanks. … " **End of Quote**

In Summary

The ecological profile focus on fisheries. In view of the dynamic changes in fishing operations from start of the original project to date, a direct comparison on the fishery ecology cannot be accurately done.

However, the important aspects are the impacts as follows:

1. **The structure involved in the Tagoloan River is the water intake system located in a small portion of the Tagoloan River.**

2. **The operational aspects with respect to the Tagoloan River is the abstraction of river water; no discharges from the Project to the River are made.**

Thus it is deemed to reasonably conclude that the original and expansion project does not impact significantly on the ecology profile of the Tagoloan River.

2.2.4.1.1 Abundance of ecologically and economically important species (fishes, benthos, planktons)

Profile of the Tagoloan River

The Tagoloan River, the nearest surface water body to the impact area of the proposed expansion projet, is the main river system in the Misamis-Bukidnon area and is the 13th largest river in the Philippines as classified by the National Water Resource Board. It has a length of 106 kilometers emanating from Bukidnon in Northern Mindanao and a basin of covering the provinces of Misamis Oriental and Bukidnon. Its headwaters include portions of the Mount Kitanglad watershed. The river mouth is located in Tagoloan municipality in Misamis Oriental. The Tagoloan River is included in the flood control project of the DPWH funded by the JICA since 2016 and includes dike system, drainage improvement, drainage channel, and excavation. The river bank has been eroded over time, bringing floods to about 1,300 hectares around the river (*Rapler.com; 11 July 2016*).

The Tagoloan River Basin emanates from the Bukidnon plateau with a catchment area of approximately 1,700 square kilometers. The basin is located between longitudes 124° 45'E and 125° 15'E and latitudes 8° 5'N and 8° 40' (*HATCH EIS for the Mindanao Power Plant, 2001*), with the highest portion being Mt. Kitanglad in the southwestern edge of the basin. The river's estuary straddles the eastern portion of the proposed power plant site and measures about 300 meters in breadth and exits into Macalajar Bay.

Based on NAMRIA topographic maps, the Tagoloan River has nine (9) tributaries coming from the south and southwestern sector of the basin and nine (9) tributaries coming from the north and northeastern sector of the basin. All the tributaries are within the Province of Bukidnon. The largest tributaries are the Mangima River passing through Manolo Fortich, Dila River coming from Malaybalay, Calaman River through Maluko, Amusig River through Santiago, Silo-o River through Silo-o, and Malitbog River through Malitbog and Santa Inez. The Pugaan River, passing through Santa Ana, has been diverted to the Tagoloan River and is now the northernmost tributary. The Malitbog River joins the main Tagoloan River channel in the vicinity of Barangay Maribojoc at the section where the latter begins to meander and forms a delta. This delta expands westward and northward as it coalesces with similar deposits of the Pugaan River and the Tagbalitang Creek. It reaches its widest on-land base in the estuary along the coast of Macajalar in the boundary of Barangays Balacanas, Villanueva in the north and Bogo, Tagaloan in the south.

The Tagaloan Rover is being used extensively for both agriculture and industrial uses. Concrete dikes have been built along both banks of the river about 1km upstream of the Tagoloan - Villanueva Highway for the purpose of flood control during the wet season where stream flows have been recorded at a mean of between 81 to 92 m3/s during the rainy months from July to August. PHIVIDEC draws water from the southern bank of Tagoloan River through a pumping station located about 800m upstream of the main highway. The reported pumping rate is 152 liters per second (lps) or 2,400 gallons per minute (gpm). Along the same riverbank, two rock crushing or aggregate plants also pump water from the river for their own use. On the right bank, a diversion canal carved out of the old Mohon creek is used for irrigating adjacent rice fields. A portion of the diverted water is also used by Steniel Corporation. Moreover, aggregate quarrying companies and locators of PHIVIDEC have used the main channel and a tributary of Tagoloan River as a source of water. Quarry operators along the southern bank of Tagoloan River use river waters for washing (HATCH EIS, 2001). Various other river water users were observed in the freshwater ecology baseline assessment – including poultry and piggery farms, vegetable, banana, eggplant and moringa plantations along the fertile banks of the river. In Barangay Mojon, Tagoloan, both small-scale and large scale sand and gravel quarries are operating.

River Sampling Station Profiles

Two (2) river stations investigated for physical parameters reveal that the Tagoloan River is a wide river system, with varying from 88 meters in the upstream station to 370 meters in its estuary, a depth ranging from 1.5 to 1.8 meters (Table 2.2-15). Constant disturbance from sand and gravel quarrying as well as sediment erosion in upstream riverbanks have lead to turbid waters, estimated at a mean of 44 cm across three stations surveyed. River substrate consisted of a mixture or rocks and pebbles, sand and mud in the downstream portions. Deposition of soil and sand have occurred in many portions of the riverbank in the upstream and midstream stations, and these accretions have been converted to vegetable plantations that include eggplant and moringa, among others. The river has largely open canopy banks, dominated by grassland and some banana trees and rain trees. In the estuary, a small clump of *Nypa fruticans* is growing in the eastern river bank. River uses include small-scale and industrial sand/gravel extraction, washing, bathing, and marginal fishing at the time of the survey. There were no gleaning for commercially-important macro-invertebrates observed during the survey even as the estuary is bordered by a wide sandy accretion. Likewise, no hunting for the mangrove crab *Scylla* sp was seen during the survey and key informants alleged that the mangrove crab can no longer be seen in the estuary.

The river station profiles are shown in Figure 2.2-49

Table 2.2-15 ***River parameters measured in two (2) survey stations in the Tagoloan River during freshwater aquatic biota assessment in the in the vicinity of the proposed water pumping station of the Misamis Power Plant.***

Station	Location	Depth	Width	Salinity	Sub-strate	River water color	Turbidity	Surface velocity	Cover & Vegetation
RVR1 Upstream	Bgy Mohon Tagoloan	1.8m	88m	0 ppt	Sand/ rock/ gravel	brown	36cm	0.22m/s	Open canopy with grassland and rain trees
RVR2 Down-stream	Bgy Sta Cruz Tagoloan	1.6m	137m	0 ppt	Sand/ mud/ gravel	brown	48cm	0.22m/s	Open canopy with grassland and banana crops

Figure 2.2-49. Summary of river features of the two (2) survey stations in the vicinity of the proposed water pumping station of the Misamis Power Plant.

Freshwater fish biota

Presence and diversity of freshwater species of fish in the Tagoloan River was determined through documentation of results of actual fishing employing a cast net in the upstream station and key informant interviews that included staff of the Tagoloan Municipal Agriculture Office to validate the species of fish claimed by fishers to be present in the river. In particular, the survey verified alleged claims by locals that the rare catadromous species of tapiroid therapon or *Mesopristes cancellatus* inhabit the Tagoloan River in previous years but has not been captured any more recently. The MAO office was also consulted to validate other large species of fish that were allegedly captured in the river early in 2018 – including a 19-kilogram "tilapia-like" fish as claimed by fishers. The MAO could not identify the said fish but the survey team identified it from pictures provided by a key informant (Plate 2.2-4) to be the freshwater snapper *Lutjanus fuscescens (local name - Tadlongan)*. The species is not endemic in the Tagoloan River and is not listed in the IUCN as endangered or threatened.

Plate 2.2-4 Rare 19-kg freshwater snapper caught in the Tagoloan River in 2018 (picture provided by key respondent). The captured snapper is considered a "super spawner".

At present, the only major fishery stock that is found extensively in the Tagaloan river is the freshwater fish *Tilapia (Oreochromis sp),* which are reseeded by the MAO with 100,000 fingerlings per year. The species is caught by cast nets thrown by fishers in shallow calm waters in the upstream section of the river. However, few fishers currently operate in the upstream region as fisheries productivity in this part of the river is lesser than the fisheries in the estuary area where fish species that migrate into brackish water can still be captured, albeit in progressively decreasing yield. Key informants declared that species of fish caught in the brackishwater estuary include shrimp *Nematopalaemon tenuepsis* (pasayan) gobies, (Gobidae), snakehead (*Channastriata*), freshwater eel (*Anguilla* sp) and mullets (*Mugil* spp).

Results of actual fishing documentation

River fishing is the main livelihood of Segundo Bakwahon, 48 years old, a resident of Bgy. Mojon. In 2.5 hours of fishing in the river portion upstream of the proposed pumping station, the catch consisted of an estimated two (2) kilos of assorted fishes such as tilapia, river mullet, scats/spadefish (*Scatophagus argus* or kitang) and gobies (*Plate 2.2-5*). The price of these species in the market is at PhP 80 to 100 per kilo ("kuridas" –mixed species). Other fishing gear he uses are allegedly gill net that targets fish species such as tilapia, mullet, scats and '*aluan'*, hook and line that targets *kasile (eel)*, *pigok (river mullet)*, *tadlongan (river snapper)*, *banak (mullet)*, and *subok (scats)*; and "Taklab" (fish trap) designed specifically for *dalapakan (seabass)*. Moreover, the fisher claims that juveniles of *ulang* (giant freshwater prawn – *Macrobrachium rosenbergii*) are caught by scoop nets if they migrate along the river banks but fishers use poison (e.g., Decis-R) and other type of agricultural pesticide to stun the crustaceans. This has caused widespread mortality of juveniles. Species such as *kasile*, *pigok* and *dalapakan* command higher market value at PhP 150 to 200 per kilo but are rarely caught recently due to quarrying and the use of agricultural chemicals in fishing.

Plate 2.2-5 Species of fish caught in actual fishing operation in the upstream station during the freshwater aquatic biota assessment conducted in the vicinity of the proposed water pumping station of the Misamis Power Plant. Upper photos: river mullet and tilapia; lower photos: spadefish and goby.

Plate 2.2-6 Catch composition of fisher documented for CPUE and species diversity in the Tagoloan River estuary. Top photos: Fisher Francis Bagyo; moonfish Mene maculata, mackerel Rastrelliger brachysoma, Bottom: bullet tuna Euthynus affinis, and sardine Clupea sp.

In summary, a total of sixteen (16) species of fish and crustaceans were documented to occur in the Tagoloan River, belonging to fourteen (14) families, shown in Table 2.2-19 These include species of fish that enter the Tagoloan River estuary. The results of actual fishing documentation is also summarized in Figure 2.2-49

Table 22-16. Freshwater and brackishwater fish and crustacean species present in the Tagoloan River documented during key informant interviews.

Family	Species Name	Local Name	Common Name	IUCN Red List Status
1. **Gobiidae**	*Glossogobiussp*	Biya	Goby	Not assessed
2. **Cichlidae**	*Oreochromisnilotica*	Tilapia	Tilapia	Least concern
3. **Channidae**	*Channastriata*	Dalag	Chevron snakehead	Not assessed
4. **Anguillidae**	*Anguilla marmorata*	Igat/Kasili	Eel	Least concern
5. **Theraponidae**	*Therapon jarbua*	Bugaong	Convex-lined therapon	Unknown/Not assessed
6. **Leiognathidae**	*Leiognathusequulus*	Sap-sap	Common slipmouth	Not assessed
7. **Scatophagidae**	*Scatophagusargus*	Kikilo/Kitang	Spotted scat	Not assessed
8. **Mugilidae**	*Mugilcephalos*	Banak	Flathead mullet	Not assessed
9. **Mugilidae**	*Valamugilcunnessius*	Aligasin	Long-arm mullet	Not assessed
10. **Gerridae**	*Gerresfilamentosus*	Malakapas	Spotted mojarras	Not assessed
11. **Claridae**	*Clarias batrachus*	Hito	catfish	Least concern
12. **Palaemonidae**	*Macrobrachium rosenbergii*	Ulang	Giant freshwater prawn	Least concern
13. **Penaeidae**	*Nematopalaemon tenuepsis*	Pasayan/hipon	Endeavor shrimp	Unknown/Not assessed
14. **Lutjanidae**	*Lutjanus fuscescens*	Tadlongan	Freshwater snapper	Unknown
15. **Theraponidae**	*Mesopristes cancellatus*	Pigok/Pigek	River mullet	unknown
16. **Latidae**	*Lates calcarifer*	Apahap	Seabass/barramundi	Least concern

Figure 2.2-50 Freshwater fish species caught during actual fishing operations in the Tagoloan River documented during freshwater/aquatic biota assessment in the vicinity of the proposed water pumping station of the Misamis Power Plant.

Results of mangrove assessment

There are no significant mangrove resources in the Tagoloan River that required detailed assessment. A small patch of *Nypa fructicans* are the only mangrove-associated vegetation found in a small corner of the river estuary. This small clump is only about 100 m^2 and is composed solely of the mangrove associated *Nypa fruticans* (Plate 2.2-7). A similar community of *Nypa* is located across the Tagaloan River, in Sitio Pulva, Bgy. Nabolod in Tagoloan. There is no observed disturbance in the Nypa plants although interviews with local residents reveal that these are being used for the fabrication of nipa shingle roofing materials, broom sticks and are being lightly exploited for vinegar. The 'nipa' plants were actually mixed with terrestrial trees such as talisay, bunot-bunot, narra, malabago and shrubs that were growing at the higher ground unreached by the estuarine waters.

Plate 2.2-7 Clump of Nipa (Nypa fruticans) trees mixed with 'talisay' are the only significant vegetation found in the Tagoloan River estuary.

Plankton Community

Plankton are free-drifting organisms typically found in the upper layers of the water column. They are often important components at the lower base of marine and aquatic food webs. However, planktons are not known to proliferate in fast moving lotic environs and the sampling stations chosen were areas of relatively slow current. Changes in ecological conditions in a stream often lead to changes in the community structure of planktons and benthic animals. Epibenthic fauna (macro-invertebrates or macrobenthos), on the other hand, serve a number of ecosystem roles at various levels of the food chain, ranging from consumers of plant material to prey for fish. Due to their filter-feeding nature, macro-invertebrates are good indicators of environmental conditions over time and can be used as indicators of water quality and the degradation of the aquatic environment. Benthic or bottom dwelling animals constitute a major part of the diet of many benthic and bottom dwelling fishes and crustaceans. Many species of bivalves in riverine and estuarine systems are also edible invertebrates collected for food and sustenance trade.

(i) Phytoplankton

An assessment of plankton abundance, diversity and richness was conducted last October 29, 2018 in Tagoloan River, Misamis Oriental for the proposed steel mill project. A total of twenty (20) phytoplankton species were identified in three water elevations (downstream, midstream, upstream) of Tagoloan river (Table 2.2-20). The phytoplankton community was comprised of four major groups namely diatoms, dinoflagellates, green algae and cyanobacteria. Cyanobacteria dominated the phytoplankton community which constituted for 51%, followed by diatoms with 44%, green algae with 4% and dinoflagellate with less than 1% (Figure 2.2-50; also see Figure 2.2-51). A total of 2.6×10^6 cells/m^3 phytoplankton organisms were quantified from all the stations combined. During this survey, cyanobacteria were found in all sampling stations but most abundant in upstream station. The filamentous cyanobacteria, *Oscillatoria* spp. recorded the highest cell density constituting for 51% of the total microalgal community. Other phytoplankton genera with significant relative abundance include *Fragilaria* sp. (36%), *Pinnularia* (5%), *Closterium* (2%) and *Surirella* (2%). All the remaining phytoplankton genera accounted for 4% of the total density. These species significantly contribute to the overall productivity of the river ecosystem

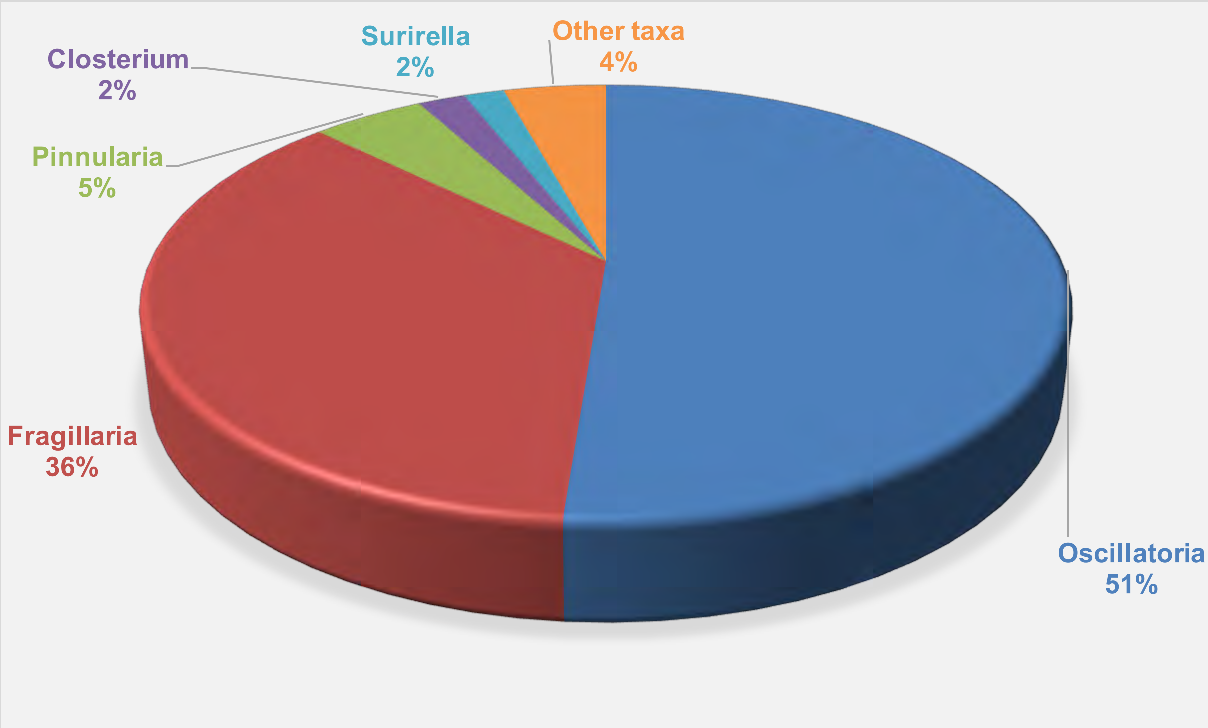


Figure 2.2-51. Percentage composition of top 5 major phytoplankton genera in three sampling stations during the freshwater ecology/aquatic biota assessment conducted in the vicinity of the proposed water pumping station of the Misamis Power Plant Project in the Tagoloan River.

Table 2.2-17. Phytoplankton composition, distribution, diversity and abundance (cells/m^3) in three sampling stations during freshwater ecology/aquatic biota assessment conducted in the vicinity of the proposed water pumping station of the Misamis Power Plant Project in the Tagoloan River. (Researcher: Garry Benico, PhD.)

TAXA	STATIONS			Grand	Rel.
	Upstream (Ph1)	Midstream (Ph2)	Downstream (Ph3)	Total	Abund.
Cyanobacteria	**794,500**	**224,400**	**1,059**	**1,343,000**	**51.34**
Arthospira	700	1,200	700	2,600	**0.10**
Oscillatoria	793,800	223,200	359	1,340,400	**51.24**
Diatoms	**356,300**	**592,700**	**212,100**	**1,161,100**	**44.38**
Achnanthes		600		600	**0.02**
Aulacosiera		300		300	**0.01**
Fragillaria	260,400	512,000	172,200	944,600	**36.11**
Gomphonema			2,800	2,800	**0.11**
Gyrosigma	1,050	1,500	1,050	3,600	**0.14**

TAXA	STATIONS			Grand	Rel.
	Upstream (Ph1)	Midstream (Ph2)	Downstream (Ph3)	Total	Abund.
Navicula	16,800	6,600	4,200	27,600	**1.06**
Nitzschia		2,100		2,100	**0.08**
Pinnularia	63,700	45,600	14,350	123,650	**4.73**
Rhabdonema	4,550		7,000	11,550	**0.44**
Surirella	9,800	24,000	10,500	44,300	**1.69**
Dinoflagellates		**2,100**		**2,100**	**0.08**
Glenodinium		2,100		2,100	**0.08**
Green Algae	**55,300**	**36,000**	**18,550**	**109,850**	**4.20**
Bulbochaete	19,250			19,250	**0.74**
Closterium	20,300	19,500	11,900	51,700	**1.98**
Cosmarium	700	5,100	2,100	7,900	**0.30**
Pediastrum			700	700	**0.03**
Spirogyra	13,650	11,400	3,500	28,550	**1.09**
Tetraedron	350		350	700	**0.03**
Tribonema	1,050			1,050	**0.04**
Grand Total	**1,206,100**	**855,200**	**554,750**	**2,616,050**	**100**
Richness	**15**	**14**	**13**		
Evenness (I')	**0.40**	**0.45**	**0.44**		
Diversity (H')	**1.10**	**1.18**	**1.13**		

The mean phytoplankton abundance during this sampling was 872,017 cells/m^3. In terms of spatial distribution, station Ph1 located at the upstream area recorded the highest phytoplankton abundance with 1.2 x 10^6 cells/m^3 and also had the most number of phytoplankton genera with 15 (Figure 2.2-51). The lowest phytoplankton abundance and richness was observed in the station Ph3 located in downstream area of the river with 554,750 cells/m^3 and 13 taxa. The diversity index based on Shannon Weiner was generally low (<2) with the highest computed value in the midstream station (1.18). The computed index of evenness among the three stations was not so variable ranging from 0.40 – 0.45. The Shannon diversity index of all the stations was below 2 which is categorized overall as low based on the Wilhm criteria (1975) classifying the diversity index <3.0 as low diversity and community stability.

The overall impression from results of the plankton survey in Tagoloan River is that in terms of richness, diversity and abundance of the phytoplankton community was relatively poor indicating a stressed environmental condition for the proliferation of phytoplankton community.

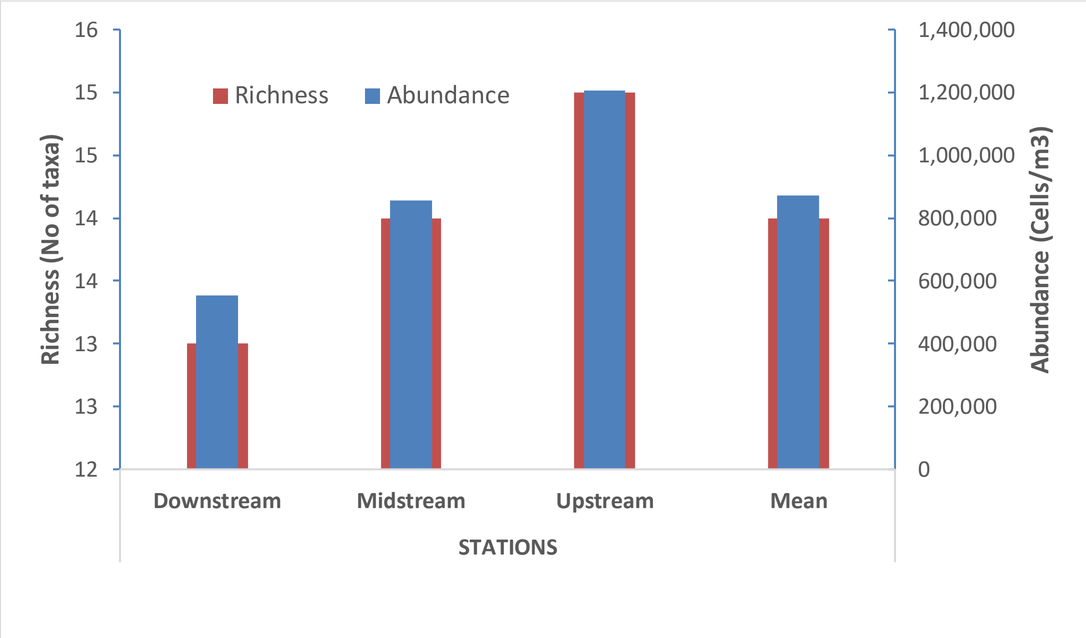


Figure 2.2-52 Total phytoplankton density and richness in three sampling during the freshwater ecology/aquatic biota assessment conducted in the vicinity of the proposed water pumping station of the Misamis Power Plant Project in the Tagoloan River.

(ii) Zooplankton

Zooplankton identified during this sampling was a typical groups/type found in freshwater environment. They were composed of protozoan (*Arcella* spp.) constituting 78%, rotifer with 19%, copepod nauplius with 2% and an insect belonging to family chaoboridae (midges) at 1% (Table 2.2-16; Figure 2.2-45). Zooplankton communities analyzed were generally totally dominated by adult forms which comprised of around 97% while larval forms constituted nearly 9%. Adult forms are mostly represented by protozoans (*Arcella* spp.) with 78% and total density of 24,583 ind/m^3 . Larval forms on the other hand, were mostly dominated by a copepod nauplius accounting for 6% and total density of 650 ind/m3. The protozoan *Arcella* inhabit freshwater pools, eutrophic waters, marshes, mosses, as well as wet foliage. Few species can also be found in soils. They nourish on diatoms, unicellular green algae or animal protozoa such as flagellates and ciliates.

The total zooplankton abundance was 10,400 individuals/m^3. The most taxa rich sample was collected from station ZP1 located in the upstream area with 6 zooplankton groups and also the station which recorded the highest zooplankton abundance with 5,133 ind/m^3 (Figure 2.4-46; Figure 2.4.-47). The most depauperate station was observed in the midstream station with only 4 zooplankton groups. Copepod nauplius were found in the downstream and upstream stations indicating a favorable recruitment habitat this small crustacean. No fish and decapod larvae were observed during the sampling period. Diversity was low (<2) with the highest calculated diversity index based on Shannon Weiner in the downstream station with 1.95 (Table 2.4.17). The computed index of evenness among the three stations was not so variable ranging from 0.92-0.97. In this survey, most of the zooplankton are common types with no endemic or rare groups encountered.

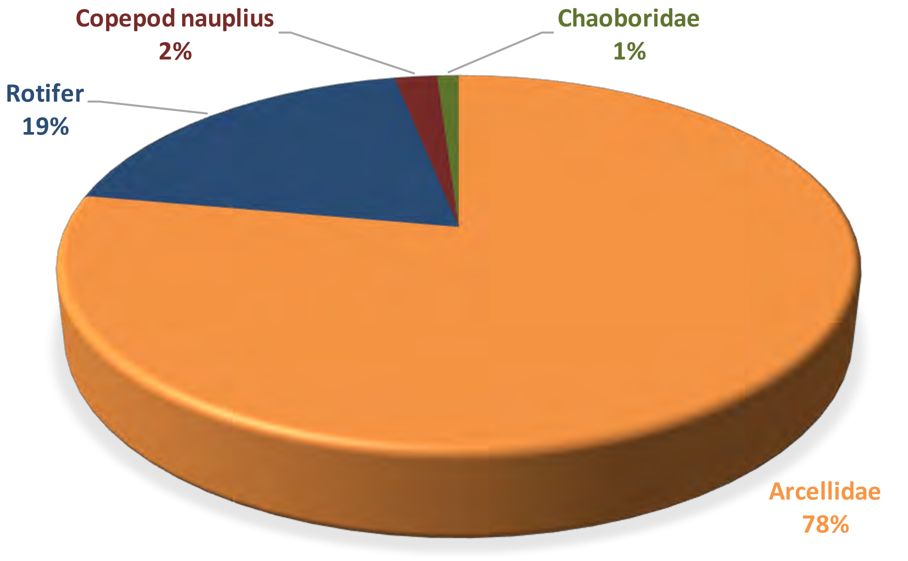


Figure 2.2-53 Percentage composition of major zooplankton taxa in three sampling stations during the freshwater ecology/aquatic biota assessment conducted in the vicinity of the proposed water pumping station of the Misamis Power Plant Project in the Tagoloan River.

Table 2.2-18 Zooplankton composition, distribution, diversity and abundance (individuals/ m^3) in three sampling stations during the freshwater ecology/aquatic biota assessment conducted in the vicinity of the proposed water pumping station of the Misamis Power Plant Project in the Tagoloan River.

TAXA	STATION			Grand	Rel.
	Upstream (Zp1)	Midstream (Zp2)	Downstream (Zp3)	Total	Abund.
Adult forms	**17,567**	**11,367**	**1,667**	**30,600**	**96.89**
Anuraeopsis rotifera	283		333	617	**1.95**
Bdelloid rotifera	283	1,467	667	2,417	**7.65**
Ploimida rotifera	567	1,467	667	2,700	**8.55**
Rotifera sp2 (Brachionidae)	283			283	**0.90**
Arcellidae	16,150	8,433		24,583	**77.84**
Larval form	**283**	**367**	**333**	**983**	**3.11**
Chaoboridae		367		367	**1.16**
Copepod nauplius	283		333	616	**1.95**
Grand Total	**17,850**	**11,733**	**2,000**	**31,583**	**100**
Richness	**6**	**4**	**5**		
Evenness (I')	**0.97**	**0.92**	**0.95**		
Diversity (H')	**1.73**	**1.27**	**1.52**		

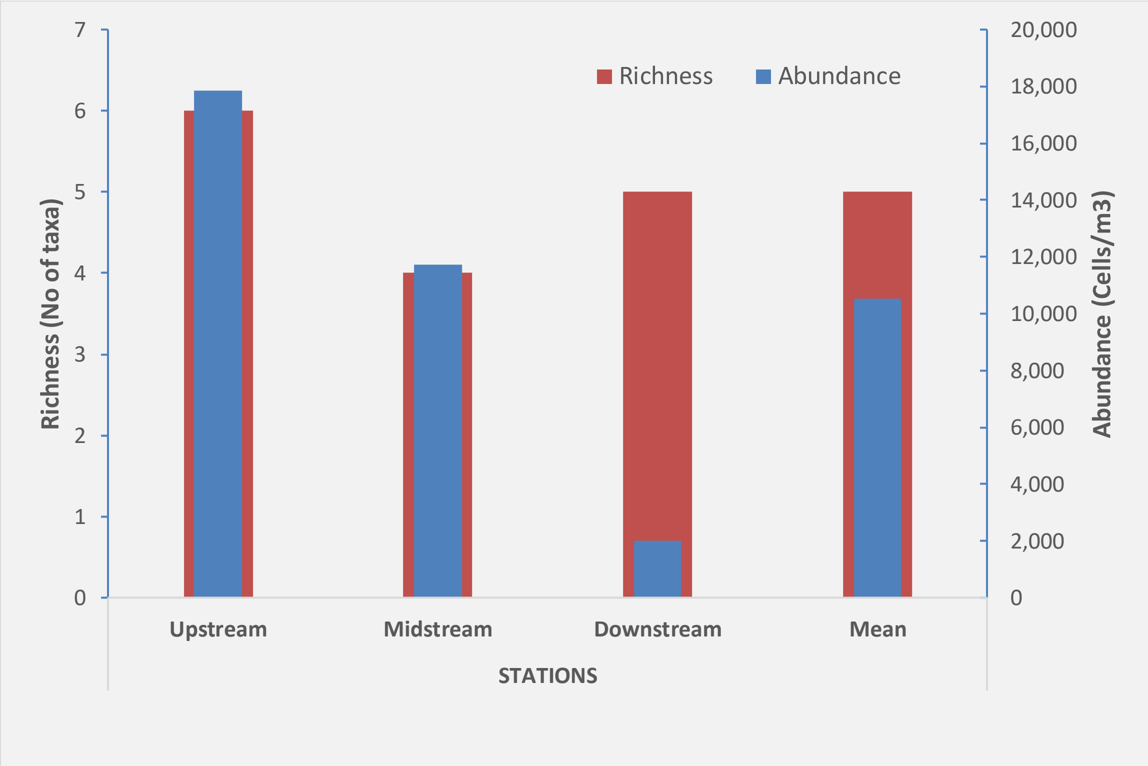


Figure 2.2-54 Total zooplankton density and taxa richness in three sampling stations during the freshwater ecology/aquatic biota assessment conducted in the vicinity of the proposed water pumping.

Figure 2.2-55 ***Diversity of dominant plankton groups in the Tagoloan River documented during the freshwater ecology/aquatic biota assessment conducted in the vicinity of the proposed water pumping station of the Misamis Power Plant Project in the Tagoloan River. (Map prepared by Jose Rene Villegas, March 2020.)***

Freshwater Macrobenthos Fauna

Macrobenthos consists of organisms that live at the bottom of a water column. In some classification schemes, these organisms are larger than 1 mm; in another, the smallest dimension must be at least 0.5 mm. They live on or within sediments, rocks, logs, debris and aquatic plants during some period in their life span includes immature forms of aquatic insects, mollusks, aquatic worms and crustaceans. The benthic macro-invertebrates community contributes immensely to the functioning of the aquatic ecosystem.

Table 2.2-22 presents the species composition, density and distribution of benthic fauna in three stations collected in three water elevations (upstream, midstream, downstream) in Tagoloan River, Misamis Oriental for the Steel Asia mill project. A total of nineteen (19) individuals belonging to six families were recorded during the study with different composition at the three sampling stations.

Table 2.2-19. Density and abundance of freshwater macrobenthos fauna in three sampling stations during the freshwater ecology/aquatic biota assessment conducted in the vicinity of the proposed water pumping station

Freshwater Benthos Taxa	BN1	BN2	BN1	Grand
	Upstream	Midstream	Down	Total
Phylum Mollusca				
Class Gastropoda				
Family Thiaridae	6	3		9
Melanoides sp.		3		3
Melanoides maculata	4			4
Tarebia granifera	2			2
Family Neritidae			2	2
Nerita sp.			2	2
Phylum Arthropoda				
Subphylum Hexapoda				
Class Insecta				
Order Ephemeroptera				
Family Baetidae	2	1		3
Baetis sp.	2	1		3
Order Diptera				
Family Chironomidae	1	1		2
Chironomous sp.	1	1		2
Phylum Chordata				
Class Actinopterygii				
Order Perciformes				
Family Gobiidae			4	4
Gobies .			4	4
TOTAL	**9**	**5**	**6**	**19**
Richness	**3**	**3**	**2**	**8**

Figure 2.2-55 shows the Relative Abundance (RA) of all the macro-invertebrate families identified in the three sampling stations observed during the October 2018. RA is the ratio of individuals in a certain taxon to the total number of individuals of all taxa which is affected by various factors. A community dominated by relatively few species could indicate environment stress (Plafkin et al., 1989 in ESS

Group, Inc. (2001). High percent contribution by a taxon generally indicates community imbalance (Bode, 1988).

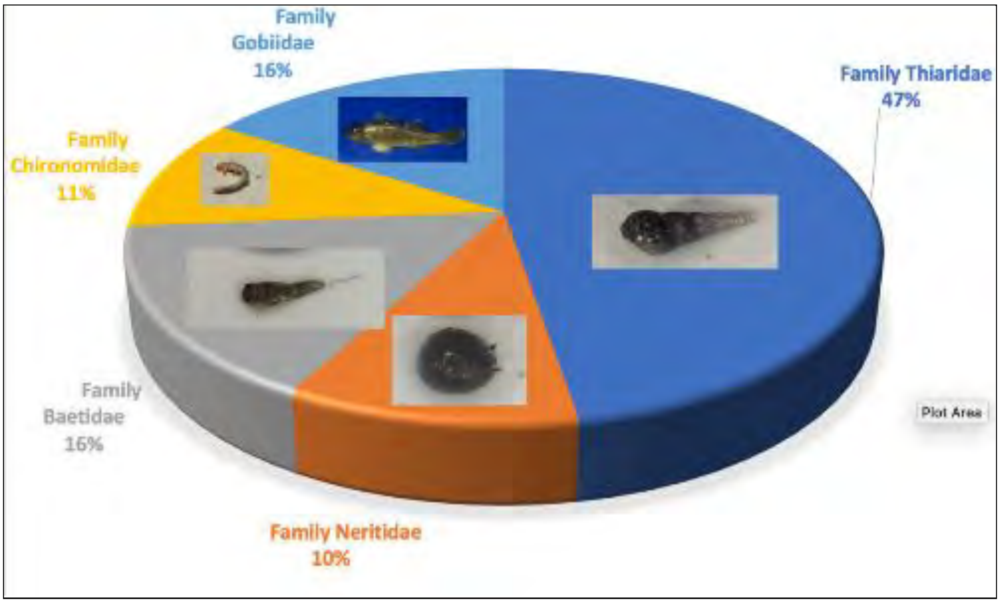


Figure 2.2-56. Percent composition macroinvertebrates class/families identified in three sampling stations during the freshwater ecology/aquatic biota assessment conducted in the vicinity of the proposed water pumping station of the Misamis Power Plant Project in the Tagoloan River.

Representatives from Family Thiaridae (*Melanoides* spp. and *Tarebia granifera*) with total count of nine (9) individuals or 49% relative abundance (RA) dominated the benthic fauna survey. Ranking in second was the taxa belonging to family Gobiidae (gobies) and Family Baetidae (mayflies) with total count of Three (3) individuals each or 16% RA. Representatives belonging Gobiidae (gobies), family Chiromonidae (mayflies) and family Neritidae only recorded two (2) individuals each or 11% RA. *Melanoides* is commonly eaten by molluscivorous fish, such as some cichlid species (Tilapia) and carp, but its use as a commercially interesting food source in fish farming requires confirmation. Occurrence of mayflies in upstream station is indicative of relatively good water condition because this group is sensitive to pollution. Figure 2.2.56 shows total density of freshwater benthic fauna observed in the three sampling stations.

In terms of spatial distribution, the highest macrobenthos count was recorded in station BN1 or upstream area with 9 while the lowest was recorded in midstream station with three (3) (Figure 2.2-57). The overall impression of the benthos assessment during this survey is poor as indicated by low abundance, richness and diversity. Also, no endemic taxa recorded during this survey but only common taxa found in freshwater community.

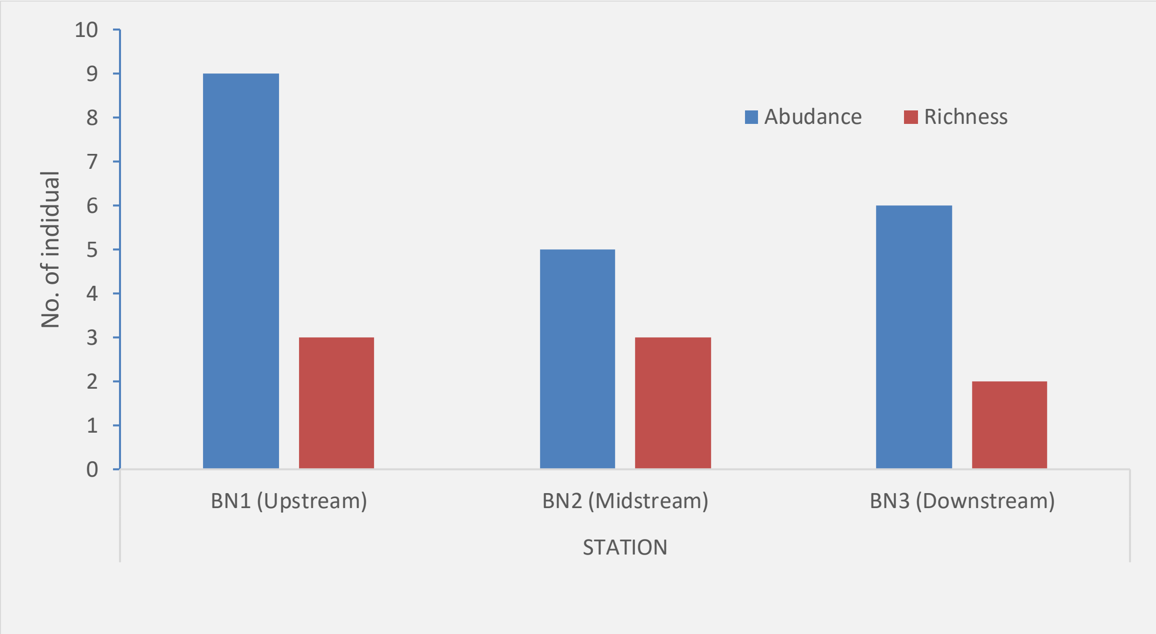


Figure 2.2-57. Total benthos abundance and richness in three sampling stations during the freshwater ecology/aquatic biota assessment conducted in the vicinity of the proposed water pumping station of the Misamis Power Plant Project in the Tagoloan River.

The highlight of macrobenthos diversity catalogued in three sampling stations during freshwater ecology/aquatic biota assessment in the Tagoloan River is presented in Figure 2.4.15.

Commercially important macro-invertebrates in Tagoloan River estuary

Opportunistic survey for macro-invertebrates of commercial importance for food or trade was undertaken in the upstream *but no macro-invertebrates were encountered in the rocky riverbank* of the upstream station other than oyser carapace in submerged rocks. It is presumed that the use of chemicals in capturing fish has caused oyster mortality.

Figure 2.2-58 ***Diversity of macrobenthos community catalogued in three sampling stations during the freshwater ecology/aquatic biota assessment conducted in the vicinity of the proposed water pumping station of the Misamis Power Plant Project in the Tagoloan River. (Map prepared by Jose Rene Villegas, March 20***

2.2.4.1.2 Summary of endemicity/conservation status

Of the species of freshwater aquatic biota encountered in two river sampling stations, only the tapiroid therapon (*Mesopristes cancellatus*), freshwater prawn (*Macrobrachium rosenbergii*), and the freshwater snapper (*Lutjanus fuscescens)* are of high conservation value although they are listed as "least concern or unknown" in the IUCN. Although they are not reported as threatened and endangered, indications of over-harvesting and loss of habitats are posing risks to natural populations and the capture of these species has allegedly become extremely rare. None of the species catalogued are endemic. The *Pigok* is classified as threatened by the Bureau of Fisheries and Aquatic Resources. This rare river mullet is known to enter upstream river systems where it seeks undisturbed feeding grounds and cleaner shelters.

Key informants claim that the Pigok exists in the Tagoloan River, migrating downstream during certain times of the year to spawn in coastal waters. During these periods, they become highly susceptible to fishing mortality, oftentimes with the use of agricultural chemicals. In the present survey, there has been no sightings of the Pigok even as it is a highly sought after fish due to its lucrative price (P 800/kilogram) and rare status. Research undertaken by the present survey team revealed that the Pigok is the same as the tapiroid therapon species known as *Pigek* (*Mesopriostes cancellatus)* which was previously thought to be endemic in the Abra River and the Rio Grande de Mindanao. The fish is allegedly captured rarely at the present time and residents suspect that the practice of capturing spawning females as they migrate downstream to lay eggs is the main reason for the disappearance of the fish. It is evident too that the habitats of the *Mesopristes cancellatus* have already been disturbed by intense quarrying operations, sedimentation and scouring of riverbanks during heavy rains. Alteration of the river mullet's migration pathway can also be a major reason for the failure of recruitment of the species.

2.2.4.1.3. Possible Threats to the Benthic Community

The overall impression of the phytoplankton community during the survey is poor due to low number of taxa observed and relatively low phytoplankton abundance during the sampling period. Likewise, macrobenthos community, with only three families recorded, is indicative of a stressed environment resulting in biodiversity imbalance. Macrobenthic organisms, because of their contact with sediments reflect that their relative abundance, ubiquity, and sedentary nature, are considered to be suitable bio-indicators of the long-term environmental status of sediments contaminated by hydrophobic organic micropollutants. (LOUATI ET AL., 2014).
The variability of macrobenthic organisms are generally affected by abiotic factors such as substrate types, salinity, water temperature, and dissolved oxygen. Moreover, the presence of pollution-tolerant and gastropod shells (F. Thiaridae) in the river should be looked upon to as it indicates that there is a factor causing the situation. Physical and habitat disturbances to the river can lead to higher natural mortality, which affects the diversity of the macrobenthic community. Conversion of the habitat by mechanical and anthropogenic disturbance would cause sediment discharge and disturbance of the bottom substrate that would lead to turbidity of the water column and displacement of benthic organisms and alteration of their habitat. Other disturbances on the habitat in either anthropogenic or natural in origin, like water pollution and introduction of thick sediments may cause severe depletion on their population due to disruption of reproductive functions

2.2.4.2 Threat to abundance, frequency and distribution

2.2.4.2.1 Presence of pollution indicator species

Freshwater fish species have not been utilized as pollution indicator species and the low species diversity and abundance as observed in the survey indicates relatively disturbed river ecology. In areas of high sediment load, there are no ecologically and economically important species apart from the hardy Tilapia and species of gobies. Sporadic fishing activities are being undertaken for household and not for commercial purposes. In the river itself, the presence of the Thiaridae species is indicative of a polluted environment, although this can be localized and not in the entire river system.

2.2.4.2.2 Predicted major impacts of project establishment and operation on freshwater ecology.

A. <u>Construction and operation stage</u>

- ***Potential degradation of freshwater ecology of the Tagoloan River***

The pumping station is 2.5 km from the Tagoloan River and the potential disturbance that can emanate from the proposed would relate to inadvertently uncontrolled small sediment spillage during pump house construction and pipe laying. Substrate infiltration into the river is projected to be minimal and is unlikely to further cause habitat alteration of fish. However, inasmuch as no major construction for the expansion project would be undertaken these impacts are deemed to be insignificant.

- ***River water extraction***

The probability of freshwater fishes being sucked into the intake pipe cannot be ignored. However, adequate filters and screens and other related measures that this probable impact could be avoided.

- ***Disturbance to fish and crustacean population***

Although fish and shrimp populations appears to be small and dwindling, the establishment of the pumping stations will nonetheless adopt adequate measures to protect fish species by ensuring that water extraction will not cause river water lowering and riverbed exposure and fish habitat alteration. The Project will in fact support replenishment of appropriate freshwater fish species in collaboration with the LGU.

Adequate filters and screens will ensure that no freshwater fishes will be sucked into the intake pipe for river water.

B. <u>Decommissioning Phase</u>

Abandonment of the project, with land restoration, re-vegetation and remediation works already in place, is not expected to produce any impacts to the river and its aquatic biota.

Mitigating measures

Project operations will not have any impact on the survival and distribution of fish and macro-invertebrates, nor the loss of its habitats upstream. The use of river waters will not result to any alteration of habitats, either in the estuary or in the upstream portions. Upstream migration of fishes, especially of the rare freshwater fish – the Pigok – will not be interrupted as no barriers will be set that may impede such animal movements. Tilapia juveniles normally swim against the current and would, therefore, be more prominent in upstream waters where salinity is lower. It is unlikely too that fishes that are estuary dwelling, such as gobies, mullets and juvenile snappers, will be affected by the project's river water extraction. Moreover, molluscan veligers (settlers) have not been found to be densely occurring in the river as revealed during zooplankton investigations and are therefore too few to be affected significantly.

- ***Abstraction of river water; blocking and congestion of stream flow***

No disruption of river water flow is anticipated as a result of pumping station establishment and operation. During water abstraction, no part of the river will be blocked and the project will install appropriate weirs to ensure fluid movement of water. The extraction of river water will not negatively impact or cause dislocation of benthic communities of animals in the estuary. Adequate filters and screens will ensure that no freshwater fishes will be sucked into the intake pipe for river water. In the same manner, the extraction of river water is not expected to result to significant reduction in freshwater outflow into the river and its estuary as the water balance computation show that the flow of river water can support the volume extracted.

2.2.5 Marine Ecology

Project Site/Study Area

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The primary direct impact area of the power plant project includes the coastal waters fronting the 500-meter coastline of the project site in Bgy. Balacanas, Villanueva, Misamis Oriental. The coastal seas in this area straddle Macajalar Bay which forms part of the greater Bohol Sea. Bgy Balacanas is the last coastal village of Villanueva, located just before the Tagoloan River estuary (**Figure 2.2-60).**

The coastal waters immediately in front of the proposed plant site are persistently influenced by sediment and silt streams from the river, especially during the southwest monsoon, where wind-driven currents drive brackishwater towards the northeast. The coastal shelf is characterized by sandy beach interspersed with rocks, becoming increasingly dominated by muddy substrate towards the river estuary. The coastline fronting the project site is only slightly concave, and the sub-littoral zone is typical of a modestly sloping shelf that drops to 10 fathoms in about 500 meters from the shore.

The nearshore seas, as well as the river estuary that can be principally influenced by project operations consist of about 8 hectares. The primary project components that can directly impact on benthic and nearshore habitats and resources in these areas include the establishment of the intake pipe and outfall pipe, and the discharge of the power plant's cooling waters.

Maps from the NAMRIA indicate the presence of fringing reefs within the 3 to 30 meter isobath, stretching from Bgy. Balacanas to Bgy. Looc in the eastern flank of the proposed project expansion area. The Looc Fish Sanctuary is located almost 2 kilometers northeast of the project site. From the STEAG jetty, the reefs are interrupted in numerous points by sandy substrate except in front of the project site where coral colonies are spread in homogeneous distribution except in the proposed site for the power plant jetty where sand and silt dominate and coral clumps are few and far between. The influence of heavily-silted brackish river waters has depressed the growth of macro-algae as these were not observed over a wide stretch of coastal waters fronting the site. Significant mangrove resources are also distinctly absent in the coastline from Bgy Looc to the Tagoloan River estuary but emerge past the southern banks of the river, in Bgy. Nabolod, Tagoloan municipality.

This updated Report is as of **April 2020**. The previous surveys were undertaken for the Original Project in **2013.**

Supplemental coral mapping studies were undertaken in **2014** by the same marine ecology team and for another project (the STEAG power plant) adjacent to this project and further supplemented by coral and fish visual census surveys undertaken in the same area in **2015.**

Data sets from the previous surveys before 2010 surveys were reviewed and analyzed against the current (2020) findings in order to discern any significant changes using consistent methods and in the same stations.

The relative changes in baseline conditions during these periods are deemed to have not changed significantly because:

a. The other industrial operations principally the STEAG Power Plant and the Philippine Sinter are not in the impact areas this FDCMP Project shown in Figure 2.2-59.

b. Other than the pier/jetty which was established in 2013, there have not been additional structures constructed or operated at the direct impact areas in Macajalar Bay. The project's jetty/pier will not be expanded.

c. Coral the transplantation works undertaken in the impact areas of the Project in 2014 decreased the coral population and thus likewise on the impacts of the project on these marine resources. The affected corals then were transferred inside the Looc Fish Sanctuary.

Figure 2.2-59. Map Showing Relative Location of the FDCMP Project With STEAG and Philippine Sinter Plants.

Figure 2.2-60 Map Showing Location of Project vis a vis of the STEAG Power Plant

Figure 2.2-61. The Project Site Survey Features Misamis, Oriental

Plate 2.2-8. Coastal seas in front of the proposed Power Plant expansion project

Objective of the marine ecology assessment

Marine ecology baseline assessment was undertaken in the primary coastal impact area of the proposed 3 x 135 MW Misamis Coal-Fired Power Plant in Barangay Balacanas, Villanueva, Misamis Oriental in 2013, further supplemented with coral mapping studies in 2014.

Since various facilities and a project jetty has already been established in the previous ECC of the project, potential impacts of the power plant expansion project will inevitably affect only the coastal habitats and benthic substrate *directly in front of the intake and outfall pipes*. The proposed new outfall pipe location is in a canal wherein there exist no coral communities. Thus, the assessment focused on the presence of coastal resources along these two critical points in order to ensure that mitigating measures can be consistently applied across a broad range of ecological niches that may be interlinked. Rapid surveys and spot dives were also undertaken over contiguous coastal areas to investigate other coastal habitats that can be ecologically linked, either as source of propagules or spillover of migrating stocks. Drawing from this premises, the scope of work of the coastal/marine survey focused on the conduct of the following activities:

- Verification and, if present in significant quantity, determination of distribution and composition and coral cover and associated benthic life forms if such habitats are present in the direct impact areas of the expansion project;
- Definition of species composition, abundance, and biomass of associated reef fish communities in the surveyed areas;
- Identification of commercially-important macro invertebrates in the inter-tidal Tagoloan River estuary where the outfall pipe is proposed to be established;
- Assessment of existence species composition, density, and diversity of seagrass resources if such resources are present in the intake and outfall pipe areas;
- Species composition and present condition of any mangrove stand within the estuary area;
- Rapid assessment of species composition, estimation of catch rates of primary target species of fish, and identification of fishing gears employed in the area that can be affected by project operations;
- Assessment of zooplankton and phytoplankton communities and the presence of HAB-causing organisms (harmful algal blooms);

Assessment of changes in the baseline conditions reckoned from the start of operations of the original project.

Unlike with other baseline parameters, e.g. ambient air and water the parameters for marine and river ecology are not reported on a regular (e.g. quarterly) basis; thus the assessment of changes over time is not readily undertaken.

The maps of the survey stations are presented per important parameters e.g. corals, etc.

Assessment methods and survey stations

The survey methods employed follow standard coastal resource survey techniques prescribed by English *et. al.* (1994) and modified in accordance with *in-situ* conditions employing prescriptions developed though rapid coastal assessment processes evolved in several coastal management projects (e.g. DENR - Coastal Resource Management Project (CRMP) and the BFAR - Fisheries Improved for Sustainable Harvest (FISH) Project. Employing the standard assessment tools, the marine survey team conducted *in-situ* surveys along the intake and outfall pipe areas to characterize diversity and distribution of three principal coastal habitats – coral reefs, seagrass beds, and reef-associated demersal fish species, if such resources are present. Plankton and macrobenthos surveys were likewise undertaken to define primary productivity in the impact area. The surveys were complemented by key informant interviews amongst fishers encountered during the surveys in order to determine current fisheries resource use practices in the impact area.

Coral Reef Distribution and Characterization

Two survey methods were employed to assess and describe bottom condition and the current state of coral reefs in the impact area of the project where they occur: (i) Manta Tows and (ii) Line Intercept Transects (LIT).

(i) Manta Tow Survey Method

Manta tows were employed to document benthic conditions and type of resources in the coastal shelf around the intake pipe area and in front of the outfall pipe area which are within the Tagoloan River estuary. Manta tow was employed as it is an effective method in generating a broad picture of resources present in the general area and the use of general categorization of reef cover allows the snorkeler-observer to cover much more distances, following the coral distribution isobath, if corals are present. In the Misamis Power Plant baseline survey in 2013, a total of thirty-one (31) manta tow benthic observation stations across the 400-meter shelf in front of the power plant site in Bgy. Balacanas, covering a 5 km distance were observed, consisting of two (2) legs); (**Figure 2.2-62**). In April 2020,) manta tow observation stations were surveyed observed following as close as possible the manta tow route undertaken in 2013 where majority of coral colonies were observed in order to compare data (**Figure 2.2-63**). (The coordinates of the tow pathways are presented in Table 2.5.7- discussion of results). In areas where significant coral reefs occur, if any, in the intake pipe area, results from the manta tow survey were used to pinpoint location of specific stations where more detailed underwater coral characterization employing the line intercept line transect method. Manta tow surveys are also used to identify areas where seagrass and macro-invertebrate communities occur. Corals observed using manta tows were segregated into five standard categories – LHC or live hard coral cover, SC or soft corals, DCA or dead corals with algae, DC or dead corals and abiotic components of sand, silt or rocks.

Figure 2.2-62. Manta tow pathways for benthic substrate characterization and location of corals and seagrass resources surveyed during the 2013 marine ecology baseline assessment.

Figure 2.2-63 Manta tow pathways for benthic substrate characterization and location of corals and seagrass resources; surveyed during additional marine ecology baseline assessment

(ii) Line Intercept Method for Corals

A *line-intercept* method (English, et. al., 1994) of coral reef assessment is used to more precisely estimate the relative abundance of living and nonliving components in a survey station where more prominent coral reef resources occur. The survey protocol involved the laying out of a 50-meter transect line parallel to the shoreline and spatially following the reef crest isobaths (Plate 2.2-9). The survey team recorded all observed benthic life forms along the transect line in order to generate more precise information of percent coral cover as well as species distribution of corals in a given area. The stations and results of the baseline LIT can be the basis for future monitoring as they are repeatable and comparable. The overall characterization of coral life forms are described following standard categorization as shown in Table 2.2-23. A major advantage of LIT is that it can pinpoint susceptible life forms that can be invariably affected by anthropogenic issues arising from intake pipe establishment, if any.

In 2013, the baseline survey the broad area benthic profiling indicated that dense corals occurred in a patch of reef a dense reef approximately 2 kilometers from the project site (starting in the Looc Fish Sanctuary). The coral colonies disappears after three (3) manta tow stations and reappears near the jetty of the STEAG power plant; disappears again after that and reappears again in front of the project site, inshore of the back of the existing jetty. To record the extent and diversity of the reefs near the project site, three (3) LIT stations were investigated. In 2015, the 3rd station investigated in 2103 which hosted the most live corals, was revisited to discern any changes in coral cover. This station of isolated coral patch is about 300 meters northwest of the project site's coastline. The coordinates of the survey station is 124^0 44" 32.6"E, 08^0 33' 56.4" N (please see Table 2.2-24). In 2015, two new stations were established alongside station 3/2013 in the same coral reef to validate the extent of live coral distribution that has already been subjected to sediment intrusion. Station 1 , which is approximately 50 meters from the old LIT station 3 with coordinates 124^0 44" 37.5"E; 08^0 33' 53.3" N (start of transect) and 124^0 44" 37.4"E; 08^0 33' 51.7" N (end of transect), and Station 2 with coordinates 124^0 44" 38.0"E; 08^0 33' 50.7" N (start of transect) and 124^0 44" 38.3"E; 08^0 33' 48.6" N (end of transect); (Figure 2.2-63 and Figure 2.2-64 showing LIT survey stations in 2013 and 2015 relative to the position of the reef pactha dn the new project site).

On the other hand, the 2020 survey focused on investigating coral cover in the area of the power plant's intake pipe which was already surveyed in 2013 and 2015 through spot dives. The 2020 survey further revisited the previous LIT stations conducting extensive spot dives in order to determine changes in live coral cover, if any. The coordinates of the **2020 stations are listed in Table 2.2-22 and mapped in Figure 2.2-66.**

Table 2.2-20. Criteria for Determining Condition of Coral Reef (Gomez, et. al., 1994)

Category	Condition in terms of live coral cover distribution within the transect
Excellent	76-100% coverage live coral cover
Good	51-75% coverage live coral cover
Fair	26-50% coverage live coral cover
Poor	0-25% coverage live coral cover

Plate 2.2-9 Detailed coral diversity survey being undertaken through the line intercept transect method in turbid waters during marine ecology baseline assessment in the coastal impact area of the 3 x 135 MW Misamis Power Plant Expansion Project in Villanueva, Misamis Oriental.

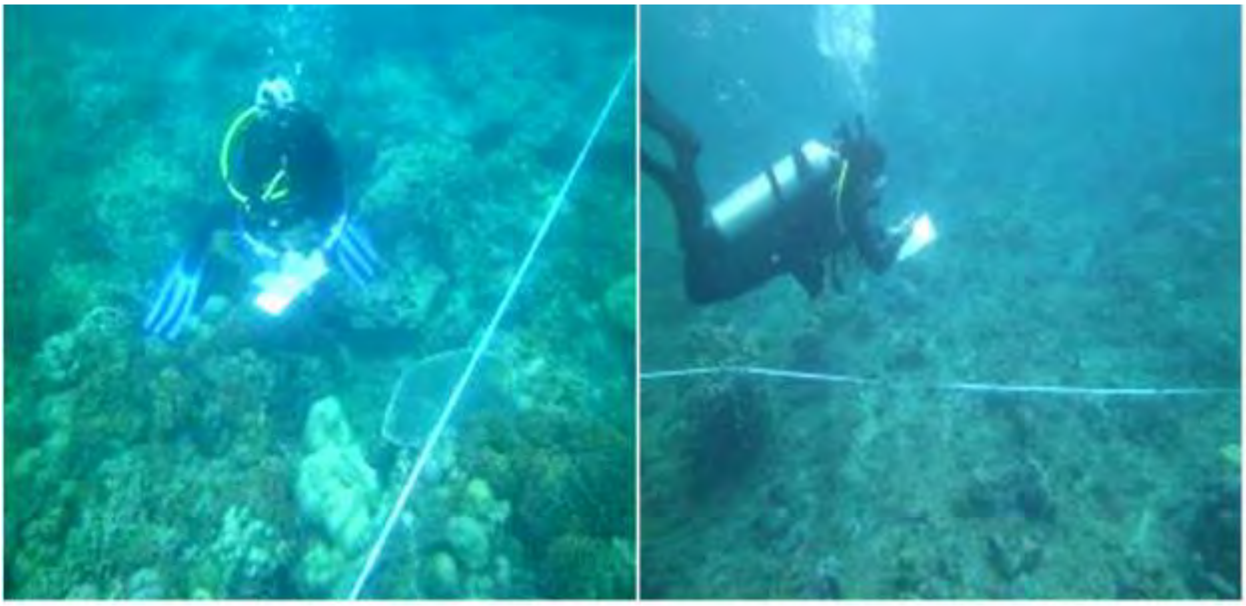


Table 2.2-21. Coordinates of spot dives in previous LIT stations surveyed during marine ecology baseline assessment in the coastal impact area of the proposed 3 x 135 MW Misamis Power Plant Expansion Project in Villanueva, Misamis Oriental.

WP Code	LATITUDE	LONGITUDE	Remarks
SPD1	N 16.092030°	E 120.106820°	Area of intake pipe
SPD2	N 16.090940°	E 120.107350°	Area of intake pipe
SPD3			Coral reef path 200-300 m NW of project site
SPD4			Coral reef path 200-300 m NW of project site

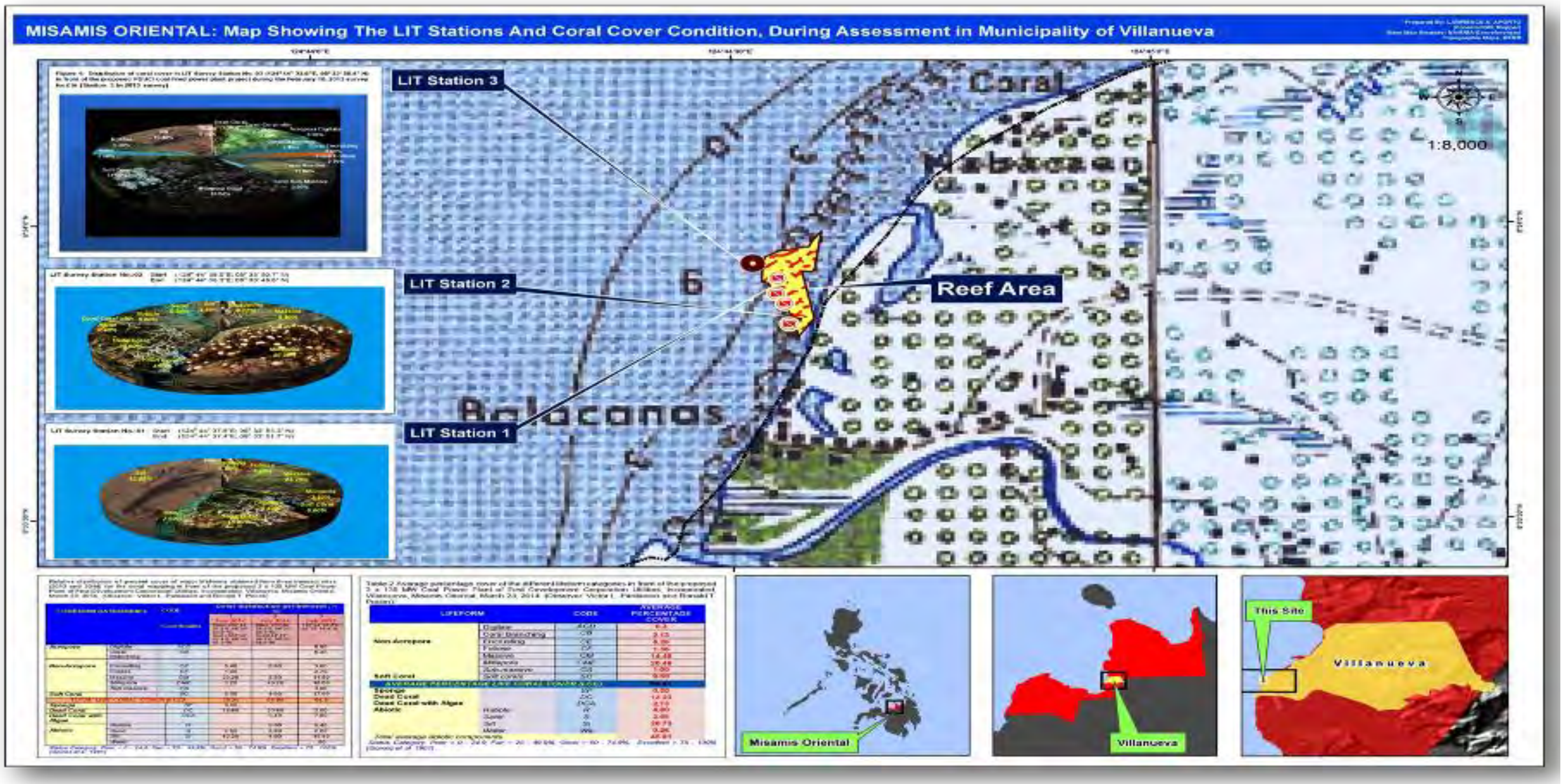


Figure 2.2-64. Location of line intercept transect survey stations for coral diversity showing location of coral reef pacth; surveyed during marine ecology baseline assessment in 2015. in the coastal impact area of the proposed 3 x 135 MW Misamis Power Expansion Project in Villanueva, Misamis Oriental; April 2020. (Map prepared by Lawrence Aporto, 2015).

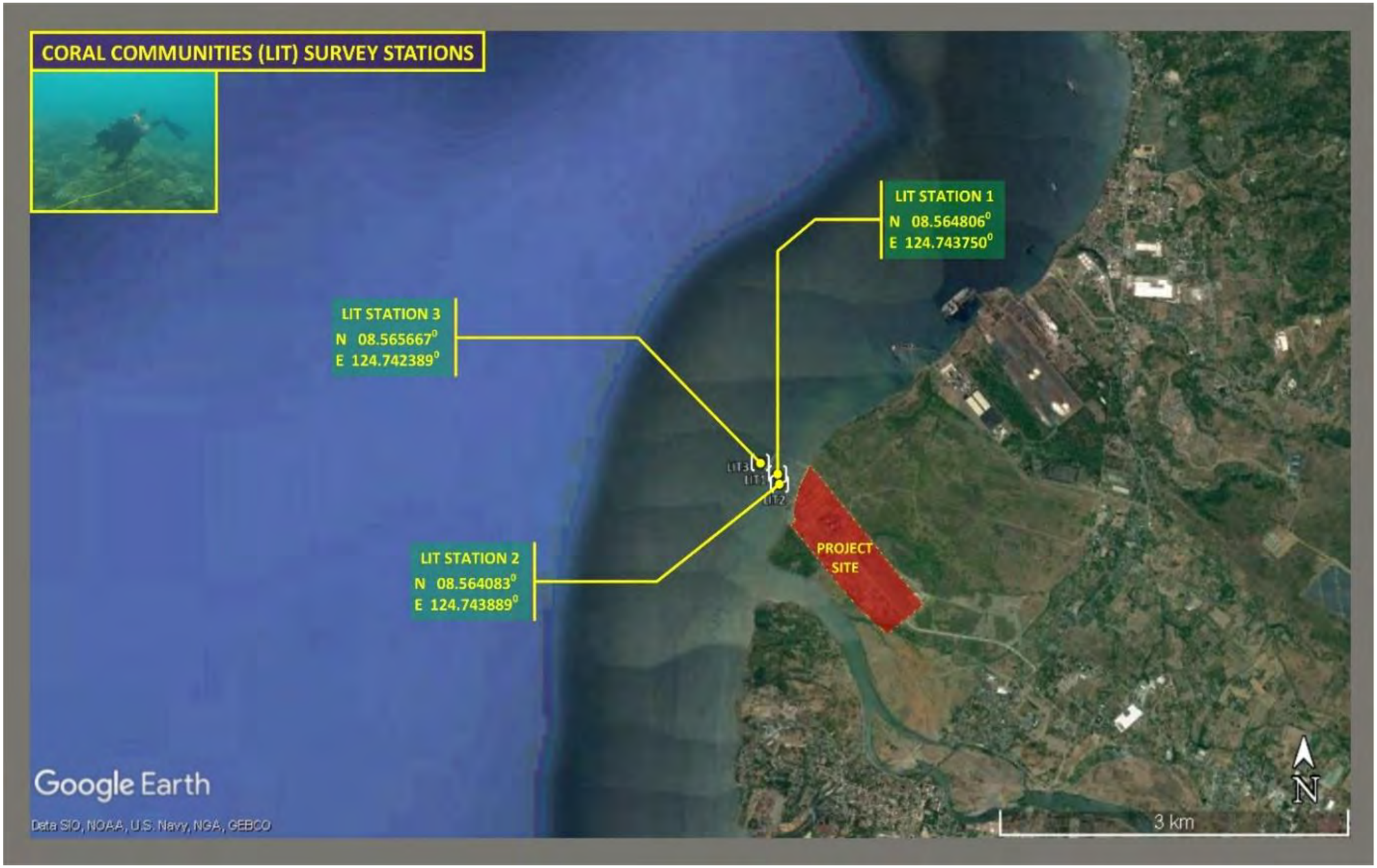


Figure 2.2-65. Location of line intercept transect survey stations for coral diversity showing location of corals relative to the location of the new/adjusted project site; surveyed during marine ecology baseline assessment in 2015.

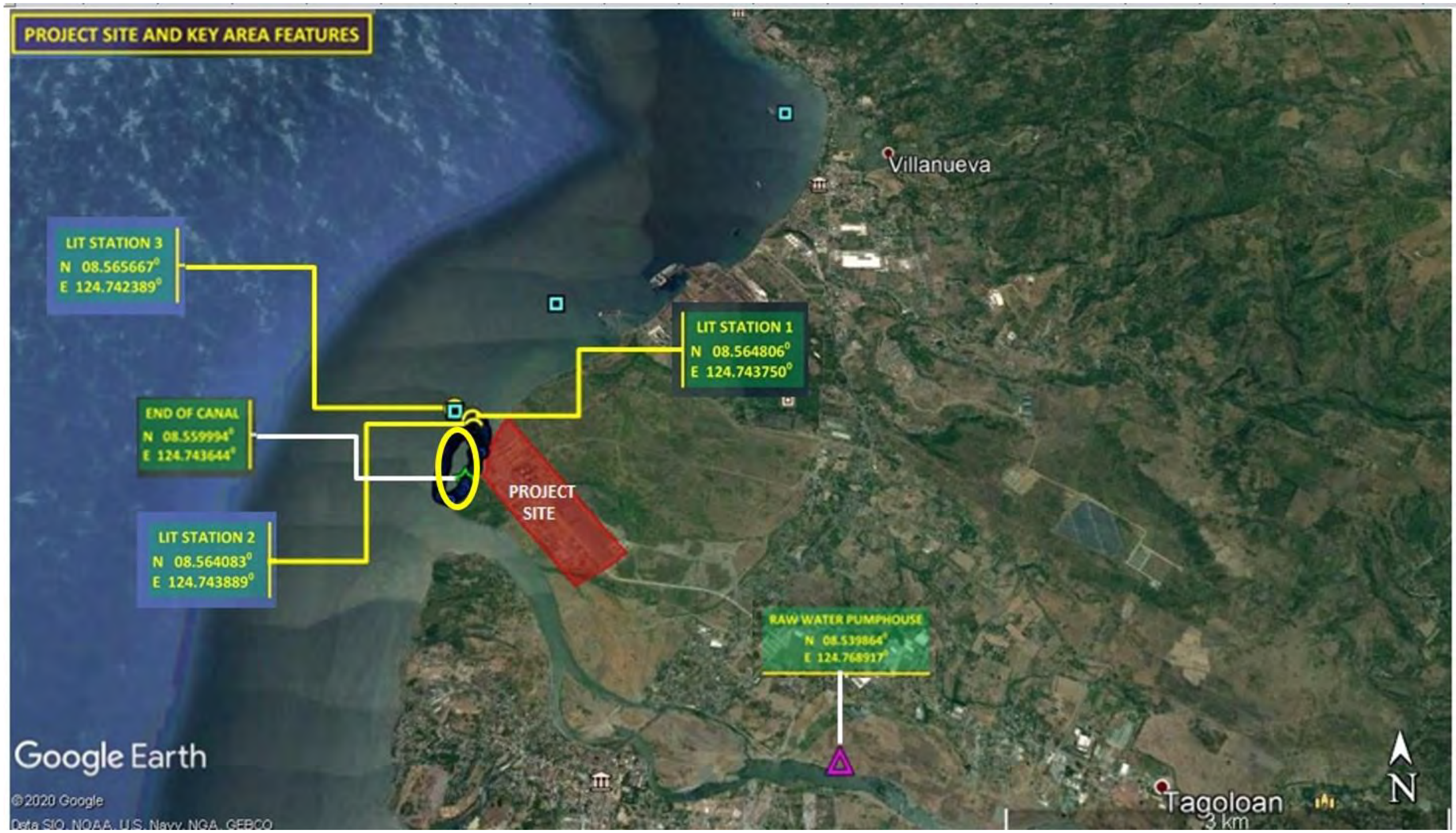


Figure 2.2-66. Location of spot dive stations for coral diversity,surveyed during additional marine ecology baseline assessment in the coastal impact area of the proposed 3 x 135 MW Misamis Power Expansion Project in Villanueva, Misamis Oriental

Note: The yellow encircled area is the domain of the 3deg C rise in temperature

Table 2.2-22. **The coordinates of the 2020 sampling stations in *yellow highlighted area***

Northing	Easting
124.7443003	8.5649030
124.7443618	8.5648808
124.7444127	8.5648290
124.7444553	8.5647734
124.7444728	8.5647487
124.7444825	8.5647068
124.7444744	8.5646920
124.7444237	8.5646526
124.7443666	8.5645712
124.7443696	8.5644373
124.7444646	8.5643208
124.7445492	8.5643496
124.7446443	8.5642731
124.7447392	8.5641397
124.7447578	8.5640446
124.7447759	8.5638164
124.7447943	8.5636643
124.7447935	8.5634933
124.7447925	8.5632842
124.7447346	8.5631325
124.7446199	8.5631140
124.7445482	8.5631523
124.7444675	8.5631907
124.7443886	8.5632606
124.7443260	8.5633133
124.7442391	8.5633437
124.7441248	8.5634013
124.7439533	8.5634591
124.7439145	8.5633452
124.7439717	8.5633259
124.7440296	8.5632707
124.7441413	8.5632418
124.7442047	8.5632008
124.7442763	8.5631155
124.7443687	8.5630750
124.7444666	8.5629816
124.7444919	8.5629209
124.744487	8.5628182
124.7444464	8.5627347
124.7444458	8.5626206

Northing	Easting
124.7442903	8.5615563
124.7442680	8.5614775
124.7442561	8.5614147
124.7442299	8.5613293
124.7442293	8.5611963
124.7442899	8.5611785
124.7443165	8.5611579
124.7443290	8.5610685
124.7443157	8.5609767
124.7442472	8.5609595
124.7441328	8.5609687
124.7441323	8.5608547
124.744055	8.5606460
124.7439205	8.5604565
124.7438814	8.5602667
124.7438022	8.5601500
124.7437450	8.5600202
124.7437222	8.5599436
124.7436885	8.5598304
124.7436492	8.5595835
124.7434762	8.5593183
124.7433227	8.5591479
124.7431313	8.5590538
124.7429779	8.5589024
124.7428745	8.5588298
124.7427989	8.5587653
124.7427171	8.5587342
124.7427285	8.5586375
124.7426571	8.5586746
124.7425650	8.5587255
124.7424582	8.5587508
124.7422754	8.5588202
124.7420567	8.5589169
124.7420067	8.5589681
124.7419504	8.5590267
124.7419266	8.5591039
124.7418844	8.5592015
124.7418633	8.5593195
124.7418483	8.5595276
124.7418369	8.5597786

Northing	Easting
124.7420823	8.5622973
124.7421138	8.5624184
124.7421341	8.5625081
124.7421803	8.5626298
124.7422046	8.5626726
124.7422350	8.5627064
124.7422899	8.5628006
124.7423495	8.5628785
124.7424063	8.5629623
124.7424531	8.5630487
124.7424712	8.5630856
124.7424868	8.5631420
124.7425017	8.5632074
124.7425172	8.5632721
124.7425203	8.5633259
124.7425519	8.5633785
124.7425682	8.5634193
124.7425924	8.5634660
124.7426233	8.5634924
124.7426460	8.5635178
124.7426679	8.5635659
124.7426962	8.5636137
124.7427295	8.5636512
124.7427768	8.5636822
124.7428188	8.5637085
124.7428674	8.5637305
124.7429468	8.5637739
124.7430034	8.5638179
124.7430635	8.5638746
124.7431301	8.5639232
124.7431886	8.5639773
124.7432401	8.5640267
124.7432725	8.5640560
124.7432983	8.5640860
124.7433147	8.5641108
124.7433299	8.5641386
124.7433595	8.5641734
124.7433919	8.5641963
124.7434281	8.5642513
124.7434532	8.5642812

Northing	Easting	Northing	Easting	Northing	Easting
124.7445983	8.5625629	124.7418290	8.5599609	124.7434886	8.5643280
124.7447235	8.5624819	124.7418310	8.5601285	124.7435132	8.5643953
124.7447531	8.5624063	124.7418601	8.5602522	124.7435768	8.5644584
124.7447067	8.5623651	124.7418876	8.5603674	124.7435939	8.5644973
124.7446672	8.5623036	124.7419098	8.5605029	124.7436301	8.5645500
124.7446024	8.5622985	124.7419340	8.5606081	124.7436647	8.5645934
124.7445400	8.5623352	124.7419579	8.5607490	124.7437047	8.5646369
124.7444638	8.5623735	124.7419887	8.5608558	124.7437458	8.5646677
124.7443495	8.5624165	124.7420107	8.5609966	124.7437700	8.5646998
124.7442158	8.5624126	124.7420325	8.5610947	124.7437997	8.5647229
124.7441405	8.5623809	124.7420602	8.5612251	124.7438451	8.5647754
124.7440928	8.5623489	124.7420737	8.5612961	124.7439027	8.5648097
124.7440817	8.5623069	124.7420828	8.5614166	124.7439485	8.5648478
124.7440996	8.5622268	124.7420788	8.5615262	124.7439902	8.5648842
124.7441765	8.5621658	124.7420572	8.5615817	124.7440546	8.5649085
124.7442715	8.5620679	124.7420629	8.5617366	124.7441160	8.5649221
124.7443045	8.5619145	124.7420589	8.5618731	124.7441841	8.5649224
124.7442893	8.5617852	124.7420549	8.5620264	124.7442391	8.5649202
124.7442908	8.5616776	124.7420606	8.5621701	124.7443003	8.5649030

CORAL COVER WITHIN THE THERMAL PLUME ZONE

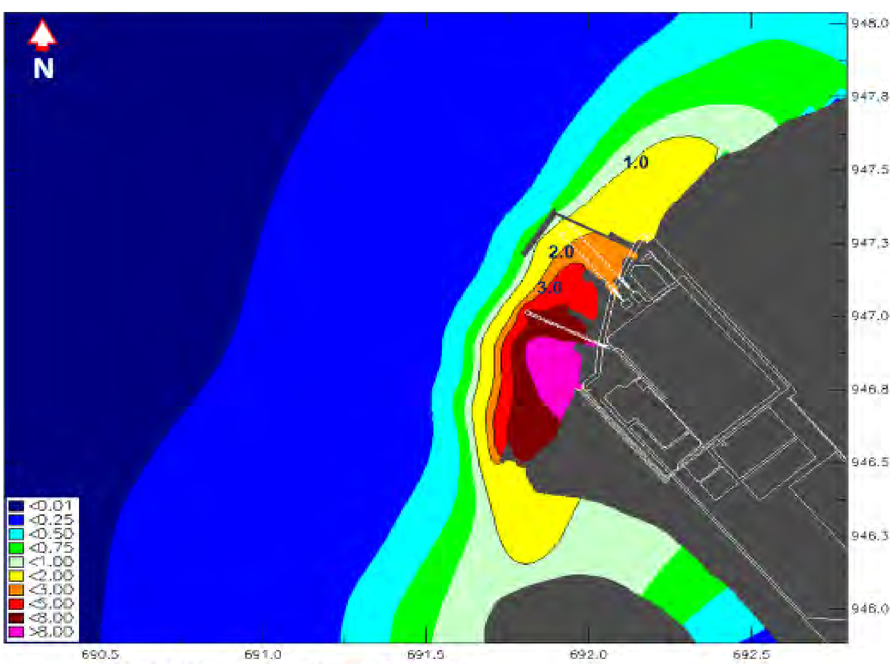


Figure 2.2-67. The composite map of the thermal plume simulation

The composite map of these thermal plume simulation runs predict that the maximum thermal concentration at the vicinity of the existing plant outfall will increase by more than 5°C; while near the shore where the outfall of the expansion project will be located, the maximum rise in ambient temperature is predicted to increase by more than 8°C. The red contour plot representing the maximum limit is visible in the figure (<5.0 in legend). The area exceeding the 3°C threshold is about 13.597 hectares.

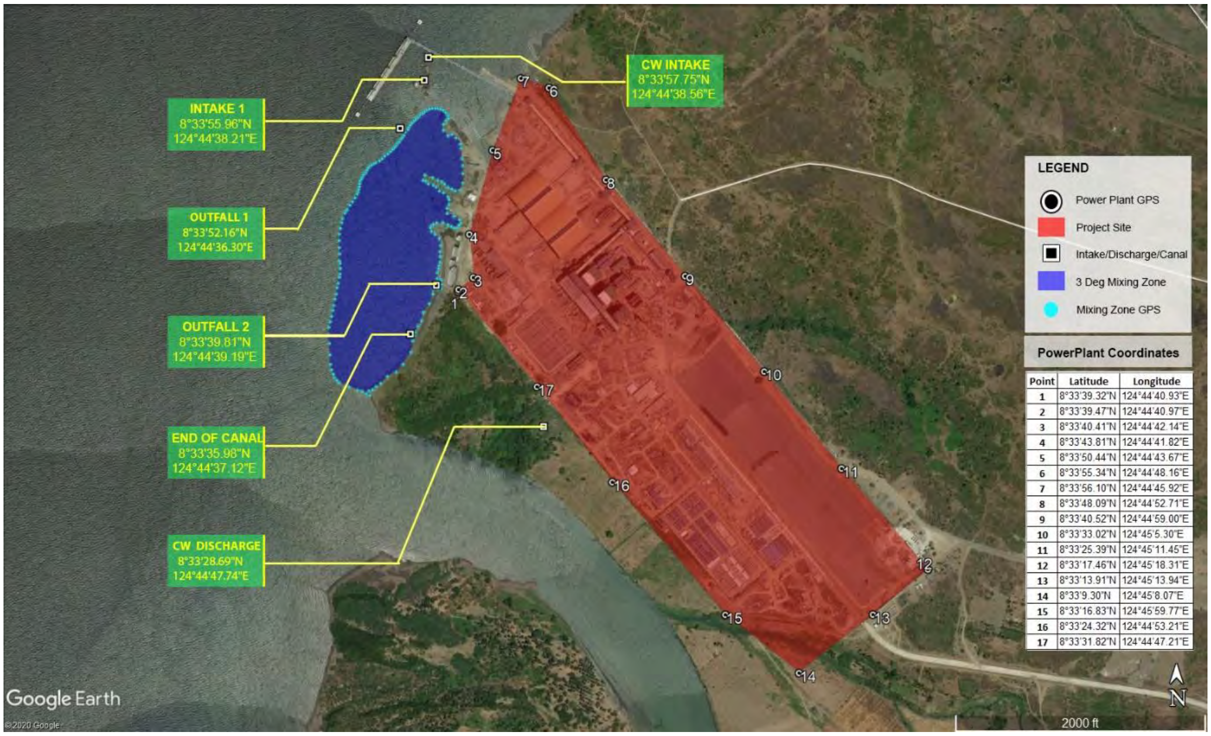


Figure 2.2-68. Map of the mixing zone relative to corals population

The absence of significant corals population signify that the cooling water discharge will not have adverse impact on the marine species of high value, principally the corals

Reef-Associated Fish Species Richness and Abundance

The two (2) additional spot stations in 2020 were subsequently used to account for fish communities associated with coral reefs through standard fish visual census (FVC) prescribed by English et. al., (1994). The conduct of FVC is designed to document a fairly accurate picture of demersal fish species richness and abundance in benthic habitats. In this case high values for these principal variables can indicate the overall ecological condition of a reef area and can give a glimpse of a healthy or poor ecosystem functioning. Collectively, the results of coral reef assessments and fish visual census are used as reference points for comparative monitoring of changes in spatial distribution and diversity of benthic life forms in periodic environmental impact monitoring. The coordinates of the stations is presented in **Table 2.2-23**

Fish species were categorized as target, major or indicator species based categories recommended in FishBase 2004. Target species are economically important fish species that are normally sought by fishers for their relatively higher economic value. These include species such as groupers, snappers, jacks and some species of surgeons. Fish that belong to the major fish category are considered to be ecologically important because they occupy unique niches and sometimes symbiotic relationships in the coral reef ecosystem. Many of these species are represented by members of the damselfishes (*Pomacentridae*) and wrasses (Labridae). Indicator species are coral-feeders whose presence, variety and abundance in a given reef may give an indication of the general condition of the reef area. These are mostly butterfly fishes (*Chaetodontidae*) and a few species of damsels and wrasses.

The total lengths of fish were estimated to the nearest centimeter and their numbers determined through actual counts. With length and abundance data, fish biomass was then calculated using the standard formula W = aLb, where W represents weight of the fish in grams, L is the total length in centimeters, and *a* and *b* are the assigned weight-length constants for fish species as prescribed in various scientific literature (Gonzales, et. al., 2000).

Results of the present additional FVC survey was compared to the 2013 baseline data and 2015 coral mapping data set in order to discern changes in fish species richness.

Table 2.2-23. Coordinates of stations surveyed for reef-associated fish species richness and abundance surveyed during additional marine ecology baseline assessment in the coastal impact area of the proposed 3 x 135 MW Misamis Power Expansion Project in Villanueva, Misamis Oriental;

WP Code	LATITUDE	LONGITUDE	Remarks
FVC1	N 16.092030°	E 120.106820°	Same location as LIT1 with a depth range of 2-5m. Recorded 74 individuals within a 500m2 transect area with 12 species distributed in 9 family taxa. Most abundant were *Neoglyphidodon melas* with 17 individuals.
FVC2	N 16.090940°	E 120.107350°	Same location as LIT1 with a depth range of 2-5m. Recorded 28 individuals within a 500m2 transect area with 6 species distributed in 5 family taxa. Most abundant were *Neoglyphidodon melas* with 13 individuals.

Seagrasses and Associated Macrobenthic Algae

Previous studies in Macajalr Bay indicate that sparse seagrass beds were found in the area of Bgy. Looc. In both the 2013 and 2015 surveys, no seagrass beds were found in front of the project site. The area of the proposed new intake pipe is also free of seagrass resources. In the site where the new pitfall pipe will be located, it is improbable that seagrass will grow in an area constantly exposed to freshwater currents from the Tagoloan River.

Mangroves

The only mangrove resources catalogued in the 2013 and 2015 assessment was a small patch of mangrove-associate *Nipa fruticans* (Nipa) in the estuary of the Tagoloan River (**Plate 2.2-10**). In this regard, no surveys for true mangroes were undertaken.

Plate 2.2-10. Nipa fruticans in the estuary of the Tagoloan River are the only mangrove – associated trees found in the impact area f the proposed 3 x 135 MW Misamis Power Expansion Project in Villanueva, Misamis Oriental

Macro-invertebrates of commercial significance

The gathering of macro-invertebrates, most often involving lucrative bivalves is sporadically practiced by community members in the estuary of the Tagoloan River. A fresh rapid assessment was conducted in the same area to compare species diversity against the 2013 baseline assessment. Identification of gastropods and bivalves were referenced through FAO's Species Identification Guide for Fisheries Purposes; Volume 1: Seaweeds, Corals, Bivalves, and Gastropods (Carpenter, K. E and V. H. Niem, eds., 1998).

Plankton and Benthos

Plankton community and macrobenthos investigation were conducted in conjunction with freshwater ecology survey.

Composition, abundance and density of phytoplankton communities was determined using standard methodologies, including plankton net surveys, Shannon-Weaver Diversity/Evenness Indices and bio-assessment metrics. Plankton sampling was conducted in three (3) stations (**Figure 2.2-69**) where water samples for quantitative and qualitative analysis were collected by vertical towing employing a 20 µm Plankton net. Morphological characteristics were used as the basis for the identification of the different plankton species. After fixing the samples with Lugol's solution (10mL:1L), the samples were transported to the UP MSI laboratory for counting and identification, where 1 ml aliquot samples were taken for plankton identification and enumeration under a Zeiss Axioskop II Microscope. Identification of the phytoplankton organisms using the taxonomic guide of Tomas (1997) were done up to species level whenever possible. Nannoplankton and piccoplankton were not included in the phytoplankton identification. Cell counts up to 200 cells were made using a Sedgewick Rafter counter chamber. Diversity (H') and evenness (J') index was computed according to Shannon-Weaver (1963) and Pielou (1966) considering only the identified organisms at genus and species level. Counting and identification of organisms was conducted using a Sedgwick-Rafter plate. For zooplankton, a dissecting microscope was used. Phytoplankton were counted and identified to the lowest taxonomic level (genera) possible while zooplankton were identified to major groups using available references. Phytoplankton and zooplankton densities are presented as number of cells or organisms per liter. The coordinates of the plankton sampling stations is presented in Table 2.2-28.

Table 2.2-24. Sampling stations for plankton community diversity during the freshwater ecology survey in Tagoloan River, Tagoloan, Misamis Oriental; 29-30 October 2018.

WP Code	LATITUDE	LONGITUDE	Remarks
PLK1	N 08.536329°	E 124.781817°	Upstream position along Tagoloan River in Barangay Mojon about 2.2 km south of the proposed steel mill site.
PLK2	N 08.540616°	E 124.764156°	Midstream position along Tagoloan River in Barangay Sta Cruz almost 3 km southwest of the proposed project site.
PLK3	N 08.557807°	E 124.743384°	Located in the 330-meter wide estuary of Tagoloan River bordered by Barangay Sto. Niño in Tagoloan and Barangay Balacanas in Villanueva.

Figure 2.2-69. Location of survey stations for plankton community and macrobenthos diversity surveyed during freshwater marine ecology/aquatic biota assessment in the proposed 3 x 135 MW coral fired Misamis Power Plant expansion Project in Villanueva, Misamis Oriental.

(Map prepared by Jose Rene Villegas, March 2020).

Coastal Fisheries

Key informant interviews amongst fishers encountered during the survey were undertaken to reinforce previous data generated in the 2013 baseline assessment

2.2.5.1 Threats to existence and/or loss of important species and habitats

Coral reefs and associated demersal fisheries

At the present time, the most plausible threats to few remaining coral colonies are sediment and silt blanketing and the sporadic occurrence of irresponsible fishing practices and anchor dropping in the reef flat. The only potential threats that can emanate from the Project are untreated thermal plumes and intensive sediment intrusion.

Accelerated and excessive erosion which will be exacerbated by earth moving activities during the project's construction phase can lead to coral polyp suffocation if silt and sediment streams reach coastal waters as a result of poor containment measures. The loss of coral reef habitats, however, can be conclusive only over wholesale, long exposures to such turbid conditions. If erosion from point sources will not be controlled effectively, the effect will be progressive siltation and impairment of coastal water integrity and invasion of reef and seagrass habitats. Silt streams suspended in the water column can also lead to a decrease in photosynthetic function and the impaired primary production can have far reaching impacts on fisheries reproductive morphology, decreased reproductive output, shortened larval duration and subsequently, low larval recruitment and survival.

2.2.5.1.1 Abundance/densities/distribution of ecologically and economically important species

A. *Results of broad area coral profiling through manta tows*

Discounting the coral patch in the vicinity of the Looc Fish Sanctuary which is more than 2 km away, the total reef patch in front of the Project's coastline originally extended throughout the length of the project site's coastline which is estimated to occupy a stretch of +/- 500 meters. Due to siltation and sediment intrusion, which are due from other sources and not from the FDCMP project, however, sustained coral mortality and sediment blanketing have led to the loss of many of the reefs in the extreme northern/nortwestern and southern portions of the reef. At present, only the middle portion (nothwest of the coastline) of the original coral reef is actually populated with a dense live coral cover. Minus the sediment and silt-laden sections that are now mostly occupied by dead corals and dead corals with algae, the fringing coral reef in front (middle section) of the project site begins to appear about 50 meters from the mean tidal mark in the shoreline and its configuration is an irregular shape resembling a tadpole, with the narrow tail end in the southwest where the Tagoloan River can be found. The widest portion in the general vicinity of coordinates 124^0 44" 32.6"E, 08^0 33' 56.4" N extends to a breadth of about 338 meters seaward towards the slope. The narrowest portion is found southwest of this point and measures only about 50 to 60 meters in breadth. The length of the reef – minus the degraded, silt-laden sections is 227 meters occupying an area of about 3 hectares more or less, in 10 to 28 feet of water. These corals are approximately 200 meters northeast of the proposed intake pipe location. Within this distance, surveys in 2020 revealed that the seabed is dominated by sediment laden rocks and dead corals. The densest live corals (64% LHC) are found in the extreme northern portion of the reef about 300 meters from the project's coastline and which was subjected again to detailed coral assessment using the LIT method in 2015. In the manta tows, this patch of reef is represented in tow numbers 25 to 26.

Observations in thirty-one manta tow pathways originally surveyed in the 2013 baseline assessment revealed that patches of coral reefs are found in only 12 of the 31 stations surveyed while the rest are completely comprised of sand and silt substrates. In areas with corals, these are distributed consistently in stations 1 to 3 and 24 to 31. These main coral colonies are located in the extreme northern section of a reef flat and slope running about 227 meters about 1.5 km from the northern boundary of the project site. In 2013, the average live hard coral cover catalogued across twelve (12) survey stations where corals were seen is 30.8%. Across all 31 stations, however, live coral cover along 5 kilometers of shelf area in front of the original project site is only 12% LHC. In the 2013 survey, very minimal and vividly stressed corals due to silt blanketing were found in the area where the jetty was to be built and few live corals were seen in the area of the original intake pipe. In front of the project site the manta tow surveys also revealed few and isolated occurrences of stressed Millepora fire corals due to silt intrusion and suffocation. The manta tows revealed the highest live hard coral cover (LHC) is found in station 1 and 3 with 70%, 10% and 20% LHC, respectively. These corals are located in the vicinity of the Looc MPA which is 2 kilometers away (NE) of the power plant project site. Station 13, which registered 60% LHC in a small isolated patch of corals are within the vicinity of the STEAG jetty which is about 1 km away from the power plant project site. In between these, only sand and silt-laden seabed has been documented.

In front of the proposed Misamis Power Plant expansion project site, nine (9) manta tow stations traversed the coastal area from the northeast and going down to the Tagoloan River. Of these, the seabed in five (5) stations (manta tow stations 19 to 23) are dominated completely by mud and silt from the Tagoloan River. Four stations – stations 24 to 27, hosted live corals at 20, 50, 40, 30 percent LHC, respectively. The entire patch is small, less than 300 sqm. A*ll of these corals are still within the boundary of the project area in front of the middle portion but are below the jetty area and do not appear to be extending up to the intake pipe pathway. The highest LHC – recorded in station 25, is about 250 to 300 meters NE of the project's boundary. None of these coral colonies are within the proposed site where the intake will be located. These corals – shown in a map in Figure 2.2-70 (coral map) and 2.2-71 (results of manta tows) are isolated; surrounded by a heavily silted area in the southwest and silted, sand and rocky area in the northeast. The silted seabed preceding the coral patch is the area inside the project site..*

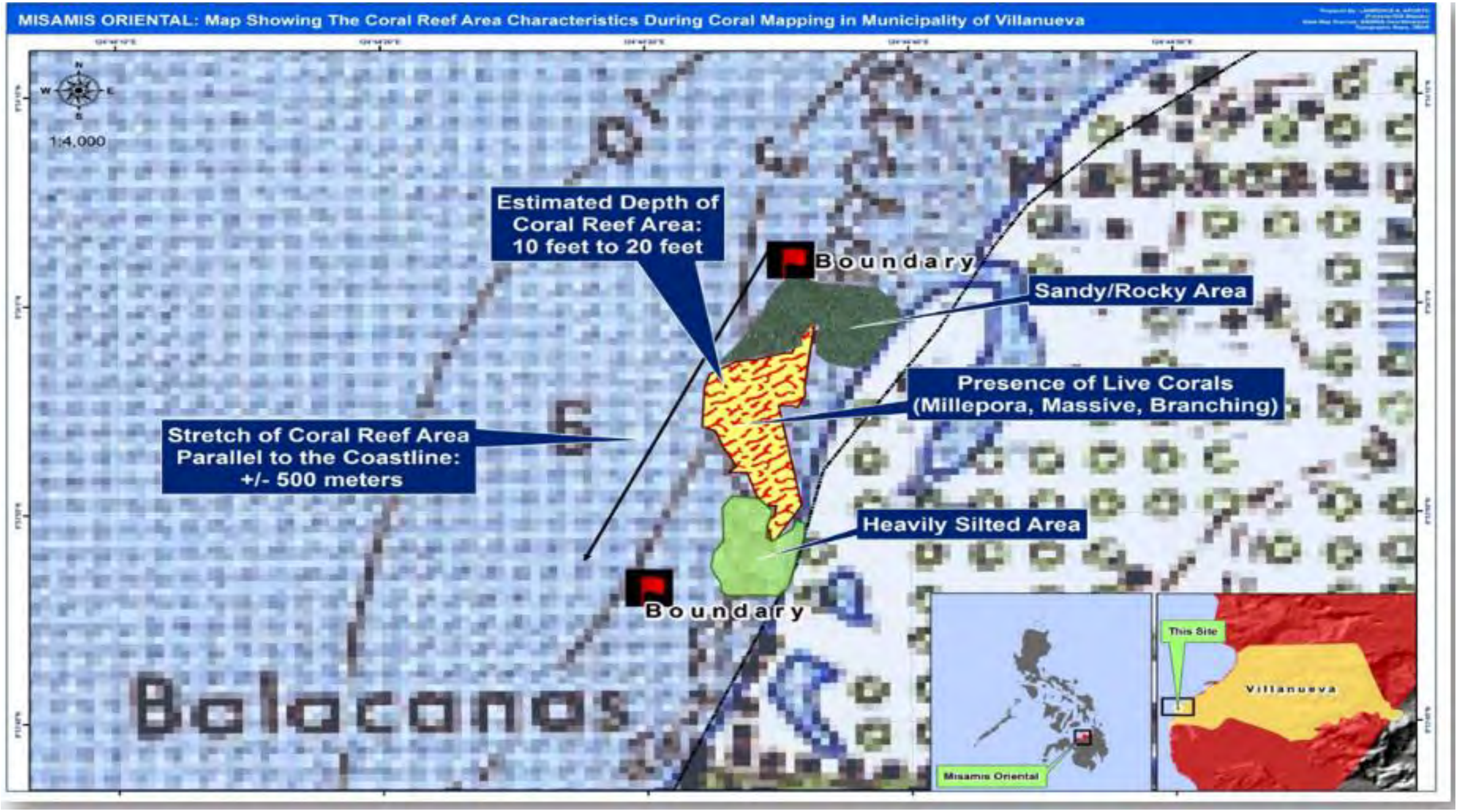


***Figure 2.2-70** Map of coral reef area near the boundary of the Misamis Power Plant project site; the rest of the major coral colonies are found 2 km away, in the vicinity of the Looc Fish Sanctuary.*

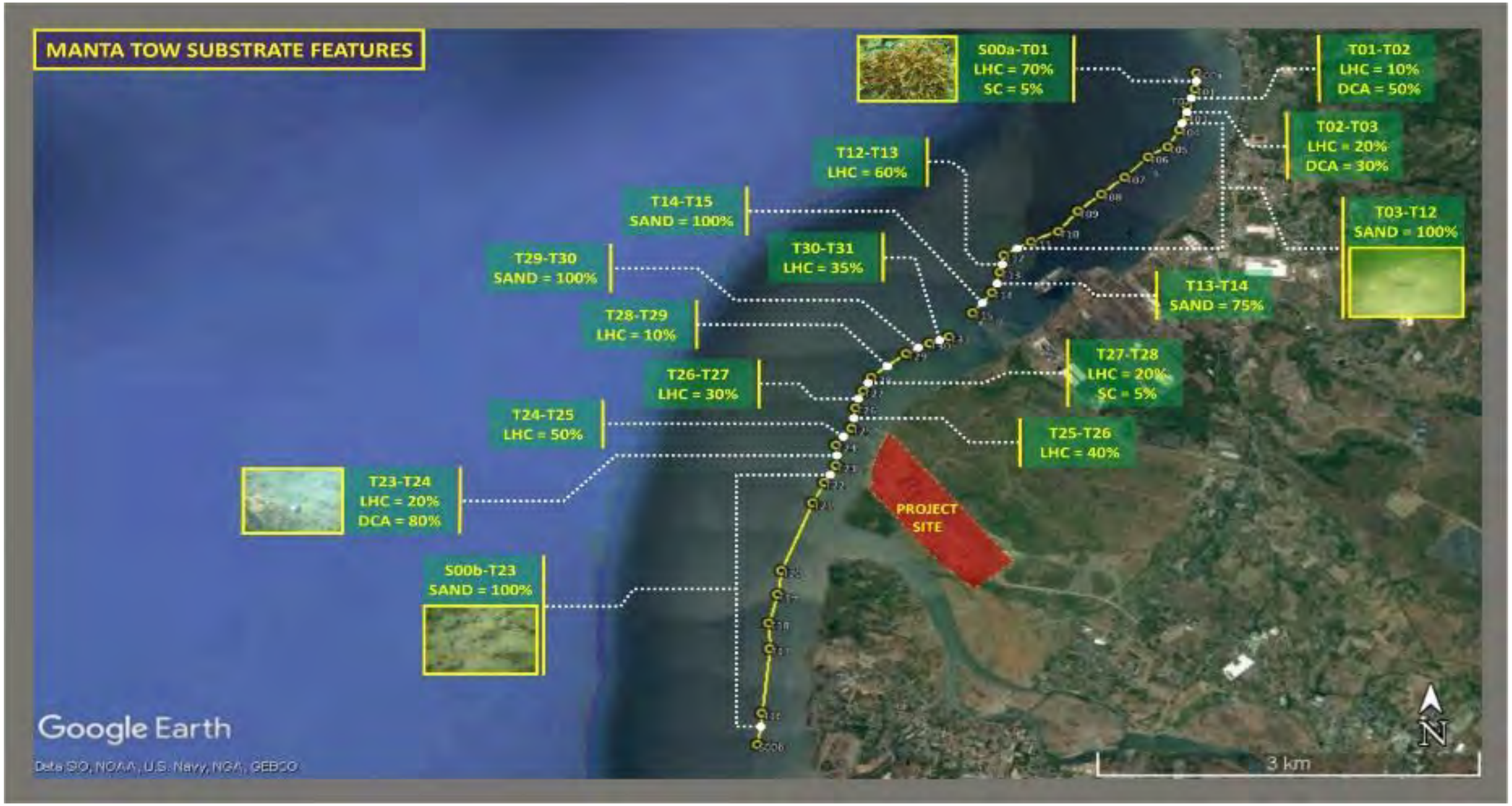


Figure 2.2-71 Results of manta tow surveys for benthic substrate characterization and location of corals and seagrass resources; surveyed during marine ecology baseline assessment in the coastal impact area of the proposed 3 x 135 MW Misamis Power Expansion Project in Villanueva, Misamis Oriental; 2013

Table 2.2-25. Comparison of results of manta tows in 2013 (baseline)and 2015; marine ecology baseline assessment in the coastal impact area of the proposed 3 x 135 MW Misamis Power Plant in Villanueva, Misamis Oriental;

Indicators	2013 baseline	2015 Coral mapping	Remarks
Number of tow observations	31	No manta tows	Survey pathway covered a stretch of 5 km starting in Looc MPA 2 km from project site and ending in Tagoloan River estuary
Number of stations with live coral cover	12	No manta tows	
Overall live coral cover (LHC; in %) across all manta tow stations	12	No manta tows	

Plate 2.2-11. Dead corals covered with sediments with isolated surviving colonies of Millepora fire corals in the vicinity of the proposed Misamis Power Pant intake pipe.

B. *Results of detailed coral assessment through line intercept transects*

The summary results reckoned from the start of the project through current period are hereunder discussed.

The LIT stations were laid out where in areas where relatively denser coral colonies were found to be occurring. The first station was established inside the Looc Fish Sanctuary; the second in the coral reef patch before the STAEG jetty and the 3rd station, located in the NE seas fronting the Misamis Power Corp. project site, was laid out in the middle of the shallow coastal sea where most of the localized corals can be found (Figure 2.2-72). In view of its strategic location, spot dives and systematic snorkeling were conducted around the LIT station in order to further strengthen the description and diversity of the fringing reef. The overall result points to the existence of at least one hectare of coral reef of relatively diverse distribution extending to about 230 meters parallel to the shoreline. The reef is vividly stressed by heavy siltation from the Tagaloan River and while some patches are already suffering from suffocation, coral recruits also occur vigorously, indicating that reef colonies in the area is an active sink area for coral planulae. This particular coral patch appears to be in front of the project site boundary but are not positioned in the intake pipe pathway.

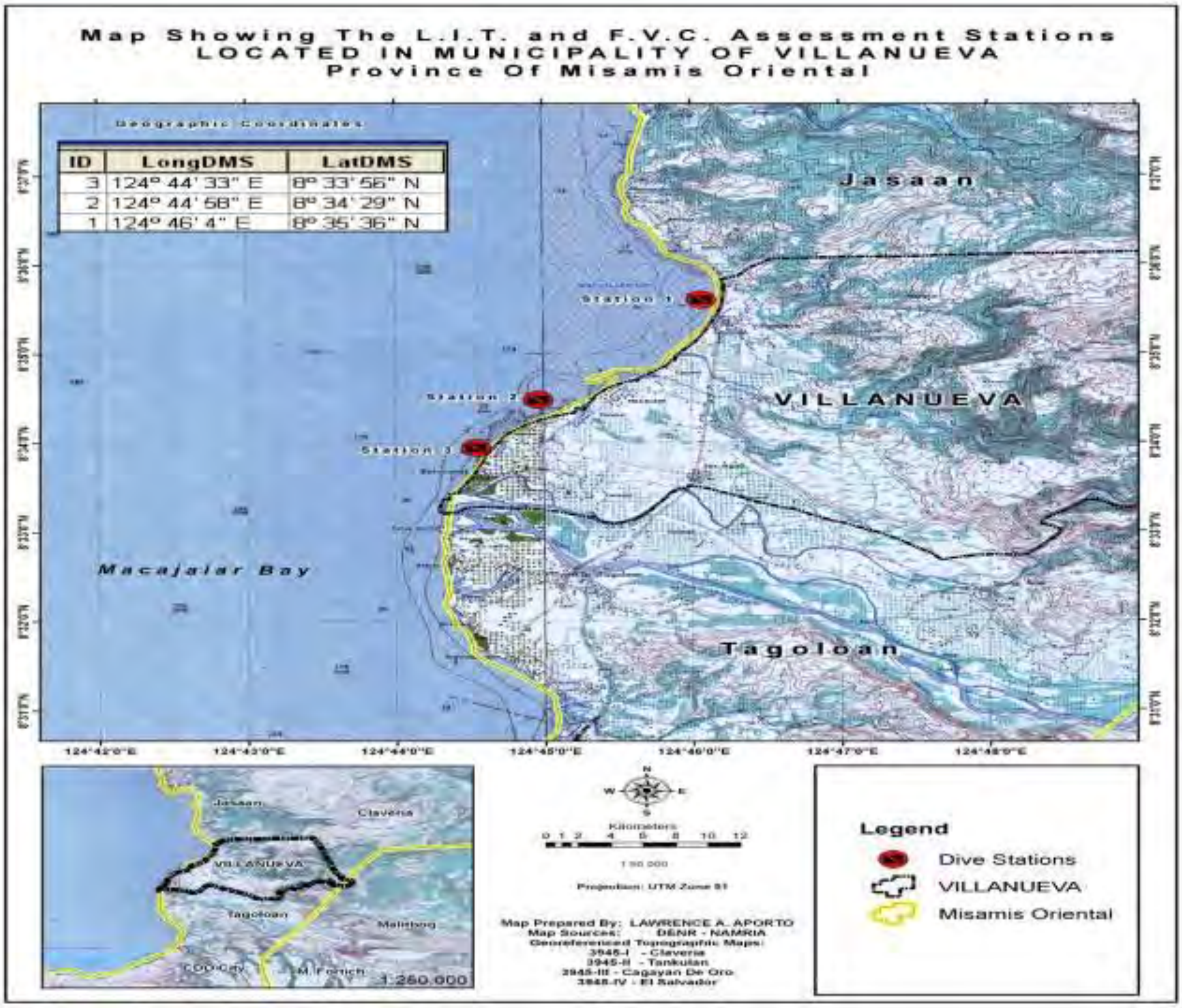


Figure 2.2-72. Location of coral line intercept (LIT) stations in the marine ecology baseline

In the original 2013 baseline assessment, an average of 66 % live coral cover were recorded across the three stations, with the highest live coral cover occurring in the Looc MPA, 2 km away, with 75.6% live *hard* coral cover, followed by Station 3 (outside of NE section project site, 250-300 m away) with 64.5 % coral cover of both hard scleratinian and soft coral species, and Station 2 (STEAG jetty) with 58.4 % coral cover (Table 2.2-30). About twenty-six (26) coral genera were encountered across all three stations, with similar varieties in all stations, except for the fact that tabulate species were few in Station 3. Dead corals were highest in Station 2 while abiotic components were highest in Station 3 (about 23 %) due to its proximity to the Tagaloan River. On the whole, the majority of the coral species are comprised of the massive scleratinian types, accounting for about 18 % of the total distribution, followed by non-acropora branching types at 10%, the fire coral *Millepora* with 9.5 % and the soft corals at 6 % (Table 2.2-26).

In the 2015 study, the result of coral assessments in two new stations beside the 2013 station 3 indicate a remarkably diminishing coral cover as the reef extends southwest and southwards of the main reef patch in Station 3 (2013 survey). Station 1, which is approximately 50 meters from Station 3, yielded a total average cover of 59.6%, dominated by the fire coral *Millepora* (42.2%). The diversity of coral types have greatly diminished going towards the Tagoloan River as only four (4) coral categories were recorded here while abiotic components occupy 40% of the sector, dominated by Dead Corals (DC) at 20.6% of abiotics.

Table 2.2-26. Relative distribution of major lifeforms, in percentage of total, obtained from three transect sites (2013 and 2015) in the impact area of the proposed 3 x 135 MW Coal Power Plant of First Development Corporation Utilities, Incorporated, Villanueva, Misamis Orienta,. (Observers: Victor L. Pantaleon and Ronald T. Pocon).

LIFEFORM CATEGORIES		CODE	Coral distribution per transect *(in %)*		
			1 (2015)	2 (2015)	3 (2013)
		Coordinates	Start (124^0 44" 37.5"E; 08^0 33' 53.3" N); End: (124^0 44" 37.4"E; 08^0 33' 51.7" N)	Start: 124^0 44" 38.0"E; 08^0 33' 50.7" N); End(124^0 44" 38.3"E; 08^0 33' 48.6" N)	124^0 44" 32.6"E, 08^0 33' 56.4" N
Acropora	Digitate	*ACD*			0.90
	Coral Branching	*CB*			6.40
Non-Acropora	Encrusting	*CE*	5.40	6.60	3.80
	Foliose	*CF*	1.40		2.70
	Massive	*CM*	23.20	8.20	11.80
	Millepora	*CME*	3.20	40.20	18.00
	Sub massive	*CS*			3.00
Soft Coral		*SC*	6.00	4.60	17.90
TOTAL LIVE CORAL COVER (LCC)			**39.20**	***59.60***	***64.5***
Sponge		*SP*	0.40		
Dead Coral		*DC*	15.60	20.60	3.50
Dead Coral with Algae		*DCA*		0.40	7.80
Abiotic	*Rubble*	*R*		9.00	5.40
	Sand	*S*	2.60	5.80	2.60
	Silt	*Si*	42.20	4.60	15.40
	Water				.80

Status Category: Poor = 0 - 24.9; Fair = 25 - 49.9%; Good = 50 - 74.9%; Excellent = 75 - 100% (Gomez et al. 1981)

Station 2, which is located at the end of the coral reef in the southern end of the project's boundary and nearer to the Tagoloan River estuary contained only 39% live coral cover and 60% silt, dead corals and sand. In this patch, the massive type of corals are predominant, with *Porites sp* as the most common. A few patches of *Millepora* and soft corals were also present but these were vividly suffocated by silt from the estuary. The survey team anticipates that coral mortality due to suffocation with silt will progress rapidly over time, leading to significant loss of coral cover. In this area, visibility in the water column is much lesser than in station 3.

On the whole, the total coral cover across three stations stretching to about 230 meters parallel to the shoreline is 54.41 percent, with the fire coral dominating the reef at an average of 20.5 % distribution, followed by the massive types at 14.4%, and soft corals at nearly 10%. The domination of these three types of coral life forms is indicative of a highly-stressed environment, in this case caused by siltation and sedimentation. The high degree of abiotics, especially silt, dead corals and coral rubble is anticipated to increase further over time. Across the southern sector of coastal sea fronting the project site, corals are subjected to heavy sediment blanketing. **The prognosis is that unless siltation and sediment intrusion from the Tagoloan River is reduced, the diversity and survival of the coral reef in front of the project site will continue to diminish over time.**

Table 2.2-27. Average percent cover of the different coral life-form categories in front of the proposed 3 x 135 MW Coal Power Plant of First Development Corporation Utilities, Incorporated, Villanueva, Misamis Oriental, March 23, 2014. (Observer: Victor L. Pantaleon and Ronald T. Pocon).

LIFEFORM		CODE	AVERAGE PERCENTAGE COVER
Non-Acropora	Digitate	*ACD*	0.3
	Coral Branching	*CB*	2.13
	Encrusting	*CE*	5.26
	Foliose	*CF*	1.36
	Massive	*CM*	14.40
	Millepora	*CME*	20.46
	Sub-massive	*CS*	1.00
Soft Coral	*Soft corals*	*SC*	9.50
AVERAGE PERCENTAGE LIVE CORAL COVER (LCC)			54.41
Sponge		*SP*	0.20
Dead Coral		*DC*	13.23
Dead Coral with Algae		*DCA*	2.73
Abiotic	*Rubble*	*R*	4.80
	Sand	*S*	3.66
	Silt	*Si*	20.73
	Water	*Wa*	0.26
Total average abiotic components			45.61

(Categories referenced from Gomez,1981)

Figure 2.2-73. Average percent cover of the different coral life-form categories in front of the proposed 3 x 135 MW Coal Power Plant of First Development Corporation

Utilities, Incorporated, Villanueva, Misamis Oriental, by Jose Rene Villegas, March 2020; observers: Victor L. Pantaleon and Ronald T. Pocon).

Plate 2.2-12. Soft and massive corals in the reef patch in front of the Misamis Power Plant expansion project site (left) and fire (Millepora sp) and encrusting corals (Montipora sp) with seasnake (right).

In summary, there are almost no more healthy coral colonies in the southern boundary of the Project and the remaining few patches are vividly in the process of failure.

Past the main 230 meter long reef patch, the seabed becomes murky with a heavy blanket of silt over previously standing corals that can no longer be discerned. In spite of this, patches of *Millepora* continue to sprout, displaying an amazing struggle to survive. However, no other species of corals were found in this southern sector. Towards the shore, the seabed is dotted with rocks that are also heavily covered in silt. Some debris carried by downstream from the river can also be found in the area, such as dead tree trunks. This sector is where the project's intake pipe is proposed to be laid out.

Status of coral transplantation and survival rate of the transpanted corals:

In 2015, FDCMPC entered into a tripartite memorandum of agreement with the Department of Agriculture and Xavier University for a research project on Coral Relocation and Impact Mitigation in Macajalar Bay. With the signing of the MOA, the Bureau of Fisheries and Aquatic Resources issued a Gratuitous Permit to conduct the research.

The BFAR conducted revisited the project and submitted a Final Coral Assessment.

Below discussion on the status of coral transplantation and survival rate of the transplanted corals are excerpt from the study made for FDC MP by BFAR and a submitted report on Final Coral Assessment. Macajalar Bay is one of the busiest and urbanized bays in Mindanao as it is surrounded by the Laguindingan Airport, Mindanao Container Port and the PHIVIDEC Industrial Estate, among others. It is also an outlet of Cagayan de Oro and Tagoloan Rivers and its tributaries. Siltation and sedimentation have been observed brought about mining activities and strong typhoons that hit the region.

Despite these challenges, Macajalar Bay is home of reef building corals. In areas with minimal stress and away from river mouths, corals abound while in highly urbanized areas and areas close to the rivers, the corals are slowly degrading due to sedimentation.

The construction of the FDC Misamis powerplant entailed developing a certain portion of their foreshore area, where a community of corals exist. The corals are in poor condition, with approximately 5% coral cover, due to its proximity to the river.

Due to the position of certain structures of the power plant and the poor condition brought about by the river, some of the coral colonies in the area were recommended to be relocated to different areas to ensure their survival. Relocated corals is expected to become a good source of transplants for collar restoration projects in nearby reefs. The study can also be used to gather information on the survival and growth rates of relocated coral colonies that can be used in future coral reef management programs for Macajalar Bay.

The main objective of the project is to identify the translocated corals conducted by the Mckeough Marine Center of Xavier University and its status.

Methodology:

An underwater assessment was conduct by surveying the translocated corals in the established areas: (1) Marine Sanctuary in Villanueva, Misamis Oriental, (2) Marine Sanctuary of Agutayan Island, Jasaan, Misamis Oriental and (3) fronting the marine station of the Mckeough Marine Center in Solana, Jasaan, Misamis Oriental.

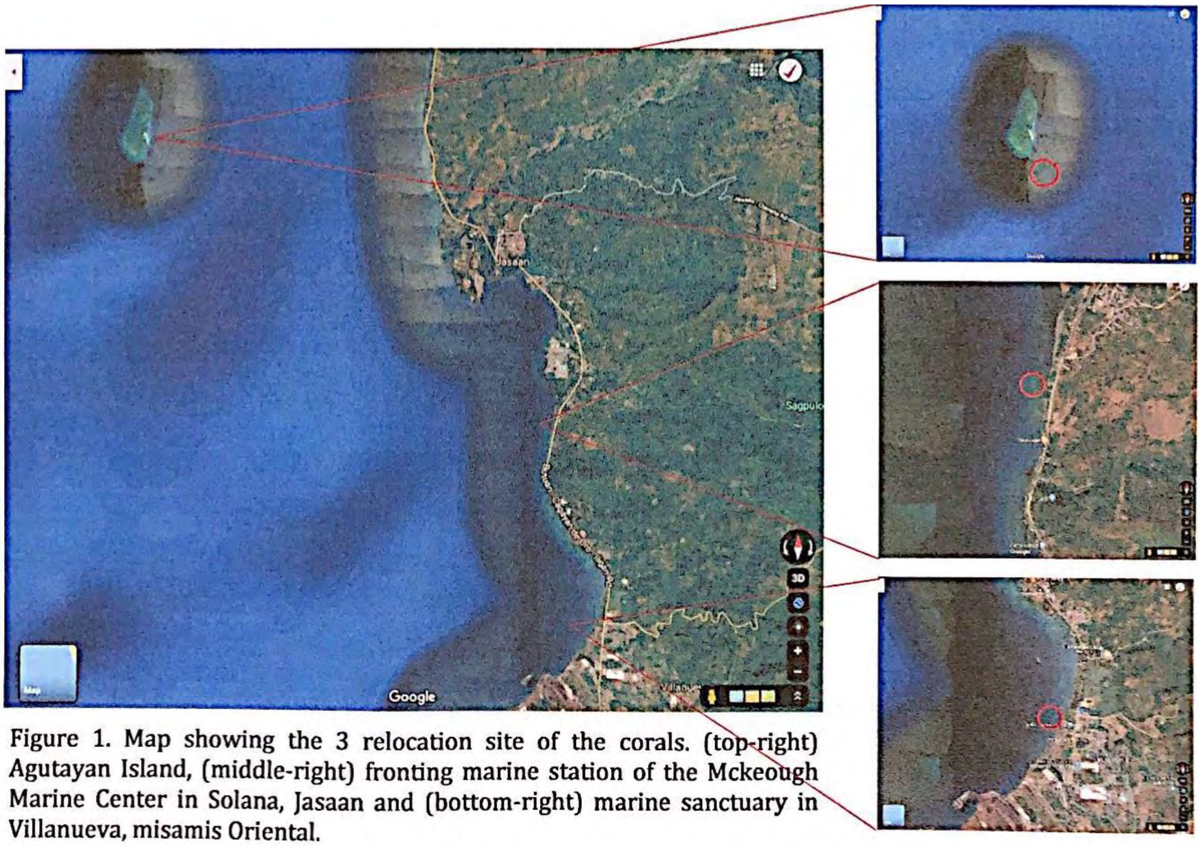


Figure 1. Map showing the 3 relocation site of the corals. (top-right) Agutayan Island, (middle-right) fronting marine station of the Mckeough Marine Center in Solana, Jasaan and (bottom-right) marine sanctuary in Villanueva, misamis Oriental.

Results and Conclusion:

Of the (10) ten artificial substrates constructed and established to the 3 relocation sites with 293 coral colonies, about (4) four were found in front of the Marine Station of Mckeough Marine Center in Solana, Jasaan, Misamis Oriental in poor coral condition. One (1) of which was destroyed leaving no trace of living corals. Heavy siltation was observed.

Figure 2. Established artificial substrate last 2016 (XU-MMC. Coral Relocation for Impact Mitigation in Macajalar Bay, 2017).

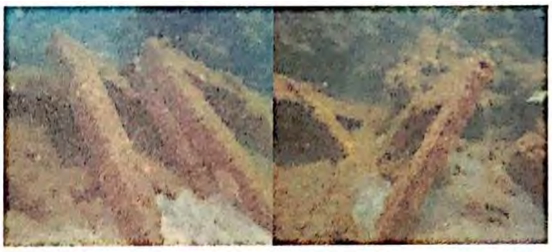


Figure 3. Some of the established artificial substrate at present (2019).

After 3 years from the deployment, the survival rate of relocated corals of the 3 relocation sites were decreased by half. Massive corals still, had the highest survival observed from the other 3 coral lifeforms: branching, foliose and blue coral. High mortality in the area was brough about by siltation due to heavy rain, predation (crown-of-torn seastar, algal overgrowth, sponge overlaying the colonies) and natural threats like big waves caused by storms.

Figure 2. Coral lifeforms observed in the artificial substrate.

The drop in coral cover in the resurvey of the source sites can be explained by the biology and life cycle of scleractinian or reef building corals. Planktonic coral larvae need hard and stable substrate in which to metamorphose into and develop into a coral colony, thus, in particular take longer to accrete and develop as compared to soft corals. Scleractinian corals also need good visibility as they are highly dependent on their zooxanthellae for food production while soft corals are better at filter feeding. This partially explains why there is a high number of soft coral recruits in the area a opposed to hard corals. The source site for relocated corals is still full of rubble and silt and has poor visibility, hence, resulting to fewer recruitment of scleractinian corals.

C. *Results of fish visual census surveys for fish species richness and abundance*

Fish visual census undertaken in the same new LIT stations in 2015 for coral reef assessments encountered a total of 192 individuals belonging to 332 species in 15 taxa. This translates to a very low fish density, estimated at .16 to .20/m^2. Non-target species, principally reef-associated damselfish and wrasses dominated the population of fish in the reef, comprising 53 % of the total abundance. Target fish, in this case the ingress of the lone basslet species *Pseudanthias anthias* comprised another 42 % of the fish encountered. This species is not commonly utilized as food fish. There were only 14 individuals of food fish encountered – 9 surgeonfishes, 2 sweetlips, 2 snappers and 1 threadfin bream; all of which were juvenile sizes. Indicator fish was only represented by the butterfly fish taxa, with only 4 species. The most numerous in the fish population over the reef are the Labrids, with 7 species and the damselfishes, with 5 species. Both species are known to be resilient in coral reefs with poor water quality. The summary of fish species encountered in two new transects in presented in Table 2.2-32 and Figure 2.2-74; fish density is presented in Figure 2.2.-75, and fish abundance by family in Figure 2.2-76.

The fish abundance is very low compared to the number of fish encountered in 2013. In that year, abundance was recorded at 1441 individuals with 64 species in 19 families in three FVC stations (including a station in the Looc MPA). In Transect 3 in February 2013 a total of 967 fish individuals were counted, consisting 22 species in 14 families. These number and diversity of fishes in the same area where the densest coral cover can be found were no longer encountered in systematic snorkeling activities undertaken in 2015. Consequently, biomass values were very low across the two new fish visual assessment stations, at only .1972 Kg for target species, .1080 kg for indicator species, and .4509 for other/non-target species per 500 square meters. Biomass values are presented in Figure 2.2-77.

The decrease in species richness and abundance can be attributed to the progressive decline in benthic habitat quality and increasing turbidity that have restricted primary productivity and subsequently, the availability of food and shelters. In highly turbid waters, juveniles and recruits that otherwise serve as prey seek cleaner seas.

Table 2.2-28. Fish abundance (total counts) and species richness in two FVC transects assessed in front of the FDCUI power plant complex project site, Villanueva, Misamis Oriental (Observer: Rowena R. Quimpo)

FAMILY	*SPECIES NAME/ENGLISH NAME*	*STATION*			*Total*
		T1	*T2*		
Acanthuridae (surgeonfish)					
	Acanthurus nigricans :White cheek surgeonfish▪	*1*			*1*
	Ctenochaetus striatus :Striated surgeonfish▪	*5*			*5*
	Ctenochaetus strigosus :Spotted surgeonfish▪		*3*		*3*
Apogonidae (cardinalfish)					
	Apogon Sp.	*13*			*13*
Aulostomidae (trumpetfishes)					
	Aulostomus chinensis:Chinese trumpetfish	*2*			*2*
Balistidae (triggerfish)					
	Balistapus undulates:Orange-lined triggerfish	*3*			*3*
	Odonus niger:Queen triggerfish/Red-toothed triggerfish	*1*			*1*
Chaetodontidae (butterflyfish)					
	Chaetodon kleinii:Sunburst butterflyfish		*3*		*3*
	Chaetodon rafflessi:Latticed butterflyfish	*1*			*1*
	Chaetodon vagabundus:Vagabond butterflyfish	*1*	*1*		*2*
	Chaetodon auriga:		*2*		*2*
Fistulariidae (flutemouths)					

FAMILY	*SPECIES NAME/ENGLISH NAME*	*STATION*			*Total*
		T1	*T2*		
	Fistularia petimba:	*2*			*2*
Haemulidae (sweetlips)					
	Plectorhincus chaetodonoides:Harlequin sweetlips▪		*2*		*2*
Labridae (wrasses)					
	Cheilinus fasciatus:Redbreast wrasse▪	*3*			*3*
	Hemigymnus melapterus:Blackeye thicklip▪	*1*	*1*		*2*
	Hemigymnus fasciatus: ▪		*2*		*2*
	Thalassoma Hardwicke:Sixbar wrasse	*3*			*3*
	Thalassoma lunare :Moon wrasse	*6*	*3*		*9*
	Halichoeres sp.: ▪	*16*			*16*
	Labroides dimidiatus:Bluestreak cleaner wrasse	*5*	*3*		*8*
Lutjanidae (snappers)					
	Lutjanus decussatus:Checkered snapper▪	*1*			*1*
Mullidae (goatfish)					
	Parupeneus barberinoides:Bicolor goatfish▪	*15*			*15*
Nemipteridae (threadfin breams)					
	Scolopsis bilineatus:Two-lined monocle bream▪	*2*			*2*
Pomacentridae (damselfish)					
	Amphiprion clarkii:Yellowtail clownfish	*2*			*2*
	Chromis caudalis:Blue-axil chromis	*5*			*5*
	Chromis ternatensis:Scissor-tailed chromis	*10*			*10*
	Neoglyphidodon melas :Botie damsel	*3*			*3*
	Pomacentrus amboinensis:Ambon damsel		*17*		*17*
Scaridae (parrotfish)					
	Scarus ghobban:Bluebarred parrotfish▪	*18*			*18*
Serranidae (basses and groupers)					
	Pseudanthias anthias:	*35*			*35*
Tetraodontidae (pufferfish)					
	Canthigaster valentine:Valentine's sharpnose puffer	*1*			*1*
		155	37		192
Density					
Total number of fish individuals					**192**
Total number of fish families					15
Total number of species					**31**
Total number of target species▪					82
Total number of indicators					8
Total number of other species					102

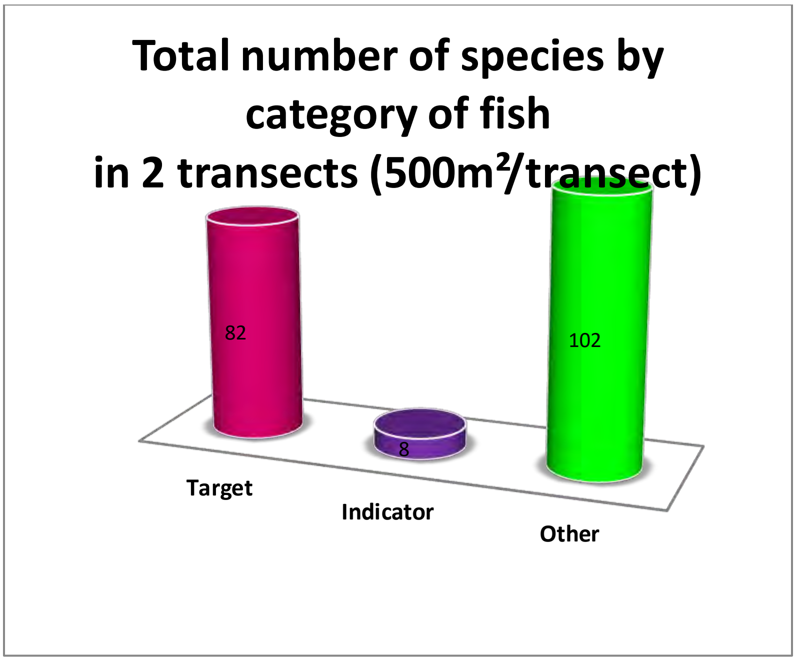


Figure 2.2-74 Fish density and distribution by category from two fish visual census transects surveyed in front of the FDCUI power plant project site in Villanueva, Misamis Oriental

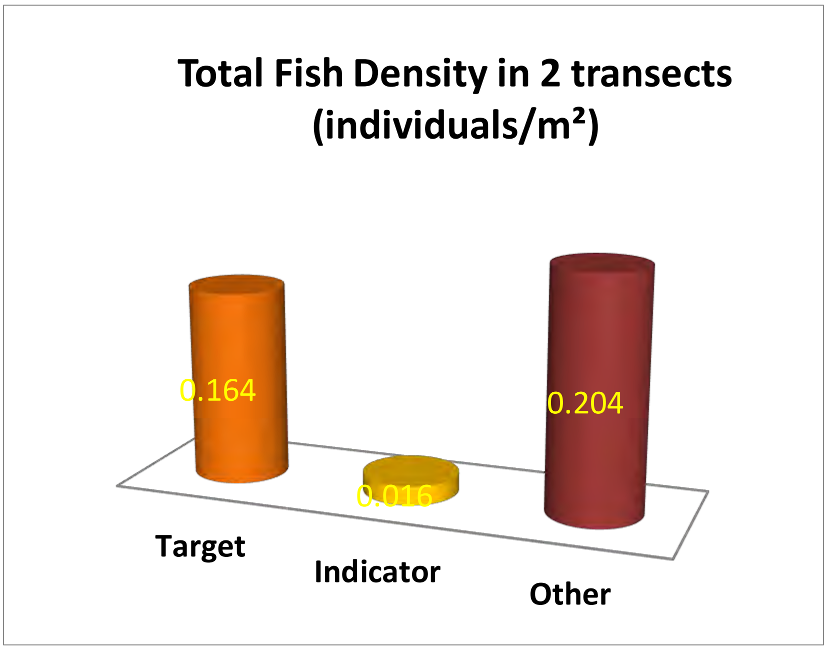


Figure 2.2-75. Comparative fish abundance by fish categories from two FVC transects assessed in 2015 in front of the FDCUI power plant project site, Villanueva, Misamis Oriental

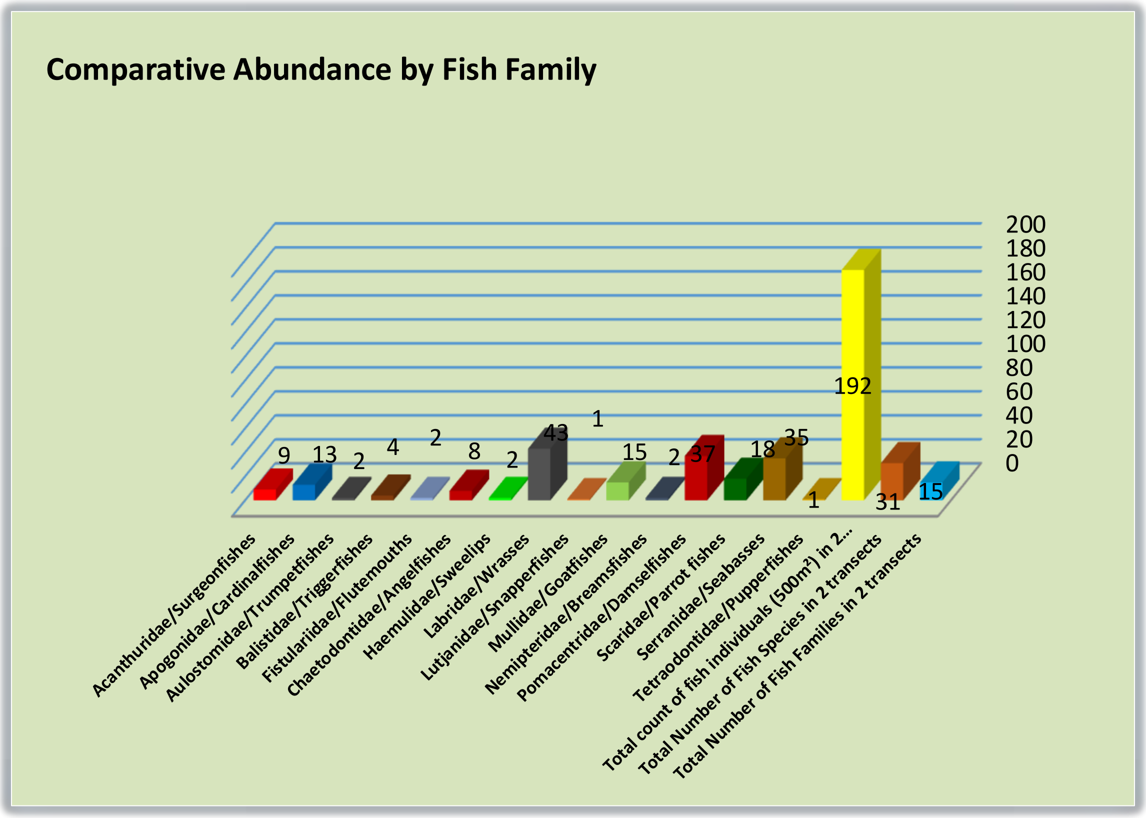


Figure 2.2-76. ***Average fish biomass of fish encountered in 2 FVC transects assessed in March 2014 in front of the FDCUI power plant project site, Villanueva, Misamis Oriental (Observer: Rowena R. Quimpo)***

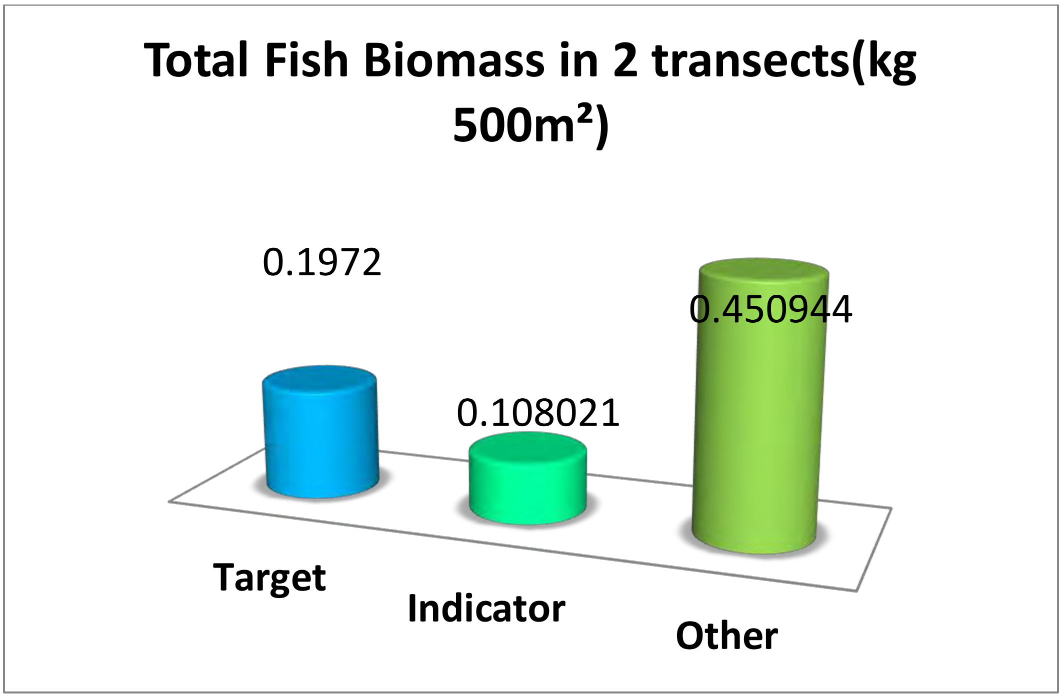


Figure 2.2-77. ***Average fish biomass of fish encountered in 2 FVC transects assessed in front of the FDCUI power plant project site, Villanueva, Misamis Oriental***

D. Municipal Capture Fisheries and Mariculture

The Integrated Coastal Management Plan of Villanueva (undated; but according to the MAO, the plan was formulated in 2011) indicates that there are only 93 fishers in the coastal barangays of Looc and Poblacion 3, majority of which undertake fishing as a part-time livelihood. Slightly over 50% of these fishers operate fishing boats while the rest practice shore-based fishing using cast nets, fish pots and traps. Apart from this, some 41 fishing boats from other municipalities allegedly intrude into the municipal waters of Villanueva to capture small pelagic species. While no figures on fisheries yield estimates were presented in the plan, anecdotal accounts reveal that over the last two decades, destructive fishing practices, largely through the use of dynamite and fine mesh nets, exacerbated by siltation in coastal waters have led to loss of important habitats that nurture demersal fish recruitment. At the present time, key informants alleged that major fishing grounds are situated farther out into Macajalar Bay, with more than one hour of navigation by motorized boat. In deeper waters, the use of fish aggregating devices (FADs-Payao) is being practiced. In principle, FADs attract small fishes into the shelter provided by the FAD and thereafter large pelagic species, such as tuna and jacks, become attracted to the schooling fish. The FAD-aided fishing areas are then fished through hook and line and surrounding nets to capture almost everything within the FAD area. The primary yield consists of Hairtails (Espada) and an assortment of large pelagic species of tuna and tuna-like species (e.g., *Thunnus tonggol*, *Euthynnus affinis, and Katsuwonus pelamis)* dolphinfish (*Coryphaena hipporus)*, spanish mackerel (*Scomberomorus commerson)*, roundscad (*Decapterus macrosoma*) and frigate mackerel (*Auxis thazard)*. For hairtails and its associated by-catch, an average of 20 kg per day is captured.

In nearshore waters, the primary fishing gears employed by small fishers are (i) set gill nets (pukot), hook and line (kawil), beach seine (aka mosquito net; baling) and cast nets. The primary observation is that fisheries is no longer productive in the near-shore areas around the project site compared to ten years ago and few fishers have continued to fish as their principal livelihood. Lucrative demersal species have diminished from the reefs, replaced by juveniles and the capture of small pelagics has become the dominant practice. There are about six (6) fisher households that have settled on the beach along the Tagaloan River estuary and all practice full time fishing with use of cast nets, gill nets and fish pots. Fishers interviewed on the beach fronting the project site claim there are about 36 fishers, many of which are part time fishers residing far from the shoreline, fishing in the coastal waters around the proposed project site but only about four boats were encountered by the survey team in 3 days of observations. Fishers report that an average of 7 kilograms of assorted fish is harvested from gillnetting with only 4 to 6 hours of gear operation (Plate 2.2-13). Even as the catch rates have declined considerably as compared to the yield projections indicated in previous EIA surveys, the present rates declared by the fishers are quite substantial if compared to other heavily-fished areas in say central Visayas. The catch composition of municipal capture fisheries, according to order of yield proportion are as follows:

Table 2.2-29. Catch composition of municipal capture fisheries in Villanueva, Misamis Oriental in order of production importance (top 10; data from key informants and actual fishing operation, 2013 and 2015.)

English name of fish	Local (common) name	Scientific Name
Indian sardines	Tamban	*Sardinella longiceps*
Hairtail	Espada	*Trichiurus lepturus*
Mackerels	Alumahan/Matang baka	*Scomber australasicus* *Selar boops*
Frigate mackerel	Tulingan	*Auxis thazard*
Spanish mackerel	Tanguige	*Scomberomorus commerson*
Lizardfish	Kambabalo	*Saurida micropectoralis*
Eastern little tuna	Tuna/bariles	*Euthynnus affinis*
Rabbitfish	Dangit	*Siganus spp.*
Gray mullet	Banak	*Mugil cephalus*

Moonfish	Chabita	*Mene maculata*
Trevally	Talakitok	*Carangoides ferdau*
Ponyfish	Sap-sap	*Photopectoralis bindus*

Catch composition of small-scale capture fisheries in Villanaueva, Misamis Oriental, in particular, near the Tagoloan River estuary includes freshwater species *Tilapia sp*, *Pasayan, Rabbitfish* and fry and fingerlings of various species caught by the "mosquito net".

Plate 2.2-13. Common species of fish caught in fishing grounds offshore of the Tagoloan River estuary.

Macro-invertebrates of Important Value for food and trade in the Coastal Impact Area of the Proposed Power Plant expansion project.

Opportunistic survey for macro-invertebrates of commercial importance for food or trade was undertaken in the estuary of the Tagoloan River which is the only gleaning area for locals in the vicinity of the power plant project site. The opportunistic survey yielded a total of eight (8) species of shellfish and one crustacean.The shellfish were comprised of three species of gastropods and four bivalves.

Based on "*FAO Species Identification Guide for Fishery Purposes*, only four (4) species encountered were noted to have commercial importance, or are considered edible. Other macro-invertebrates species not covered by the random selection of sampling area stations could still be present as indicated by anecdotal accounts of local fishers. Apart from penaeid shrimps in the estuary, key informants claim that significantly important and lucrative macro-invertebrates will include species of ark shells, pen shells and holothurian sea cucumbers (e.g., the black holothurian *Stichopus chloronotus* - trepang or balatan).

Table 2.2-30. Macro-invertebrates catalogued in the estuary station surveyed in Tagoloan River, Tagoloan, Misamis Oriental

Species Name	Common Name	Habitat	Group
Chana iostoma	Talabang bato/oyster	Sandy-muddy littoral	Bivalve
Nerita costata	Costate nerite	Mangrove flats	Gastropod
Telinna sp	Telin	Sandy substrate	Bivalve
Anadar antiquata	Ark shell/litob	Sandy substrate	Bivalve
Trachycardium orbita	Orbit cockle	Sandy substrate	Bivalve

Species Name	Common Name	Habitat	Group
Littoria scabra	Perwinkle	Mangrove	Gastropod
Tereblralia palustris	Swamp cerith	Muddy substrate	Gastropod
Carcinus sp	common shore crab	Muddy substrate	Crustacean

Plate 2.2-14. Some macro-invertebrates collected in the Tagoloan River estuary; left to rigth: costate nerith, telin and oyster.

Indicators of the degraded macro-invertebrate community in the river and estuary include the extremely low numbers of benthic organisms and low species variety in the stations surveyed. There were no major macro-invertebrates of commercial importance seen in the other two stations upstream. The poor shellfish diversity can be attributed to issues of sediment loading and blanketing, erosion, and river water pollution caused by domestic wastes.

- **Predicted Impacts and Mitigation Measures**

Prognosis of future conditions

Drawing from the current condition of the near-shore coral reefs in Bgy. Balacanas, Villanueva, it is unlikely that live coral cover and associated benthic life forms in areas near the proposed power plant will improve significantly if current silt and sediment plumes from the Tagoloan River affecting the area persist. In this area, ecological structures and biodiversity niches may further deteriorate with continued ecosystem modification, brought about by issues that have exacerbated denudation and run-off in the upper zones of the Tagoloan River watershed. The Looc River north of the project site is also reported as heavily silted. Findings from the past and present surveys denote impaired coral reef habitats in front of the proposed project site, with siltation and sedimentation further imposing stress to the few recruits that were encountered across manta tow and LIT stations. The reduction in live coral cover, ostensibly due to sediment suffocation from the Tagoloan River, is noticeable based on the 2013 baseline assessment, 2015 survey and the current additional assessments. Coral recruits are few which indicate that settlement is not occurring actively, perhaps due to unfavorable seabed condition and the intense growth of macro-algae. Recovery of these principal ecological niches should be the principal aim of environmental impact mitigation measures associated with project establishment and operations, reinforced by a broader local government effort to restore existing resources, notably coral reefs, mangrove forests and seagrass meadows. Even as a significant portion of the coral reef resources present in the surveyed areas consist of impaired colonies, the presence of good coral cover in small patches, especially in the Looc MPA, and some recruits represents an important factor that needs to be sustained to improve coral ecosystem health. These coral areas should be protected from further anthropogenic degradation and stressor pathways, notably the reduction in sediment and silt intrusion.

- **Predicted environment impacts from the power plant extension project**

During Construction Phase

Project activities relating to establishment and operation of the power plant that will have direct potential impacts on the coastal environment are (i) laying of the intake pipe and outfall pipes, (ii) construction of support facilities and structures (e.g., seawalls or groins) on the shoreline itself, (iii) release of thermal water, (iv) increased human settlement and traffic in the land-sea interface, and (v) potential increase in domestic wastes

During construction phase, the main issue is possible sediment streams over corals. The installation of the intake pipe will not pass through any major coral formation.

On the other hand, since the outfall pipe will be installed in a portion of the Tagoloan River near the estuary, no corals or seagrass meadows will be affected. The riverbed in this area is completely covered with sand and mud.

During Operations Phase

- ***Sediment streams***

Additional sediment loading is not expected to occur during project operation phase.

- ***Thermal plumes***

The discharge of thermal water from the power plant that have not been adequately cooled will invariably affect growth of the few remaining coral colonies, macro algae survival and affect fish feeding and reproductive processes. In events of El Niño, thermal plumes can be exacerbated and have extensive negative impacts on the growth, reproduction and general physiology of many marine organisms, with benthic and sessile animals exposed to higher risks. Juvenile fish stocks may definitely move away from the impact area and larger, cryptic species will seek habitats elsewhere. If the condition is persistent, the issue can lead to permanent reduction in fish catch rates. Excessive warming of waters, especially during El Niño events, is also likely to affect the culture of milkfish in the mariculture zone of Sual. If warm waters are incessant, growth of milkfish stocks can be slower.

- ***Wastewater and hyper-nutrient loading that can trigger algal 'blooms'***

The outflow of domestic wastewaters from project facilities if such waste streams are not properly treated and managed can lead to hyper-nutrient loading which in turn can cause algal blooms. In the project area where seawater flushing is weak and water turbidity is already intense, such phenomenon can lead to paralytic shellfish poisoning. Harmful Algal Blooms (HAB) is the term used to describe the "bloom" or rapid multiplication of single-celled marine algae or phytoplankton. In the Philippines, HAB episodes have been occurring for more than two decades and the primary causative organism for PSP is the dinoflagellate *Pyrodinium bahamense* var. *Compressum*. *Pyrodinium* and other biotoxin - forming phytoplankton species produce potent neurotoxins that can be transferred through the food web and negatively affect the marine ecosystem. Episodes of these blooms have been known to disrupt many fisheries and cause health hazards to entire coastal communities especially those dependent on shellfish and small fish species for food.

Similar to HABs is the possibility of "jellyfish swarms" in seawater where surface temperatures have increased abnormally (more than 3 degrees Celsius higher that the ambient seawater temperature which are not dispersed effectively). It should be recalled that in 1999, a huge swarm of jellyfish temporarily clogged the intake pipe of a power plant in the Philippines, forcing the plant to halt down operations until the creatures were cleared. Due to the fact that jellyfish swarms can occur naturally, the possibility of this phenomenon happening in the power plant's intake and outfall pipe areas cannot be discounted. This can specially occur if thermal water plumes become too warm.

- ***Oil and grease contamination***

Further, the risk of oil and grease contamination on nearshore waters can occur if disposal of fuel-based wastes is not undertaken properly, e.g., from the project's day-to-day dispensing of fuel and vehicle oil replacements in motor pools and inadvertent small spills from fuel depot. While the issue is not anticipated to be severe, oil slicks caused by unintentional disposal may remain sequestered in waterways and drainage facilities or carried by rainwater run-off to coastal waters and dispersed in small blotches towards the direction of tidal movement. Areas with inter-tidal corals and macro algae colonies could be considered at greatest risk from direct contamination, leading to immediate coral mortality and algae wilting. The chain reaction can be far-reaching, affecting not only benthic communities but stocks of fish that are dependent on this segment of the marine food chain. Remaining corals in nearby waters can be susceptible to oil and grease contamination, dispersed through current movement. While this issue is not anticipated to be severe, oil slicks can be very detrimental not only to corals and organisms in the benthic environment but can also defile inter-tidal sandy areas and rock pools where communities of macro-invertebrates exists. The detrimental effects can be irreversible. Thus if some of the spilled oil have the potential to enter the water column either as a dissolved fraction or suspended in small aggregations, this pathway must be considered and addressed through early preventive measures because much of the constituent material in oil has a relatively low solubility in water and may even contaminate sandy substratum as well as the coastline and remain persistent for a long time.

- ***Fisheries***

In terms of fisheries production and fisheries resource management, the demand for fishery products, both in fresh and processed form, is likely to increase significantly as a result of increased demand during project operations and lead to enhanced fishing effort. In the light of current efforts to resuscitate viable and stable fish production level and species diversity, intense demand for fish and other seafood may lead to overcapacity in fishing effort over the long term. On the other hand, the operation of the Project is also seen to increase employment opportunities for skilled labor and provide certain fisheries-based livelihood to local fishers. Small-scale aquaculture and fisheries product value-adding can evolve into profitable livelihoods, especially for women in fisheries.

Uncontrolled sediment streams during construction phase can be carried towards the mariculture zone and clog the net walls of floating cages. In very turbid waters, feed consumption of affected fish is reduced and grow-out period can be disrupted.

➢ ***Predicted impacts on benthic macro-invertebrates***

Benthic macro-invertebrates, especially bivalves and gastropods for food or commercial trade have the capacity to resist sediment blanketing up to a threshold where anaerobic conditions start to set in. In most cases, such mobile animals, although slow-moving, can actually relocate to more suitable areas. Communities of bivalves and gastropods in the inter-tidal shelf and seagrass meadows, including ark shells will be most susceptible to physical alteration of the seabed and massive disturbance and reconfiguration of macro-invertebrate habitats can lead to mortality of shellfish stocks. Reproductive and recruitment capacity can be greatly reduced and with persistent exposure to such stressors, entire stocks can be lost irretrievably.

➢ ***Potential impacts of the construction of the access road on mangrove resources***

Due to their natural capacity for accretion of sediments it is unlikely that incursion of sediment and silt – laden seawater into mangrove swamps will have profound impacts on growth, recruitment and overall survival of mangrove trees. Only isolated clumps of mangrove trees are in the vicinity of the proposed access road going to the ash pond inland.

➢ ***Potential impacts arising from climate change scenarios***

Climate change projections of the PAGASA indicate that mean temperatures in all areas in the Philippines are expected to rise by 0.9 °C to 1.1 °C in 2020 and by 1.8 °C to 2.2 °C in 2050, with the largest seasonal temperature increase anticipated to occur during the summer season (PAGASA, 2011). There are few coral colonies in the coastal area of the project site that can be affected by climate-induced seawater surface temperature rise. Even as this is the case, the remaining coral colonies in the project's impact area have low tolerance limits on warm seawater temperatures and may bleach in seawater temperatures that breach an increase of 3 degrees Celsius. Such warming will ultimately lead to the complete eradication of the surviving corals. In times of El Nino episodes, such a possibility can happen if the situation is exacerbated by climate-induced seawater temperature rise and thermal plumes from the project. Grow-out of milkfish and other species cultured in floating cages will be certainly affected by persistent introduction of El Niño-enhanced warm water in the cage environment. Juveniles will have lower survival rates; feeding regimens can be altered as fish feeding will be abnormally affected, and oxygen supply can be lowered. If hyper-nutrient loading in warm waters become intensified – either from domestic wastewaters or from point sources in the project, the risk of oxygen depletion and fish kills over a broad area can be possible.

In the absence of significant coral reefs, one fundamental mitigating measure currently accepted is to ensure that mangrove resources are enhanced with progressive mangrove reforestation and rehabilitation, as mangrove forests are effective carbon sinks.

Mitigation measures

The Project aims to improve and thereafter maintain the integrity and resilience of the components of a healthy coastal ecosystem as these are the main coastal assets that are primarily susceptible to potential anthropogenic issues that can emanate from the Project. The present condition of the coastal environment indicates that the degree of restoration of ecosystem functions will certainly take a long time and efforts to conserve ecological niches where growth, reproduction and recruitment can take place undisturbed, is of early primary consideration.

- ***Protection of corals***

Recruitment and settlement of corals can only be enhanced in benthic environments that are firm, sediment-free and not covered with thick macro-algae. Enhancing the quality of benthic habitats where coral recruits have been observed to be settling will thus be a primary strategy and further disturbance to such patches of reef flats through sediment – prevention measures will be adopted.

- ***Prevention of sediment and silt spills***

The overall mitigation strategy for all phases of the Project's construction and operational phases is to ensure that silt and sediment streams emanating from project activities do not reach coastal waters indiscriminately to further infiltrate habitats that are already stressed at the present condition. A diverse series of sediment mitigation measures and facilities will be established in strategic locations to ensure that silt and sediments will not wantonly pollute waterways or escape to creeks in the project site. This will include installation of environment-friendly silt curtains during pipe laying and screens in project areas where liquid waste and fugitive soil run-off occur, and establishment of settling ponds to contain sediments before they are discharged to the waterways. In heavy construction areas, loose materials shall be stockpiled in areas away from waterways and where erosion control measures can be easily applied. As a precautionary approach, the stabilization of areas where earth moving and construction has occurred will be undertaken in appropriate areas through extensive vegetation cover enrichment and enhancement in order to increase sediment amalgamation capacity and soil compacting. Equally important is for the Project to engage the local government to collaborate in measures designed to protect integrity of the coral reefs and enhance re-colonization of degraded areas in front of the project site.

- ***Mangrove enhancement***

Mangrove reforestation and protection shall be at the forefront of the mining company's environmental impact mitigating strategies as the benefits of mangrove management will be felt over the longer term – and will redound to improvements in fisheries productivity and other non-direct benefits. Re-vegetation and stabilization of disturbed area around the project site will be a continuing program of the company and this is designed to reinforce sediment management and will significantly help to minimize soil erosion and improve natural sediment accretion. Supporting local efforts on mangrove reforestation program will be a major strategy to further ensure natural sediment accretion, especially near the access road and pier. Mangrove rehabilitation projects employing community-based stewardship agreements will be adopted and community participation in mangrove rehabilitation and management will be the principal tool for engaging stewardship and conservation arrangements. Tangible benefits for the community will be enabled, and income generating projects associated with mangrove-aquasilviculture will be supported. Protecting mangrove forests can be supplemented with mariculture–based income generating activities such as provision of mud crab juveniles for culturing in mangrove-based pens, or the culture of sea cucumbers in suitable sites.

- ***Fisheries***

Over a broader respect, the Project likewise needs to consider that improving catch rates from small-scale municipal capture fisheries will be beneficial and should not be affected in any way by potential issues and by possible infusion of thermal waters. This will be primarily undertaken by ensuring that thermal water plumes from the project will be properly and adequately cooled through innovative state-of-the-art water cooling systems and structures along the discharge pipe line. The project's outfall pipe will be positioned in an area where the continental slope can ensure fast dispersion, mixing and dilution. Constant monitoring of seawater temperature, including in areas near the mariculture zone, will be implemented by the power plant company.

Likewise, the Project's environmental monitoring system will thus include periodic coral reef monitoring, fish visual census, and seawater temperature measurements in order to monitor live coral cover or coral mortality and seagrass condition, with the results compared with the baseline data sets.

- ***Wastewater management***

The use of 3-chambered septic tanks shall be adopted in all project facilities where wastewaters and other effluents are generated both during construction and operations phase. Waste minimization will be practiced in all aspects of project operation. The objective is to ensure that pollution-causing effluents that can be potentially carried downstream are treated at the source.

- ***Oil and grease spill control***

Potential risks of small oil spills will be addressed through strict fuel and oil dispersal protocols backed-up by an oil/fuel spill contingency plan. Oil depots will be located a good distance from the coastline.

2.2.5.2.1 Presence of pollution indicator species

Corals – The suffocation of coral polyps is an indication of turbid waters which can emanate from anthropogenic sources. Corals thrive well in clear waters as their symbiotic relationship with a host algae requires that sustained sunlight penetration for food production. Based on observations of DCA values across coral reef assessment stations undertaken in the survey, silt is already affects coral recruitment and has caused mortality of coral colonies which were eventually overcome by algae colonization. The colonization of other dead standing corals in the project site is most likely the result of dynamite fishing practices in the past. The correlation of sediment intrusion and coral suffocation can therefore be a valuable analogy for determining impacts of project-induced silt and sediment pollution in coastal waters.

Bivalves and fish species – Bivalves have been used to determine biotoxin levels that can be harmful to humans if they are consumed indiscriminately. In many areas, this is represented by Red Tide episodes triggered by hyper-nutrient loading in coastal waters.

Fish - Marine fish species have not been used as indicators of pollution, except where biotoxins are involved (e.g. plankton-filtering fish species in PSP-affected areas such as Anchovies). On the contrary, some species of fish have been used as “indicators” of a relatively good coral reef habitat and its ecosystem functions. In the survey stations in the project area, “indicator” species, represented in most areas by species of the butterfly fish *Chaetodontidae and the ‘Moorish Idol’ - were completely absent.*

Environmental Impact Management Plan for Coastal and Fisheries Management
3 x 1350 MW Misamis Coal-Fired Power Plant Expansion Project

Project Activity	Impact Description	Mitigation Measures	Cost	Schedules	Responsible Entity and Mechanisms
Construction Phase	Increase in siltation/sedimentation loading in coastal waters	• Provision of drainage canals with series of silt traps; • Provision of sediment basin or ditch in strategic points inside plant complex; • Scheduling of earthmoving activities during dry season; • Provision of silt curtain where disposal of wastewaters will occur if such areas are near reef flats in the coast; • Mangrove planting in foreshore areas and tidal flats; • Installation of silt curtains in sensitive coral reef areas where coastal construction activities will occur; particularly the reef flats in front of the 'headland'; • Periodic environmental monitoring, i.e., to comparatively determine coral survival before and after construction phase; extent of seagrass meadows and indicators of wilting.	Integral to construction cost	During construction	Project Proponent/Contractor
Operation Phase	Increased freshwater run-off from slope of headland	• Re-vegetation and enrichment planting in slopes, open areas and in areas near creeks or natural drainage.	Operational cost	During operation	Project proponent/Contractor
	Inadvertent spill of domestic wastewaters	• Use of 3-chamber septic tanks in all project facilities; • Construction of wastewater canal to divert fugitive liquid waste streams into a containment and treatment area;	Operational cost	During operation	Project Management

Environmental Impact Management Plan for Coastal and Fisheries Management 3 x 1350 MW Misamis Coal-Fired Power Plant Expansion Project					
Project Activity	**Impact Description**	**Mitigation Measures**	**Cost**	**Schedules**	**Responsible Entity and Mechanisms**
		• Adoption of clean practices by all project operating units and personnel; • Greening of project's compound. • Adoption of the most advanced system for septic tanks waste treatment and filtration.			
	Inadvertent sediment intrusion into coral reefs; Overexploitation/utilization of marine habitats & resources	• Support fisheries management programs to ensure fish stock reproduction and habitat restoration; • Delineation of areas in reef flat where coral recruits occur so that such areas will be subjected to silt curtains, and special management strategies on sediment clear-out and prevention; • Support adoption of income-generating livelihood projects involving women in fisheries and strengthening organized fisher groups; • Support advocacy and IEC for responsible fishing practices; • Support mangrove reforestation and stewardship arrangements • Support to coastal management initiatives of the municipality • Support conduct of training on fisheries law enforcement and monitoring, control and surveillance; • Support LGU initiative to establish a close season/close area where fish spawning aggregates are occurring seasonally as observed in baseline assessment.		Depending on Collaborative arrangements with LGU and BFAR Fisheries and CRM specialists to be engaged by the Project for the development of coastal management plan and CRM training.	Project Management, Provincial Government and institutional partners; MMT; local government, in collaboration with FARMC/Bantay Dagat.

Environmental Impact Management Plan for Coastal and Fisheries Management 3 x 1350 MW Misamis Coal-Fired Power Plant Expansion Project					
Project Activity	**Impact Description**	**Mitigation Measures**	**Cost**	**Schedules**	**Responsible Entity and Mechanisms**
	Untreated thermal plumes	• Ensure adequate thermal water cooling systems and engineering; • Periodic SST monitoring; • Adoption of contingency plan in cases of fugitive warm thermal water dispersal;		Consistent throughout operations	Project Management
	Mariculture	• Periodic water quality monitoring; • Periodic plankton community monitoring; • Adoption of appropriate thermal water management engineering systems and precautionary strategies. • Periodic dialogues with mariculture farm operators.		Monthly monitoring activity	Project Management and MMT
	Jellyfish swarms	• Installation of jellyfish screens and fish exclusion devices in intake pipe; • Monitoring of abrupt jellyfish population increases.		Monitoring and networking of key informants	Project Management

SECTION 2 – ASSESSMENT OF KEY ENVIRONMENTAL IMPACTS

2.3 AIR

2.3.1 Meteorology/Climatology

2.3.1.1 Change in the local micro-climate e.g. local temperature

"**Climate**" refer to weather conditions prevailing in an area over a long period.

The baseline data for climate are reckoned from key parameters such as rainfall, temperature and wind rose diagrams. These are provided in **Table 2.3-2 Climatological Normals, Table 2.3-3 Climatological Extremes and in the Wind rose diagrams Figures 2.3-2 and 2.3-3.**

Elements of climate/micro or local climate

The elements of climate may be gleaned from **Table 2.3.1** and are the following:

- **Rainfall**
- **Temperature**
  - **Wet Bulb**
  - **Dry Bulb**
  - **Dew Point**
- **Vapour Pressure**
- **Relative Humidity**
- **Wind Velocities and Directions**

2.3.1.1.1 Change in/Effects of Project on Microclimate

Local climate (Microclimate) refers to the climatological characteristics in a particular site, i.e. the Project Site.

Rainfall

Rainfall patterns are generally recognized to be the result of global climate change phenomena which (climate change) is generally held to be caused by GHG emissions. Because of the largely insignificant contribution of the Philippines and the Project to global GHG inventory, it may be safely concluded that the Project will not influence the rainfall patterns at the microclimate level.

Temperature

Likewise, the global climate change is being generally accepted as the cause of temperature rises, and thus similarly, the Project will not influence changes in local temperatures.

Large bodies of water, such as the Macajalar Bay, tends to stabilize the temperature at the lands adjacent to the water. Evapotranspiration from trees and vegetation will tend to create a cooling effect on local temperatures. Radiation from the sun has the most significant influence on temperatures, and thus the site location relative to the sun is an influencing factor.

Since the above-cited influencing factors to local temperature will remain unchanged, the Project **by itself** will therefore not exert effects on local temperature.

Wind

Wind is also an influencing factor in temperature due to its cooling effect. Site characteristics that can influence wind patterns are (a) **Topography**. Air velocity is lower near the ground surface because of friction. Topography (or contour) influences the air movement patterns, as evidenced by higher wind velocities at elevated places (b) **Physical obstructions**. Air will tend to flow around objects or obstructions rather than reflecting off these obstructions (c) **Convection**. The temperature and density of the air at specific sites will influence wind velocities and direction (d) **Atmospheric Pressure**. This is illustrated in the case of Low Pressure Areas (LPAs) causing typhoons/storms which in turn affect wind circulation.

The configuration of the project will not in any way affect the factors which influence wind characteristics.

In summary, the Project will not cause changes in microclimate because it will not cause changes in rainfall, temperature and wind patterns.

2.3.1.1.2 Effects/Influence of Microclimate on the Project

On the other hand, significant changes in microclimate may affect the Project particularly in the dispersion in the ambient air of pollutive substances particularly fugitive dust. Such dispersion is predictive in the Air Dispersion Modelling (ADM) undertaken and discussed hereunder.

2.3.1.1.3 Consideration of the PAG-ASA climate change projections for 2020 and 2050

For some understanding although admittedly still limited, of the climate change phenomena, PAGASA has adopted the **"PRECIS"** (Providing Regional Climates for Impacts Studies) system which was developed at the Met Office Hadley Centre to provide a tool for predictions. It is made widely available to developing countries more as an **adaptation tool.**

Referring to **Table 2.3-1** following observations are made:

- Maximum rainfall increase of 2.9 % by SON, 2020 emissions scenario
- Maximum rainfall decrease of -17.8 by MAM, 2050 emissions scenario
- Maximum temperature increase of by 2.4 deg C by JJA, 2050 emissions scenario

Implications of the above projections on the effect **of and by** the Project:

Further evaluation of the thermal effects of the cooling water return to Macajalar Bay in consideration of the predicted 2.4 °C rise, 2050 emission scenario. This re-evaluation will also have to consider that the already unhealthy marine life at the area of the outfall may further deteriorate because of temperature rise.

The drainage plan of the project may need to be re-evaluated unless the engineering design at this time (prior to project implementation) already consider the increased rainfall scenario.

Table 2.3.1 Climate Change Projections for Region 10

Table 2.3-1a: Seasonal temperature increases (in °C) in 2020 and 2050 under medium-range emission scenario in provinces in Region 10

Provinces	OBSERVED BASELINE (1971 - 2000)				CHANGE in 2020 (2006 - 2035)				CHANGE in 2050 (2036 - 2065)			
	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON
Region 10												
BUKIDNON	25.1	26.5	25.8	25.7	1.0	1.2	1.2	1.0	1.9	2.3	2.4	2.1
LANAO DEL NORTE	24.4	25.5	25.4	25.2	1.0	1.1	1.0	1.0	1.9	2.2	2.1	1.9
MISAMIS OCCIDENTAL	25.6	26.7	26.6	26.4	1.0	1.1	1.1	1.0	1.9	2.2	2.2	1.9
MISAMIS ORIENTAL	25.4	26.8	26.9	26.5	1.0	1.1	1.2	1.0	1.9	2.3	2.4	2.0

Table 2.3-1b: Seasonal rainfall change (in %) in 2020 and 2050 under medium-range emission scenario in provinces in Region 10

Provinces	OBSERVED BASELINE (1971 - 2000) mm				CHANGE in 2020 (2006 - 2035)				CHANGE in 2050 (2036 - 2065)			
	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON
Region 10												
BUKIDNON	329.7	335.6	653.8	559.5	2.9	-10.3	-4.4	-0.3	-5.1	-13.0	-9.7	-5.8
LANAO DEL NORTE	337.5	350.3	662.5	621.1	9.6	-0.6	-2.2	6.9	2.5	-1.9	1.4	7.1
MISAMIS OCCIDENTAL	392.1	323.4	633.1	728.3	9.1	1.4	-6.1	6.1	5.2	0.3	-5.1	4.6
MISAMIS ORIENTAL	442.5	296.0	615.7	581.1	4.6	-10.4	-3.7	2.9	1.8	-17.8	-5.2	-0.1

Table 2.3-1c: Frequency of extreme events in 2020 and 2050 under medium-range emission scenario in provinces in Region 10

Provinces	Stations	No. of Days w/ Tmax >35 °C			No. of Dry Days			No. of Days w/ Rainfall > 150mm		
		OBS (1971-2000)	2020	2050	OBS	2020	2050	OBS	2020	2050
BUKIDNON	Malaybalay	26	477	1441.0	6537	3977	4461	4.0	9	9
LANAO DEL NORTE	Dipolog	217	2155	4004.0	7481	5384	5470	3	6	1
MISAMIS ORIENTAL	Cagayan De Oro	383	4539	6180	8251	6413	7060	10	13	9
	Lumbia	106	2012	3759	6495	6290	6580	3	6	1

Note:
- For Western portion of Misamis Occidental, use values of Dipolog City.
- OBS-Observed Baseline

(Source: "Climate Change in the Philippines. February 2011" by PAGASA and others)

Rainfall maybe optionally included in the above tables but may be deleted. Its significance for the project is with respect to (a) possibility of increasing moisture content in the stored coal (b) overeflow of the Tagoloan River which discharges to the portion of Macajalar Bay adjacent to the project site

2.3.1.1.4 Monthly average rainfall and temperature of the area; Climatological normals/extremes; Wind rose diagrams; Frequency of Tropical cyclones

Table 2.3-2 Climatological Normals

NORMAL VALUES

Station Name : LUMBIA AIRPORT, MISAMIS ORIENTAL   Lattitu: 08°24'12" N Elevatio 182.0 m
Period : 1981 - 2010   Longtit : 124°33"18 E

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	
	Rainfall		Temperature									Wind			No. Days w/	
Month	Amount	No. of	Max	Min	Mean	Dry Bulb	Wet Bulb	Dew Pt.	Vapor Pressure	Rel. Hum.	MSLP	DIR	SPD	Cloud Amount	TSTM	LTNG
	(mm)	RD	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(mbs)	%	(MBS)	(16 pt)	(mps)	(okta)		
JAN	98.9	12	29.6	21.6	25.6	25.0	23.0	22.2	26.7	48	1010.7	N	2	5	2	2
FEB	68.0	8	30.2	21.4	25.8	25.2	22.9	22.0	26.3	82	1011.0	N	2	5	2	1
MAR	49.8	6	31.3	21.6	26.5	25.9	23.3	22.3	26.8	80	1010.7	N	2	4	4	2
APR	52.6	5	32.5	22.4	27.5	26.9	23.8	22.6	27.3	77	1009.8	N	2	4	7	4
MAY	125.0	12	32.9	23.2	28.0	27.3	24.3	23.2	28.3	78	1009.2	N	2	5	17	12
JUN	212.7	17	32.0	22.8	27.4	26.5	24.0	23.1	28.1	81	1009.4	S	2	6	18	11
JUL	245.6	18	31.6	22.4	27.0	26.1	23.8	22.9	27.9	83	1009.5	S	2	6	17	10
AUG	195.8	15	32.1	22.5	27.3	26.4	23.8	22.8	27.7	80	1009.4	S	2	6	13	9
SEP	219.7	16	31.8	22.3	27.1	26.1	23.7	22.8	27.6	82	1009.8	S	2	6	17	10
OCT	185.9	16	31.4	22.3	26.9	26.1	23.8	22.9	27.9	83	1009.5	S	2	5	16	13
NOV	136.0	12	30.9	22.1	26.5	25.9	23.7	22.9	27.8	83	1009.3	S	2	5	10	8
DEC	113.2	11	30.1	21.8	26.0	25.5	23.4	22.6	27.3	84	1010.0	N	2	5	5	4
ANNUAL	1703.3	148	31.4	22.2	26.8	26.1	23.6	22.7	27.5	81	1009.9	N	2	5	128	86

Table 2.3-3 Climatological Extremes

Republic of the Philippines
Department of Science and Technology
Philippine Atmospheric, Geophysical and Astronomical Services Administration
Climatology and Agrometeorology Division
CLIMATE AND AGROMET DATA SECTION
PAGASA Science Garden Complex, Agham Road, Diliman Quezon City, Philippines
Telefax: (632)-434-2698

CLIMATOLOGICAL EXTREMES

STATION : LUMBIA AIRPORT, CAGAYAN DE ORO CITY
YEAR : AS OF 2011

	TEMPERATURE (°C)				GREATEST DAILY RAINFALL (MM)		HIGHEST WIND (MPS)			SEA LEVEL PRESSURE (MBS)			
MONTH	**HIGH**	**DATE**	**LOW**	**DATE**	**AMOUNT**	**DATE**	**SPD**	**DIR**	**DATE**	**HIGH**	**DATE**	**LOW**	**DATE**
JAN	35.0	01-26-1988	16.1	01-13-1991	104.4	01-13-2009	12	NE	01-30-1984	1018.1	01-27-1983	982.8	01-21-1989
FEB	36.0	02-14-2009	17.1	02-05-1990	107.8	02-05-1999	14	N	02-20-1993	1017.8	02-28-1981	1001.6	02-24-1980
MAR	37.6	03-28-1998	17.1	03-10-1992	84.2	03-19-1982	13	NNW	03-19-1982	1018.9	03-07-1981	1002.0	03-19-1982
APR	37.0	04-11-1998	18.0	04-13-1983	58.0	04-23-2000	20	NNW	04-29-1983	1017.3	04-14-1993	1002.8	04-01-2000
MAY	38.2	05-07-1998	20.7	05-28-1984	94.3	05-21-1990	18	WNW	05-27-1998	1015.5	05-20-1979	1003.3	05-05-2002
JUNE	38.4	06-06-2009	20.0	06-11-1992	96.0	06-01-1995	18	WNW	06-10-1997	1015.6	06-20-1982	1002.4	06-17-2007
JULY	36.2	07-11-2002	20.0	07-17-1994	142.0	07-31-1999	22	WNW	07-31-1999	1014.8	07-01-1987	1001.0	07-03-2001
AUG	37.8	08-28-1990	19.4	08-26-1995	129.3	08-21-1998	22	WNW	08-05-1999	1015.6	08-11-1997	1002.9	08-17-1990
SEP	36.7	09-02-1992	19.0	09-23-1991	92.8	09-10-1995	24	NNW	09-23-1986	1016.1	09-26-1982	983.8	09-16-1988
OCT	39.0	10-31-1991	19.0	10-31-1982	114.1	10-20-1980	17	WNW	10-24-1988	1017	10-07-1987	1001.4	10-29-1995
NOV	34.7	11-30-2006	18.0	11-25-1992	237.1	11-24-2009	18	NNW	11-11-1990	1016.3	11-17-1982	1000.7	11-06-1996
DEC	34.4	12-08-1996	17.8	12-31-1990	180.9	12-16-2011	14	S	12-21-1986	1016.8	12-27-2001	1002.2	12-16-2011
ANNUAL	39.0	10-31-1991	16.1	01-13-1991	1809.0	12-16-2011	24	NNW	09-23-1996	1018.9	03-07-1981	982.8	01-21-1989
Period of Record	1979 - 2011				1977 - 2011		1979 - 2011			1979-2011			

PREPARED BY: CADS/CAD/PAGASA

The Wind rose diagrams are depicted **in Figure 2.3-1** and **Figure 2.3-2,** the latter showing that wind direction and wind speed blowing predominantly towards the Northern and Southern directions

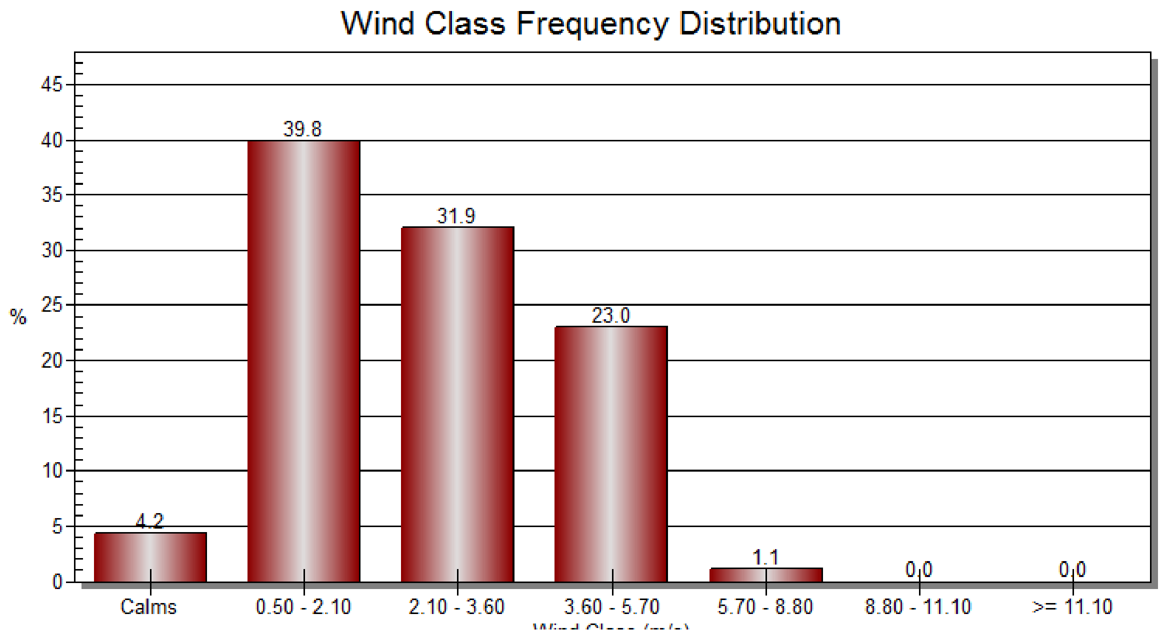


Figure 2.3-1 Wind Direction Frequency Diagram, Lumbia, Cagayan De Oro (WRplot ver. 5.9)

Note to the above diagram:
Windrose diagram generated using WRPlot view Version 5.8 software which utilizes SCRAM (.DAT) files. Wind direction was oriented in "Blowing from" configuration. In **Figure 2.3.2** wind rose diagram shows frequency distribution of wind direction and wind speed blowing predominantly towards the Northern and Southern directions.

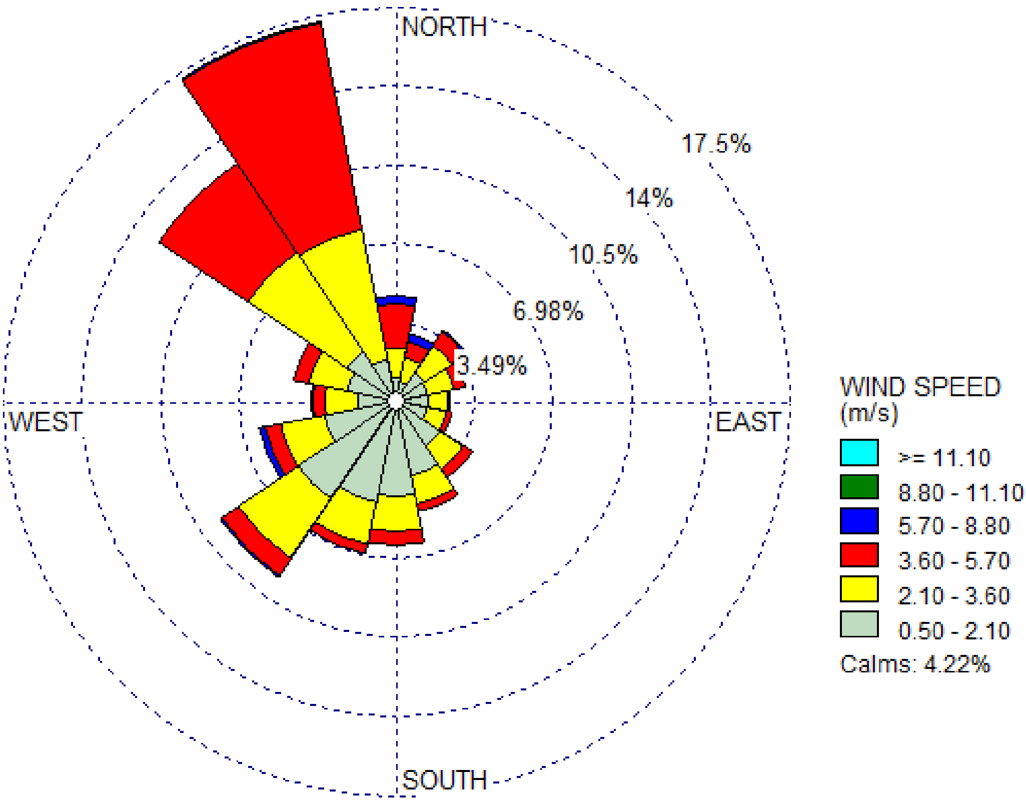


Figure 2.3-2 Wind Rose Diagram, Lumbia, (1951-2007)PAGASA CDO (Station 747)

The monthly wind rose diagrams are shown in **Figures 2.3-3**.

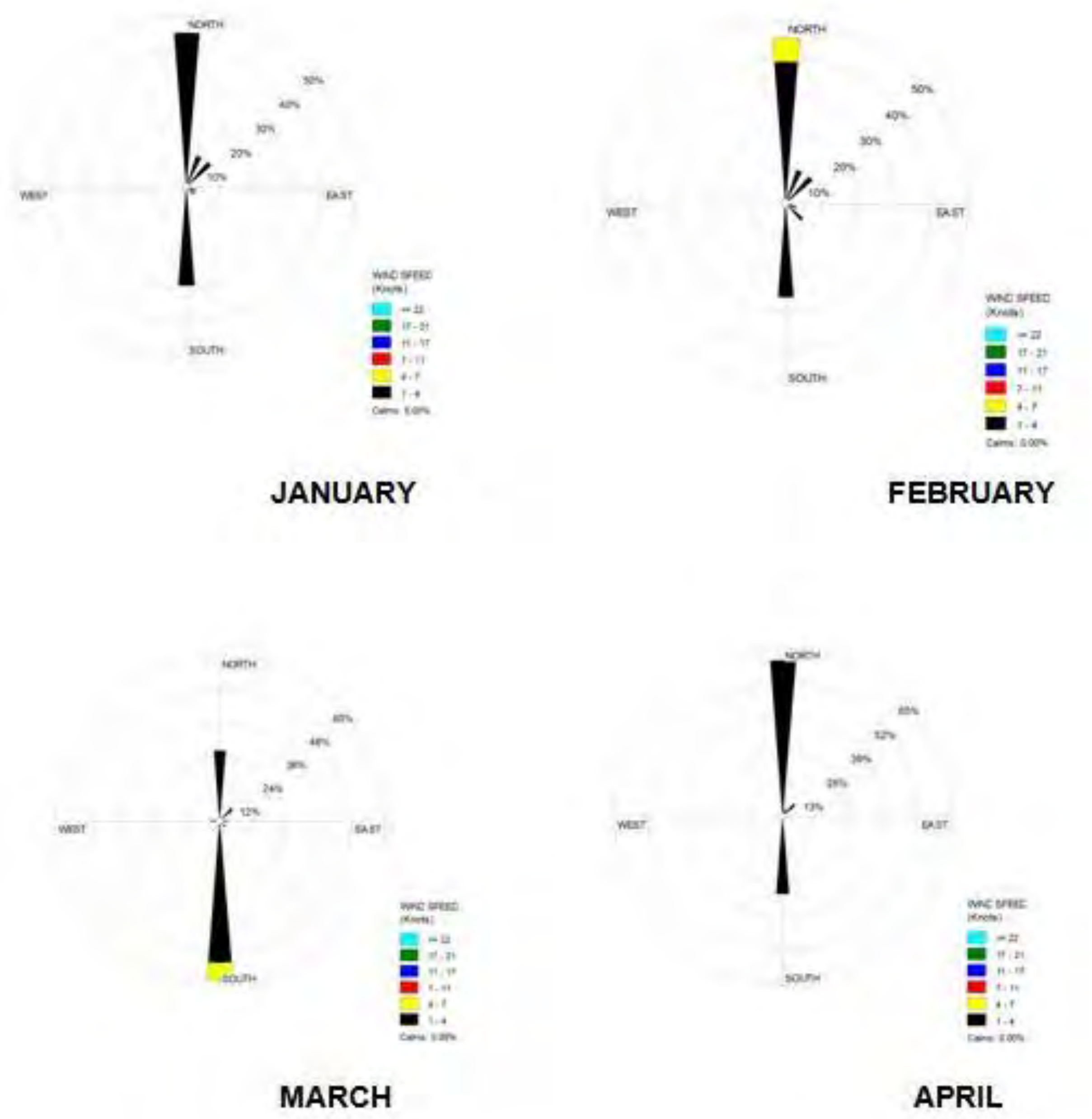


Figure 2.3-3a Monthly Wind Rose Diagram (January to April)

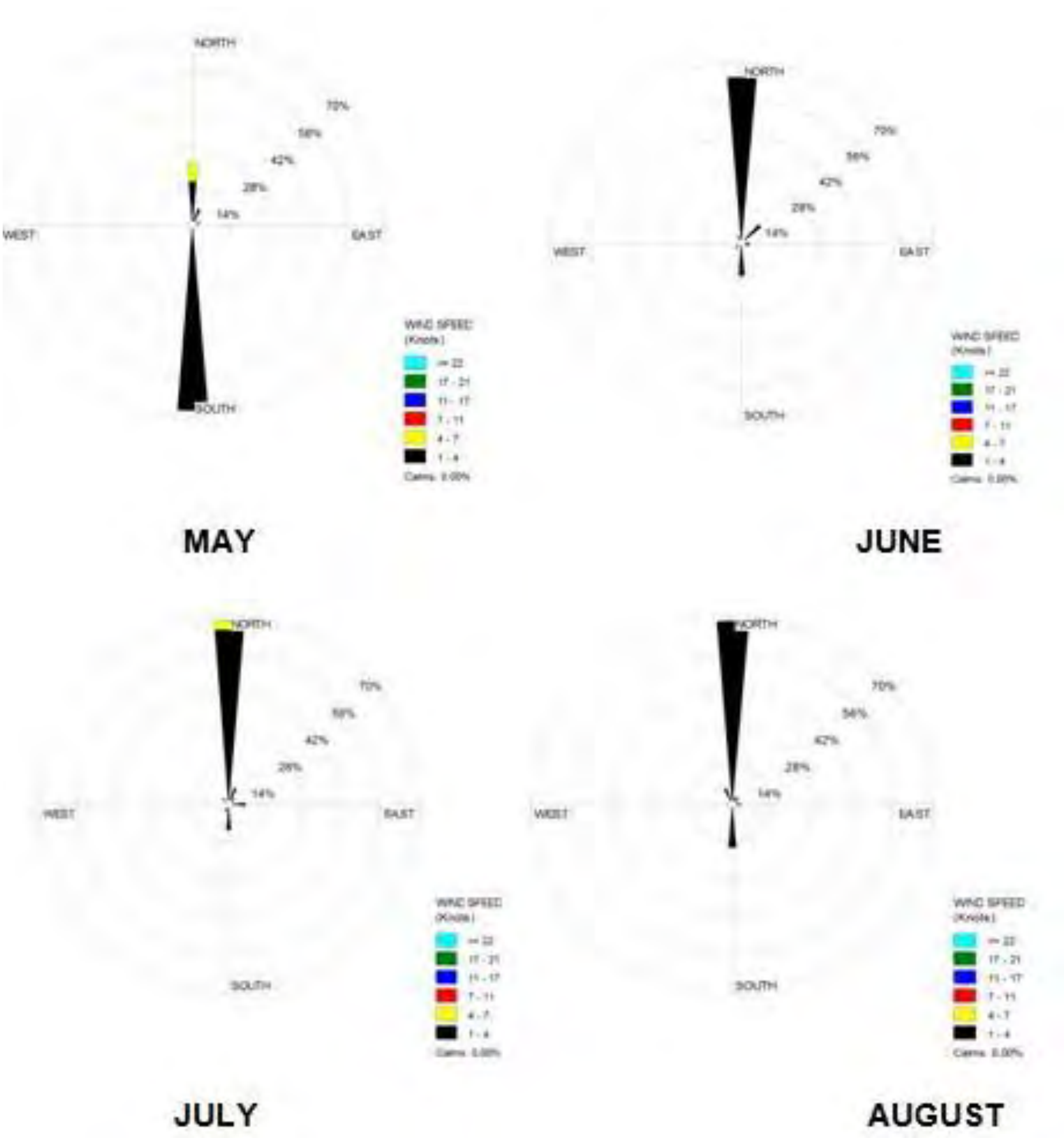


Figure 2.3-3b   Monthly Wind Rose Diagram (May to August)

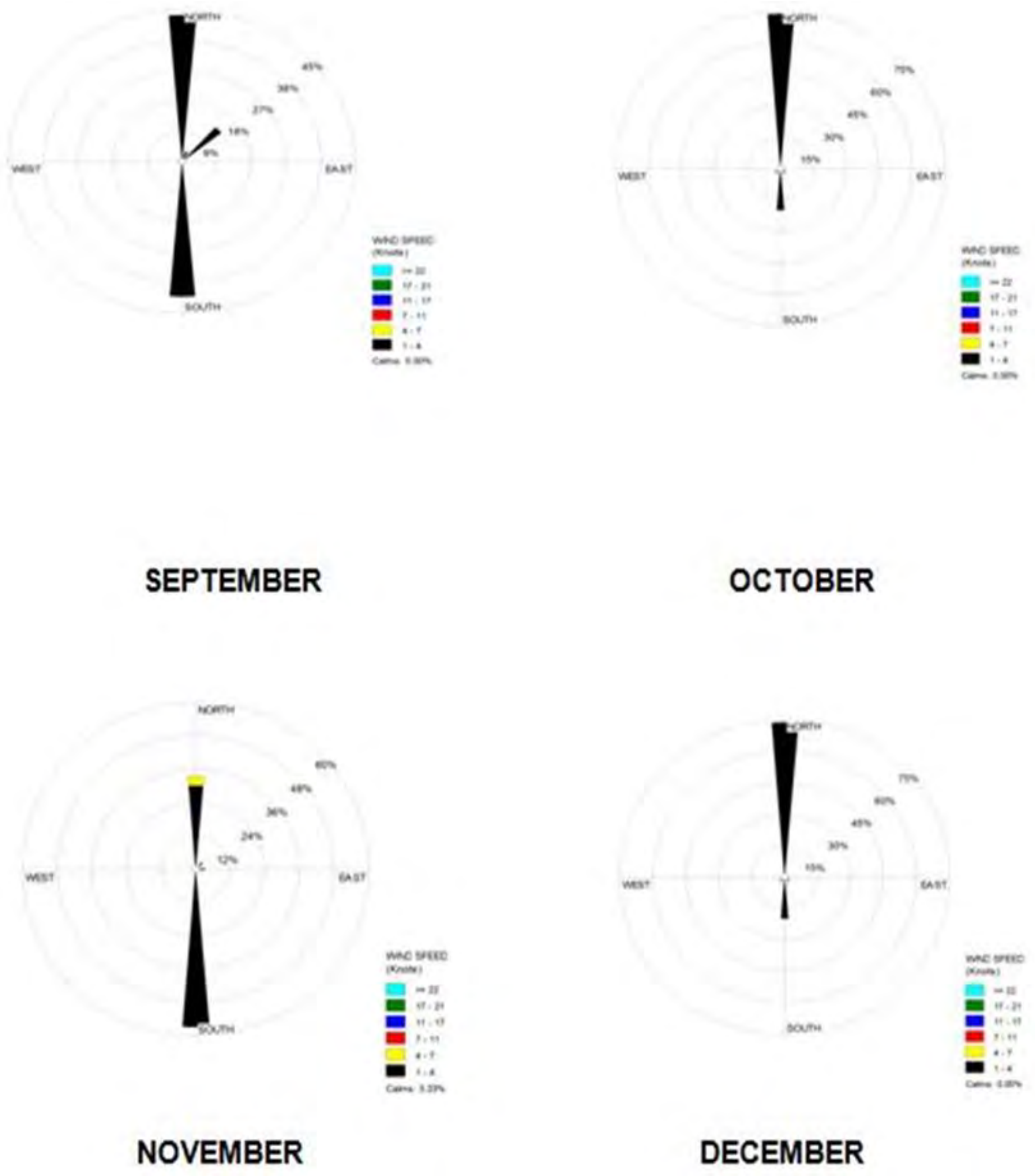


Figure 2.3-3c Monthly Wind Rose Diagram (September to December)

2.3.1.2 Contribution in terms of Greenhouse Gas Emissions (or GHG mitigation potential)

Data on Greenhouse gasses (i.e. carbon dioxide, nitrous oxide); Methane, SOx
Climate change is reckoned from the global context and in terms of greenhouse gases (GHGs). The impacts of the Project are referenced to the Philippine GHG the official data of which remains to be based on the 2nd NFCC and on global inventory records are shown below.

Table 2.3-4 National Greenhouse Gas (GHG) Inventory (2010)

Sector	CO_2, Gg	CH_4,Gg	N_2O, Gg	*CO_2eEmission,Gg
Energy	74,415.58	80.51	2.85	77,278.25
Industrial Processes	11,161.95	0.35	0.06	11,874.41
Agriculture	695.57	1,354.11	28.87	43,152.06
LUCF	(37,007.00)	-	-	(37,007.00)
Waste	14.60	581.07	3.41	15,558.63
Totals	**(32,936.45)**	**1,968.56**	**43.11**	**21,767.41**

Source: *National Integrated Climate Change Database Information and Exchange System*

Table 2.3-5 List of top 20 countries that emitted the most carbon dioxide in 2017

Rank	Country	CO2 emissions (total)
1	China	9.3GT
2	United States	4.8GT
3	India	2.2GT
4	Russian Federation	1.5GT
5	Japan	1.1GT
6	Germany	0.7GT
7	South Korea	0.6GT
8	Islamic Republic of Iran	0.6GT
9	Canada	0.5GT
10	Saudi Arabia	0.5GT
11	Indonesia	0.5GT
12	Mexico	0.4GT
13	Brazil	0.4GT
14	South Africa	0.4GT
15	Australia	0.4GT
16	United Kingdom	0.4GT
17	Turkey	0.4GT
18	Italy	0.3GT
19	Poland	0.3GT
20	France	0.3GT

All emissions from 2017. Fuel combustion only. GT = Metric gigatons

2.3.1.2.1 Assessment Methodology/Approach

Estimate of annual and projected greenhouse gases (GHG) (i.e. carbon dioxide, nitrous oxide) using IPCC guidelines. Methodology and approach as shown below:

Derivation of Fuel Rate (FR) and GHG Emission Rate (ER)

From Engineering ***Efficiency*** Formula:

$$Efficiency = \frac{Output}{Input}$$

Solving/Simplifying for Input:

$$Input = \frac{Output}{Efficiency}$$

Where:

$$Output = \_\_\_ MWxPF$$
$$Input = FRxHHVxSG$$

Simplifying/Substituting formulas:

$$FRxHHVxSG = \frac{\_MWxPF}{Efficiency}$$

Rearranging/Simplifying formulas:

The fuel rate/consumption is:

$$FR = \frac{\_MWxPF}{EfficiencyxHHVxSG}$$

Using the IPCC GHG emission factor, the GHG emission rate is:

$$ER = FRxEF$$

Or from Tier 1 Approach Equation:

$$Emissions_{GHG,fuel} = FuelConsumption_{fuel} xEmissionFactor_{GHG,fuel}$$

Where:

FR = *Fuel Rate*
ER = *GHG Emission Rate*
PF = *Power Factor*
HHV = *High Heating Value*
SG = *Specific Gravity*
EF = *Emission Factor*

Table 1 Specific Gravity

Average Specific Graity of Various Rock Types		
Material	Specific Gravity	Tons / Cubic Yard
Coal – Anthracite	1.3	1.08
Coal – Bituminous	1.1 – 1.4	0.92 – 1.18

Note : "Rock" is the IPCC terminology used for Coal

Table 2 Tier 1 Approach

TIER 1 APPROACH

Applying a Tier 1 emission estimate requires the following for each surce category and fuel:

- Data on the amount of fuel combusted in the source category
- A defaut emission factor

Emission factors come from the default values provided together with associated uncertainty range in Section 2.3.2.1 The following equition is used:

EQUATION 2.1
GREENHOUSE GAS EMISSIONS FROM STATIONARY COMBUSTION

$$Emissions_{GHG,fuel} = Fuel\ Consumption_{fuel} \bullet Emission\ Factor_{GHG,fuel}$$

Where:

$Emissions_{GHG,\ fuel}$ = emissions of a given GHG by type of fuel (kg GHG)
$Fuel\ Consumption_{fuel}$ = amount of fuel combusted (TJ)
$Emission\ Factor_{GHG,\ fuel}$ = default emission factor of a given GHG by type of fuel (kg gas/TJ). For CO_2, it includes the carbon oxidation factor, assumed to be 1.

Table 3 GHG Emission Factors

GHG	COAL EMISSION FACTORS							
	Anthracite		Bituminous Coal		Other Bituminous Coal		Lignite Coal	
	Value	Unit	Value	Unit	Value	Unit	Value	Unit
CARBON DIOXIDE	98,300	kg/TJ	96,100	kg/TJ	94600	kg/TJ	101,000	kg/TJ
METHANE	1	kg/TJ	1	kg/TJ	1	kg/TJ	1	kg/TJ
NITROUS OXIDE	1.5	kg/TJ	1.5	kg/TJ	1.4	kg/TJ	1.5	kg/TJ
	Data Provider => IPCC							

<u>GHG Calculation Process</u>:

Emission Strength were taken using 1,833,030 Tons of Bituminous Coal per year and Operating Hours of (7,884 hour/yr) for the 3 X 135 MW CFB Coal Fired Power Plant.

Therefore:

Data Assumed for 1 x 135MW:

INPUTS		CALCULATED FUEL RATE, FR				
HHV, BTU/LB	9,741.0	tons/year =>	611,010		5400	KCal/kg
ST., C	144	tons/hr =>	70		5400000	Cal/kg
AT., C	28.2	gm/sec =>	19,374.99		9741.0	BTU/lb
Effeciency, %	27.6102	kg/hr =>	69,749.95			
RATED, MW	**135**	kg/sec =>	19.37			
PF, %	90	gm/hr =>	69,749,954			
		(MBTU/yr) =>	13,094,101.93			
INPUT, MW	**489**					
		Fuel Rate =	***19,374.99***	*gm/sec*		
			69,749,954	*gm/hr*		
			69,750	*kg/hr*		
		7,884	hour/yr			

$$FR = \frac{\_MWxPF}{EfficiencyxHHVxSG} = \frac{135x3412.2x8760x90}{27.6102x9741.0x2.21} = 611{,}010\, {}^{tons}\!/\!_{year}$$

Solving for Heat Energy Input in ***MMBtu/Year***, ***Btu/Year***, ***KJ/Year***, ***J/Year*** and ***TJ/Year***:

where:

MMBtu = Million British Thermal Unit
Btu = British Thermal Unit
KJ = KiloJoule
J = Joule
TJ = TeraJoule

$$\frac{MMBtu}{Year} = \frac{611{,}010x9741.0x2.2}{1000} = 13{,}094{,}101.93$$

$$\frac{Btu}{Year} = 13{,}094{,}101.93x10^{6} = 13{,}094{,}101{,}929{,}869.10$$

$$\frac{KJ}{Year} = 13{,}094{,}101{,}929{,}869.10x1.055 = 13{,}814{,}277{,}536{,}011.90$$

$$\frac{J}{Year} = 13{,}814{,}277{,}536{,}011.90x1000 = 13{,}814{,}277{,}536{,}011{,}900.00$$

$$\frac{TJ}{Year} = 13{,}814{,}277{,}536{,}011{,}900.00/10^{12} = 13{,}814.28$$

Therefore:

GHG Calculation (for **1x135 MW**):

$$CO_2 = \frac{13{,}814.28x96{,}100}{1000} = 1{,}327{,}552.07\, {}^{tons}\!/\!_{year} = 1{,}327.5\, {}^{ktons}\!/\!_{year}$$

$$CH_4 = \frac{13{,}814.28x1}{1000} = 13.81 \,{}^{tons}\!/_{year} = 0.01381 \,{}^{ktons}\!/_{year}$$

$$N_2O = \frac{13{,}814.28x1.5}{1000} = 20.72 \,{}^{tons}\!/_{year} = 0.02072 \,{}^{ktons}\!/_{year}$$

Summary Table

Summary in PDF (by Excel Programming) for 6 x 135 MW

GHG CALCULATION FOR 6 x 135 MW

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
HHV, BTU/LB	5400	KCal/kg	*Hours Operation*	7,884	hour/yr	*Fuel Rate*	69,749.95	kg/hr
	5400000	Cal/kg	*PF, %*	90	%		19.37	kg/sec
	9,741.0	BTU/LB	*Fuel Rate*	611,010	tons/year		69,749,954	gm/hr
Effeciency, %	27.6102	%		70	tons/hr	*Equivalent INPUT*	489	MW
RATED, MW	135	MW		19,374.99	gm/sec			

GHG	COAL EMISSION FACTORS							
	Anthracite		Bituminous Coal		Other Bituminous Coal		Lignite Coal	
	Value	Unit	Value	Unit	Value	Unit	Value	Unit
CARBON DIOXIDE	98,300	kg/TJ	96,100	kg/TJ	94600	kg/TJ	101,000	kg/TJ
METHANE	1	kg/TJ	1	kg/TJ	1	kg/TJ	1	kg/TJ
NITROUS OXIDE	1.5	kg/TJ	1.5	kg/TJ	1.4	kg/TJ	1.5	kg/TJ

Data Provider => IPCC

GHG Calculation								
Parameter	135	135	135	135	135	135	Total	
*Fuel Rate, tons/year	611,010	611,010	611,010	611,010	611,010	611,010	3,666,057.6	
Unit	Heat Energy Input							
*MBTU/yr	13,094,102	13,094,102	13,094,102	13,094,102	13,094,102	13,094,102	78,564,612	
TJ/yr	13,814	13,814	13,814	13,814	13,814	13,814	82,886	
Greenhouse Gas Calculation	135	135	135	135	135	135	Total	
CARBON DIOXIDE , tons/yr	1,327,552.07	1,327,552.07	1,327,552.07	1,327,552.07	1,327,552.07	1,327,552.07	7,965,312.43	
METHANE , tons/yr	13.81	13.81	13.81	13.81	13.81	13.81	82.89	
NITROUS OXIDE, tons/yr	20.72	20.72	20.72	20.72	20.72	20.72	124.33	

Note: Per cent Contribution of Project Not Included because of variances in the miscellaneous GHG inventories methodology, especially with respect to the use of or reference to LUFC/LULUCF.

Mitigation and/or sequestration for both construction and operation phases.

2.3.1.2.2 GHG/Carbon Dioxide Emission from the Project

A. During the Construction Phase

While noting the many variables that would effect dust (TSP) emission such as

- Construction methodology, including time (number of hours) of continuous earthworks, etc.
- Site topography (The site is essentially flat in terrain)
- Area for activities – This is small and already developed

- Wind conditions
- Rains
- Use of dust suppression

Estimates are nevertheless made based on engineering and internationally accepted procedures as follows:

Area Source Emission Factor Estimate (Basis: US EPA California. AP-42. Compilation of Emission Factors, Item 13.2.3, "Heavy Construction Operation")

Estimated (conservative) activity (soil works) area to be worked on – 20 hectares/2 years or 10 has/year

EF - 2.69 tons/TSP/Month/Hectare

Annual dust – 322.8 tons/year

The mitigating measures for dust during construction are:

i. Requirement for the prospective civil works contractor to comply with all rules and regulations appertaining to the Philippine Clean Air Act.
ii. Water sprinkling for dusty portion of the site, when necessary such as during windy and dry days
iii. Use of cover, e.g. tarpaulin on transport vehicles
iv. Use of protective equipment for the construction crew, e.g. dust covers, especially during unloading of truck cargos (sand, excavated earth)

B. During the Operations Phase, i.e. simultaneous full operations of 6 x 135 MW Plant

Table 2.3-6 Estimation of GHG from Coal Combustion

FUEL COAL TYPE	COAL CONSUMPTION tons/year	HHV	GHG FACTOR		GHG	TOTAL GHG
		BTU/lb	kg CO_2 / MMBtu	kg CO_2 / TJ	kg CO_2/year	6 x 135 MW
Sub-Bituminous	600,000 tons/yr	9,445 Btu/lb	101.39	96,100.00		
Other Bituminous Coal	600,000 tons/yr	9,445 Btu/b	99.81	94,600.00		

REFERENCE: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2: Energy, Tables 1.4 and 2.2

Using the above table, the following estimations are made

a. For (1 UNIT): 600,000 (tons/year) X 9 445 BTU / Lb X 2210 Lb/Tons X 101.39 kg CO2 /MMBTU X 1MMBTU/1,000,000 BTU = 1,269,815 kg CO2

b. for 6X135MW) : 6 X 1,269,815 kg CO2 = 7 618 gg CO2

Estimations based on stoichiometry

Coal usage per unit/per year (estimate only) = 607,058 tons per year
%Carbon in coal = 46.70%

C + O_2	=	CO_2
C in coal	=	62.3% (adb) 0.4670 x 607,058 =283,496 tons/year
Assuming 99 % complete combustion		
C in combustion gases	=	283,496 x 0.99 = 280,661 tons/year
CO_2 generated	=	280,661 x { 44/12 } = tons/day

For 2 power plants, CO_2 generated per year (330 stream days) = 1,029,090 tons/yr

Total = 3,087,270 tons per year

Contribution of Project to global GHG 33 gigatonnes (Gt) in 2019 (https://www.iea.org/articles/global-co2-emissions-in-2019)

= { **3,087,270**/21,371,218,000} **x 100 = 0.0144 %**

Computation of the 2016-2020 actual GHG emissions based on the CEMS data, generation data and/or coal consumption data is show below.

Table 2.3-7. Summary of Emission for FDC Misamis Plant

Parameter	Unit	2018	2019	2020	Average	Median	Max	Min
Gross Generation	MWh	1,630,901.81	1,980,345.89	1,634,651.66	1,748,633.12	1,634,651.66	1,980,345.89	1,630,901.81
Coal Consumed	tons	855,120.32	1,093,010.09	949,061.54	965,730.65	949,061.54	1,093,010.09	855,120.32
Diesel Consumed	liters	1,697,118.81	1,442,669.40	826,691.77	1,322,159.99	1,442,669.40	1,697,118.81	826,691.77
GHG emissions	tC02e	1,564,580.55	1,997,887.19	1,733,623.17	1,765,363.64	1,733,623.17	1,997,887.19	1,564,580.55
Emissions Factor	tCO2e/MWh	0.96	1.01	1.06	1.01	1.01	1.06	0.96

Notes:
GHG Emissions Calculation uses GHG Protocol Calculation Tool for Stationary Combustion

Comparison:

Mindanao Grid Emissions Factor	**tCO2e/MWh**
Simple Operating Margin	0.7797
Build Margin	0.8045
Simple Operating Margin	0.7797
Build Margin	0.8045

Source: https://www.doe.gov.ph/electric-power/2015-2017-national-grid-emission-factor-ngef

The estimates of the emissions for the next twenty (20) will depend on operating factors not yet firmly determined to date

Notwithstanding the micro contribution of the project to global GHG emissions, the Project Proponent will continue to undertake the following initiatives and operational plans to help mitigate global climate change.

Continue with active participation in the Carbon Sink and Reforestation Programme

Endeavor to the extent feasible the use of good quality coal feed such that the emission of CO_2 is minimized.

From an operations perspective take due note of the observation and recommendation from EMB Region X for an assurance that wet limestone shall not be feed in the furnace because it will increase the SO2 emission (there was an incident when SO2 emission was above the emission standard that was observed by the Chief of EMED, Engr. Dominguez upon looking at the CEMS this is due to the wet limestone that was inadvertently feed to the furnace.

Participate activiely in on going initiatives by industry groups and NGOs for the updating of the GHG baselines, The most basic element of a responsible but realistic actions on GHG mitigation is an understanding of the baseline GHG inventory of the Philippines.

On the matter of GHG inventory it is significantly noted from **'Second National Communication to the United Nations Framework Convention on Climate Change' THAT THE Overall contribution to 2000 GHG emissions by the energy sector shown in the table below are minimal; however, the GHG inventories have not been recently updated.**

Table 2.3-8. Overall contribution to 2000 GHG emission by non-LUCF sectors

	a	b	c	d	e	f	g
Sector	CO_2 (in Gg)	CH_4 (in Gg)	CH_4 GW Potential	N_2O (in Gg)	N_2O GW Potential	CO_2-eq Emission (in Gg) a+(b*c)+(d*c)	Percent Share (in %)
Energy	62,499.10	304.14	21	2.52	310	69,667.24	55
Industrial Processes	8,604.74	0.24	21	-	-	8,609.78	7
Agriculture	-	1,209.79	21	37.41	310	37,002.69	29
Waste	-	500.67	21	3.50	310	11,599.07	9
Totals	**71,103.84**	**2,014.84**		**43.43**		**126,878.78**	**100**

[1]To a large extent, this is due to the change in definition of forests, and availability of data. This would require a recomputation of the GHG for the INC to meaningfully compare the INC with the SNC.

The table below provides the data and estimates for the generation of SOx as used in the Air Dispersion Modelling to assess the impacts on air quality.

Air Dispersion Modelling Data Requirements

Individual Bundle

No.	1) For Point Sourse Modelling	Existing			Expansion		
		Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6
1	Rated Capacity, MW	135	135	135	135	135	135
2	Coordinate of Stack/s	124°44'54.81"E, 8°33'41.11"N			124°45'0.07"E, 8°33'34.98"N		
3	No. of Stacks	**1**		1	1	1	1
4	Plant Stack Diameter, m.	**5.2**		3.7	3.7	3.7	3.7
5	Plant Stack Height, m.	120		120	120	120	120
6	Plant Stack Temperature, °C	144		144	144	144	144
7	Pollutant Source Strength, g/s						
	NO2, g/sec	**49.2**		0.5	29.68	29.68	29.68
	CO, g/sec	**177.1**		1.8	10.76	10.76	10.76
	SO2, g/sec	**105.7**		3.4	67.12	67.12	67.12
	TSP, g/sec	**12.9**		6.4	11.59	11.59	11.59
	Volumetric Flow Rate, Ncm/min	**25,484.66**		12,902.55	12,902.55	12,902.55	12,902.55
8	Guaranteed Stack Emission Concentration in mg/Ncm for the following:						
	NO2	**424.74**		215.04	138.04	138.04	138.04
	CO	**212.37**		107.52	50.02	50.02	50.02
	SO2	**297.32**		150.53	312.14	312.14	312.14
	TSP	**63.71**		32.26	53.88	53.88	53.88

2.3.1.2.4 GHG Mitigations

Use of Sound Coal Technology and Good Quality Coal

The technology which will be used in this power plant project is the Circulating Fluidized Bed which can be classified as a sound coal technology. Compared to the traditional coal power plant, this technology guarantees a lower emission of nitrous oxides, which is one type of greenhouse gas. The energy efficiency of the technology results in optimum coal requirements per MW energy produced and thus of relatively smaller CO_2 generation.

Engine Maintenance

The proponent shall continue to implement regular maintenance of the boiler to maintain high thermal efficiency meaning a lower rate of fuel used per unit of power output, resulting in lower GHG emission.

Carbon Sink/Tree Growing Programmes

Trees utilize CO_2 during the process of photosynthesis. As trees grow, they take in CO_2 from the atmosphere. Therefore growing trees play an essential role in the reduction of greenhouse gas, specifically CO_2.

As part of the GHG reduction program, the proponent has implemented and will continue with its tree growing project within the plant site, Villanueva, and other parts of Misamis Oriental, as part of its carbon sink program.

Status of the Carbon Sink Program

FDC Misamis Power Corporation established its Carbon Sink Program at Barangay Sambulawan, El Salvador City, Misamis Oriental. The project covers 100 hectares of land area with 80 hectares of fully forested area and the other 20 hectares intended for tree growing. By 2020, there are 16,000 Eucalyptus, Gemelina and Mangium trees planted and maintained in the 20-hectare area with an average growth height of 16 to 20 feet as of mid-year 2020.

Solid Waste Minimization and Recycling

Waste prevention and recycling, or commonly referred to as waste reduction, assist in the management of the solid waste that is generated. The prevention and recycling of waste are potent strategies for reducing greenhouse gas emissions. For example (1) The prevention and recycling of waste diverts organic wastes from landfills, as a result, a reduction in the release of methane gas from the decomposition of these organic materials; (2) A reduction of greenhouse gas emissions from incinerators from the combustion of waste through waste prevention and recycling; and (3) Waste prevention and recycling of paper products allow more trees to remain standing in the forest, where they can continue to remove carbon dioxide from the atmosphere, in a process commonly referred to as carbon sequestration.

Energy Conservation

Energy conservation means less use of fossil fuel, therefore, a reduction in GHG emissions. This measure will involve programs such as judicious use of lighting, among others, both in the plant and in the head office.

2.3.2 Air Quality (& Noise)

2.3.2.1 Degradation of air quality; *Characterization of ambient air quality; Use DENR standard methods and procedures for sampling and analysis; Identification and assessment of impact of the project to the identified parameters including VOCs and odor through air dispersion modeling (as may be applicable)*

SMRs CMRs and CMVRs are regularly officially submitted to the Regional Director, EMB Region X.

This sub-section cites the ambient test results as indicated hereunder

Baseline Data:

Characterization of ambient air quality:

- ✓ *TSP*
- ✓ *PM10*
- ✓ *SO2*
- ✓ *NO2*
- ✓ *CO*
- ✓ *Trace Metals: Hg, Pb, Cd, Cr, As*
- ✓ *Sampling site map*

From the SMRs for the current projects, the following baseline characterization are provided.

Baseline reports from the SMRs for the periods 2016- 2020"

Included in the SMRs are the quality of the emissions from the APSEs and APCFs representing the stack monitoring test reports.

From the SMRs for the current projects, the following baseline characterization are provided.

Baseline: Ambient Air Monitoring from SMR from 2016 to 2020

Ambient Air Sampling Stations:

1. *Ash Yard South Side*
2. *Balacana Elementary School, Villanueva, Misamis Oriental*
3. *Brgy. San Martin, Villanueva, Misamis Oriental*
4. *Brgy. Sta. Cruz, Tagoloan, Misamis Oriental*
5. *Jetty Area near Transfer Tower 1*
6. *Zone 6A Brgy. Baluarte, Togoloan Misamis Oriental*

The historical trend of ambient air monitoring is shown in **Table 2.3-7** below.

The general sampling stations map is shown in **Figure 2.3-4** including therein the stations for air and noise monitoring. Coordinates of air and noise sampling station is also presented below in **Table 2.3-9**.

Table 2.3-9 Baseline for the metallic and other related parameters

Location of Monitoring Station	TSP					PM-10 (µg/Ncm)						No_x (µg/Ncm)					So_x (µg/Ncm)					CO (µg/Ncm)				
	2016	2017	2018	2019	2020	2016	2017	2018	2019	2020	R Stand	2016	2017	2018	2019	2020	2016	2017	2018	2019	2020	2016	2017	2018	2019	2020
DENR Standard	230					150						150					180					10				
Brgy. San Martin, Villanueva Misamis Oriental	524						25		31	30	150	0.002	23		6	0.9	4	4		4.4	4		1	1	1	1
Brgy. Sta.Cruz, Tagoloan Misamis Oriental							25	28	36	24	150		0.4	2.80	7	0.5		4	4	5	4		1	1	1	1
Zone 6A Brgy. Baluarte, Togoloan Misamis Oriental							35	50	51	21	150		0.4	2.90	5	0.4		4	4	7	4		1	1	1	1
Jetty Area near Transfer Tower 1	459						21	19	33	26	150	0.002	0.4	2.00	4.3	0.5	4	4	2	7	4		1	1	1	1
Ash Yard South Side	443						24	41	42	12	150	0.002	0.4	0.40	2.5	0.4	4	4	4	7	4		1	1	1	1
Balacanas Elementary School, Villanueva Misamis Oriental							16	25	42	20	150		21	2.00	5	0.4		4	2	4.5	4		1	1	1	1

Table 2.3-10 Coordinates of Sampling Station for Air and Noise

FDC Coordinates for Air and Noise		
Station	**Location**	**Coordinates**
Station 1	Jetty Area near Transfer Tower 1	Lat 8°33'53"N, Long 124°44'46"E
Station 2	Ash Yard South Side (Near Main Gate)	Lat 8°33'12"N, Long 124°45'13"E
Station 3	Balacanas Elementary School, Villanueva Misamis Oriental	Lat 8°34'5"N, Long 124°46'33"E
Station 4	Brgy. San Martin, Villanueva Misamis Oriental	Lat 8°33'36"N, Long 124°46'5"E
Station 5	Brgy. Hall, Sta. Cruz, Tagoloan Misamis Oriental	Lat 8°32'40"N, Long 124°46'7"E
Station 6	Zone 6A, Brgy. Baluarte, Tagoloan Misamis Oriental	Lat 8°32'35"N, Long 124°44'35"E

Figure 2.3-4 The air and noise sampling stations shown in the general map of sampling station

Figure 2.3-5. Trends for Air Quality for the last 5 years

The baselines and historical trends are also reported in Section 6, Environmental Compliance Monitoring.

General compliance to established standards are determined.

VOLATILE ORGANIC COMPOUNDS (VOCs) and ODOR

VOCs and ODOR are not included in the SMRs and in the parameters for the MMT.

There are no ambient guidelines for these parameters under the Philippine Clean Air Act.

In the case of odor, it is noteworthy that there has not been any complaints from the communities nor from residents adjacent to the project site.

Discussions on the ash storage and disposal facility and transport

Ash storage essentially involves the disposal facility through ash ponds layered with protective membranes while transport is via covered dump trucks travelling a short distance between the boiler and the ash repository pond.

An Air Dispersion Modelling Study

An Air Dispersion Model Run (Aermod/*Ausplume ver.6* software) was conducted in compliance under MC 2008 003 Guidelines for Dispersion Modeling Guidance on carrying out atmospheric dispersion modeling in the Philippines to meet the requirements under the RA 8749: the Philippine Clean Air Act of 1999 and its IRR DAO 2000-81): **Tiers 3 and 4.**

The objectives of the ADM are:

- *Generate Meteorological Data of project area.*
- *To generate 1-Hr Dispersion Isopleth of criteria pollutants and identify Maximum Ground Level*
- *concentration (GLC_{MAX}) and provide model run print outs*
- *To generate 24Hr Dispersion Isopleth (Optional) to determine compliance with Ambient Air Quality Guideline Values.*
- *Generated Dispersion Isopleth will utilize existing available Meteorological/MM5 data applicable in the area.*
- *To identify the Area Sensitive Receptors (ASRs)*

- *To Identify Critical Impact Areas and recommend air pollution abatement measures.*
- *To Recommend Upwind and Downwind Ambient Air Quality Monitoring Sites/Stations.*

The summary of the major results are hereunder given. In the **Annex 8.2** is provided the full report.

6 X 135 MW Circulating Fluidized Bed Boiler
Summary of Results

ASRs results

CO - Concentration - Source Group: ALL

Averaging Period	Rank	Peak	Units	Receptor ID	X (m)	Y (m)	ZELEV (m)	ZFLAG (m)	ZHILL (m)
1-HR	1ST	13.09299	ug/m^3	ASR1	694835.42	949528.49	13.99	0	431
1-HR	1ST	14.04947	ug/m^3	ASR2	695328.44	948995.6	22.96	0	431
1-HR	1ST	10.97737	ug/m^3	ASR3	695068.83	950516.82	38.47	0	431
1-HR	1ST	14.55522	ug/m^3	ASR4	694594.5	949228.47	9.98	0	431
1-HR	1ST	12.6775	ug/m^3	ASR5	696037.01	949244.46	97.99	0	431
1-HR	1ST	14.6018	ug/m^3	ASR6	695589.23	948252.93	42.62	0	431
1-HR	1ST	15.08777	ug/m^3	ASR7	695630.81	947993.85	48.39	0	421
1-HR	1ST	12.60373	ug/m^3	ASR8	696488	947798.74	84.07	0	412
1-HR	1ST	16.40495	ug/m^3	ASR9	694885.56	947984.26	31.05	0	31.05
1-HR	1ST	15.87056	ug/m^3	ASR10	695384.52	947674	49.98	0	49.98
1-HR	1ST	16.83584	ug/m^3	ASR11	695000.7	946765.63	23.88	0	23.88
1-HR	1ST	18.08513	ug/m^3	ASR12	694869.57	946461.77	18.67	0	18.67
1-HR	1ST	14.89923	ug/m^3	ASR13	693526.2	945006.46	10	0	10
1-HR	1ST	16.38477	ug/m^3	ASR14	694703.24	945080.03	11.98	0	11.98
1-HR	1ST	13.94339	ug/m^3	ASR15	694392.99	945937.22	12.45	0	12.45
1-HR	1ST	19.04219	ug/m^3	ASR16	692919.88	944562.09	12	0	12
1-HR	1ST	14.68145	ug/m^3	ASR17	693495.39	943543.88	32.55	0	32.55
1-HR	1ST	14.85002	ug/m^3	ASR17	694309.96	944004.29	38.67	0	38.67
1-HR	1ST	18.90704	ug/m^3	ASR18	691826.41	944637.35	7.27	0	7.27

1-HR	1ST	14.36245	ug/m^3	ASR19	695824.34	944433.55	21.58	0	30
CO - Concentration - Source Group: ALL									
Averaging Period	**Rank**	**Peak**	**Units**	**Receptor ID**	**X (m)**	**Y (m)**	**ZELEV (m)**	**ZFLAG (m)**	**ZHILL (m)**
8-HR	1ST	10.23054	ug/m^3	ASR1	694835.42	949528.49	13.99	0	431
8-HR	1ST	8.16196	ug/m^3	ASR2	695328.44	948995.6	22.96	0	431
8-HR	1ST	7.82532	ug/m^3	ASR3	695068.83	950516.82	38.47	0	431
8-HR	1ST	10.88669	ug/m^3	ASR4	694594.5	949228.47	9.98	0	431
8-HR	1ST	9.01761	ug/m^3	ASR5	696037.01	949244.46	97.99	0	431
8-HR	1ST	10.50995	ug/m^3	ASR6	695589.23	948252.93	42.62	0	431
8-HR	1ST	11.59229	ug/m^3	ASR7	695630.81	947993.85	48.39	0	421
8-HR	1ST	7.96645	ug/m^3	ASR8	696488	947798.74	84.07	0	412
8-HR	1ST	12.2285	ug/m^3	ASR9	694885.56	947984.26	31.05	0	31.05
8-HR	1ST	12.04565	ug/m^3	ASR10	695384.52	947674	49.98	0	49.98
8-HR	1ST	11.10451	ug/m^3	ASR11	695000.7	946765.63	23.88	0	23.88
8-HR	1ST	10.96664	ug/m^3	ASR12	694869.57	946461.77	18.67	0	18.67
8-HR	1ST	8.01212	ug/m^3	ASR13	693526.2	945006.46	10	0	10
8-HR	1ST	7.03993	ug/m^3	ASR14	694703.24	945080.03	11.98	0	11.98
8-HR	1ST	3.79591	ug/m^3	ASR15	694392.99	945937.22	12.45	0	12.45
8-HR	1ST	11.4795	ug/m^3	ASR16	692919.88	944562.09	12	0	12
8-HR	1ST	11.00003	ug/m^3	ASR17	693495.39	943543.88	32.55	0	32.55
8-HR	1ST	10.69579	ug/m^3	ASR17	694309.96	944004.29	38.67	0	38.67
8-HR	1ST	13.25405	ug/m^3	ASR18	691826.41	944637.35	7.27	0	7.27
8-HR	1ST	7.80721	ug/m^3	ASR19	695824.34	944433.55	21.58	0	30
24-HR	1ST	4.02989	ug/m^3	ASR1	694835.42	949528.49	13.99	0	431
CO - Concentration - Source Group: ALL									

Averaging Period	Rank	Peak	Units	Receptor ID	X (m)	Y (m)	ZELEV (m)	ZFLAG (m)	ZHILL (m)
24-HR	1ST	3.17548	ug/m^3	ASR2	695328.44	948995.6	22.96	0	431
24-HR	1ST	3.06545	ug/m^3	ASR3	695068.83	950516.82	38.47	0	431
24-HR	1ST	4.26887	ug/m^3	ASR4	694594.5	949228.47	9.98	0	431
24-HR	1ST	3.51337	ug/m^3	ASR5	696037.01	949244.46	97.99	0	431
24-HR	1ST	4.20262	ug/m^3	ASR6	695589.23	948252.93	42.62	0	431
24-HR	1ST	4.68677	ug/m^3	ASR7	695630.81	947993.85	48.39	0	421
24-HR	1ST	4.02517	ug/m^3	ASR8	696488	947798.74	84.07	0	412
24-HR	1ST	4.78424	ug/m^3	ASR9	694885.56	947984.26	31.05	0	31.05
24-HR	1ST	4.83636	ug/m^3	ASR10	695384.52	947674	49.98	0	49.98
24-HR	1ST	4.36462	ug/m^3	ASR11	695000.7	946765.63	23.88	0	23.88
24-HR	1ST	4.28767	ug/m^3	ASR12	694869.57	946461.77	18.67	0	18.67
24-HR	1ST	3.11606	ug/m^3	ASR13	693526.2	945006.46	10	0	10
24-HR	1ST	2.73776	ug/m^3	ASR14	694703.24	945080.03	11.98	0	11.98
24-HR	1ST	1.47632	ug/m^3	ASR15	694392.99	945937.22	12.45	0	12.45
24-HR	1ST	4.11207	ug/m^3	ASR16	692919.88	944562.09	12	0	12
24-HR	1ST	4.27779	ug/m^3	ASR17	693495.39	943543.88	32.55	0	32.55
24-HR	1ST	4.18687	ug/m^3	ASR17	694309.96	944004.29	38.67	0	38.67
24-HR	1ST	6.34779	ug/m^3	ASR18	691826.41	944637.35	7.27	0	7.27
24-HR	1ST	3.03619	ug/m^3	ASR19	695824.34	944433.55	21.58	0	30
ANNUAL		0.05626	ug/m^3	ASR1	694835.42	949528.49	13.99	0	431
ANNUAL		0.08756	ug/m^3	ASR2	695328.44	948995.6	22.96	0	431

CO - Concentration - Source Group: ALL

Averaging Period	Rank	Peak	Units	Receptor ID	X (m)	Y (m)	ZELEV (m)	ZFLAG (m)	ZHILL (m)

ANNUAL		0.04986	ug/m^3	ASR3	695068.83	950516.82	38.47	0	431
ANNUAL		0.05371	ug/m^3	ASR4	694594.5	949228.47	9.98	0	431
ANNUAL		0.1268	ug/m^3	ASR5	696037.01	949244.46	97.99	0	431
ANNUAL		0.13624	ug/m^3	ASR6	695589.23	948252.93	42.62	0	431
ANNUAL		0.14308	ug/m^3	ASR7	695630.81	947993.85	48.39	0	421
ANNUAL		0.13382	ug/m^3	ASR8	696488	947798.74	84.07	0	412
ANNUAL		0.13487	ug/m^3	ASR9	694885.56	947984.26	31.05	0	31.05
ANNUAL		0.14184	ug/m^3	ASR10	695384.52	947674	49.98	0	49.98
ANNUAL		0.10193	ug/m^3	ASR11	695000.7	946765.63	23.88	0	23.88
ANNUAL		0.08669	ug/m^3	ASR12	694869.57	946461.77	18.67	0	18.67
ANNUAL		0.47885	ug/m^3	ASR13	693526.2	945006.46	10	0	10
ANNUAL		0.17582	ug/m^3	ASR14	694703.24	945080.03	11.98	0	11.98
ANNUAL		0.04439	ug/m^3	ASR15	694392.99	945937.22	12.45	0	12.45
ANNUAL		0.5432	ug/m^3	ASR16	692919.88	944562.09	12	0	12
ANNUAL		0.95563	ug/m^3	ASR17	693495.39	943543.88	32.55	0	32.55
ANNUAL		1.13747	ug/m^3	ASR17	694309.96	944004.29	38.67	0	38.67
ANNUAL		0.24199	ug/m^3	ASR18	691826.41	944637.35	7.27	0	7.27
ANNUAL		0.2131	ug/m^3	ASR19	695824.34	944433.55	21.58	0	30

NOx - Concentration - Source Group: ALL

Averaging Period	Rank	Peak	Units	Receptor ID	X (m)	Y (m)	ZELEV (m)	ZFLAG (m)	ZHILL (m)
1-HR	1ST	1.61145	ug/m^3	ASR1	694835.42	949528.49	13.99	0	431
1-HR	1ST	1.72917	ug/m^3	ASR2	695328.44	948995.6	22.96	0	431
1-HR	1ST	1.35106	ug/m^3	ASR3	695068.83	950516.82	38.47	0	431
1-HR	1ST	1.79141	ug/m^3	ASR4	694594.5	949228.47	9.98	0	431

1-HR	1ST	1.56031	ug/m^3	ASR5	696037.01	949244.46	97.99	0	431
1-HR	1ST	1.79714	ug/m^3	ASR6	695589.23	948252.93	42.62	0	431
1-HR	1ST	1.85696	ug/m^3	ASR7	695630.81	947993.85	48.39	0	421
1-HR	1ST	1.55123	ug/m^3	ASR8	696488	947798.74	84.07	0	412
1-HR	1ST	2.01907	ug/m^3	ASR9	694885.56	947984.26	31.05	0	31.05
1-HR	1ST	1.9533	ug/m^3	ASR10	695384.52	947674	49.98	0	49.98
1-HR	1ST	2.0721	ug/m^3	ASR11	695000.7	946765.63	23.88	0	23.88
1-HR	1ST	2.22586	ug/m^3	ASR12	694869.57	946461.77	18.67	0	18.67
1-HR	1ST	1.83375	ug/m^3	ASR13	693526.2	945006.46	10	0	10
1-HR	1ST	2.01659	ug/m^3	ASR14	694703.24	945080.03	11.98	0	11.98
1-HR	1ST	1.71611	ug/m^3	ASR15	694392.99	945937.22	12.45	0	12.45
1-HR	1ST	2.34365	ug/m^3	ASR16	692919.88	944562.09	12	0	12
1-HR	1ST	1.80695	ug/m^3	ASR17	693495.39	943543.88	32.55	0	32.55
1-HR	1ST	1.8277	ug/m^3	ASR17	694309.96	944004.29	38.67	0	38.67
1-HR	1ST	2.32702	ug/m^3	ASR18	691826.41	944637.35	7.27	0	7.27
1-HR	1ST	1.76769	ug/m^3	ASR19	695824.34	944433.55	21.58	0	30
8-HR	1ST	1.25914	ug/m^3	ASR1	694835.42	949528.49	13.99	0	431

NOx - Concentration - Source Group: ALL

Averaging Period	Rank	Peak	Units	Receptor ID	X (m)	Y (m)	ZELEV (m)	ZFLAG (m)	ZHILL (m)
8-HR	1ST	1.00455	ug/m^3	ASR2	695328.44	948995.6	22.96	0	431
8-HR	1ST	0.96312	ug/m^3	ASR3	695068.83	950516.82	38.47	0	431
8-HR	1ST	1.3399	ug/m^3	ASR4	694594.5	949228.47	9.98	0	431
8-HR	1ST	1.10986	ug/m^3	ASR5	696037.01	949244.46	97.99	0	431
8-HR	1ST	1.29353	ug/m^3	ASR6	695589.23	948252.93	42.62	0	431
8-HR	1ST	1.42674	ug/m^3	ASR7	695630.81	947993.85	48.39	0	421

8-HR	1ST	0.98049	ug/m^3	ASR8	696488	947798.74	84.07	0	412
8-HR	1ST	1.50505	ug/m^3	ASR9	694885.56	947984.26	31.05	0	31.05
8-HR	1ST	1.48254	ug/m^3	ASR10	695384.52	947674	49.98	0	49.98
8-HR	1ST	1.36671	ug/m^3	ASR11	695000.7	946765.63	23.88	0	23.88
8-HR	1ST	1.34974	ug/m^3	ASR12	694869.57	946461.77	18.67	0	18.67
8-HR	1ST	0.98611	ug/m^3	ASR13	693526.2	945006.46	10	0	10
8-HR	1ST	0.86645	ug/m^3	ASR14	694703.24	945080.03	11.98	0	11.98
8-HR	1ST	0.46719	ug/m^3	ASR15	694392.99	945937.22	12.45	0	12.45
8-HR	1ST	1.41286	ug/m^3	ASR16	692919.88	944562.09	12	0	12
8-HR	1ST	1.35385	ug/m^3	ASR17	693495.39	943543.88	32.55	0	32.55
8-HR	1ST	1.3164	ug/m^3	ASR17	694309.96	944004.29	38.67	0	38.67
8-HR	1ST	1.63127	ug/m^3	ASR18	691826.41	944637.35	7.27	0	7.27
8-HR	1ST	0.96089	ug/m^3	ASR19	695824.34	944433.55	21.58	0	30
24-HR	1ST	0.49599	ug/m^3	ASR1	694835.42	949528.49	13.99	0	431
24-HR	1ST	0.39083	ug/m^3	ASR2	695328.44	948995.6	22.96	0	431
NOx - Concentration - Source Group: ALL									
Averaging Period	**Rank**	**Peak**	**Units**	**Receptor ID**	**X (m)**	**Y (m)**	**ZELEV (m)**	**ZFLAG (m)**	**ZHILL (m)**
24-HR	1ST	0.37729	ug/m^3	ASR3	695068.83	950516.82	38.47	0	431
24-HR	1ST	0.5254	ug/m^3	ASR4	694594.5	949228.47	9.98	0	431
24-HR	1ST	0.43242	ug/m^3	ASR5	696037.01	949244.46	97.99	0	431
24-HR	1ST	0.51725	ug/m^3	ASR6	695589.23	948252.93	42.62	0	431
24-HR	1ST	0.57683	ug/m^3	ASR7	695630.81	947993.85	48.39	0	421
24-HR	1ST	0.49541	ug/m^3	ASR8	696488	947798.74	84.07	0	412
24-HR	1ST	0.58883	ug/m^3	ASR9	694885.56	947984.26	31.05	0	31.05
24-HR	1ST	0.59524	ug/m^3	ASR10	695384.52	947674	49.98	0	49.98

24-HR	1ST	0.53718	ug/m^3	ASR11	695000.7	946765.63	23.88	0	23.88
24-HR	1ST	0.52771	ug/m^3	ASR12	694869.57	946461.77	18.67	0	18.67
24-HR	1ST	0.38352	ug/m^3	ASR13	693526.2	945006.46	10	0	10
24-HR	1ST	0.33695	ug/m^3	ASR14	694703.24	945080.03	11.98	0	11.98
24-HR	1ST	0.1817	ug/m^3	ASR15	694392.99	945937.22	12.45	0	12.45
24-HR	1ST	0.5061	ug/m^3	ASR16	692919.88	944562.09	12	0	12
24-HR	1ST	0.5265	ug/m^3	ASR17	693495.39	943543.88	32.55	0	32.55
24-HR	1ST	0.51531	ug/m^3	ASR17	694309.96	944004.29	38.67	0	38.67
24-HR	1ST	0.78127	ug/m^3	ASR18	691826.41	944637.35	7.27	0	7.27
24-HR	1ST	0.37369	ug/m^3	ASR19	695824.34	944433.55	21.58	0	30
ANNUAL		0.00692	ug/m^3	ASR1	694835.42	949528.49	13.99	0	431
ANNUAL		0.01078	ug/m^3	ASR2	695328.44	948995.6	22.96	0	431
ANNUAL		0.00614	ug/m^3	ASR3	695068.83	950516.82	38.47	0	431

NOx - Concentration - Source Group: ALL

Averaging Period	Rank	Peak	Units	Receptor ID	X (m)	Y (m)	ZELEV (m)	ZFLAG (m)	ZHILL (m)
ANNUAL		0.00661	ug/m^3	ASR4	694594.5	949228.47	9.98	0	431
ANNUAL		0.01561	ug/m^3	ASR5	696037.01	949244.46	97.99	0	431
ANNUAL		0.01677	ug/m^3	ASR6	695589.23	948252.93	42.62	0	431
ANNUAL		0.01761	ug/m^3	ASR7	695630.81	947993.85	48.39	0	421
ANNUAL		0.01647	ug/m^3	ASR8	696488	947798.74	84.07	0	412
ANNUAL		0.0166	ug/m^3	ASR9	694885.56	947984.26	31.05	0	31.05
ANNUAL		0.01746	ug/m^3	ASR10	695384.52	947674	49.98	0	49.98
ANNUAL		0.01255	ug/m^3	ASR11	695000.7	946765.63	23.88	0	23.88
ANNUAL		0.01067	ug/m^3	ASR12	694869.57	946461.77	18.67	0	18.67
ANNUAL		0.05894	ug/m^3	ASR13	693526.2	945006.46	10	0	10

ANNUAL		0.02164	ug/m^3	ASR14	694703.24	945080.03	11.98	0	11.98
ANNUAL		0.00546	ug/m^3	ASR15	694392.99	945937.22	12.45	0	12.45
ANNUAL		0.06686	ug/m^3	ASR16	692919.88	944562.09	12	0	12
ANNUAL		0.11762	ug/m^3	ASR17	693495.39	943543.88	32.55	0	32.55
ANNUAL		0.14	ug/m^3	ASR17	694309.96	944004.29	38.67	0	38.67
ANNUAL		0.02978	ug/m^3	ASR18	691826.41	944637.35	7.27	0	7.27
ANNUAL		0.02623	ug/m^3	ASR19	695824.34	944433.55	21.58	0	30

SOx - Concentration - Source Group: ALL

Averaging Period	Rank	Peak	Units	Receptor ID	X (m)	Y (m)	ZELEV (m)	ZFLAG (m)	ZHILL (m)
1-HR	1ST	5.2372	ug/m^3	ASR1	694835.42	949528.49	13.99	0	431
1-HR	1ST	5.61979	ug/m^3	ASR2	695328.44	948995.6	22.96	0	431
1-HR	1ST	4.39095	ug/m^3	ASR3	695068.83	950516.82	38.47	0	431
1-HR	1ST	5.82209	ug/m^3	ASR4	694594.5	949228.47	9.98	0	431
1-HR	1ST	5.071	ug/m^3	ASR5	696037.01	949244.46	97.99	0	431
1-HR	1ST	5.84072	ug/m^3	ASR6	695589.23	948252.93	42.62	0	431
1-HR	1ST	6.03511	ug/m^3	ASR7	695630.81	947993.85	48.39	0	421
1-HR	1ST	5.04149	ug/m^3	ASR8	696488	947798.74	84.07	0	412
1-HR	1ST	6.56198	ug/m^3	ASR9	694885.56	947984.26	31.05	0	31.05
1-HR	1ST	6.34822	ug/m^3	ASR10	695384.52	947674	49.98	0	49.98
1-HR	1ST	6.73433	ug/m^3	ASR11	695000.7	946765.63	23.88	0	23.88
1-HR	1ST	7.23405	ug/m^3	ASR12	694869.57	946461.77	18.67	0	18.67
1-HR	1ST	5.95969	ug/m^3	ASR13	693526.2	945006.46	10	0	10
1-HR	1ST	6.55391	ug/m^3	ASR14	694703.24	945080.03	11.98	0	11.98
1-HR	1ST	5.57735	ug/m^3	ASR15	694392.99	945937.22	12.45	0	12.45
1-HR	1ST	7.61687	ug/m^3	ASR16	692919.88	944562.09	12	0	12

1-HR	1ST	5.87258	ug/m^3	ASR17	693495.39	943543.88	32.55	0	32.55
1-HR	1ST	5.94001	ug/m^3	ASR17	694309.96	944004.29	38.67	0	38.67
1-HR	1ST	7.56281	ug/m^3	ASR18	691826.41	944637.35	7.27	0	7.27
1-HR	1ST	5.74498	ug/m^3	ASR19	695824.34	944433.55	21.58	0	30
8-HR	1ST	4.09221	ug/m^3	ASR1	694835.42	949528.49	13.99	0	431

SOx - Concentration - Source Group: ALL

Averaging Period	Rank	Peak	Units	Receptor ID	X (m)	Y (m)	ZELEV (m)	ZFLAG (m)	ZHILL (m)
8-HR	1ST	3.26479	ug/m^3	ASR2	695328.44	948995.6	22.96	0	431
8-HR	1ST	3.13013	ug/m^3	ASR3	695068.83	950516.82	38.47	0	431
8-HR	1ST	4.35468	ug/m^3	ASR4	694594.5	949228.47	9.98	0	431
8-HR	1ST	3.60704	ug/m^3	ASR5	696037.01	949244.46	97.99	0	431
8-HR	1ST	4.20398	ug/m^3	ASR6	695589.23	948252.93	42.62	0	431
8-HR	1ST	4.63692	ug/m^3	ASR7	695630.81	947993.85	48.39	0	421
8-HR	1ST	3.18658	ug/m^3	ASR8	696488	947798.74	84.07	0	412
8-HR	1ST	4.8914	ug/m^3	ASR9	694885.56	947984.26	31.05	0	31.05
8-HR	1ST	4.81826	ug/m^3	ASR10	695384.52	947674	49.98	0	49.98
8-HR	1ST	4.4418	ug/m^3	ASR11	695000.7	946765.63	23.88	0	23.88
8-HR	1ST	4.38665	ug/m^3	ASR12	694869.57	946461.77	18.67	0	18.67
8-HR	1ST	3.20485	ug/m^3	ASR13	693526.2	945006.46	10	0	10
8-HR	1ST	2.81597	ug/m^3	ASR14	694703.24	945080.03	11.98	0	11.98
8-HR	1ST	1.51837	ug/m^3	ASR15	694392.99	945937.22	12.45	0	12.45
8-HR	1ST	4.5918	ug/m^3	ASR16	692919.88	944562.09	12	0	12
8-HR	1ST	4.40001	ug/m^3	ASR17	693495.39	943543.88	32.55	0	32.55
8-HR	1ST	4.27831	ug/m^3	ASR17	694309.96	944004.29	38.67	0	38.67
8-HR	1ST	5.30162	ug/m^3	ASR18	691826.41	944637.35	7.27	0	7.27

8-HR	1ST	3.12288	ug/m^3	ASR19	695824.34	944433.55	21.58	0	30
24-HR	1ST	1.61196	ug/m^3	ASR1	694835.42	949528.49	13.99	0	431
24-HR	1ST	1.27019	ug/m^3	ASR2	695328.44	948995.6	22.96	0	431

SOx - Concentration - Source Group: ALL

Averaging Period	Rank	Peak	Units	Receptor ID	X (m)	Y (m)	ZELEV (m)	ZFLAG (m)	ZHILL (m)
24-HR	1ST	1.22618	ug/m^3	ASR3	695068.83	950516.82	38.47	0	431
24-HR	1ST	1.70755	ug/m^3	ASR4	694594.5	949228.47	9.98	0	431
24-HR	1ST	1.40535	ug/m^3	ASR5	696037.01	949244.46	97.99	0	431
24-HR	1ST	1.68105	ug/m^3	ASR6	695589.23	948252.93	42.62	0	431
24-HR	1ST	1.87471	ug/m^3	ASR7	695630.81	947993.85	48.39	0	421
24-HR	1ST	1.61007	ug/m^3	ASR8	696488	947798.74	84.07	0	412
24-HR	1ST	1.9137	ug/m^3	ASR9	694885.56	947984.26	31.05	0	31.05
24-HR	1ST	1.93454	ug/m^3	ASR10	695384.52	947674	49.98	0	49.98
24-HR	1ST	1.74585	ug/m^3	ASR11	695000.7	946765.63	23.88	0	23.88
24-HR	1ST	1.71507	ug/m^3	ASR12	694869.57	946461.77	18.67	0	18.67
24-HR	1ST	1.24642	ug/m^3	ASR13	693526.2	945006.46	10	0	10
24-HR	1ST	1.0951	ug/m^3	ASR14	694703.24	945080.03	11.98	0	11.98
24-HR	1ST	0.59053	ug/m^3	ASR15	694392.99	945937.22	12.45	0	12.45
24-HR	1ST	1.64483	ug/m^3	ASR16	692919.88	944562.09	12	0	12
24-HR	1ST	1.71112	ug/m^3	ASR17	693495.39	943543.88	32.55	0	32.55
24-HR	1ST	1.67475	ug/m^3	ASR17	694309.96	944004.29	38.67	0	38.67
24-HR	1ST	2.53911	ug/m^3	ASR18	691826.41	944637.35	7.27	0	7.27
24-HR	1ST	1.21448	ug/m^3	ASR19	695824.34	944433.55	21.58	0	30
ANNUAL		0.0225	ug/m^3	ASR1	694835.42	949528.49	13.99	0	431
ANNUAL		0.03502	ug/m^3	ASR2	695328.44	948995.6	22.96	0	431

ANNUAL		0.01994	ug/m^3	ASR3	695068.83	950516.82	38.47	0	431
SOx - Concentration - Source Group: ALL									
Averaging Period	**Rank**	**Peak**	**Units**	**Receptor ID**	**X (m)**	**Y (m)**	**ZELEV (m)**	**ZFLAG (m)**	**ZHILL (m)**
ANNUAL		0.02148	ug/m^3	ASR4	694594.5	949228.47	9.98	0	431
ANNUAL		0.05072	ug/m^3	ASR5	696037.01	949244.46	97.99	0	431
ANNUAL		0.0545	ug/m^3	ASR6	695589.23	948252.93	42.62	0	431
ANNUAL		0.05723	ug/m^3	ASR7	695630.81	947993.85	48.39	0	421
ANNUAL		0.05353	ug/m^3	ASR8	696488	947798.74	84.07	0	412
ANNUAL		0.05395	ug/m^3	ASR9	694885.56	947984.26	31.05	0	31.05
ANNUAL		0.05674	ug/m^3	ASR10	695384.52	947674	49.98	0	49.98
ANNUAL		0.04077	ug/m^3	ASR11	695000.7	946765.63	23.88	0	23.88
ANNUAL		0.03468	ug/m^3	ASR12	694869.57	946461.77	18.67	0	18.67
ANNUAL		0.19154	ug/m^3	ASR13	693526.2	945006.46	10	0	10
ANNUAL		0.07033	ug/m^3	ASR14	694703.24	945080.03	11.98	0	11.98
ANNUAL		0.01775	ug/m^3	ASR15	694392.99	945937.22	12.45	0	12.45
ANNUAL		0.21728	ug/m^3	ASR16	692919.88	944562.09	12	0	12
ANNUAL		0.38225	ug/m^3	ASR17	693495.39	943543.88	32.55	0	32.55
ANNUAL		0.45499	ug/m^3	ASR17	694309.96	944004.29	38.67	0	38.67
ANNUAL		0.0968	ug/m^3	ASR18	691826.41	944637.35	7.27	0	7.27
ANNUAL		0.08524	ug/m^3	ASR19	695824.34	944433.55	21.58	0	30
TSP - Concentration - Source Group: ALL									
Averaging Period	**Rank**	**Peak**	**Units**	**Receptor ID**	**X (m)**	**Y (m)**	**ZELEV (m)**	**ZFLAG (m)**	**ZHILL (m)**
1-HR	1ST	0.70501	ug/m^3	ASR1	694835.42	949528.49	13.99	0	431
1-HR	1ST	0.75651	ug/m^3	ASR2	695328.44	948995.6	22.96	0	431

1-HR	1ST	0.59109	ug/m^3	ASR3	695068.83	950516.82	38.47	0	431
1-HR	1ST	0.78374	ug/m^3	ASR4	694594.5	949228.47	9.98	0	431
1-HR	1ST	0.68263	ug/m^3	ASR5	696037.01	949244.46	97.99	0	431
1-HR	1ST	0.78625	ug/m^3	ASR6	695589.23	948252.93	42.62	0	431
1-HR	1ST	0.81242	ug/m^3	ASR7	695630.81	947993.85	48.39	0	421
1-HR	1ST	0.67866	ug/m^3	ASR8	696488	947798.74	84.07	0	412
1-HR	1ST	0.88334	ug/m^3	ASR9	694885.56	947984.26	31.05	0	31.05
1-HR	1ST	0.85457	ug/m^3	ASR10	695384.52	947674	49.98	0	49.98
1-HR	1ST	0.90655	ug/m^3	ASR11	695000.7	946765.63	23.88	0	23.88
1-HR	1ST	0.97381	ug/m^3	ASR12	694869.57	946461.77	18.67	0	18.67
1-HR	1ST	0.80227	ug/m^3	ASR13	693526.2	945006.46	10	0	10
1-HR	1ST	0.88226	ug/m^3	ASR14	694703.24	945080.03	11.98	0	11.98
1-HR	1ST	0.7508	ug/m^3	ASR15	694392.99	945937.22	12.45	0	12.45
1-HR	1ST	1.02535	ug/m^3	ASR16	692919.88	944562.09	12	0	12
1-HR	1ST	0.79054	ug/m^3	ASR17	693495.39	943543.88	32.55	0	32.55
1-HR	1ST	0.79962	ug/m^3	ASR17	694309.96	944004.29	38.67	0	38.67
1-HR	1ST	1.01807	ug/m^3	ASR18	691826.41	944637.35	7.27	0	7.27
1-HR	1ST	0.77336	ug/m^3	ASR19	695824.34	944433.55	21.58	0	30
8-HR	1ST	0.55088	ug/m^3	ASR1	694835.42	949528.49	13.99	0	431

TSP - Concentration - Source Group: ALL

Averaging Period	Rank	Peak	Units	Receptor ID	X (m)	Y (m)	ZELEV (m)	ZFLAG (m)	ZHILL (m)
8-HR	1ST	0.43949	ug/m^3	ASR2	695328.44	948995.6	22.96	0	431
8-HR	1ST	0.42136	ug/m^3	ASR3	695068.83	950516.82	38.47	0	431
8-HR	1ST	0.58621	ug/m^3	ASR4	694594.5	949228.47	9.98	0	431
8-HR	1ST	0.48556	ug/m^3	ASR5	696037.01	949244.46	97.99	0	431

8-HR	1ST	0.56592	ug/m^3	ASR6	695589.23	948252.93	42.62	0	431
8-HR	1ST	0.6242	ug/m^3	ASR7	695630.81	947993.85	48.39	0	421
8-HR	1ST	0.42896	ug/m^3	ASR8	696488	947798.74	84.07	0	412
8-HR	1ST	0.65846	ug/m^3	ASR9	694885.56	947984.26	31.05	0	31.05
8-HR	1ST	0.64861	ug/m^3	ASR10	695384.52	947674	49.98	0	49.98
8-HR	1ST	0.59793	ug/m^3	ASR11	695000.7	946765.63	23.88	0	23.88
8-HR	1ST	0.59051	ug/m^3	ASR12	694869.57	946461.77	18.67	0	18.67
8-HR	1ST	0.43142	ug/m^3	ASR13	693526.2	945006.46	10	0	10
8-HR	1ST	0.37907	ug/m^3	ASR14	694703.24	945080.03	11.98	0	11.98
8-HR	1ST	0.2044	ug/m^3	ASR15	694392.99	945937.22	12.45	0	12.45
8-HR	1ST	0.61813	ug/m^3	ASR16	692919.88	944562.09	12	0	12
8-HR	1ST	0.59231	ug/m^3	ASR17	693495.39	943543.88	32.55	0	32.55
8-HR	1ST	0.57593	ug/m^3	ASR17	694309.96	944004.29	38.67	0	38.67
8-HR	1ST	0.71368	ug/m^3	ASR18	691826.41	944637.35	7.27	0	7.27
8-HR	1ST	0.42039	ug/m^3	ASR19	695824.34	944433.55	21.58	0	30
24-HR	1ST	0.21699	ug/m^3	ASR1	694835.42	949528.49	13.99	0	431
24-HR	1ST	0.17099	ug/m^3	ASR2	695328.44	948995.6	22.96	0	431

TSP - Concentration - Source Group: ALL

Averaging Period	Rank	Peak	Units	Receptor ID	X (m)	Y (m)	ZELEV (m)	ZFLAG (m)	ZHILL (m)
24-HR	1ST	0.16506	ug/m^3	ASR3	695068.83	950516.82	38.47	0	431
24-HR	1ST	0.22986	ug/m^3	ASR4	694594.5	949228.47	9.98	0	431
24-HR	1ST	0.18918	ug/m^3	ASR5	696037.01	949244.46	97.99	0	431
24-HR	1ST	0.22629	ug/m^3	ASR6	695589.23	948252.93	42.62	0	431
24-HR	1ST	0.25236	ug/m^3	ASR7	695630.81	947993.85	48.39	0	421
24-HR	1ST	0.21674	ug/m^3	ASR8	696488	947798.74	84.07	0	412

24-HR	1ST	0.25761	ug/m^3	ASR9	694885.56	947984.26	31.05	0	31.05
24-HR	1ST	0.26042	ug/m^3	ASR10	695384.52	947674	49.98	0	49.98
24-HR	1ST	0.23502	ug/m^3	ASR11	695000.7	946765.63	23.88	0	23.88
24-HR	1ST	0.23087	ug/m^3	ASR12	694869.57	946461.77	18.67	0	18.67
24-HR	1ST	0.16779	ug/m^3	ASR13	693526.2	945006.46	10	0	10
24-HR	1ST	0.14742	ug/m^3	ASR14	694703.24	945080.03	11.98	0	11.98
24-HR	1ST	0.07949	ug/m^3	ASR15	694392.99	945937.22	12.45	0	12.45
24-HR	1ST	0.22142	ug/m^3	ASR16	692919.88	944562.09	12	0	12
24-HR	1ST	0.23034	ug/m^3	ASR17	693495.39	943543.88	32.55	0	32.55
24-HR	1ST	0.22545	ug/m^3	ASR17	694309.96	944004.29	38.67	0	38.67
24-HR	1ST	0.3418	ug/m^3	ASR18	691826.41	944637.35	7.27	0	7.27
24-HR	1ST	0.16349	ug/m^3	ASR19	695824.34	944433.55	21.58	0	30
24-HR	8TH	0.02214	ug/m^3	ASR1	694835.42	949528.49	13.99	0	431
24-HR	8TH	0.05652	ug/m^3	ASR2	695328.44	948995.6	22.96	0	431
24-HR	8TH	0.01773	ug/m^3	ASR3	695068.83	950516.82	38.47	0	431

TSP - Concentration - Source Group: ALL

Averaging Period	Rank	Peak	Units	Receptor ID	X (m)	Y (m)	ZELEV (m)	ZFLAG (m)	ZHILL (m)
24-HR	8TH	0.01829	ug/m^3	ASR4	694594.5	949228.47	9.98	0	431
24-HR	8TH	0.07152	ug/m^3	ASR5	696037.01	949244.46	97.99	0	431
24-HR	8TH	0.10061	ug/m^3	ASR6	695589.23	948252.93	42.62	0	431
24-HR	8TH	0.1357	ug/m^3	ASR7	695630.81	947993.85	48.39	0	421
24-HR	8TH	0.0914	ug/m^3	ASR8	696488	947798.74	84.07	0	412
24-HR	8TH	0.10931	ug/m^3	ASR9	694885.56	947984.26	31.05	0	31.05
24-HR	8TH	0.10412	ug/m^3	ASR10	695384.52	947674	49.98	0	49.98
24-HR	8TH	0.06717	ug/m^3	ASR11	695000.7	946765.63	23.88	0	23.88

24-HR	8TH	0.03413	ug/m^3	ASR12	694869.57	946461.77	18.67	0	18.67
24-HR	8TH	0.11394	ug/m^3	ASR13	693526.2	945006.46	10	0	10
24-HR	8TH	0.05867	ug/m^3	ASR14	694703.24	945080.03	11.98	0	11.98
24-HR	8TH	0.01461	ug/m^3	ASR15	694392.99	945937.22	12.45	0	12.45
24-HR	8TH	0.18088	ug/m^3	ASR16	692919.88	944562.09	12	0	12
24-HR	8TH	0.19576	ug/m^3	ASR17	693495.39	943543.88	32.55	0	32.55
24-HR	8TH	0.14734	ug/m^3	ASR17	694309.96	944004.29	38.67	0	38.67
24-HR	8TH	0.19452	ug/m^3	ASR18	691826.41	944637.35	7.27	0	7.27
24-HR	8TH	0.06637	ug/m^3	ASR19	695824.34	944433.55	21.58	0	30
1-HR	176TH	0.00269	ug/m^3	ASR1	694835.42	949528.49	13.99	0	431
1-HR	176TH	0.00254	ug/m^3	ASR2	695328.44	948995.6	22.96	0	431
1-HR	176TH	0.00178	ug/m^3	ASR3	695068.83	950516.82	38.47	0	431
1-HR	176TH	0.00313	ug/m^3	ASR4	694594.5	949228.47	9.98	0	431

TSP - Concentration - Source Group: ALL

Averaging Period	Rank	Peak	Units	Receptor ID	X (m)	Y (m)	ZELEV (m)	ZFLAG (m)	ZHILL (m)
1-HR	176TH	0.00883	ug/m^3	ASR5	696037.01	949244.46	97.99	0	431
1-HR	176TH	0.00239	ug/m^3	ASR6	695589.23	948252.93	42.62	0	431
1-HR	176TH	0.00237	ug/m^3	ASR7	695630.81	947993.85	48.39	0	421
1-HR	176TH	0.00577	ug/m^3	ASR8	696488	947798.74	84.07	0	412
1-HR	176TH	0.00317	ug/m^3	ASR9	694885.56	947984.26	31.05	0	31.05
1-HR	176TH	0.0026	ug/m^3	ASR10	695384.52	947674	49.98	0	49.98
1-HR	176TH	0.00331	ug/m^3	ASR11	695000.7	946765.63	23.88	0	23.88
1-HR	176TH	0.00352	ug/m^3	ASR12	694869.57	946461.77	18.67	0	18.67
1-HR	176TH	0.26332	ug/m^3	ASR13	693526.2	945006.46	10	0	10
1-HR	176TH	0.04973	ug/m^3	ASR14	694703.24	945080.03	11.98	0	11.98

1-HR	176TH	0.00392	ug/m^3	ASR15	694392.99	945937.22	12.45	0	12.45
1-HR	176TH	0.31918	ug/m^3	ASR16	692919.88	944562.09	12	0	12
1-HR	176TH	0.44035	ug/m^3	ASR17	693495.39	943543.88	32.55	0	32.55
1-HR	176TH	0.4137	ug/m^3	ASR17	694309.96	944004.29	38.67	0	38.67
1-HR	176TH	0.01271	ug/m^3	ASR18	691826.41	944637.35	7.27	0	7.27
1-HR	176TH	0.0761	ug/m^3	ASR19	695824.34	944433.55	21.58	0	30
ANNUAL		0.00303	ug/m^3	ASR1	694835.42	949528.49	13.99	0	431
ANNUAL		0.00471	ug/m^3	ASR2	695328.44	948995.6	22.96	0	431
ANNUAL		0.00268	ug/m^3	ASR3	695068.83	950516.82	38.47	0	431
ANNUAL		0.00289	ug/m^3	ASR4	694594.5	949228.47	9.98	0	431
ANNUAL		0.00683	ug/m^3	ASR5	696037.01	949244.46	97.99	0	431

TSP - Concentration - Source Group: ALL

Averaging Period	Rank	Peak	Units	Receptor ID	X (m)	Y (m)	ZELEV (m)	ZFLAG (m)	ZHILL (m)
ANNUAL		0.00734	ug/m^3	ASR6	695589.23	948252.93	42.62	0	431
ANNUAL		0.0077	ug/m^3	ASR7	695630.81	947993.85	48.39	0	421
ANNUAL		0.00721	ug/m^3	ASR8	696488	947798.74	84.07	0	412
ANNUAL		0.00726	ug/m^3	ASR9	694885.56	947984.26	31.05	0	31.05
ANNUAL		0.00764	ug/m^3	ASR10	695384.52	947674	49.98	0	49.98
ANNUAL		0.00549	ug/m^3	ASR11	695000.7	946765.63	23.88	0	23.88
ANNUAL		0.00467	ug/m^3	ASR12	694869.57	946461.77	18.67	0	18.67
ANNUAL		0.02578	ug/m^3	ASR13	693526.2	945006.46	10	0	10
ANNUAL		0.00947	ug/m^3	ASR14	694703.24	945080.03	11.98	0	11.98
ANNUAL		0.00239	ug/m^3	ASR15	694392.99	945937.22	12.45	0	12.45
ANNUAL		0.02925	ug/m^3	ASR16	692919.88	944562.09	12	0	12
ANNUAL		0.05146	ug/m^3	ASR17	693495.39	943543.88	32.55	0	32.55

ANNUAL		0.06125	ug/m^3	ASR17	694309.96	944004.29	38.67	0	38.67
ANNUAL		0.01303	ug/m^3	ASR18	691826.41	944637.35	7.27	0	7.27
ANNUAL		0.01147	ug/m^3	ASR19	695824.34	944433.55	21.58	0	30
1-HR	1ST	0.70501	ug/m^3	ASR1	694835.42	949528.49	13.99	0	431
1-HR	1ST	0.75651	ug/m^3	ASR2	695328.44	948995.6	22.96	0	431
1-HR	1ST	0.59109	ug/m^3	ASR3	695068.83	950516.82	38.47	0	431
1-HR	1ST	0.78374	ug/m^3	ASR4	694594.5	949228.47	9.98	0	431
1-HR	1ST	0.68264	ug/m^3	ASR5	696037.01	949244.46	97.99	0	431
1-HR	1ST	0.78625	ug/m^3	ASR6	695589.23	948252.93	42.62	0	431

TSP - Concentration - Source Group: ALL

Averaging Period	Rank	Peak	Units	Receptor ID	X (m)	Y (m)	ZELEV (m)	ZFLAG (m)	ZHILL (m)
1-HR	1ST	0.81242	ug/m^3	ASR7	695630.81	947993.85	48.39	0	421
1-HR	1ST	0.67866	ug/m^3	ASR8	696488	947798.74	84.07	0	412
1-HR	1ST	0.88334	ug/m^3	ASR9	694885.56	947984.26	31.05	0	31.05
1-HR	1ST	0.85457	ug/m^3	ASR10	695384.52	947674	49.98	0	49.98
1-HR	1ST	0.90655	ug/m^3	ASR11	695000.7	946765.63	23.88	0	23.88
1-HR	1ST	0.97382	ug/m^3	ASR12	694869.57	946461.77	18.67	0	18.67
1-HR	1ST	0.80227	ug/m^3	ASR13	693526.2	945006.46	10	0	10
1-HR	1ST	0.88226	ug/m^3	ASR14	694703.24	945080.03	11.98	0	11.98
1-HR	1ST	0.7508	ug/m^3	ASR15	694392.99	945937.22	12.45	0	12.45
1-HR	1ST	1.02535	ug/m^3	ASR16	692919.88	944562.09	12	0	12
1-HR	1ST	0.79054	ug/m^3	ASR17	693495.39	943543.88	32.55	0	32.55
1-HR	1ST	0.79962	ug/m^3	ASR17	694309.96	944004.29	38.67	0	38.67
1-HR	1ST	1.01807	ug/m^3	ASR18	691826.41	944637.35	7.27	0	7.27
1-HR	1ST	0.77336	ug/m^3	ASR19	695824.34	944433.55	21.58	0	30

8-HR	1ST	0.55088	ug/m^3	ASR1	694835.42	949528.49	13.99	0	431
8-HR	1ST	0.43949	ug/m^3	ASR2	695328.44	948995.6	22.96	0	431
8-HR	1ST	0.42136	ug/m^3	ASR3	695068.83	950516.82	38.47	0	431
8-HR	1ST	0.58621	ug/m^3	ASR4	694594.5	949228.47	9.98	0	431
8-HR	1ST	0.48556	ug/m^3	ASR5	696037.01	949244.46	97.99	0	431
8-HR	1ST	0.56592	ug/m^3	ASR6	695589.23	948252.93	42.62	0	431
8-HR	1ST	0.6242	ug/m^3	ASR7	695630.81	947993.85	48.39	0	421

TSP - Concentration - Source Group: ALL

Averaging Period	Rank	Peak	Units	Receptor ID	X (m)	Y (m)	ZELEV (m)	ZFLAG (m)	ZHILL (m)
8-HR	1ST	0.42896	ug/m^3	ASR8	696488	947798.74	84.07	0	412
8-HR	1ST	0.65846	ug/m^3	ASR9	694885.56	947984.26	31.05	0	31.05
8-HR	1ST	0.64861	ug/m^3	ASR10	695384.52	947674	49.98	0	49.98
8-HR	1ST	0.59794	ug/m^3	ASR11	695000.7	946765.63	23.88	0	23.88
8-HR	1ST	0.59051	ug/m^3	ASR12	694869.57	946461.77	18.67	0	18.67
8-HR	1ST	0.43142	ug/m^3	ASR13	693526.2	945006.46	10	0	10
8-HR	1ST	0.37907	ug/m^3	ASR14	694703.24	945080.03	11.98	0	11.98
8-HR	1ST	0.2044	ug/m^3	ASR15	694392.99	945937.22	12.45	0	12.45
8-HR	1ST	0.61813	ug/m^3	ASR16	692919.88	944562.09	12	0	12
8-HR	1ST	0.59231	ug/m^3	ASR17	693495.39	943543.88	32.55	0	32.55
8-HR	1ST	0.57593	ug/m^3	ASR17	694309.96	944004.29	38.67	0	38.67
8-HR	1ST	0.71368	ug/m^3	ASR18	691826.41	944637.35	7.27	0	7.27
8-HR	1ST	0.42039	ug/m^3	ASR19	695824.34	944433.55	21.58	0	30
24-HR	1ST	0.21699	ug/m^3	ASR1	694835.42	949528.49	13.99	0	431
24-HR	1ST	0.17099	ug/m^3	ASR2	695328.44	948995.6	22.96	0	431
24-HR	1ST	0.16506	ug/m^3	ASR3	695068.83	950516.82	38.47	0	431

Averaging Period	Rank	Peak	Units	Receptor ID	X (m)	Y (m)	ZELEV (m)	ZFLAG (m)	ZHILL (m)
24-HR	1ST	0.22986	ug/m^3	ASR4	694594.5	949228.47	9.98	0	431
24-HR	1ST	0.18918	ug/m^3	ASR5	696037.01	949244.46	97.99	0	431
24-HR	1ST	0.2263	ug/m^3	ASR6	695589.23	948252.93	42.62	0	431
24-HR	1ST	0.25236	ug/m^3	ASR7	695630.81	947993.85	48.39	0	421
24-HR	1ST	0.21674	ug/m^3	ASR8	696488	947798.74	84.07	0	412
TSP - Concentration - Source Group: ALL									
Averaging Period	**Rank**	**Peak**	**Units**	**Receptor ID**	**X (m)**	**Y (m)**	**ZELEV (m)**	**ZFLAG (m)**	**ZHILL (m)**
24-HR	1ST	0.25761	ug/m^3	ASR9	694885.56	947984.26	31.05	0	31.05
24-HR	1ST	0.26042	ug/m^3	ASR10	695384.52	947674	49.98	0	49.98
24-HR	1ST	0.23502	ug/m^3	ASR11	695000.7	946765.63	23.88	0	23.88
24-HR	1ST	0.23087	ug/m^3	ASR12	694869.57	946461.77	18.67	0	18.67
24-HR	1ST	0.16779	ug/m^3	ASR13	693526.2	945006.46	10	0	10
24-HR	1ST	0.14742	ug/m^3	ASR14	694703.24	945080.03	11.98	0	11.98
24-HR	1ST	0.07949	ug/m^3	ASR15	694392.99	945937.22	12.45	0	12.45
24-HR	1ST	0.22142	ug/m^3	ASR16	692919.88	944562.09	12	0	12
24-HR	1ST	0.23034	ug/m^3	ASR17	693495.39	943543.88	32.55	0	32.55
24-HR	1ST	0.22545	ug/m^3	ASR17	694309.96	944004.29	38.67	0	38.67
24-HR	1ST	0.3418	ug/m^3	ASR18	691826.41	944637.35	7.27	0	7.27
24-HR	1ST	0.16349	ug/m^3	ASR19	695824.34	944433.55	21.58	0	30
ANNUAL		0.00303	ug/m^3	ASR1	694835.42	949528.49	13.99	0	431
ANNUAL		0.00471	ug/m^3	ASR2	695328.44	948995.6	22.96	0	431
ANNUAL		0.00268	ug/m^3	ASR3	695068.83	950516.82	38.47	0	431
ANNUAL		0.00289	ug/m^3	ASR4	694594.5	949228.47	9.98	0	431
ANNUAL		0.00683	ug/m^3	ASR5	696037.01	949244.46	97.99	0	431
ANNUAL		0.00734	ug/m^3	ASR6	695589.23	948252.93	42.62	0	431

ANNUAL	0.0077	ug/m^3	ASR7	695630.81	947993.85	48.39	0	421
ANNUAL	0.00721	ug/m^3	ASR8	696488	947798.74	84.07	0	412
ANNUAL	0.00726	ug/m^3	ASR9	694885.56	947984.26	31.05	0	31.05

Table 2.3-11 The Modelling Runs Input Data

Air Dispersion Modelling Data Requirements

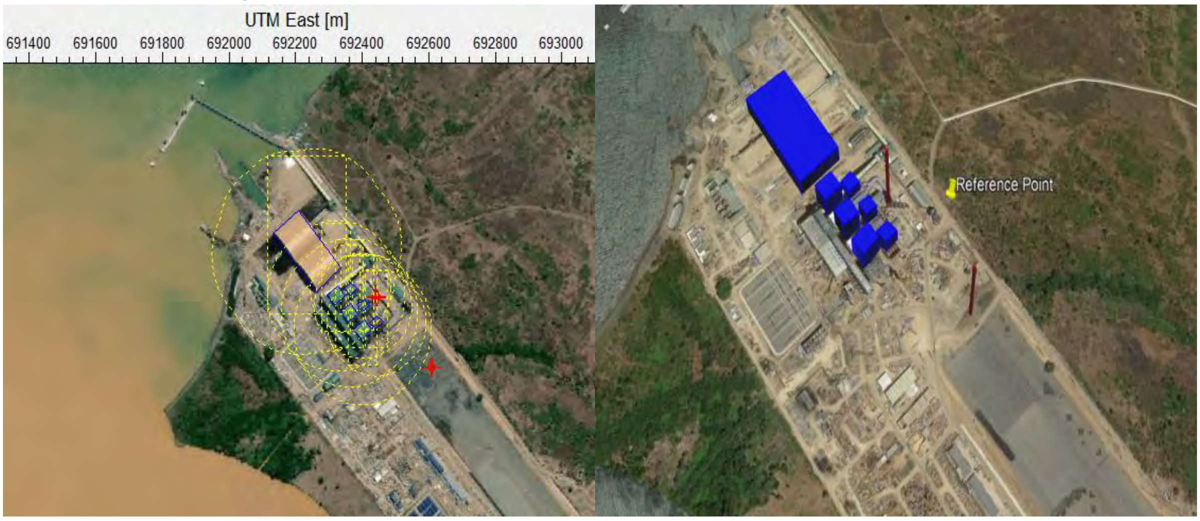
Individual Bundle

No.	1) For Point Sourse Modelling	Existing			Expansion		
		Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6
1	Rated Capacity, MW	135	135	135	135	135	135
2	Coordinate of Stack/s	124°44'54.81"E, 8°33'41.11"N			124°45'0.07"E, 8°33'34.98"N		
3	No. of Stacks	**1**		1	1	1	1
4	Plant Stack Diameter, m.	**5.2**		3.7	3.7	3.7	3.7
5	Plant Stack Height, m.	120		120	120	120	120
6	Plant Stack Temperature, °C	144		144	144	144	144
7	Pollutant Source Strength, g/s						
	NO2, g/sec	**49.2**		0.5	29.68	29.68	29.68
	CO, g/sec	**177.1**		1.8	10.76	10.76	10.76
	SO2, g/sec	**105.7**		3.4	67.12	67.12	67.12
	TSP, g/sec	**12.9**		6.4	11.59	11.59	11.59
	Volumetric Flow Rate, Ncm/min	**25,484.66**		12,902.55	12,902.55	12,902.55	12,902.55
8	Guaranteed Stack Emission Concentration in mg/Ncm for the following:						
	NO2	**424.74**		215.04	138.04	138.04	138.04
	CO	**212.37**		107.52	50.02	50.02	50.02
	SO2	**297.32**		150.53	312.14	312.14	312.14
	TSP	**63.71**		32.26	53.88	53.88	53.88

Basis for the Pollution Strenght is averaged CEMS data for 2019

Plate 2.3-1 The Bundled Individual Stack

Plate 2.3-2 Image of the Source Influence Zone



The Area Sensitive Receptors (ASRs)

Based on the Air Dispersion Run, the ASRs are determined as shown in the map below.

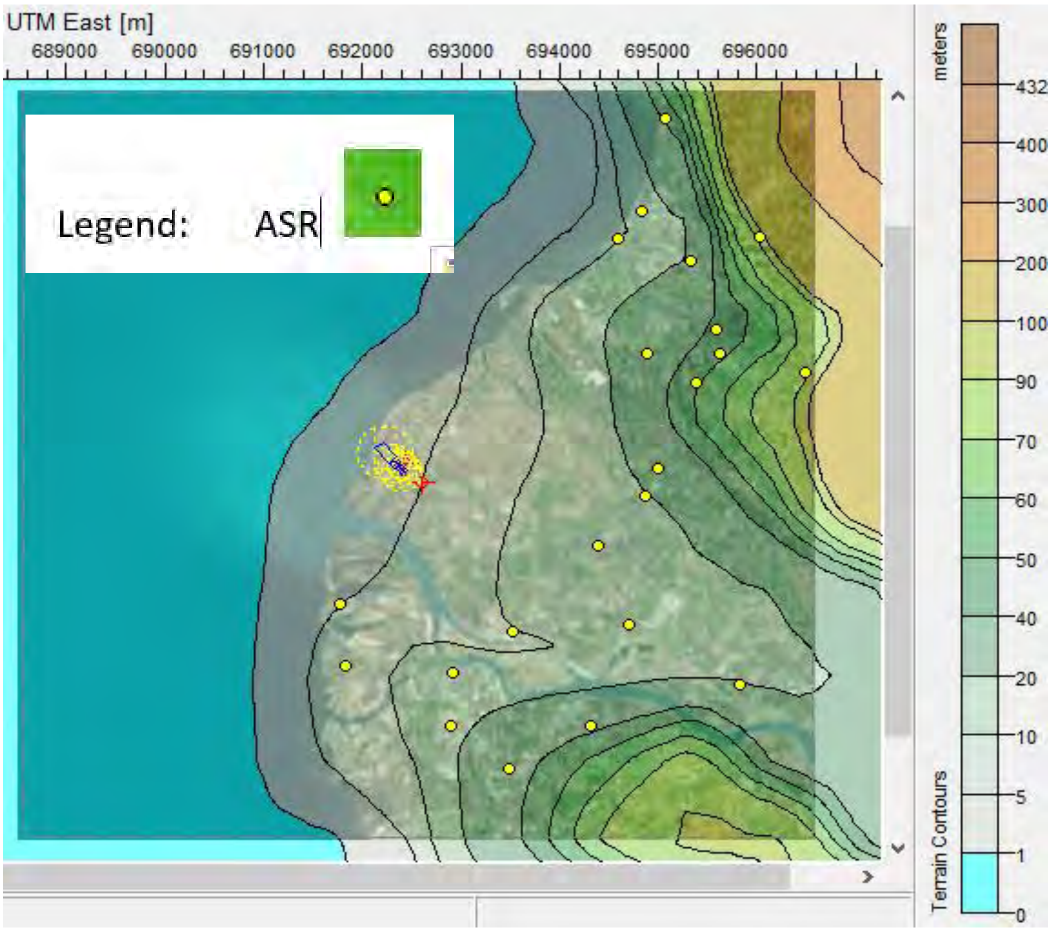


Figure 2.3-5 Map of the Area Sensitive Receptors in Isophlet Diagram

Table 2.3-12 Coordinates of the ASRs in WGS 84 UTM

Longtitude	Latitude	ASR's
694835.4	949528.5	ASR1
695328.4	948995.6	ASR2
695068.8	950516.8	ASR3
694594.5	949228.5	ASR4
696037.0	949244.5	ASR5
695589.2	948252.9	ASR6
695630.8	947993.9	ASR7
696488.0	947798.7	ASR8
694885.6	947984.3	ASR9
695384.5	947674.0	ASR10
695000.7	946765.6	ASR11
694869.6	946461.8	ASR12
693526.2	945006.5	ASR13
694703.2	945080.0	ASR14
694393.0	945937.2	ASR15
692919.9	944562.1	ASR16
693495.4	943543.9	ASR17
694310.0	944004.3	ASR18
691826.4	944637.4	ASR19
695824.3	944433.6	ASR20

Longtitude	Latitude	ASR's
124.77037881	8.58597289	ASR1
124.77483480	8.58113448	ASR2
124.77254050	8.59489857	ASR3
124.76817784	8.58327047	ASR4
124.78128152	8.58335472	ASR5
124.77717244	8.57440916	ASR6
124.77753924	8.57206510	ASR7
124.78531701	8.57026520	ASR8
124.77076957	8.57200950	ASR9
124.77528872	8.56918365	ASR10
124.77176441	8.56098714	ASR11
124.77056066	8.55824541	ASR12
124.75829859	8.54514360	ASR13
124.76899226	8.54576006	ASR14
124.76621007	8.55352276	ASR15
124.75277324	8.54115100	ASR16
124.75795821	8.53192165	ASR17
124.76537553	8.53605061	ASR18
124.74284470	8.54187623	ASR19
124.77914766	8.53986863	ASR20

Map of the ASRs in Google Earth

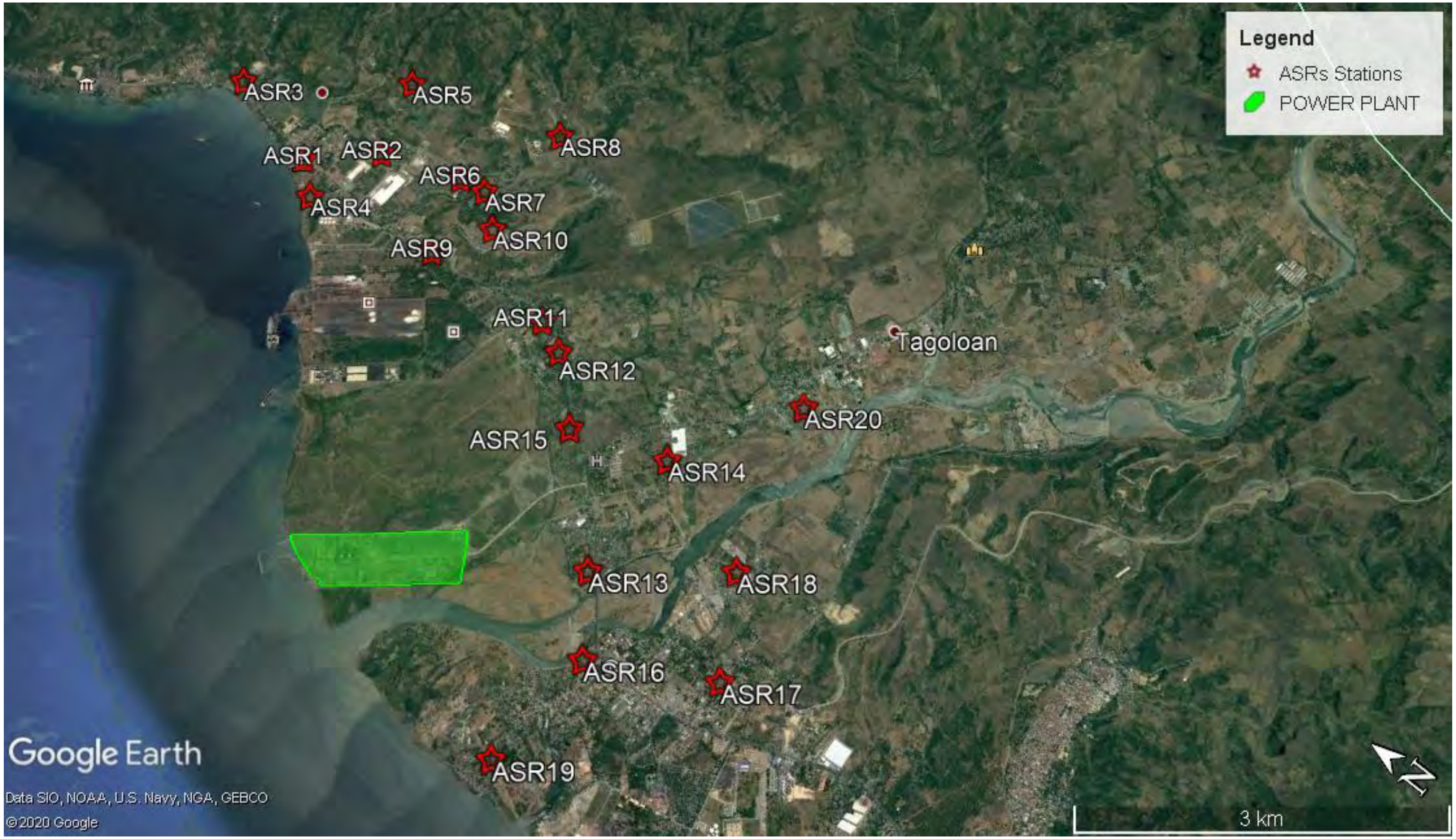


Figure 2.3-6 The ASRs in a Google Earth Map

KEY RESULTS OF THE AIR DISPERSION MODELING

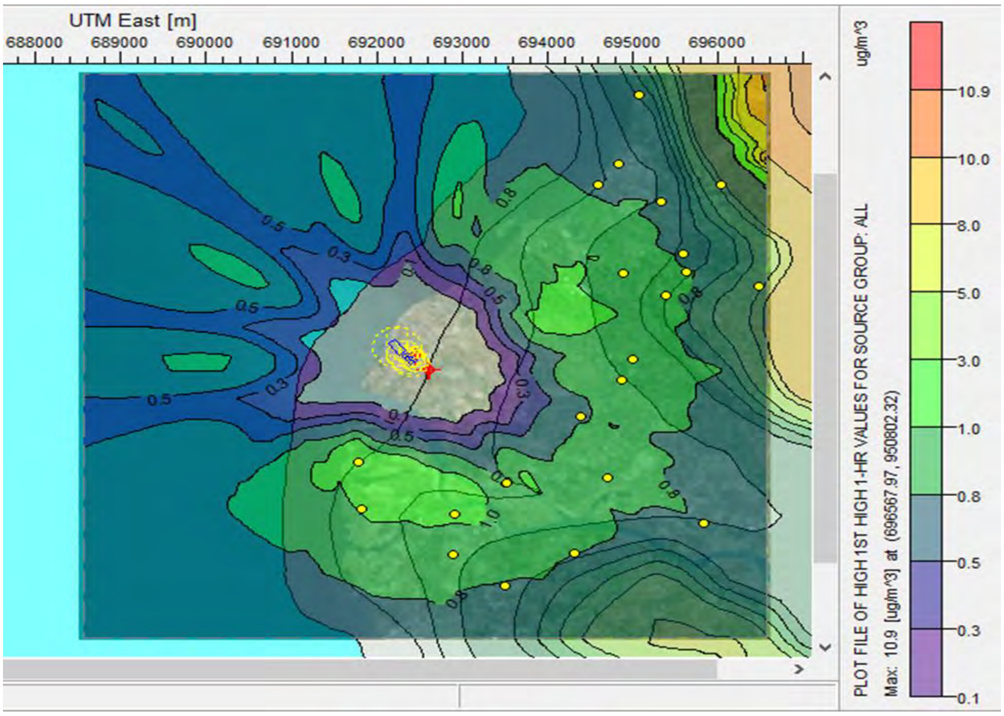


Figure 2.3-7 Isophlets of the Highest 1-hr TSP values

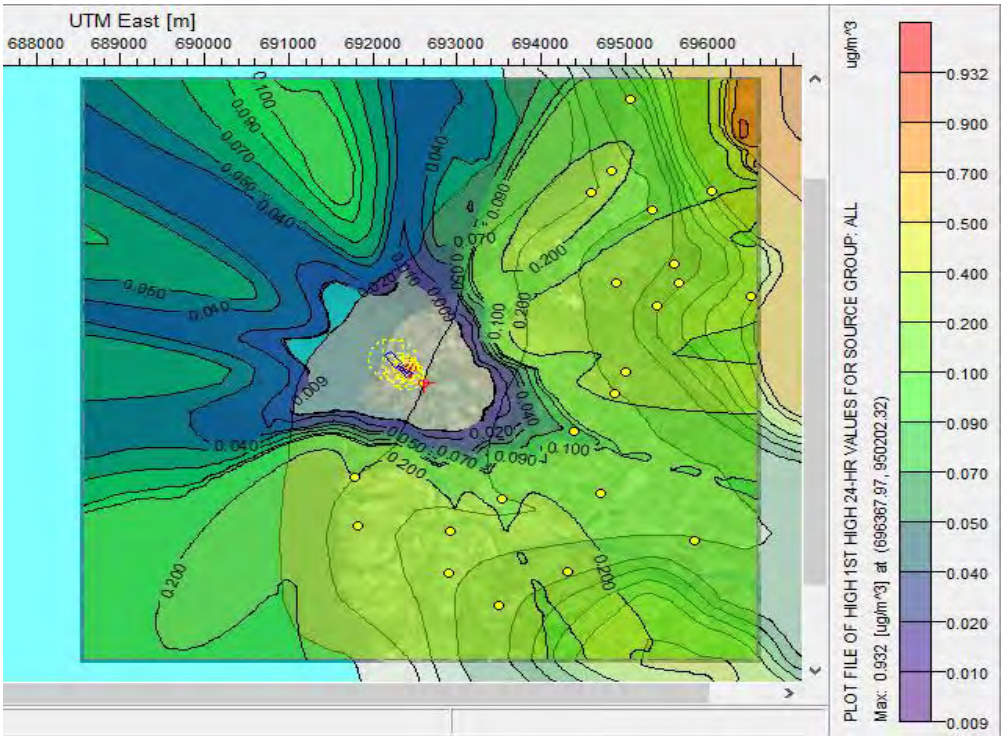


Figure 2.3-8 Isophlets of Highest 24-hr TSP values

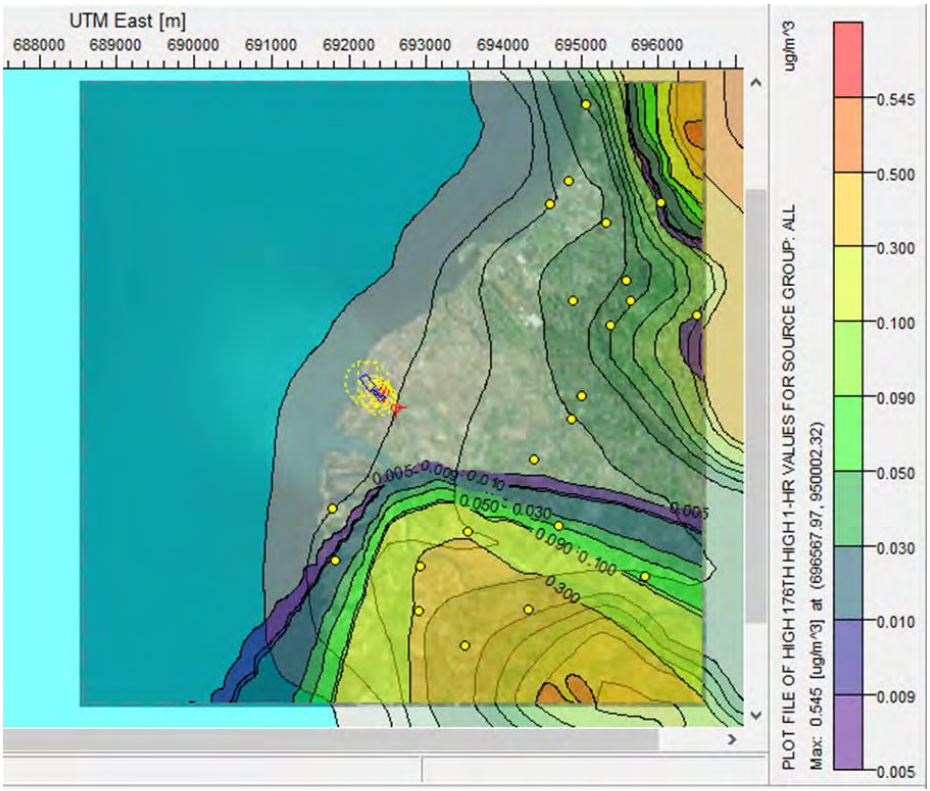


Figure 2.3-9 Isophlets of the 1 Hr 98th TSP Percentile

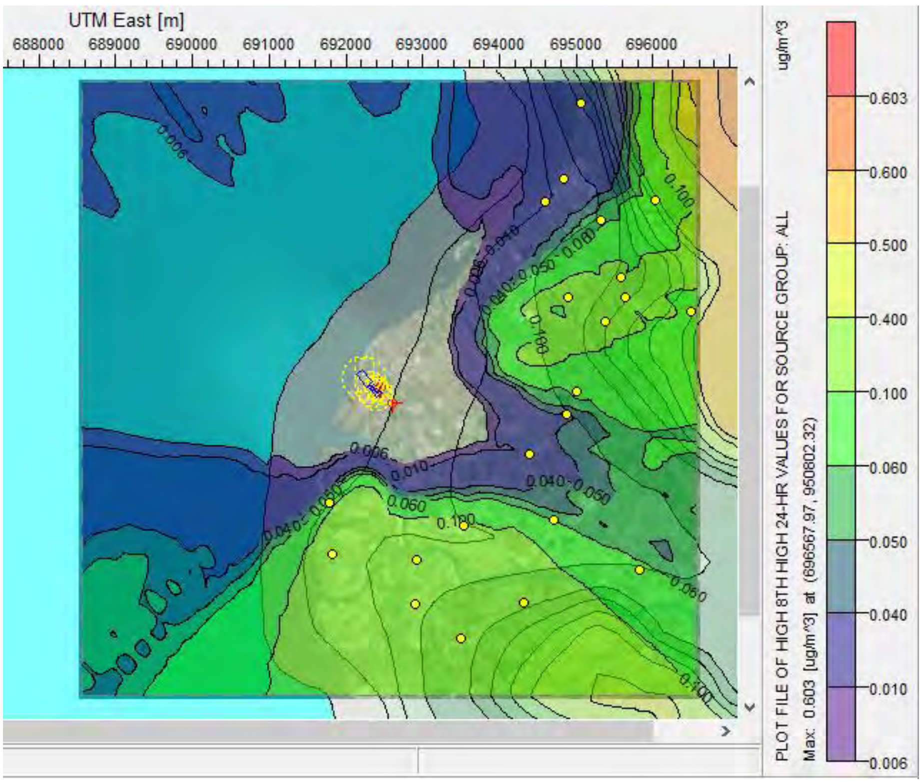


Figure 2.310 Isophlets of the 24-hour 98th Percentile

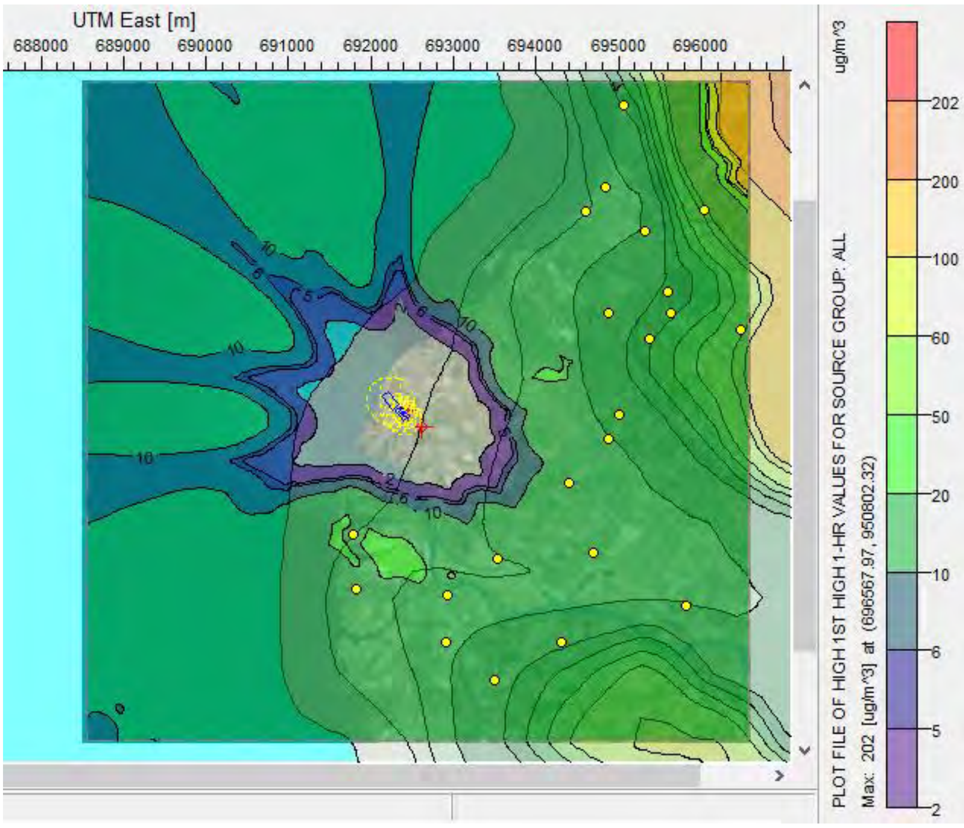


Figure 2.3-11 Isophlets of the 1 hr CO GL

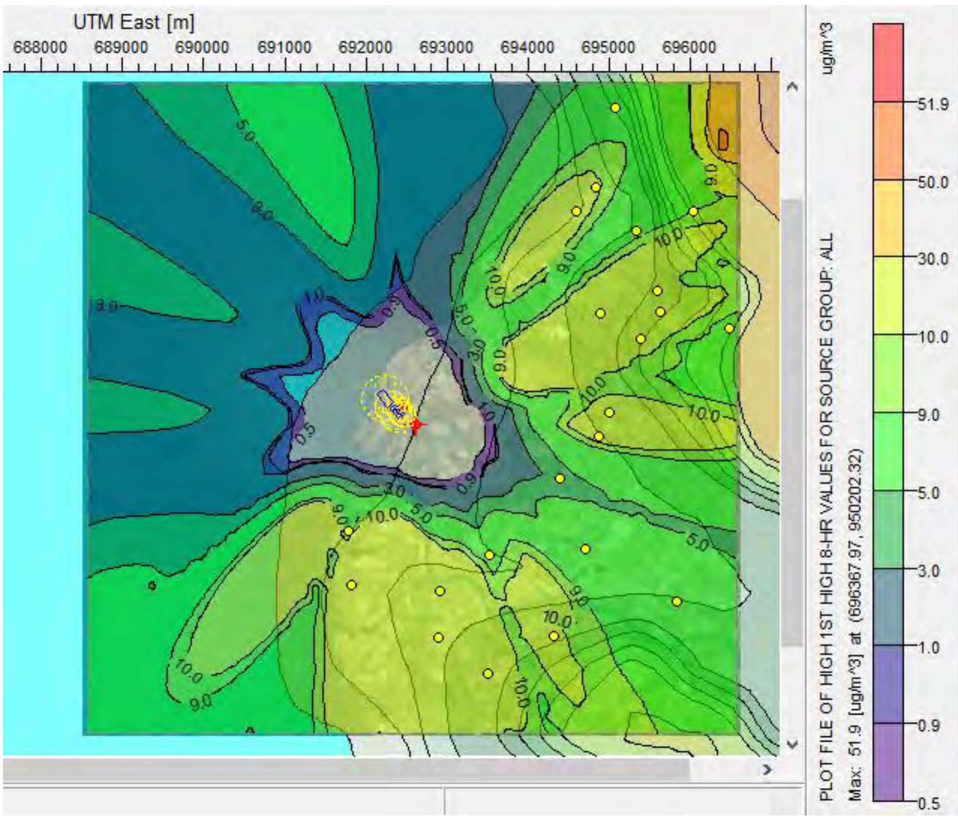


Figure 2.3-12 Isophlets of the 8 hr CO GLCs

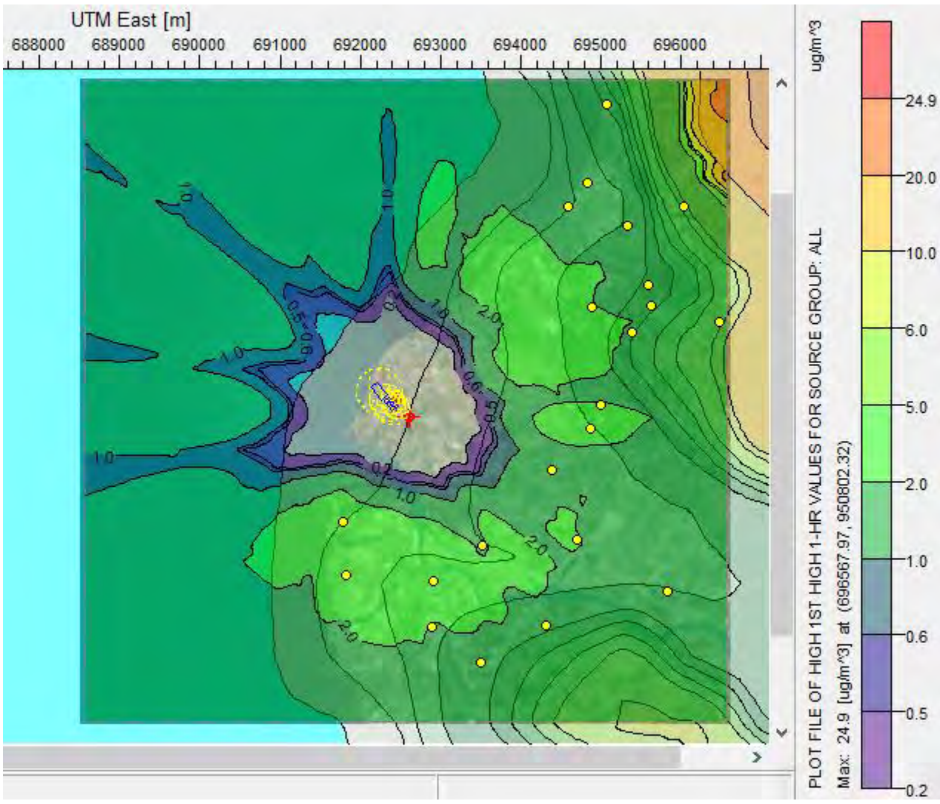


Figure 2.3-13 Isophlets of the 1- hr NOX GLCs

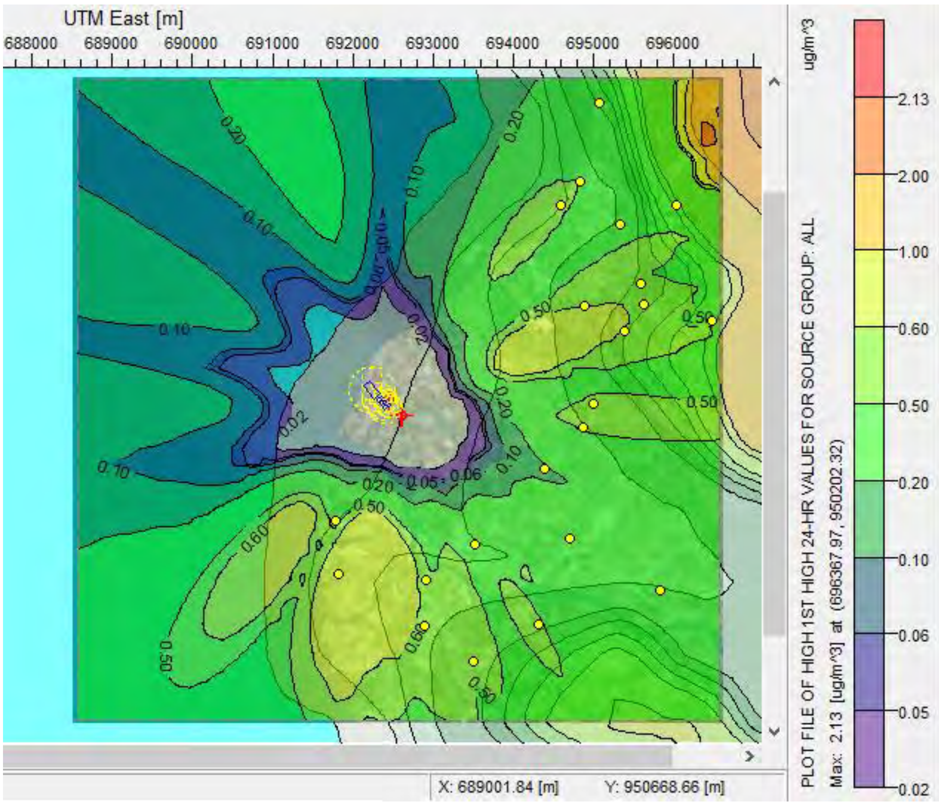


Figure 2.3-14 Isophlets of the 24- hr NOX GLCs

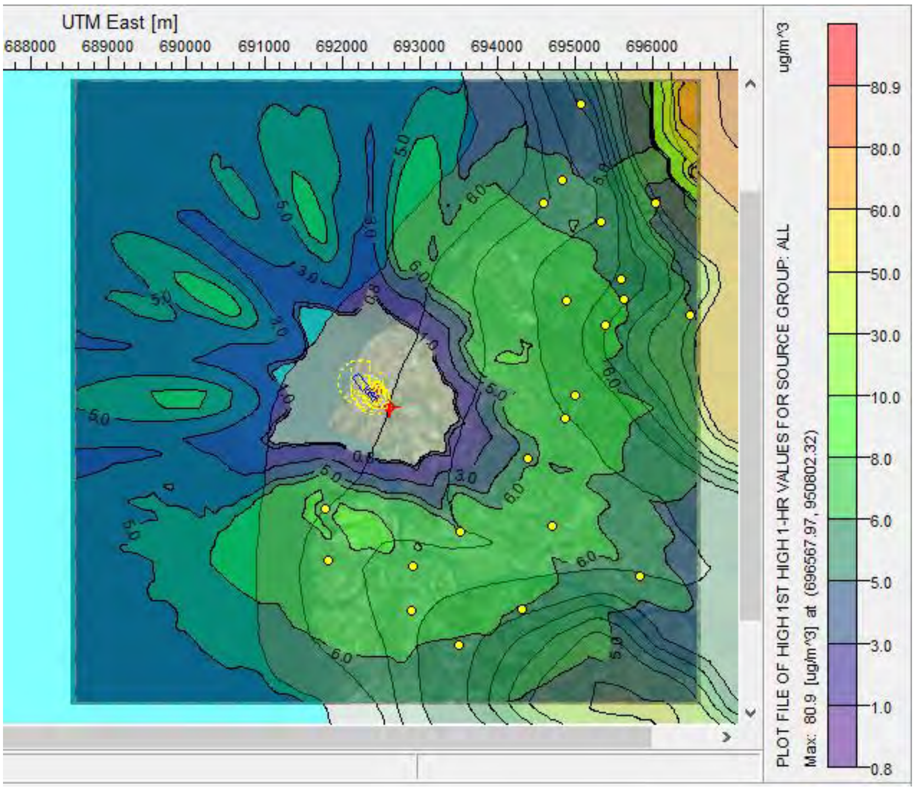


Figure 2.3-15 Isophlets of the 1 hr SOx GLCs

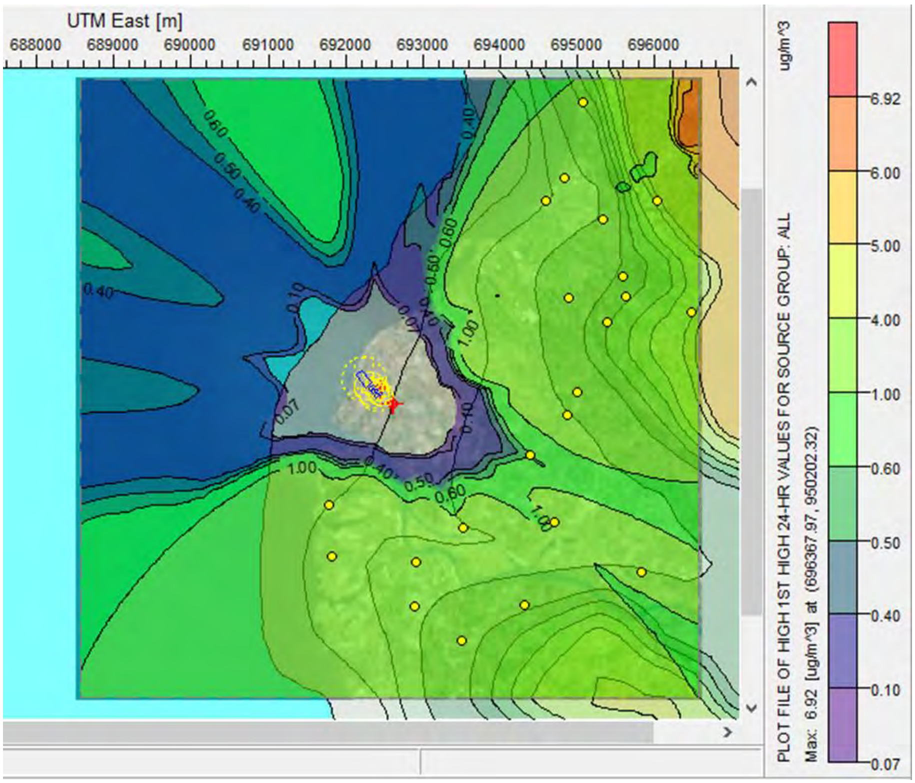


Figure 2.3.16 Isophlets of the SOx 24 hr GLCs

Table Summary of Key Results.

Table 2.3-13 1 – Hr GLC Values

COMPARISON OF THE PREDICTED MAXIMUM CO, NO_2, SO_2 AND TSP Ground Level Concentration (GLC) WITH THE DENR STANDARDS FOR 1-HR AVERAGING TIME

UTM COORDINATE, M		Averaging Time	CRITERIA POLLUTANT	PREDICTED AMBIENT MAXIMUM Ground Level Concentration (GLC) CONC.	DENR AMBIENT STD	Distance From Map Domain Center, m.	Direction
X (m)	Y (m)			ug/Ncm	ug/Ncm		
696567.97	950802.32	1-HR	CO	202.3	35000	5656.9	NE
696567.97	950802.32		NO_2	24.9	260	5656.9	NE
696567.97	950802.32		SO_2	80.9	340	5656.9	NE
696567.97	950802.32		TSP	10.9	300	5656.9	NE

Table 2.3-14 24-hr GLCs

COMPARISON OF THE PREDICTED MAXIMUM CO, NO_2, SO_2 AND TSP Ground Level Concentration (GLC) WITH THE DENR STANDARDS FOR 24-HR AVERAGING TIME

UTM COORDINATE, M		Averaging Time	CRITERIA POLLUTANT	PREDICTED AMBIENT MAXIMUM Ground Level Concentration (GLC) CONC.	DENR AMBIENT STD	Distance From Map Domain Center, m.	Direction
X (m)	Y (m)			ug/Ncm	ug/Ncm		
656367.97	950202.32	24-HR	CO	51.9	10000	5099.0	NE
656367.97	950202.32		NO_2	2.1	150	5099.0	NE
656367.97	950202.32		SO_2	6.9	180	5099.0	NE
656367.97	950202.32		TSP	0.9	150	5099.0	NE

MAJOR CONCLUSIONS

The simultaneous operation of 6 x 135 MW CFB Coal Power Plant will not degrade the ambient air environment.

The ASRs are distant from the source of emissions and are not adversely affected.

Worst case scenario of failure of Air Pollution Control Facility

The worst case scenario is the failure of the Electrostatic Precipitaor
This is deemed, however, not to be a significant concern because:

There are back up facilities for the ESPs
Shutdown of the pollution (i.e. TSPs and PMs) source is readily undertaken
Even in worst case scenarios, these are short term and will involve the temporary increase in a temporary concentrtion increase to

0.9 ug/Ncm / 0.01 = 90 ug/Ncm

which is still much lower than the standard of 150 ug/Ncm (Reference : Table 2.3-9) above.

Sampling sites for monitoring purposes based on the above Air Dispersion Modeling results.

Figure 2.3-16 is the map showing the monitoring stations, the final sites to be subject to prospective discussions by the MMT. The rationale for this map are (a) location of the ASRs and (b) wind direction as indicated by the Windrose diagram, inset in this figure

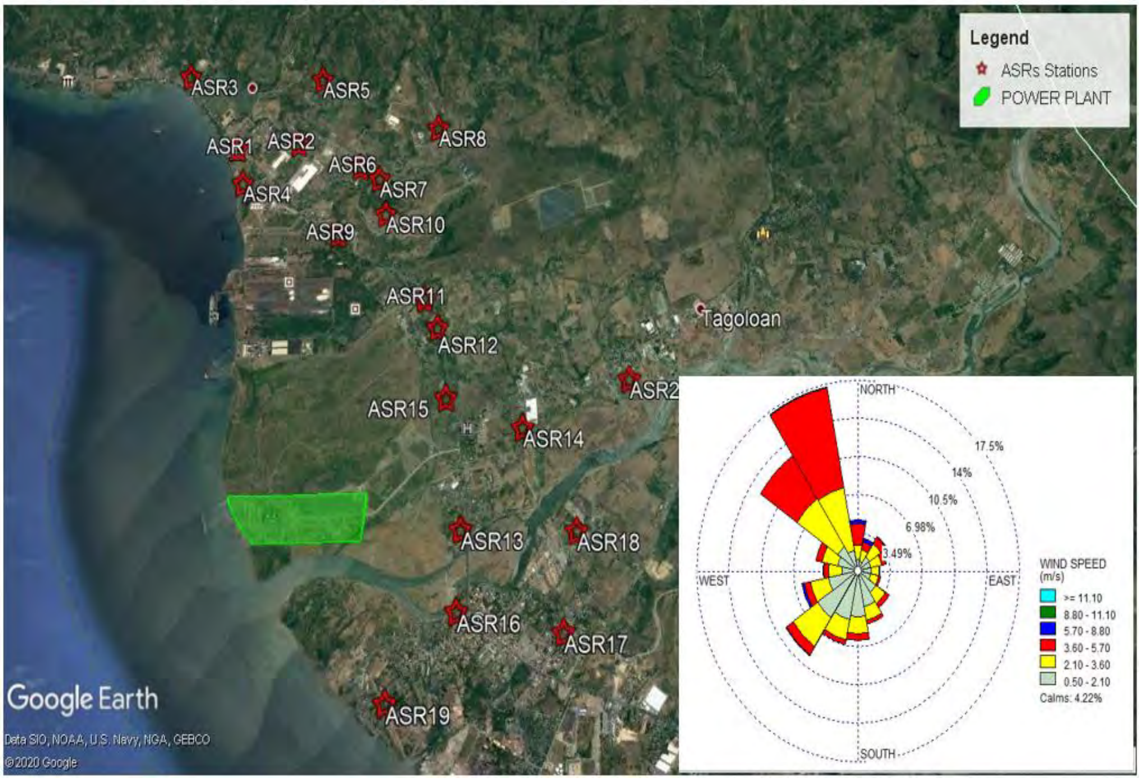


Figure 2.3-17 Map showing the Monitoring Stations

The Buffer Zone referenced to Potential Air Pollution.

The designation of the buffer zone is based on the location of the ASRs and is indicated in the map hereunder given.

Figure 2.3-18 PROPOSED BUFFER ZONE FOR POTENTIAL AIR POLLUTION DOMAIN

Comparison of changes in air quality over time using statistical tools e.g. across sampling sites overtime and test for significant changes.

Based on the regular monitoring and from the SMRs thus reported Table 2.3-11 and Figure 2.3-18 show the historical values of the results. These result show compliances to the limits prescribed in the Philippine Clean Air Act.

Table 2.3-15 The Historical Trend of Values of Baseline Air Parameters

TIME	UNIT 1					
	SOx	NOx	CO	O2	PM	OPACITY
DAO 2000-81 Limits	700	1000	500	10	150	20
2018	323.21270	125.09773	55.01996	5.80977	45.15083	4.40789
2019	140.99180	213.40330	20.69353	2.48942	32.97652	7.74388
2020	124.41269	137.54429	25.52292	2.76291	29.98225	3.67797
TIME	UNIT 2					
	SOx	NOx	CO	O2	PM	OPACITY
DAO 2000-81 Limits	700	1000	500	10	150	20
2018	279.38735	93.20004	24.78836	10.86062	482.14827	4.95560
2019	174.24568	192.70837	22.74645	-4299.21179	57.71226	3.01852
2020	181.07884	136.49313	8.83169	17.32438	71.38680	3.23880
TIME	UNIT 3					
	SOx	NOx	CO	O2	PM	OPACITY
DAO 2000-81 Limits	700	1000	500	10	150	20
2018	272.08726	128.25578	71.87942	6.86690	18.19064	11.37884
2019	182.05990	211.53205	25.77636	4.54254	25.45942	2.95726
2020	127.29129	149.18334	16.07409	1.26003	24.17867	3.90045

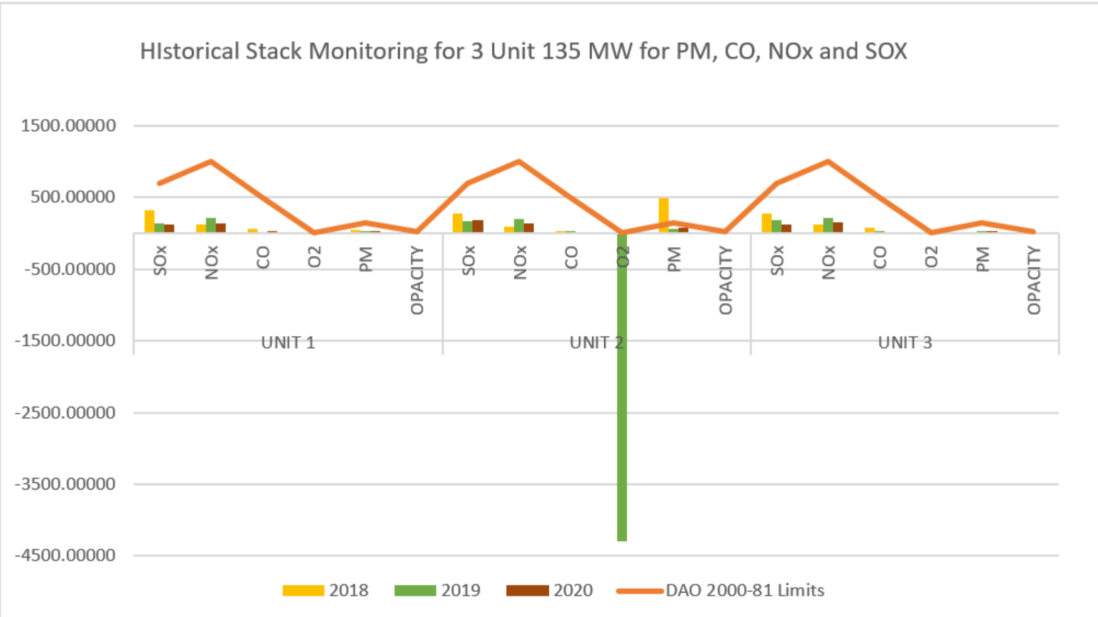


Figure 2.3-19 Graph of the Historical Trend of Values of Baseline Air Parameters

The sampling station map for the baseline tests is provided in Figure 2.3-19,

The observed negative value of the Oxygen in the above graph was the malfunction of the card in the machine.

Figure 2.3-20 The Sampling Station Map

Discussion on the Ash storage and disposal facility and transport

There are no concerns on air pollution related to the storage of ash, disposal and transport. These activities are more related to ground water pollution and soil contamination.

The layouts of the project facilities in Figures 1-15 and 1-16 provides the basis for the discussions.
Figure 1-15 Proposed Layout/Footprints of Project Facilities
Figure 1-16 Layout of Project Facilities Showing More Details

Ash Transport

- Bottom Ash – Through conveyor system
- Fly Ash – Generated in the Electrostatic Precipitator and directly discharged to trucks for ultimate disposal

Ash Storage

- Bottom Ash – Stored and Disposed/Managed in Ash Repository System
- Fly Ash – Directly disposed to delivery trucks. Fly Ash bins are also provided for temporary storage when needed.

Ash Disposal/Management

- Bottom Ash

An important aspect of the impact management system, the existing and successful operation of the ash management system shall continue to be adopted and further enhancement undertaken if the need arises.

The base design of permanent ash disposal repositories shall be compliant with the environmental regulation framework of the Philippines government and local authorities. The ash repository capacity shall be based on a life span of 30 years

An impermeable layer of HDPE liner shall be applied on the compacted ground and another approximately 100mm layer of sand before placing the gravel layer of approximately 300mm.

The area shall be designed with sufficient drainage system in order to drain out the water collected above the impervious HDPE membrane. The said waste water shall be directed to A Coal Dust Settlement basin before discharging them into natural water course in order to ensure compliance to the of permissible level of Total Suspended Solid TSS in accordance to the Philippines Environmental Code and Standard.

The ash repositories shall be raised above grade with a robust working surface that facilitates running on and off of trucks and front end loaders. These shall be designed to take account of any long term settlement expected.

- Fly Ash

This is basically reused by third parties, principally the Cement Manufacturing Plants as standard raw materials in cement production.

2.3.2.2 Increase in ambient noise

Baseline Data

Characterization of ambient noise level; *Use DENR standard methods and procedures for sampling and measurement; identification and assessment of impact to ambient noise level using noise attenuation modeling and comparing it with relevant standards.*

Sampling site map (see Figure 2.3-19)

Noise Sampling Stations:

1. *Ash Yard South Side*
2. *Balacana Elementary School, Villanueva, Misamis Oriental*
3. *Brgy. San Martin, Villanueva, Misamis Oriental*
4. *Brgy. Sta. Cruz, Tagoloan, Misamis Oriental*
5. *Jetty Area near Transfer Tower 1*
6. Zone 6A Brgy. Baluarte, Togoloan Misamis Oriental

Table 2.3-16 Ambient Noise Quality Monitoring during Morning

Location of Monitoring Station	Morning				
	2016	2017	2018	2019	2020
DENR Standard	70				
Jetty Area near Transfer Tower 1	55	54	59	59	54
Ash Yard South Side	52	46	51	51	50
Balacas Elementary School, Villanueva Misamis Oriental	50	57	52	52	47
Brgy. San Martin, Villanueva Misamis Oriental	49	48	41	41	44
Brgy. Sta.Cruz, Tagoloan Misamis Oriental		48	49	49	49
Zone 6A Brgy. Baluarte, Togoloan Misamis Oriental		53	56	56	55

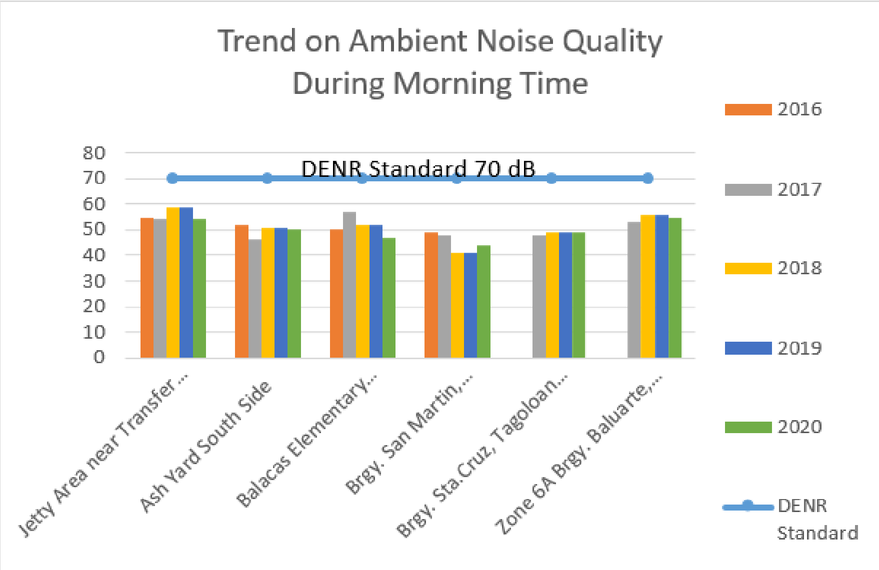


Figure 2.3-21 Annual Noise quality during Morning.

Table 2.3-17 Ambient Noise Quality Monitoring during Daytime

Location of Monitoring Station	Daytime				
	2016	2017	2018	2019	2020
DENR Standard	75				
Jetty Area near Transfer Tower 1	53	53	58	58	49
Ash Yard South Side	59	47	49	49	47
Balacas Elementary School, Villanueva Misamis Oriental	60	60	53	53	49
Brgy. San Martin, Villanueva Misamis Oriental	59	48	58	58	47
Brgy. Sta.Cruz, Tagoloan Misamis Oriental		48	51	51	46
Zone 6A Brgy. Baluarte, Togoloan Misamis Oriental		55	54	54	50

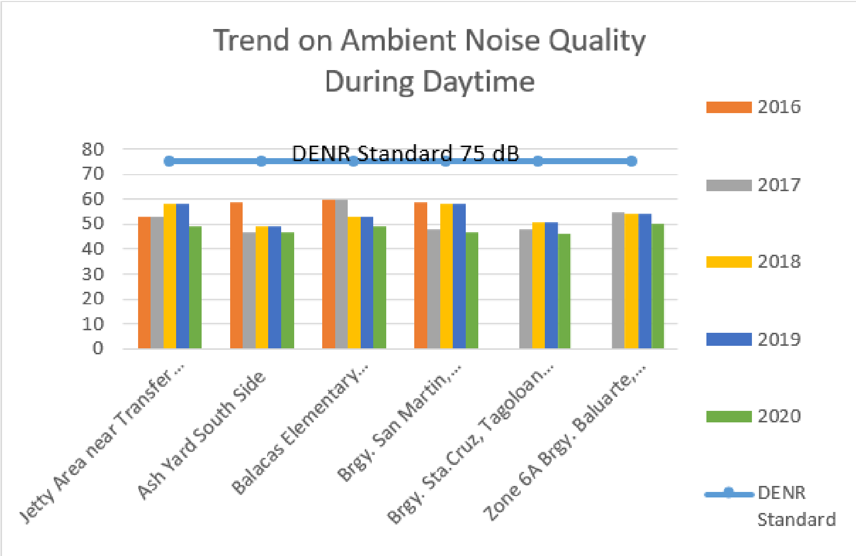


Figure 2.3-22 Annual Noise quality during Daytime.

Table 2.3-18 Ambient Noise Quality Monitoring during Evening

Location of Monitoring Station	Evening				
	2016	2017	2018	2019	2020
DENR Standard	70				
Jetty Area near Transfer Tower 1	55	54	59	59	53
Ash Yard South Side	64	46	50	50	50
Balacas Elementary School, Villanueva Misamis Oriental	56	55	49	49	45
Brgy. San Martin, Villanueva Misamis Oriental	53	47	51	51	47
Brgy. Sta.Cruz, Tagoloan Misamis Oriental		45	50	50	47
Zone 6A Brgy. Baluarte, Togoloan Misamis Oriental		50	52	52	50

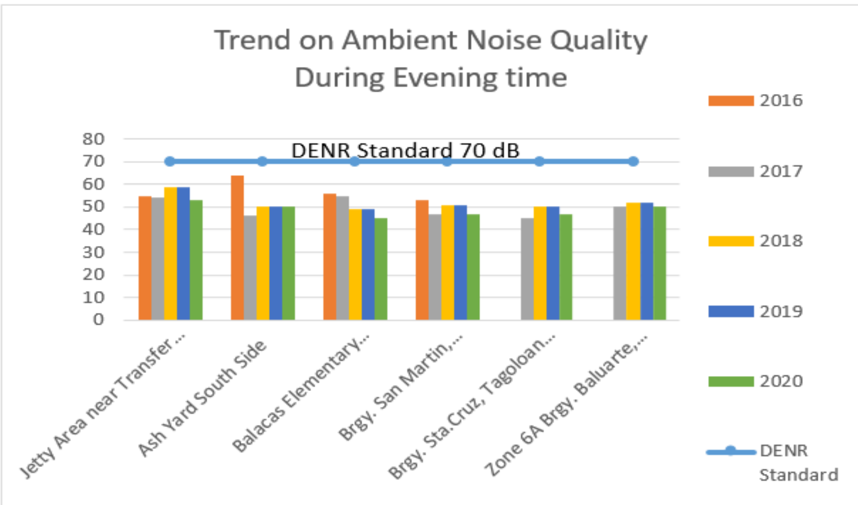


Figure 2.3-23 Annual Noise quality during Evening.

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Table 2.3-19 Ambient Noise Quality Monitoring during Nighttime

Location of Monitoring Station	Nighttime				
	2016	2017	2018	2019	2020
DENR Standard	65				
Jetty Area near Transfer Tower 1	49	52	60	60	59
Ash Yard South Side	53	45	48	48	49
Balacas Elementary School, Villanueva Misamis Oriental	51	41	41	41	41
Brgy. San Martin, Villanueva Misamis Oriental	48	48	42	42	44
Brgy. Sta.Cruz, Tagoloan Misamis Oriental		46	42	42	41
Zone 6A Brgy. Baluarte, Togoloan Misamis Oriental		47	42	42	45

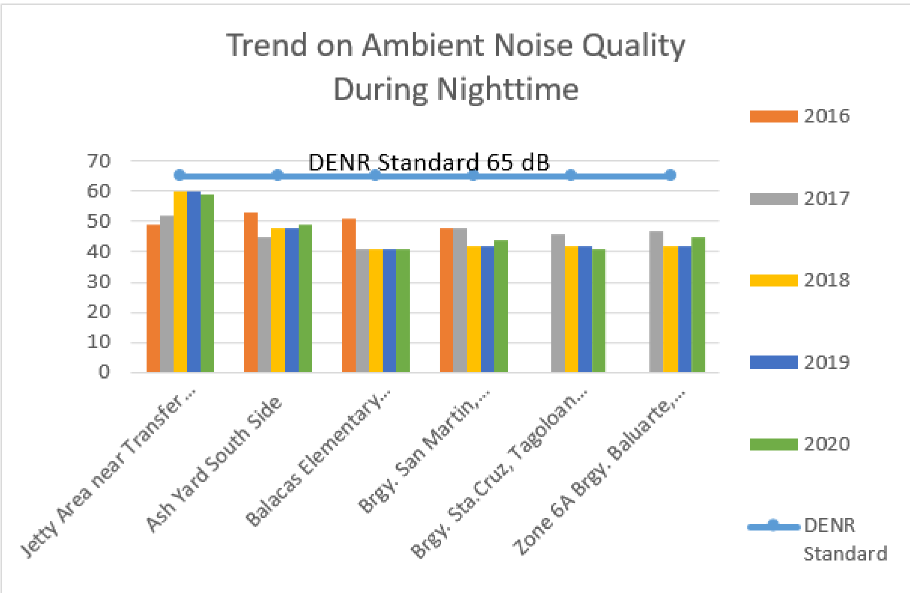


Figure 2.3-24 Annual Noise quality during Night time.

Assessment Methodology/Approach

Identification and assessment of impact to ambient noise level using noise attenuation modelling and comparing it with relevant standards. (applicable if estimated total noise level will exceed noise standard).

NOISE AND SOUND

Sound is a sensation caused in the ear by the vibration of the surrounding air or other medium.
Noise on the other hand is an unpleasant sound especially a loud one.

Sound has a positive connation whereas noise has a negative connotation.

The Components of Sound

- **Intensity**

Sound is a wave and waves have amplitude, or height. Amplitude is a measure of energy. The more energy a wave has, the higher its amplitude. As amplitude increases, intensity also increases. Intensity is the amount of energy a sound has over an area. It is measured in terms of “decibels”. A whisper is about 10 decibels while thunder is 100 decibels. 120 decibels is the threshold of pain.

- **Pitch**

Pitch helps distinguish between low and high sounds. **Pitch** depends on the frequency of a sound wave. **Frequency** is the number of wavelengths that fit into one unit of time. A wavelength is equal to one compression and one rarefaction. Frequencies are measured in hertz. One hertz is equal to one cycle of compression and rarefaction per second. High sounds have high frequencies and low sounds have low frequencies. Thunder has a frequency of only 50 hertz, while a whistle can have a frequency of 1,000 hertz.

The human ear is able to hear frequencies of 20 to 20,000 hertz. Sounds that are too high to hear are called **ultrasonic**.

- **Tone & Harmonics**

When a source vibrates, it actually vibrates with many frequencies at the same time. Each of those frequencies produces a wave. Sound quality depends on the combination of different frequencies of sound waves.

A propagating **sound wave** consists of alternating compressions and rarefactions which are detected by a receiver as changes in pressure. Structures in human ears, and also most man-made receptors, are sensitive to these changes in sound pressure (Richardson *et al.*1995, Gordon and Moscrop 1996). **Figure 2.3-24** shows the basic components of a sound wave such as the **amplitude**, **wavelength**, and **frequency**.

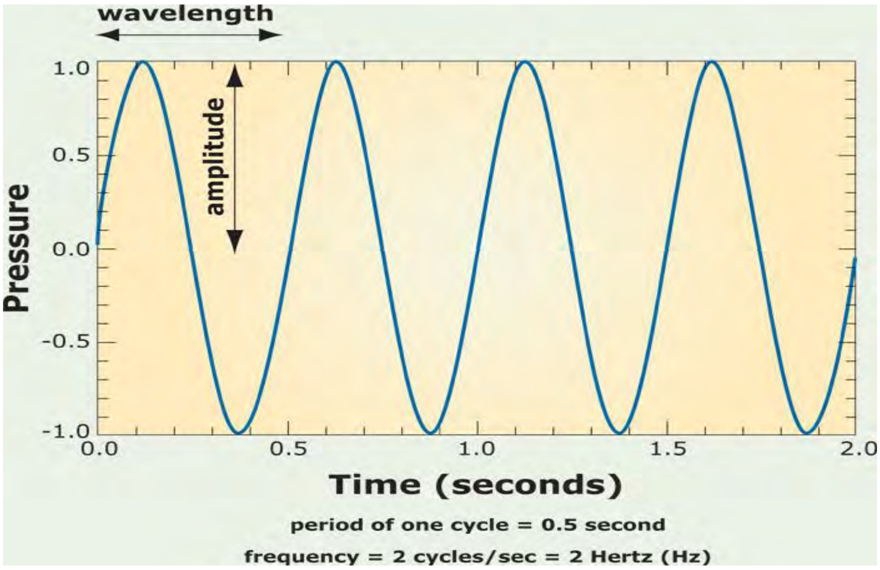


Figure 2.3-25 The Basic Components of a Sound Wave

The **amplitude** of a sound wave is proportional to the maximum distance a vibrating particle is displaced from rest. Small variations in amplitude produce weak or quiet sounds, while large variations produce strong or loud sounds. The **wavelength** of a wave is the distance between two successive compressions or the distance the wave travels in one cycle of vibration. The **frequency** of a sound wave is the rate of oscillation or vibration of the wave particles (i.e. the rate amplitude cycles from high to low to high, etc.). Frequency is measured in **cycles/sec** or **Hertz (Hz)**. To the human ear, an increase in frequency is perceived as a higher pitched sound, while an increase in amplitude is perceived as a louder sound. Below are examples of sound waves that vary in frequency and amplitude. **Figure 2.2-21** shows the relationship between the **amplitude**, **wavelength**, and **frequency**.

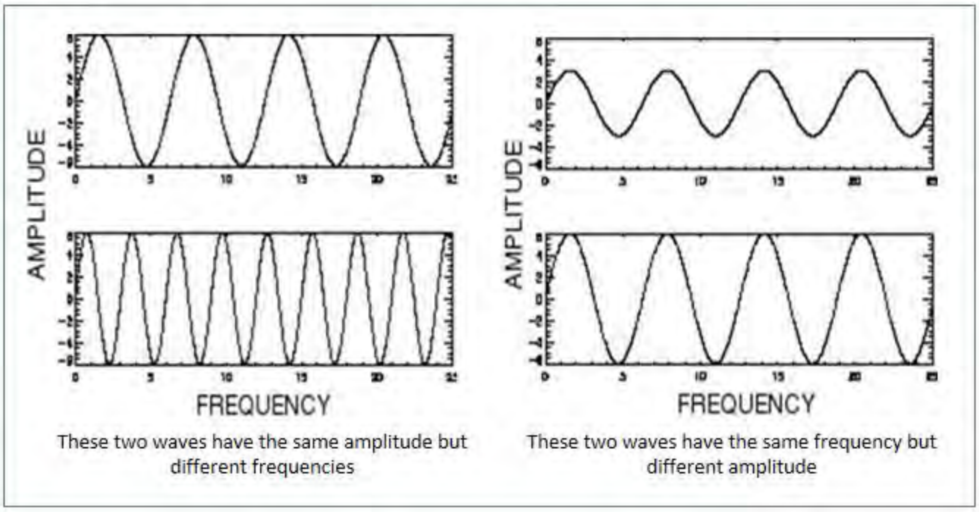


Figure 2.3-26 Relationship between the Amplitude, Wavelength, and frequency

NOISE GENERATION ASPECTS FOR THE EXPANSION PLANT PROJECT

CONSTRUCTION NOISE EMISSIONS

Generic sources of noise from construction works would include motor operations, exhaust gas emission from equipment silencers, pneumatic and mechanical operations of tools, material transfers and structures assembly works. Construction works would entail emission of noise of various levels depending on the equipment in operation and type of activity, to which workers and adjacent populated areas are exposed temporarily.

Suter (2002) compiled and reported various results of studies on construction noise. **Table 2.3-18 to 2.3-21** shows the result of the study.

Table 2.3-20 Average Noise Exposure Levels (Daily Leq) by Trade, Activity, or Equipment

Trade, Activity, or Equipment	Average dBAˆ	Range dBAˆ	Number of Samples
1. Dozer	102	85-108	6
2. Paver	90	84-92	6
3. Front-end loader	90	87-92	2
4. Scraper	90	88-91	5
5. Roller	98	93-100	2
6. Heavy equipment	90	86-94	4
7. Gravel plant	102	88-106	4
8. Crane	99	95-102	3

Trade, Activity, or Equipment	Average dBAˆ	Range dBAˆ	Number of Samples
9. Install rear	89	88-90	2
10. Capenter	90	82-94	3
11. Mason	91	84-97	14

Adapted from: Sinclair, J.D.N., And W.O. Haflidson:
Appl. Occup. Environ. Hyg. 10:457-460 (1995). In Suter (2002).

Table 2.3-21 Average Noise Exposure Levels (Daily L_{eq}) by Type of Construction

Type of Construction	**Number Samples**	**Average dBAˆ**	**Range dBAˆ**
1. Residential	7	93	87-96
2. Roads/bridges	16	93	84-100
3. shop work [B]	26	95	85-104
4. Maintenance	2	95	91-97
5. ICI [c]	23	96	81-108
6. Sewer/water	17	99	85-108
7. Plant work [D]	6	101	87-106
8. Power Station	6	108	93-113
9. Total	103	99	81-113
[A] Rounded to the nearest integer [B] Shop work - work in a contractor's fabrication shop [c] ICI =industrial, commercial, orinstitutional [D] Plant work = work in a construction contractor's plant			

Adapted from: Sinclair, J.D.N., And W.O. Haflidson: Appl. Occup. Environ. Hyg. 10:457-460 (1995). In Suter (2002)

Table 2.3-22 Average Daily Noise Exposure Levels (8-Hour TWA) of Heavy Equipment Operators and Associated Laborers in dBA

Operator or Task	**Mean TWA**	**SD**	**Range**
1. Heavy-duty bulldozer	99	5	91-107
2. Crawler crane >35 ton Non-insulated cab	97	2	93-101
3. Vibrating road roller	97	4	91-104
4. Light-duty bulldozer	96	2	93-101
5. Asphalt road roller	95	4	85-103
6. Wheel loader	94	4	87-100
7. Crawler crane <35 ton Non-insulated cab, insulated cab	94	3	90-98
	84	3	80-89
8. Asphalt spreader	91	3	87-97
9. Laborers	90	6	78-107
10. Light-duty grader	89	1	88-91
11. Power shovel	88	3	80-93
12. Rubber tired cane >35 ton Non-insulated cab, insulated cab	84	5	78-90
	74	9	59-87

Operator or Task	Mean TWA	SD	Range
13. Rubber tired crane <35 ton insulated cab	81	4	77-87
14. Truck-mounted crane	79	2	76-83
15. Tower crane	74	2	70-76

Adapted from : Legris, M., and P. Poulin: Noise Exposure Profile among Heavy Equipment Operators, Associated Laborers, and Crane operators. Am. Ind. Hyg. Assoc. J. 59:774-778. (1998). In Suter (2002)

Table 2.3-23 Median 1-Min Sound Levels in L_{eq} by Equipment/Tool

Tool Name	Tool Drive Type	Minutes	Median dBA	SD dBA	Range dBA
1. Jackhammer	pneumatic	267	104	11.4	70-112
2. Chipping gun	pneumatic	1151	93	13.1	70-120
3. Air Compressor	pneumatic	255	96	11.2	70-114
4. Bulldozer	gasoline	494	89	8.2	70-104
5. Lejeune gun	pneumatic	390	89	8.4	70-120
6. Backhoe	gasoline	1908	86	6.0	70-108
7. Forklift	gasoline	3727	85	5.8	62-125
8. Hand hammer	mechanical	4443	85	8.0	56-110
9. Welding torch	other	1923	84	8.9	70-118
10. Chopsaw	electric	631	80	8.6	70-106
11. Crane	electric	3059	78	7.7	70-110
12. Truck	gasoline	970	78	8.0	70-123

Adopted from : Neitzel, R., N. Seixas, M. Yost, and J. Camp . 1998: An assessment of occupational noise exposures in four construction trades. MS thesis, Department of Environmental Health, University of Washington, Seattle, 1998; with additional data by Neitzel, R.: "Table showing one-minute sound levels by task and tool for both L_{OSHA} and L_{eq}." September 22, 1999. [Personal Communication] Dept. of Environmental Health, Univ. of Washington School of Public Health and Community Medicine, Box 354695, Seattle, WA 98195. In Suter (2002)

POWER PLANT OPERATION NOISE EMISSIONS

Generic sources of noise during the operation of the 6 x 135 MW Coal Fired Power Plant would mainly coming from the boiler, turbine, condenser and other plant's auxiliary. The power plant operation noise emission ranged from **93-113** Dba, shown below **Table 2.3-24.**

Table 2.3-24 Noise Measurements at Source

LOCATION	Enclose		Noisse Reading (dbA)			Coordinates	
	w/	w/o	Morning	Afternoon	Night	N°	E°
TURBINE Unit 1	X		unit not running			8°33'37"	124°44'49"
GENERATOR Unit 1	X					8°33'38"	124°44'49"
TURBINE Unit 2	X		88.3	86.3	88	8°33'36"	124°44'51"
GENERATOR Unit 2	X		89.5	87.6	87.1	8°33'37"	124°44'50"
TURBINE Unit 3	X		86.4	85.8	85.8	8°33'36"	124°44'52"
GENERATOR Unit 3	X		88.1	87.6	86.7	8°33'37"	124°44'51"
BOILER Unit 1							
FAB A, B, C,	X		unit not running				
SAF A. PAF A		X					
SAF B. PAF B		X					
BOILER Unit 2							
FAB A, B, C,	X		101.3	96.9	97.1	8°33'37"	124°44'53"
SAF A. PAF A		X	93.4	93.4	92.8	8°33'41"	124°44'51"
SAF B. PAF B		X	94	94.1	95.1	8°33'36"	124°44'54"
BOILER Unit 3							
FAB A, B, C,	X		94.4	94.6	95.2	8°33'44"	124°44'42"
SAF A. PAF A		X	94.2	94.8	93.8	8°33'38"	124°44'52"
SAF B. PAF B		X	93.1	94.2	93.5	8°33'34"	124°44'54"
COAL CRUSHER 1	X		94.3	94.5	95	8°33'45"	124°44'55"
COAL CRUSHER 2	X		Unit under repair				
AIR COMPRESSOR BUILDING	X		99.3	98.9	99.6	8°33'41"	124°44'52"

The above values are shown in **Figure 2.3-26.**

Figure 2.3-27 Noise level measurements at source equipment

Ambient Noise Level Measurements (Source : SMR)

Summary of Ambient Noise from SMR

Table 2.3-25 Noise Level Area Categorization and DENR Standards

AREA CATEGORY	DAYTIME 9AM - 6PM	MORNING 5AM - 9AM	EVENING 6PM - 10PM	NIGHTTIME 10PM - 5AM
AA School, Hospitals	50	45		40
A Residential	55	50		45
B Commercial	65	60		55
C Light Industrial	70	65		60
D Heavy Industrial	75	70		65

PREDICTIVE NOISE LEVEL ATTENUATION Assessment

Basically, attenuation is a **damping or decreasing of sound levels**, an interruption that diminishes the volume and quality of the sound wave.

The following are noted from the above data and discussions

The sound levels at source are already in compliant with the DENR standards reckoned from various time of the day (nighttime, morning and evening). It is obvious therefore that when the sound waves propagate from source to the ESRs, the tendency is for the noise level to decrease. There are no other noise generators between the plant and the ESRs. Further, the sources of the noise, i.e. the various equipment are housed or enclosed in concrete walls.

Moreover:

The noise baseline monitoring values clearly indicate compliances with the DENR standards.

There has not been any complaints from noise generated by the plant facilities

The MMT has not recorded any exceedances with respect to noise.

IT IS DEEMED THAT THE SOUND LEVELS WILL NOT EXCEED AT THE ESRs. NOISE ATTENUATION MODELLING IS NOT RELEVANT.

SECTION 2. ASSESSEMENT OF KEY ENVIRONMENTAL IMPACTS

2.4 The PEOPLE

INTRODUCTION:

The significance of the "People" module are the following:

a. *The securing of an Environmental Compliance Certificate (ECC) is strongly influenced by the communities directly and indirectly affected by the proposed project. The support and opposition of the communities to the proposed project is vital aspect in the Philippine EIS System.*

b. *This module serves as a relevant baseline for the Municipality of Villanueva, Misamis Oriental particularly the directly affected barangays. Thus, this module will also serve as a guideline to the impacts of the proposed project and how the proponent will provide its mitigating measures.*

c. *This module is relevant to the Corporate Social Responsibility (CSR) of the project proponent. The programs of the CSR can be harmonized with the perceived needs and impact of the proposed project and affected communities.*

d. *"People" factor could be key to the success of a project.*

Methodology and Limitations

Baselines presented in this module are gathered and conducted for the discussion of the proposed expansion project. Primary data were obtained through household Socio-Economic perception surveys was conducted last October 2019 in Barangays Tambobong, Mohon Balacanas, Baluarte, San Martin and Sta. Cruz. Secondary data presented are derived from the Comprehensive Land Use Plan (CLUP) of the Municipality of Villanueva 2017-2027.

Background

Villanueva is a coastal municipality located within the political jurisdiction of the Province of Misamis Oriental along the northern coast of Mindanao Island. It is a 2nd class municipality with a total of eleven (11) barangays, six (6) of which are coastal barangays and the rest located within the coastal flats and upland areas of the municipality.

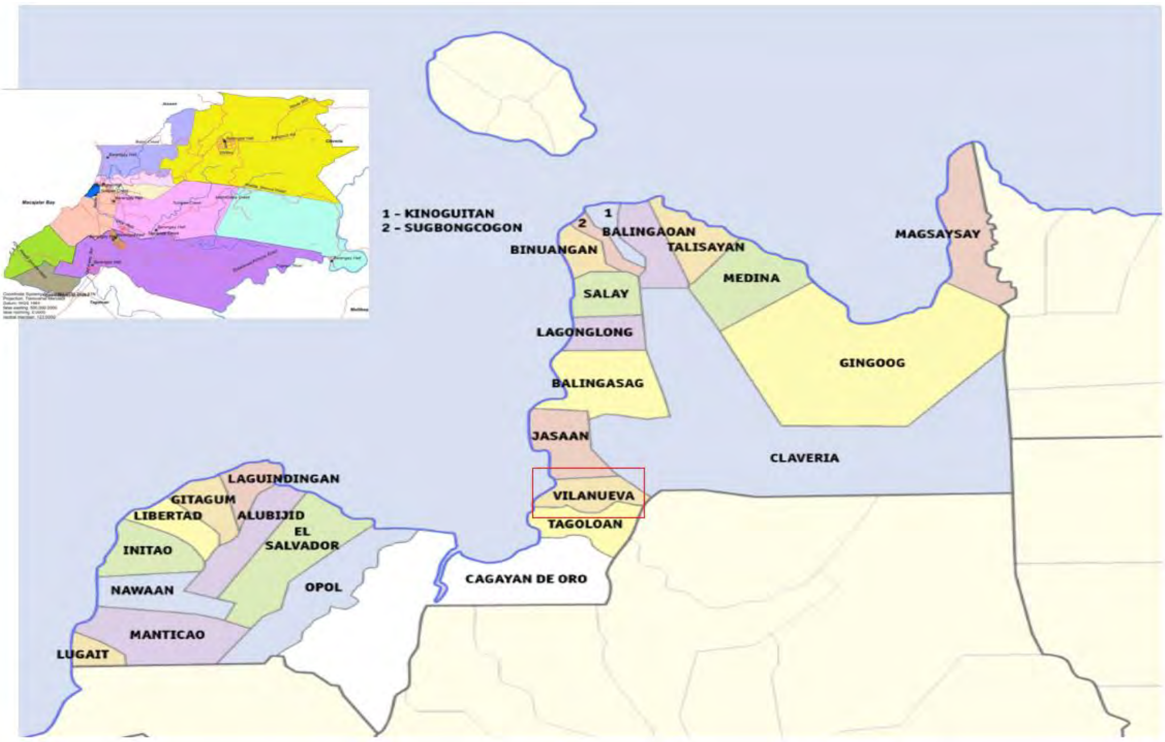
The second coastal municipality East of Cagayan de Oro City, Villanueva lies within the geographic coordinates 8 degrees, 32 minutes, and 30 seconds, (8, 32", 30') to 8 degrees, 36 minutes and 30 seconds (8,36", 30') latitude and 124 degrees, 45 minutes (124, 45") to 124 degrees, 52 minutes (124, 52") East longitude.

Villanueva is bordered by the Macajalar Bay towards the west and the Municipality of Jasaan and Claveria towards the north. The southern extension of the municipality is bounded by the adjacent Municipality of Tagoloan while the majority of the eastern regions are bounded by the Municipality of Claveria.

The Municipality is easily accessible via the well-paved Maharlika National Highway (Route 9) which cuts the western section of the municipality running through barangays San Martin, Katipunan, Poblacion 1-2 and Looc. Along this highway, landmarks of the municipality include the vast land area occupied by industries including the Philippine Sinter Corporation, STEAG-SPI Coal-fired Power Plant, and the Coca-Cola Mega Plant.

Access roads towards the interior of the barangays are conveniently connected with the transverse national highway of Route 955 connecting Villanueva-Claveria-Gingoog City. They are composed of a combination of cemented and graveled all weather roads. Farther into the upland barangays, access roads degrade into rough and muddy roads which may become inaccessible during heavy rains especially during the rainy season.

As seen in Figure 2.4.1 below, Villanueva is one of the twenty three (23) municipalities in Misamis Oriental bounded on the north by the Municipality of Jasaan, on the south by the Municipality of Tagoloan, on the west by the Macajalar Bay, and on the east by the Municipality of Claveria. It is within approximately 30-40 minutes from the City of Cagayan de Oro when travelling by road.



Source: https://www.mapsofworld.com/philippines/provinces/misamis-oriental.html

Figure 2.4-1 Map of Political Boundaries of Misamis Oriental

Demographic Profile

The demographic data presented in this Section are based from the latest CLUP.

- **Number of Household, and Household Size**

The total number of households in the municipality was 37,253 in 2015 and the first five barangays that had bigger number of households are: San Martin 6,550 (17%) ; Dayawan, 6,340 , (17%); Katipunan, 5,350 (14%) Looc, 4,009 (11%) , ; Poblacion 3 3,731 (10%) and Imelda 3,208 (9%). The remaining six barangays had lower number of households, such as: Poblacion 1, 2,402 (6.4%) (8%); Balacanas, 2,388 (6.4%); Poblacion 2, 2,228 (5.9%); Kimaya,1,041 (2.8%); and finally Tambobong with 11 households which resulted with the creation of the Tambal (Tambobong and Balacanas) Resettlement project which represents the population of the two barangays.

With the fast-faced industrialization of the municipality where some sixteen (16) industries have already located, only one (1) of the eleven (11) barangays remains rural and the other ten (10) has become urban.

Barangay Katipunan which is a highway barangay and the site of most of the industries had the most number of populations at 3,854 or thirteen (13) percent of the total population followed closely by Dayawan also with locator industries with 3,842 and also thirteen (13) percent of the total population. Barangays Looc, another highway barangay, Poblacion 3, the original Central Business District of the town and Barangay San Martin also a highway barangay have comparatively bigger population of 3,555 (12%), 3499 (11.93%), and San Martin 3,452 (11.78%), respectively.
Imelda, which is a relocation site, Poblaciones 1 and 2 which was created from now the Poblacion 3 populations 2,737 (9.33%), 2,466 (8.41%), 2,130 (7.28%), respectively. The barangays of Balacanas and Tambobong which are PHIVIDEC barangays have populations 1,590 (5.42%) and 1,473 (5.02%); respectively. The hinterland barangay of Kimaya had a population of 717 or 2.45 percent of the total population.

The total number of households in the municipality was 37,253 in 2015 and the first five barangays that had bigger number of households are: **San Martin 6,550 (17%)** ; Dayawan, 6,340, (17%); Katipunan, 5,350 (14%) Looc, 4,009 (11%) , ; Poblacion 3 3,731 (10%) (6; and Imelda 3,208 (9%). The remaining six barangays had lower number of households, such as: Poblacion 1, 2,402 (6.4%) (8%); Balacanas, 2,388 (6.4%); Poblacion 2, 2,228 (5.9%); ; Kimaya,1,041 (2.8%); and finally Tambobong, with 11 households which resulted with the creation of the **Tambal** (Tambobong and Balacanas) Resettlement project which represents the population of the two barangays.

As of to date, August 2019, Barangay San Martin has total population of 6,924 and 920 households, Barangay Tambobong has a population of 1,400 and 156 households and Barangay
Balacanas with population of 1,611 and 254 households.

Table 2-4.1 Household Population by Urban and Rural Barangay and Average Household size, 2015

Barangay	2000			2010			2015		
	HH Population	Number of Households	Average Household Size	HH Population	Number of Households	Average Household Size	HH Population	Number of Households	Average Household Size
Urban	**23,918**	**4,644**	**5.11**	**31,044**	**6,401**	**4.84**	**36,212**	**8,496**	**4.26**
Poblacion 1	6,697	1,311	5.11	2,500	516	4.84	2,402	564	4.26
Poblacion 2	-	-	-	2,226	459	4.85	2,228	523	4.26
Poblacion 3	-	-	-	3,508	723	4.85	3,731	875	4.26
Dayawan	3,672	678	5.42	5,428	1,119	4.85	6,340	1,487	4.26
Imelda	2,511	466	5.39	3,144	648	4.85	3,208	753	4.26
Katipunan	2,735	565	4.84	4,459	920	4.85	5,350	1,255	4.26
Looc	3,084	601	5.13	3,857	795	4.85	4,009	941	4.26
San Martin	3,150	628	5.02	5,495	1,133	4.85	6,550	1,537	4.26
Balacanas	1,118	227	4.93	375	77	4.87	2,388	560	4.26
Tambobong	951	168	5.66	52	11	4.73	6	1	6.00
Rural	**742**	**135**	**5.50**	**904**	**186**	**4.86**	**1,041**	**244**	**4.27**
Kimaya	742	135	5.50	904	186	4.86	1,041	244	4.27
Total	**24,660**	**4,779**	**5.16**	**31,948**	**6,587**	**9.70**	**37,253**	**8,740**	**4.26**

Source: Philippine Statistics Authority, 2015

- **Land Area**

The Municipality of Villanueva occupies a total land area of 5,222 hectares. Approximately 1,790 hectares or 34.27 percent of this total land area is within the jurisdiction of the Philippine Veterans Development Corporation (PHIVIDEC) or the PHIVEDEC Industrial Authority (PIA). It covers eleven (11) barangays, Poblacion having been segregated into Poblacion 1, Poblacion 2, and Poblacion 3 effective 2006. The eleven barangays, in the order of land area size are the following: Imelda, 1508 hectares; San Martin, 1252 hectares; Kimaya, 747 hectares; Dayawan, 592 hectares; Looc, 322 hectares; Balacanas, 241 hectares; 134 hectares; Tambobong, 134 hectares; Katipunan, 264 hectares; Poblacion 1, 88 hectares; Poblacion 2, 81 hectares; and Poblacion 3, 13 hectares. With the advent of industrialization, the residents were relocated to Barangay Imelda when Philippine Sinter Corporation was established Barangay Nabacaan (144 hectares) in 1972,
source: Villanueva CLUP, 2017-2027.

- **Population and Population Growth**

The latest Census of Population undertaken by the Philippine Statistics Authority in August 2015 recorded Villanueva's population at 39,878 ranking the municipality as the Eight among the Top Ten of the twenty three municipalities and two component cities of the province of Misamis Oriental in terms of population. This is a step higher from the previous census where this rapid growing town ranked number nine (9). Also in the 2015 census, Villanueva registered a population density (number of persons per square kilometers) of 810, the highest in the province.

Historical growth of the municipality's population from the various periodic censuses of population as reflected in ***Table 2.4-2*** *and* ***Chart 2.4-1***, *Historical Growth of Population, 1970-2015,* illustrates that population growth rates were high in the census years 1975, 1995, and 2015.

The highest growth rate experienced by Villanueva was during the censal period 1970 to 1975 which was a really high 7.44 percent which could have been largely due to in-migration brought about by industrialization. It was in 1974 that the Philippine Sinter Corporation was established in Barangay Katipunan.

This extraordinary high growth rate (7.44%), made a decreasing trend in the succeeding two censal periods but this rate increased again to a high 4.47 percent in the censal period 1900 to 2000 decreasing again during the 2000 to 2010 census but again in 2015 the growth rate grew to a high 4.26 percent.

The high population growth rate of 4.47 percent for the censal period 1990 to 1995 was the highest for the entire province and the growth rate of 4.26 percent for the period 2010-2015 was the second highest in the province during the period.

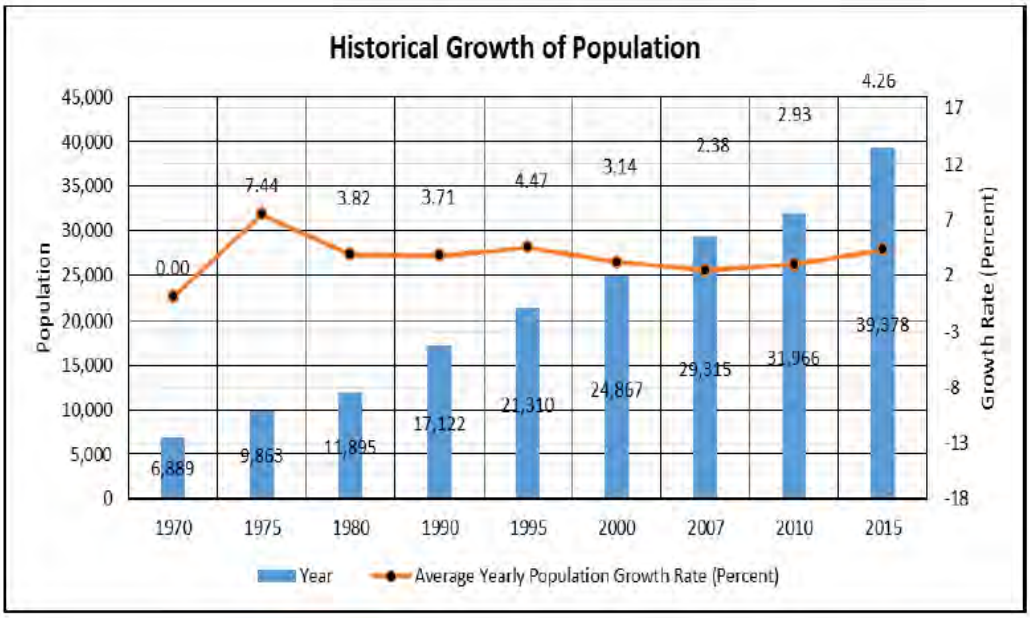
On the other hand, Villanueva's comparatively lowest population growth rate of 2.38 percent during the period 2000 to 2007 was still much higher than the growth rate of the province which was 1.66 percent for the same period. This drop in population growth rate then was experienced in the entire province.

If this population growth rate prevails over time the population of Villanueva would double in a short period of 17 years.

Table 2.4-2 Historical Growth of Population, 1970-2015

Year	Population	Increase/Decrease	Average Yearly Population Growth Rate (Percent)
1970	6,889	0	0
1975	9,863	2,974	7.44
1980	11,895	2,032	3.82
1990	17,122	5,227	3.71
1995	21,310	4,188	4.47
2000	24,867	3,557	3.14
2007	29,315	4,448	2.38
2010	31,966	2,651	2.93
2015	39,378	7,412	4.26

Source: Philippine Statistics Authority
Municipality of Villanueva, Misamis Oriental - CLUP 2017 - 2027



Source: Philippine Statistics Authority,2015
Municipality of Villanueva, Misamis Oriental – CLUP 2017 - 2027

Figure 2.4-2 *Historical Growth of Population, 1970-2015*

- **Population Density by Barangay**

Barangay Poblacion 3 recorded the highest gross population density at 303 inhabitants per hectare as reflected in ***Table 2.4-3***. The other 10 barangays had much lower gross population density at 29 inhabitants per hectare for barangays Poblacion 1 and Poblacion 2, 19 for Katipunan, 11 for Looc, Dayawan and Balacanas, 6 for San Martin, 2 for Imelda and 1 for Kimaya. Total gross population density for the entire municipality is 7.

By population, the top 5 are the barangay Katipunan as number 1 and closely followed by Dayawan, while the 3rd to the 5th barangay which are close in ranks in terms of number of population are the barangays of Looc, Poblacion 3 and San Martin. Shown in Chart 2.4-2 below.

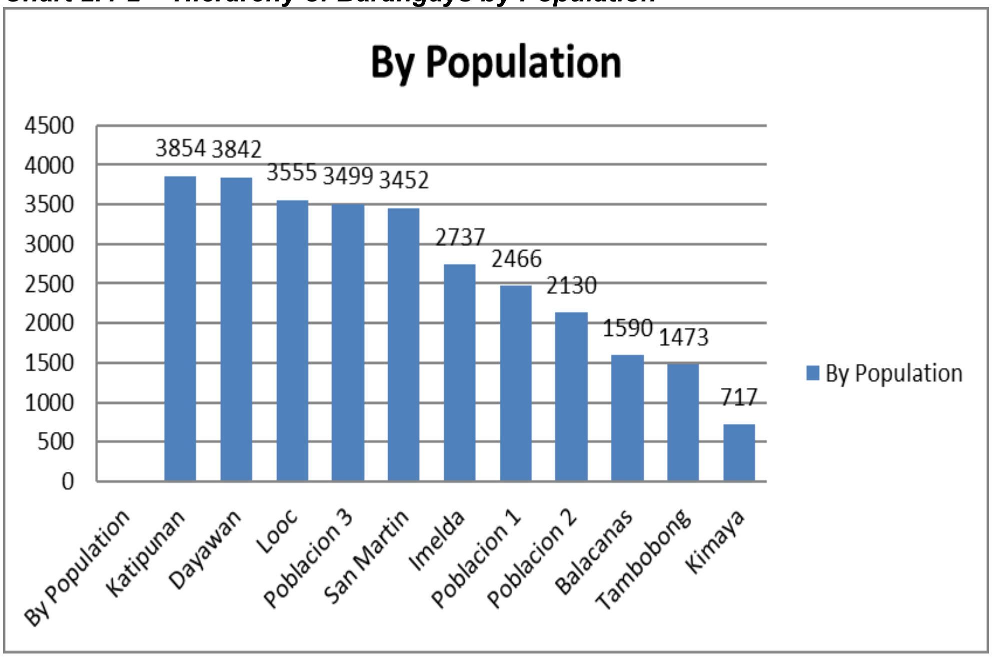
By population density, Barangay Poblacion 3 has the biggest at a gross density of 303, while the other barangays had much lower density at 29, 19, 11, 5 and 2, with the hinterland barangay of Kimaya with the lowest population density at 1.55 as shown in **Chart 2-4.2** below.

Table 2-4.3 Population Density by Urban and Rural Barangay, Gross and A & D Density, 2015

Barangay	Population	Land Area (In Hectares)		Density	
		Gross	A & D	Gross	A & D
Urban	**38,278**	**4,512**	**3,721**	**8**	**10**
Poblacion 1	2,539	87.00	87.00	29.18	29.18
Poblacion 2	2,355	81.00	81.00	29.07	29.07
Poblacion 3	3,944	13.00	13.00	303.38	303.38
Dayawan	6,702	588.00	412.30	11.40	16.26
Imelda	3,391	1,505.00	1,099.50	2.25	3.08
Katipunan	5,655	294.00	294.00	19.23	19.23
Looc	4,238	362.00	362.00	11.71	11.71
San Martin	6,924	1,218.00	1,008.10	5.68	6.87
Balacanas	2,524	223.00	223.00	11.32	11.32
Tambobong	6	141.00	141.00	0.04	0.04
Rural	**1,100**	**710**	**487**	**2**	**2**
Kimaya	1,100	710.00	486.90	1.55	2.26
Total	**39,378**	**5,222**	**4,208**	**7.50**	**9.40**

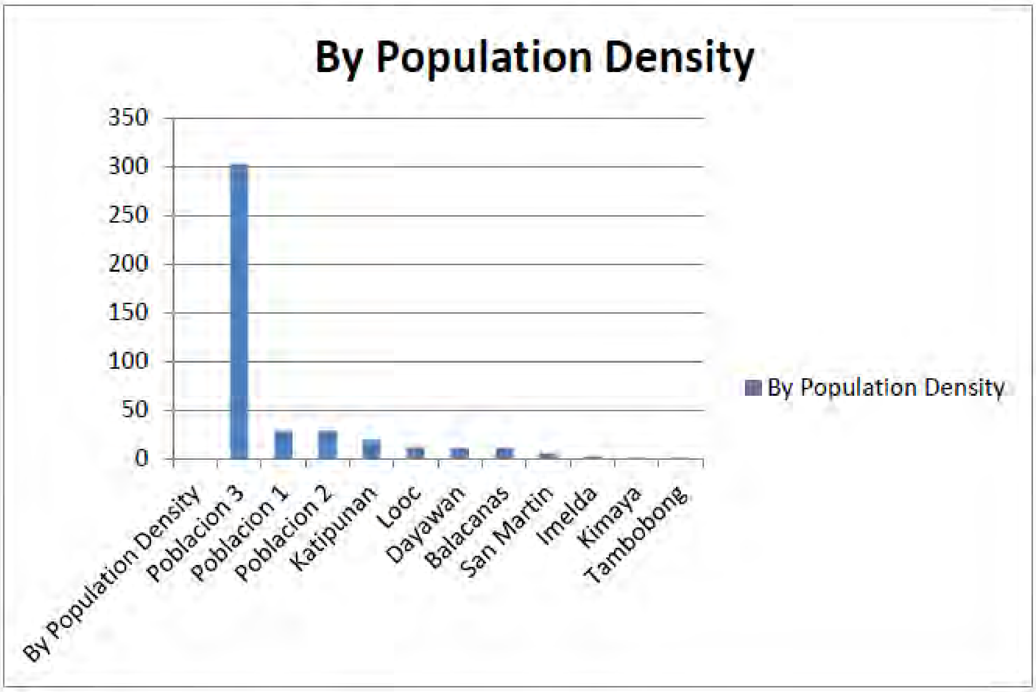
Source: Philippine Statistics Authority, 2015
Municipality of Villanueva, Misamis Oriental - CLUP 2017-2027

Chart 2.4-2 Hierarchy of Barangays by Population



Source: Municipality of Villanueva CLUP 2017-2027

Figuer 2-4.3 Hierarchy of Barangays by Population



Source: *Municipality of Villanueva CLUP 2017-2027*

Figuer 2-4.4 Hierarchy of Barangays Population by Density

- **Urbanization Level for the past 20 years**

Urbanization levels of the municipality for the past thirty-five years (refer Table 2.4-4) was high and was at its highest at 97.21 percent in 2015 affirming its functional role as a major industrial center of the province and of the region, for that matter. From a level of urbanization placed at an average of 65 percent from 1980 to 2000 the urbanization level grew to an almost 100 percent at 97.17 in 2010 and 97.21 percent in 2015.

Table 2.4-4 Urbanization Levels, 1980-2015

Year	Barangay Population			Level of Urbanization (Percent)
	Urban	Rural	Total	
1980	7,920	3,975	11,895	66.58%
1990	11,524	5,598	17,122	67.31%
1995	12,707	8,603	21,310	59.63%
2000	16,167	8,700	24,867	65.01%
2010	31,061	905	31,966	97.17%
2015	38,278	1,100	39,378	97.21%

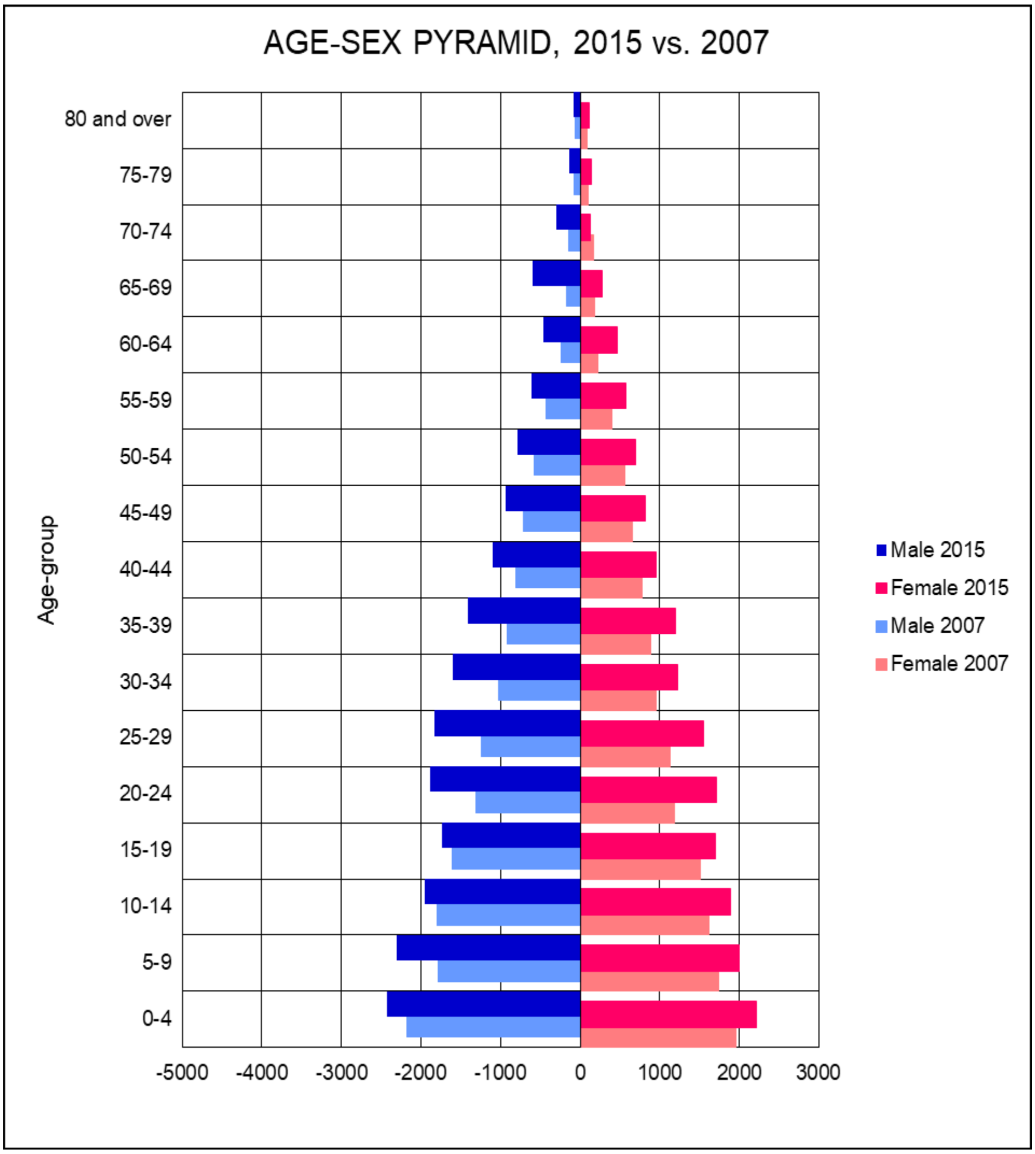
Source: Philippine Statistics Authority, 2015
Municipality of Villanueva, Misamis Oriental - CLUP 2017-2027

- **Gender and Age Profile**

The *Population Pyramid,* ***Chart 2.4-4****,* shows at a glance, the distribution of population in a locality. The form of population pyramid generally reflects the pattern of fertility, mortality and migration in the past.

A broad-based pyramid which is the case of Villanueva is brought about by high fertility rate. A glance at Villanueva's Population Pyramid shows the highest population at age-group 0-4 and 5-9 or the pyramid base which remains comparatively high until age group 30-34, then the population starts to dwindle at age-group 40-44 further down to age-group 65-69, then dwindles further starting age-group 70-74 until pyramid shows a thinning tip at age-group 80 and over.

By Sex classification, as can be gleaned in ***Table 2.4-5****, Household Population Distribution by Age-Group and Sex, census years 2007 and 2015*, the Males predominate over the Females in all age-groups except in the age-groups 75-79 and 80 and over, where Females predominate over the Males. *(source: Municipality of Villanueva CLUP, 2017-2027).*



Source: Municipality of Villanueva CLUP, 2017-2027

Figure 2.4-5 Population Pyramid. Age-Sex Population Pyramid, Villanueva, 2015 vs. 2017

Table 2.4-5 Household Population Distribution by Age-Group and Sex, 2007 and 2015

AGE GROUP	2007			2015		
	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE
0-4	4,136	2,176	1,960	4,638	2,429	2,209
5-9	3,514	1,780	1,734	4,303	2,304	1,999
10-14	3,415	1,794	1,621	3,839	1,956	1,883
15-19	3,124	1,612	1,512	3,441	1,741	1,700
20-24	2,498	1,314	1,184	3,589	1,879	1,710
25-29	2,370	1,244	1,126	3,381	1,825	1,556
30-34	1,991	1,030	961	2,821	1,601	1,220
35-39	1,797	912	885	2,601	1,405	1,196
40-44	1,587	810	777	2,054	1,095	959
45-49	1,370	713	657	1,747	932	815
50-54	1,133	575	558	1,486	793	693
55-59	829	433	396	1,183	613	570
60-64	468	245	223	921	457	464
65-69	362	176	186	580	591	278
70-74	322	149	173	260	302	126
75-79	182	75	107	225	134	137
80 and over	142	58	84	182	88	115
TOTAL	**29,240**	**15,096**	**14,144**	**37,251**	**20,145**	**17,630**

Source: Philippine Statistics Authority
Municipality of Villanueva CLUP, 2017-2027

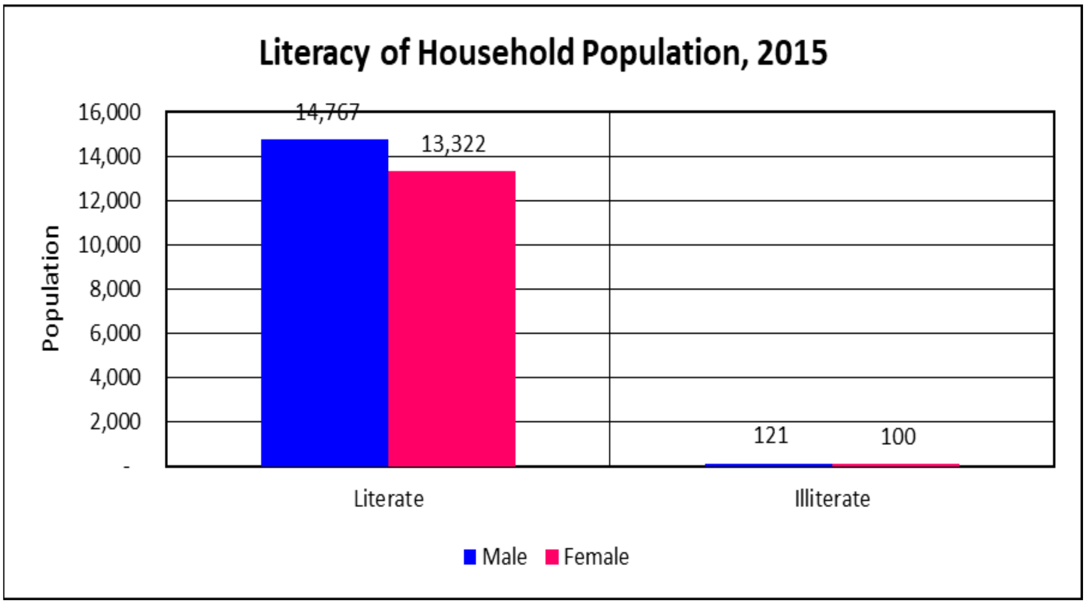
- **Literacy of Population**

Literacy rate of population 10 years old and over **(Table 2.4-6, *Chart 2.4-5 & 2-4.6*)**, records a literacy rate of the population at 99.2 percent and only 0.78 percent or less than one percent of the population is illiterate. The male population reflects a higher (52.16%) literacy rate compared to the females with 47.06 percent literacy rate**,** *source: Villanueva CLUP, 2017-2027*.

Table 2.4-6 Literary of Household Population 10 Years Old and Over by Age Group and Sex, 2015

Age-Group	Total Population			Literate			Illiterate		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
10 - 14	3,839	1,956	1,883	3,817	1,944	1,873	22	12	10
15 - 19	3,441	1,741	1,700	3,426	1,732	1,694	15	9	6
20 -24	3,589	1,879	1,710	3,575	1,869	1,706	14	10	4
25 - 29	3,381	1,825	1,556	3,365	1,814	1,551	16	11	5
30 - 34	2,821	1,601	1,220	2,811	1,595	1,216	10	6	4
35 - 39	2,601	1,405	1,196	2,582	1,391	1,191	19	14	5
40 -44	2,054	1,095	959	2,038	1,085	953	16	10	6
45 - 49	1,747	932	815	1,731	924	807	16	8	8
50 - 54	1,486	793	693	1,475	789	686	11	4	7
55 - 59	1,183	613	570	1,163	599	564	20	14	6
60 - 64	921	457	464	908	449	459	13	8	5
65 and over	1,247	591	656	1,198	576	622	49	15	34
TOTAL	**28,310**	**14,888**	**13,422**	**28,089**	**14,767**	**13,322**	**221**	**121**	**100**

Source: Philippine Statistics Authority, Generated using ratio and proportion from 2010 census
Municipality of Villanueva, CLUP 2017-2027



Source: Philippine Statistics Authority, Generated using ratio and proportion from 2010 census
Municipality of Villanueva, CLUP 2017-2027

Figuret 2.4-5 Literacy of Household Population, 2015

- **Profile of Educational Attainment**

Household population 5 years old and over constitute 93 percent of the total household population or numbers 34,740. By highest completed, most number of the population or a total of 15,415 (44%) had high school education, followed by 10,742 (31%) of the household population with elementary education. The remaining 25 percent of the household population 5 years old and over were spread over the following: 11 percent with college education, 7 percent had academic degree, 3 percent with pre-school education and 2.5 percent had no grade completed. A little portion of 1 percent recorded as having post-secondary education. 0.04 percent had post-baccalaureate courses and 0.06 percent belongs to the category of “Not Stated”.

Segregated by sex, the males predominate at the lower levels of education, i.e., at pre-school elementary and those with no grade completed while as the grade level rises, the females predominate. Thus there are more females than males in high school, post-secondary, college undergraduate, academic degree holder and in those with post-baccalaureate studies. (***Table 2.4-7***)

Table 2.4-7 Population by Highest Grade Completed, 2015

POPULATION BY HIGHEST GRADE/YEAR COMPLETED	HH POPULATION 5 YEARS OLD AND OVER	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20-24	25-59	30-34	35 AND OVER
Both Sexes	**34,740**	**801**	**891**	**865**	**893**	**853**	**882**	**809**	**762**	**707**	**679**	**724**	**629**	**667**	**731**	**694**	**3,790**	**3,773**	**3,232**	**12,358**
No Grade Completed	870	626	71	16	7	5	5	4	-	3	1	4	3	-	2	2	8	13	**5**	**95**
Pre-School	1,016	161	688	135	15	5	1	2	1	-	-	-	1	-	-	-	3	2	**1**	**1**
Special Education	10	-	-	1	1	1	3	-	2	1	1	-	-	-	-	-	-	-	**-**	**-**
Elementary	10,742	-	132	713	870	842	873	803	716	441	193	123	73	82	95	102	437	455	**434**	**3,358**
1st - 4th Grade	5,736	-	132	713	870	842	792	384	143	99	50	33	22	28	31	33	134	127	**136**	**1,167**
5th - 6th Grade	1,781	-	-	-	-	-	81	363	271	83	39	29	27	26	14	19	85	99	**88**	**557**
Graduate	3,225	-	-	-	-	-	-	56	302	259	104	61	24	28	50	50	218	229	**210**	**1,634**
High School	15,415	-	-	-	-	-	-	-	43	262	484	597	502	410	411	343	2,121	2,276	**1,890**	**6,076**
Undergraduate	6,007	-	-	-	-	-	-	-	43	262	484	571	332	197	175	118	627	649	**540**	**2,009**
Graduate	9,408	-	-	-	-	-	-	-	-	-	-	26	170	213	236	225	1,494	1,627	**1,350**	**4,067**
Post-Secondary	357	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	39	61	**51**	**203**
Undergraduate	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	2	**3**	**17**
Graduate	332	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	37	59	**48**	**186**
College Undergraduate	3,781	-	-	-	-	-	-	-	-	-	-	-	50	175	214	237	742	493	**471**	**1,399**
Academic Degree Holder	2,512	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	439	470	**379**	**1,216**
Post Baccalaureate	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	**1**	**10**
Not Stated	22	14	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	**-**	**-**
Male	**19,282**	**420**	**469**	**473**	**482**	**460**	**453**	**402**	**392**	**360**	**349**	**371**	**308**	**339**	**362**	**365**	**2,074**	**2,206**	**2,004**	**6,993**
No Grade Completed	455	323	34	13	2	3	3	3	-	2	1	4	1	-	1	1	6	10	4	44
Pre-School	578	91	377	88	12	3	1	2	1	-	-	-	1	-	-	-	2	-	-	-
Special Education	8	-	-	1	1	1	2	-	2	1	-	-	-	-	-	-	-	-	-	-
Elementary	5,894	-	58	371	467	453	447	397	370	236	122	76	41	67	64	75	284	307	279	1,780
1st - 4th Grade	3,216	-	58	371	467	453	408	194	88	71	36	26	14	21	23	27	100	100	99	660
5th - 6th Grade	981	-	-	-	-	-	39	179	135	51	22	18	14	22	11	15	55	61	56	303
Graduate	1,697	-	-	-	-	-	-	24	147	114	64	32	13	24	30	33	129	146	124	817
High School	8,903	-	-	-	-	-	-	-	19	121	226	291	248	208	211	171	1,202	1,360	1,216	3,630
Undergraduate	3,236	-	-	-	-	-	-	-	19	121	226	277	176	104	94	59	355	361	324	1,120
Graduate	5,667	-										14	72	104	117	112	847	999	892	2,510
Post-Secondary	169	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	21	39	34	73
Undergraduate	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2	2	7
Graduate	156	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	20	37	32	66
College Undergraduate	2,034	-	-	-	-	-	-	-	-	-	-	-	17	64	78	115	366	261	282	851
Academic Degree Holder	1,221	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	193	228	189	610
Post Baccalaureate	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-			1	-	5
Not Stated	14	6	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-
Female	**15,458**	**381**	**422**	**392**	**411**	**393**	**429**	**407**	**370**	**347**	**330**	**353**	**321**	**328**	**369**	**329**	**1,716**	**1,567**	**1,228**	**5,365**
No Grade Completed	415	303	37	3	5	2	2	1	-	1	-	-	2	-	1	1	2	3	1	51
Pre-School	438	70	311	47	3	2	-	-	-	-	-	-	-	-	-	-	1	2	1	1
Special Education	2	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-
Elementary	4,848	-	74	342	403	389	426	406	346	205	71	47	32	15	31	27	153	148	155	1,578
1st - 4th Grade	2,520	-	74	342	403	389	384	190	55	28	14	7	8	7	8	6	34	27	37	507
5th - 6th Grade	800	-	-	-	-	-	42	184	136	32	17	11	13	4	3	4	30	38	32	254
Graduate	1,528	-	-	-	-	-	-	32	155	145	40	29	11	4	20	17	89	83	86	817
High School	6,512	-	-	-	-	-	-	-	24	141	258	306	254	202	200	172	919	916	674	2,446
Undergraduate	2,771	-	-	-	-	-	-	-	24	141	258	294	156	93	81	59	272	288	216	889
Graduate	3,741	-	-	-	-	-	-	-	-	-	-	12	98	109	119	113	647	628	458	1,557
Post-Secondary	188	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	18	22	17	130
Undergraduate	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	10
Graduate	176	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	17	22	16	120
College Undergraduate	1,747	-	-	-	-	-	-	-	-	-	-	-	33	111	136	122	376	232	189	548
Academic Degree Holder	1,291	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	246	242	190	606
Post Baccalaureate	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	1	5
Not Stated	8	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Source: Philippine Statistics Authority, Generated using ratio and proportion from 2010 census
Municipality of Villanueva, CLUP 2017-2027

Settlement Map

This is provided in the Barangay Settlement Map in **Figure 2-4.2.**

2.4.1 Displacement of Settler/s

The project site has been cleared by PHIVIDEC of any settlers and properties (e.g. houses) owned by other parties, public or private; hence there are no issues on displacements and disturbance of properties. The area of the proposed expansion is located within the existing facility of the proponent.

2.4.1.1 Displacement/Disturbance of Properties

No properties that will be disturbed in the area considering that no settlers will be displaced.

2.4.1.2 Change/Conflict in Land Ownership

FDC Misamis is in legal possession of the site/land by virtue of its lease agreement with PHIVIDEC. Authority over the foreshore will be secured through a separate foreshore lease agreement with the PHIVIDEC, the latter having possession of a foreshore lease over portions of the Macajalar Bay.

2.4.1.3 Change/Conflict Right of Way

There is no issue on Right of Way for the existing power plant site and proposed extension in view of its being located in an Industrial Estate and no public roads will be used as access to the site.

The transmission line project alignment will necessarily require Right of Way agreements. This project component is not included in the application for an ECC.

2.4.1.4 Impact on Public Access

The project is bounded by PHIVIDEC Road on the west south where access shall remain to the public including the proponent.

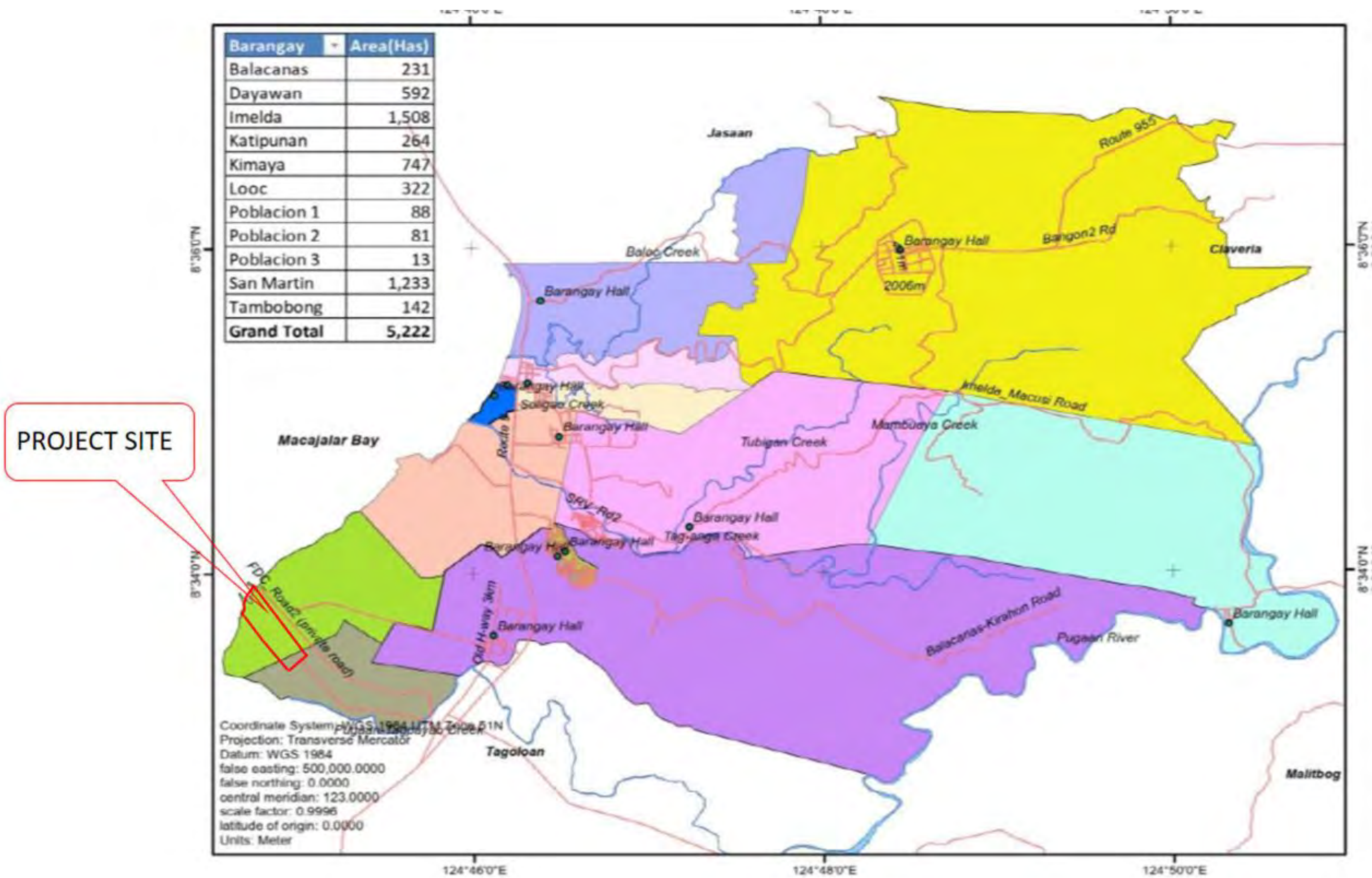
2.4.2 In-Migration

In-migration pattern as a result of the Project

The indirect consequence of propagation of informal settlers of a power project is not foreseen. Economic growth could most likely spur developments of housing project and thus potentially remove the root causes of informal settling.

Informal settling at the land acquired by the Proponent is not possible. During the construction stage, workers will not be residing at the site. During the operations stage, employees and contractual workers will be returning to their respective homes/residences after office hours.

Informal settling inside the PHIVIDEC is within the control and mandate of the Estate.



Barangay	Area(Has)
Balacanas	231
Dayawan	592
Imelda	1,508
Katipunan	264
Kimaya	747
Looc	322
Poblacion 1	88
Poblacion 2	81
Poblacion 3	13
San Martin	1,233
Tambobong	142
Grand Total	**5,222**

Figure 2.4-7 Barangay Settlement Map

A census of the population/property that will be displaced/disturbed, housing ownership profile and availability of housing/number of informal settlers are not relevant to the Project.

2.4.2.1 Proliferation of Informal Settlers

The proliferation of the informal settlers is unlikely to occur because of the coming of the project in the area, as the location is situated in an Industrial estate.

2.4.3 Cultural/Lifestyle change (especially on indigenous People, if any)

There are no indigenous people at the project site and the project is not foreseen to significantly affect the Culture and Lifestyle of the people. On the other hand, with the expansion project of the proponent, this means increased revenue of the host barangay due to the tax payment from proponent, more projects may be implemented that will improve the lifestyle of the people.

Since there are no Indigenous People (IPs) in the project site nor are displaced by the project, the provisions of R.A. 8371 as follows are rendered moot and academic.

"Chapter 3d (Rights to Ancestral Domains- Rights in Case of Displacement) of Republic Act 8371 "In case displacement occurs, basic services and livelihood shall be provided to the Indigenous Peoples (IPs) to ensure that their needs are adequately addressed."

Changes in cultural/lifestyle may possibly occur as a result of the uplift of the lives of the IPs and of the people within the host Municipality such as could arise from the prospective Social Development Plans (SDP) that will be established by (a) the Program from implementation of IR 1-94 and (b) the Proponent's SDP.

Cultural/Lifestyle of all population affected by the Project.

The provision for electricity to all the service areas will naturally result in increased economic growth, livelihood and employment. The effects on culture and lifestyle are not immediately quantifiable.

Electricity will also spur greater human activities such in the areas of entertainment (movies), in greater number of facilities, e.g. food and recreation, shopping centers, etc. and in others. Quantification of these changes is not immediately feasible.

2.4.4 Impacts on physical cultural resources

There is no identified impact on physical and cultural resources in the area considering that the subject expansion project is located in Industrial estate which is within PHIVIDEC Industrial Authority (PIA) which was established since 1974 creating the area as an Industrial Estate. However, the provision for additional volume of electric supply to all the service areas will naturally result in increased economic growth, livelihood and employment. The effects on culture and lifestyle are not immediately quantifiable.

Electricity will also spur greater human activities such in the areas of entertainment (movies), in greater number of facilities, e.g. food and recreation, shopping centers, etc. and in others. Quantification of these changes is not immediately feasible.

2.4.5 Threat to delivery of basic services/resource competition

Basic services may include supply of electricity, potable water, education (availability of public schools) and health services. Availability of these services will not be affected with the project.

Supply of electricity and water are available from the local service provider.

2.4.5.1 Water Supply

The LGU operates Level 3 local waterworks system which has a total of 3,088 connections, ninety seven percent (97%) of these are domestic consumers, two percent (2%) are commercial and less than one percent (1%) is industrial. While less than one percent is industrial consumption, these industries consume the biggest in terms of cubic meter per industry per month.

Industries consume an average of 458 cubic meters per industrial establishment and, while commercial establishments consume only 54 cubic meters per establishment and domestic consumption only at 22 cubic meters per household per month.

Level 3 water system serves 10 barangays of the municipality.

The project will not create competition on water resources because there will be no underground water extraction and more importantly the abstraction from the Tagoloan River will be subject to separate permits/clearances from the NWRB. As a matter of policy and procedure the NWRB takes due and significant note of water resource competition in its processing of water permits.

Water Resources of the project

(a) The extraction of process water from **Tagoloan river** is subject to a permit/clearance to be required from the NWRB, the process of which will undergo a Public Consultation to ascertain that the right of the public to water is not compromised;

(b) Potential threat to fisher folks. Access to fishing will not be impeded because the frontage of the project site towards the Bay is not presently use as docking points for fishing boats. There are no large scale fishing activities, such being confined normally to the fishing spot at the points of the River wherein water will be abstracted.

(C) Competition in the use of Macajalar Bay for navigation is absent in view of the non-existence of navigation in the Bay impact area fronting the project site.

2.4.5.2 Communication Service Facilities

PHLPOST, a public postal services occupying 10 square meters in the municipal hall building operates postal servicing while PLDT provides telephone services and this telephone service is backed up by 1. Smart and 2 Globe Telecommunications which started operating in 2003 and 2006. Cable television is provided by PARASAT while radio broadcasting is provided by V Radio,Bandera and Hope Radio.

There will be no resource competition due to the nature of the Project.

2.4.5.3 Power Supply, Power Transmission and Distribution Lines

There are two power transmission/distribution lines in the locality one is by CEPALCO which was developed in 1965 with 138kv, 69kv, 34.5kv, 13.8kv, and 220v while the other one is by NGCP constructed in 1980 with 138kv and 69kv.

The presence of the Cagayan Electric Power and Light Company (CEPALCO) in the municipality, power supply and maintenance is taken care of.

Relating to the above services/resources and infrastructures of the Municipality the following assessments are thus made.

There will be no threat to the above basic services and resources.

2.4.5.4 Educational Facilities

The academic ladders of Basic Education which stemmed from Kindergarten, Elementary and Secondary Education are flourishing in Villanueva. With the existing fourteen (14) pre-schools, three of which are private; eleven (11) public elementary schools, and three (3) private schools, a total of fourteen (14) elementary schools; four (4) public high schools including the Senior High School Stand-Alone and one (1) private high school, a total of four (5) high schools; one (1) Alternative Learning System (ALS) with informal and Non-Formal Education; and with participation rates growing, these clearly indicate how much the Municipality values education as a vital tool in empowering the most essential capital to progress – its own people. However, college institution in the locality is still inexistent.

2.2.5.5 Literacy rate, profile of educational attainment

By highest educational attainment of population 5 years old and over, a population comprising 37.44 percent had elementary schooling while 37.00 percent had high school education and of this number about 8.5 percent were college undergraduate; five (5) percent had no grade completed, five (5) percent were academic degree holder; three (3) percent had pre-school education; and almost one (1) percent had post-baccalaureate studies. Males predominate at the lower levels of education, i.e., at pre-school, elementary and those with no grade completed while as the grade level rises, the females predominate. Thus there are more females than males in high school, post-secondary, college undergraduate, academic degree holder and in those with post-baccalaureate studies.

2.4.5.6 Recreational/Sports Facilities

All barangays of the municipality has at least one basketball court owned by the barangay government. Some barangays have tennis courts, covered courts, playground stage and covered court are located.

The proponent’s expansion project of coal power plant is not a treat, instead a boost to the above basic services. The production of electricity itself does not conflict with these services.

2.4.5.7 Peace and Order/Crime

Based on the record under review, the crime incidence of Villanueva has gone down (2013-2017). Of the crimes recorded, the most prevalent crimes were Reckless Imprudence Resulting in (Physical Injury, Damage to property and Homicide) followed by Theft and followed by Physical Injury. These crimes were usually transpired at the urban barangays namely: Brgy Looc, Poblacions 1, 2, & 3, Katipunan, and San Martin. However, of the three prevalent crimes, theft and Physical injury were attributed by illegal drugs and intoxication of liquor respectively. But these crimes have gone down due to the relentless conduct of police-initiated operations and police presence of the identified crime prone areas, thus, peace and order situation of the municipality of Villanueva is Manageable therefore it is generally peaceful, safe place to live, visit and invest.

Whilst the power plant operations do not relate to peace and order/crime because the personnel in the plant and their activities are within the control and managed by FDC Misamis Corporation. Restrictions will be made on aspects that could likely contribute to peace and order/crime situations such as carrying of firearms and other deadly weapons, drunkenness and unruly conducts on the part of the personnel and guests.

The provision for electricity will in effect improve the peace and order/crime situation since this will provide better lighting especially to streets, more effective operation of the local police force, and the proliferation of business/commercial establishments which be sustained if peace and order / crime is effectively controlled.

On the other hand, watch should be made on the potential impacts of electricity supply that could affect peace and order/crime such as increase in night time establishments, including restaurants and food services that could be selling liquors.

2.4.5.8 Food Security

Villanueva, even of its new industrial status, is still basically an agricultural municipality. It has a total land area of five thousand, two hundred twenty-two hectares (5,222). The area of about 961.25 hectares is being planted with different agricultural commodities which is 18% of the total land area.

The top three major crops planted in the municipality are corn, rice, and banana. The total area planted with corn is 222 hectares or about 4.25%. The total area of rice land amounts to 194 hectares of which 137 hectares are irrigated; 38 hectares are rained and 19 hectares upland. It comprises 3.71% of the total agricultural area of 961.25 hectares. Banana plantation has an area of 212 hectares or about 4.06% of the total agricultural area of the municipality.

Out of the eleven barangays in the municipality, only four (4) Barangays have irrigated rice lands. They are Barangay Poblacion 1, Poblacion 2, Looc and Kimaya. Coconuts, corn and root crops are also planted mainly in Barangay Imelda, San Martin, Looc, Dayawan, and Kimaya.

Total volume corn production is estimated at about 1,554 metric tons (MT) amounting to 23,310,000.00 pesos for local market alone. Barangay Kimaya contributed most of this production amounting to 420 MT in its 60 hectares or 27.02% of the total corn production in the municipality.

The total volume of production of rice in the municipality is estimated to be about 1,234.5MT with a total production value of about 19,752,000.00. The volume of rice production for irrigated area is estimated to be 959 MT with a production value of 15,344,000.00. It has an average yield of 99 sacks per hectare. It has an average yield of 3.5/hectares. Upland rice considering 50 kilos/bag of rice and 45.00 pesos per kilo, it has a total value of 2,250 pesos per bag. Banana has a total average production of 2,650 MT with a production value of 20,900,000 on a 212 hectare plantation with Barangay Kimaya as the top producer at 37.74% of all overall production of 1,000 MT at 80 hectares, this amounts to 8,000,000 on average.

Coconut covers an overall of 69 hectares yielding an average production of 193.2 MT valued at 7,728,000.00. Barangay Dayawan has the highest coconut production with 31 hectares planted yielding 86.8 MT amounting to 3,472,000.

With the current available production in the Municipality, the town's food security is considered enough and available.

The project site was not previously used for agriculture; hence food security aspects are not relevant as impacts of the project. On the contrary, the availability of more adequate power supply can result in better food supply such as in food processing plant projects which invariably needs electricity.

2.4.6 Threat to Public Health and Safety

Public health issues could arise if there are significant hazardous substances being used. However, as discussed on the Section 4 "ERA" there are no hazardous substances or waste that are used for the project except for small quantities of chemicals/materials.

Regarding public safety, as also discussed in Section 4 "ERA" there are also no major public safety issues associated to the projects.

As part of Social Development Program through proponent's CSR, several community health and sanitation programs were conducted to help the impact communities address their common health and sanitation issues as well as educate the communities to maintain cleanliness of their surroundings especially the water bodies (*esteros*) within their communities.

2.4.6.1 Medical Health Personnel, Facilities, and Condition

The municipality has its main Health Center located in Barangay Poblacion 1 together of total seven (7) health stations in barangays Poblacion 3, Kimaya, Imelda, Looc, Katipunan, San Martin, Dayawan, SRV

(San Roque Village). Barangays without health stations are Poblacion 1 and 2, Tambobong and Balacanas but assigned with competitive midwives and NDP to continuously implement the Department of Health Programs. All Barangay Health Stations are in relatively good condition.

The main health center is managed by a doctor, a nurse, and 2 NDPs, a midwife and 2RHMPPs, a rural sanitation inspector and 1 assistant, a dentist and a dental aide, a medical technologist and a microscopist, a utility and 38 BHW of Poblacion 1 and 2. Adjacent to main health center is the Villanueva Lying-In which is open 24 hours a day every day, manned by trained midwives.

Each Barangay health station is manned by a midwife, barangay health workers and a nurse deployed from the Department of Health. Poblacion 1 and Poblacion 2 shares 1 BHS at main Health Center. In terms of midwife to population ratios, the municipality satisfies the standards, however, the doctor and nurse ratio population does not.

The municipality has 1 permanent doctor, nurse, rural sanitation inspector, dentist, medical technologist and 8 rural midwives. Among the 12 Rural Health Midwives, 8 of them are permanent employees. The 242 BHW, utility and 2 drivers were locally paid. To augment manpower and bring quality health services to purok or sitios in barangays, the Department of Health thru its Human Resource for Health Program provide additional 8 nurses and 4 midwives to the municipality.

Categorically, there is no existing Hospital in the municipality but we are fenced by nearby hospitals like Claveria MOPH, Jasaan Municipal Hospital and Tagoloan Polymedic General Hospital voluntarily available for immediate referrals. These hospitals can be reached by our ambulance about 5 to 10 minutes from Main Health Center. Depending on the kind of transportation used, the main health center can be reached for 2-45 minutes generally from known sitios and barangays within the municipality.

2.4.6.2 Ten Leading Causes of Morbidity and Mortality for the Past Three Years

- **Morbidity**

The furthermost notifiable is the Upper Respiratory Tract Infection (URTI) with an increase of above 100% in 2015 compared to previous year. Other diseases like Hypertension, Pulmonary Tuberculosis, Wound, Animal Bite, Dengue, Diabetes Mellitus, and Systemic Viral Infection has figuratively increases its cases compared from the foregoing years. There is a drop of case in Acute Gastroenteritis and Urinary Tract Infection in 2014 then slowly increase in 2015. Dengue on the other hand, gradually grows to almost 100% from 2014 to 2015 which is disturbingly alarming. As presented in Table 2-42.

These illnesses are mostly infectious and/or communicable in nature. Hypertension and Diabetes Mellitus are lifestyle-related diseases mainly affected by our diet, unhealthy activities and habits. Wounds are due to occupational hazards and accidents by employees working in factories and industries within the Municipality.

Table 2.4-8 Ten Leading Causes of Morbidity for the Past Three Years

CAUSES	Number of Morbidity Cases		
	2013	2014	2015
Acute Respiratory Tract Infection	1189	1029	2916
Wounds	83	97	359
Hypertension	85	83	199
Dengue	41	48	80
Acute Gastroenteritis	265	72	135
Skin Diseases	128	126	263
Urinary Tract Infection	291	67	110
Pulmonary Tuberculosis	65	79	91
Abdominal Pain	123	175	210
Diabetes Mellitus	87	101	195
Animal Bites	47	62	71
Systemic Viral Infections	25	41	56
TOTAL	**2429**	**1980**	**4685**

Source: Villanueva CLUP 2017 - 2027

- **Mortality**

Table 2.4-9 shows the leading causes of mortality are heart disease, hypertension, accidents, cancer, COPD, renal disease, sepsis, liver cirrhosis, diarrheal diseases, and birth injury. Non-communicable Diseases are complications of lifestyle-related diseases such as hypertension, diabetes and cancer which could have been prevented if early regular check-up and compliance to prescribed medications are appropriately followed. Sepsis sets in usually because of delay in seeking care and poor defiance to antibiotic medications.

Table 2.4-9 The leading Causes of Mortality for the Last Three Years

Cause and Number of Deaths									
	2013	No.		2014	No.		2015	No.
1	Heartg Disease	33	1	Heartg Disease	43	1	Heartg Disease	62
2	Hypertension	8	2	Hypertension	9	2	Hypertension	12
3	Accidents	6	3	Accidents	7	3	Accidents	7
4	Cancers	6	4	Cancers	5	4	Cancers	4
5	COPD	6	5	COPD	5	5	COPD	3
6	Renal Desease	6	6	Renal Desease	4	6	Renal Desease	3
7	Sepsis	5	7	Sepsis	4	7	Sepsis	2
8	Liver Cirrrhosis	3	8	Liver Cirrrhosis	3	8	Liver Cirrrhosis	2
9	Diarrheal Disease	1	9	Diarrheal Disease	2	9	Diarrheal Disease	2
10	Birth Injury	1	10	Birth Injury	1	10	Birth Injury	1

Source: Villanueva CLUP 2017 - 2027

Threats to public health and safety may be viewed from the perspective of:

a. The electricity generated by the power plant which is not considered a threat to public health and safety.
b. The power plant which produces the electricity.

Although there are no documented evidences from Philippine experiences linking coal power plant to ill health effects, particularly cancer, in response to a question raised by a stakeholder during the Public Scoping, following discussions are made.

Table 2.4-10 Summary Matrix of Perceived Threats to Public Health

Substance	Human Toxicity		Remarks
	Acute	Chronic	
By Inhalation in air discharges			
Sulfur Dioxide	Lung irritation Asthma trigger	Lung function reduction	GLC way below NAAQGV based from the Air Dispersion Modeling. Mobile sources major contribution to air quality
Nitrogen Oxides	Lung function reduction Respiratory ailment in children	Susceptibility to respiratory illnesses	Same as above
Particulate Matter	Asthma attacks Cardiovascular problems	Cardiovascular disease Pneumonia COPD	Same as above PM_{10} is current parameter
Mercury	Elemental Hg->central nervous system effects Gastrointestinal tracts and respiratory system	Methyl mercury->developmental effects Kidney damage	NESSAP Limit= 5 mg/Ncm (elemental Hg)
$Chromium^{+6}$	High exposure-> Renal toxicity Internal hemorrhage	High potency-> Carcinogen	
Cadmium	Bronchial and pulmonary irritation	Medium potency ->carcinogen	NESSAP Limit= 10 mg/Ncm as Cd
Lead	Carcinogen Brain damage		NESSAP Limit = 10 mg/Ncm as Pb
Arsenic	Gastrointestinal and Central nervous system effects	High potency carcinogen	NESSAP Limit = 10 Mg/Ncm (elemental As)
Others			
Acid rains		Lung effects on children	No known occurrence in Philippines

Substance	Human Toxicity		Remarks
	Acute	Chronic	
			May result from combination of PM. Sulfur dioxide, carbon monoxide, lead, chlorofluorocarbons and carbon dioxide
In drinking water through ash leaching			
Chromium^{+6}	Carcinogen	Carcinogen	No drinking water source at project site

Source: US EPA, Various

From the above table it may be deduced that if there are no causative agents to illnesses there should not be any health effects.

It follows that the use of good quality coal, i.e. such that the prescribed limits of concentrations in the ambient air, in soil and in water (the latter in an event of leaching from the ash generated) will ensure the protection of the impact populations.

In addition to clean technology through the use of good quality of coal, pollution control devices for the air emissions and for the ash generated will be installed.

- **Baseline Health Conditions**

There are no local or international authoritative studies that correlate morbidity and mortality baseline conditions to coal power plant operations. It is a fact that communities/populations are located close to coal power plants.

Further, the potential causative agents for diseases are not present in the baselines.

- **Ambient Air Quality**

Criteria pollutants and metal concentrations in the ambient air do not reach values that may suggest health effects. These are further discussed in Section 2.3.

- **Soil Baseline Quality**

Lead, Mercury and Cadmium are either essentially absent or at low concentrations in the various soil samples at the site. The concentration limits are reckoned from the prescribed international/Dutch standards for values requiring intervention. These are further discussed in Section 2.1.

The relevance of soil quality to health is in the potential for leaching of toxic elements to the water systems and thus finding their ways to the human bodies.

In summary in respect of the important aspects of health effects:

There exist no reasons to believe that there are in fact threats to public health from the Project for the following reasons:

(a) The concentrations of the regulated pollutants at the ambient air as predicted by an Air Dispersion Modelling are well within the Ambient Air Guideline Values of the Philippine Clean Air Act, discussed in Section 2.3.
(b) The feed coal to be used is the same with the existing plant which is of good quality particularly in respect of elemental mercury content/concentration

(c) Metallic leachates are not generated when good quality coal is used

In addition, the perception of Chromium^{+6} **leaching into public drinking water** is not applicable since there are no public drinking water source at the Direct Impact Areas (DIA) of the Project.

- **Diseases that may be affected by Climate Change**

Climate change phenomenon is necessarily viewed from a global perspective. Thus although combustion process will necessarily result in the production of **ghg CO2**, the operation of the power plant itself will not in any way impact on the global phenomen of climate change, as discussed in Section 2.3. Thus it follows that diseases affected by climate change resulting from the project is not germane to health effects resulting from the project..

Climate Change has various significant effects such as on health. In the absence of data or experiences from health impacts from coal power plants as applied to the Philippine scenario, articles in the public domain such as from the Authority World Health Organization (WHO) are instead referred to. In citing this reference it is to be noted that the observations therein made while significant may not necessarily apply to the 6 x 135 MW Power Plant Project.

Reference : https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health
Climate change affects many of the social and environmental determinants of health – clean air, safe drinking water, sufficient food and secure shelter.

Extreme heat

Extreme high air temperatures contribute directly to deaths from cardiovascular and respiratory disease, particularly among elderly people. In the heat wave of summer 2003 in Europe for example, more than 70 000 excess deaths were recorded

High temperatures also raise the levels of ozone and other pollutants in the air that exacerbate cardiovascular and respiratory disease.

Pollen and other aeroallergen levels are also higher in extreme heat. These can trigger asthma, which affects around 300 million people. Ongoing temperature increases are expected to aggravate this burden.

Variable rainfall patterns

Variable rainfall patterns are likely to affect the supply of fresh water. A lack of safe water can compromise hygiene and increase the risk of diarrhoeal disease, which kills over 500 000 children aged under 5 years, every year. In extreme cases, water scarcity leads to drought and famine. By the late 21st century, climate change is likely to increase the frequency and intensity of drought at regional and global scale.

Floods and extreme precipitation.

Floods contaminate freshwater supplies, heighten the risk of water-borne diseases, and create breeding grounds for disease-carrying insects such as mosquitoes. They also disrupt the supply of medical and health services.

Rising temperatures and variable precipitation are likely to decrease the production of staple foods in many of the poorest regions. This will increase the prevalence of malnutrition and undernutrition.
Climate Change Projections on Rainfalls and Temperature Extremes.

Utilizing the "PRECIS (Providing Regional Climates for Impact Studies)" model in two time frames; 2020 and 2050 the DOST in cooperation with others published the study "Climate Change in the Philippines February 2011" from which the extreme scenarios in Table 2.4-xx were extracted.

(Note : The PRECIS model was developed by the UK Met Hadley Centre (in the United Kingdom) to facilitate impact, vulnerability and adaptation assessments in developing countries where capacities to do climate modeling are still not fully developed or do not exist. Three of the emission scenarios developed by the Intergovernmental Panel on Climate Change in its Special Report on Emission Scenarios (IPCC SRES) were chosen to run the models; namely, A2 (high-range), A1B (mid-range), and B2 (low-range). The A2 scenario is at the so-called higher end of the emission scenarios (although not the highest), and is preferred by most countries because from an impacts and adaptation point of view, if man can adapt to a larger climate change, then the smaller climate changes of the lower end scenarios can also be adapted.)

Table 2.4-11 Extreme Cases Projections for Misamis Oriental

Provinces	Stations	No. of Days w/ Tmax >35 °C			No. of Dry Days			No. of Days w/ Rainfall >150mm		
		OBS (1971-2000)	2020	2050	OBS	2020	2050	OBS	2020	2050
BUKIDNON	Malaybalay	26	477	1441	6537	3977	4461	4	9	9
LANAO DEL NORTE	Dipolog	217	2155	4004	7481	5384	5470	3	6	1
MISAMIS ORIENTAL	Cagayan De Oro	383	4539	6180	8251	6413	7060	10	13	9
	Lumbia	106	2012	3759	6495	6290	6580	3	6	1

The applicability of these projections, however, need to be validated under the current experiences and more updated projections technology.

Patterns of infection
Climatic conditions strongly affect water-borne diseases and diseases transmitted through insects, snails or other cold-blooded animals.

Changes in climate are likely to lengthen the transmission seasons of important vector-borne diseases and to alter their geographic range. For example, climate change is projected to widen significantly the area of China where the snail-borne disease schistosomiasis occurs.

Measuring the health effects

Measuring the health effects from climate change can only be very approximate. Nevertheless, a WHO assessment, taking into account only a subset of the possible health impacts, and assuming continued economic growth and health progress, concluded that climate change is expected to cause approximately 250 000 additional deaths per year between 2030 and 2050; 38 000 due to heat exposure in elderly people, 48 000 due to diarrhoea, 60 000 due to malaria, and 95 000 due to childhood undernutrition.

While the above discussions provide useful information and guidelines, the specific impacts on the population within the DIA and IIA of the project are not immediately determinable.

- **Safety**

As discussed in Section 4 (ERA), safety is a normal concern for industrial facilities. Based on inquiries made from the Safety Organization of the Philippines, Inc. or with personnel who have been involved in the operation of coal power plants there exists no record or there have been no recorded major accidents that have caused man-hour losses.

Further, even if accidents would occur, the public/communities shall not be affected; there are no societal risk with the project. Potential accidents that could affect communities such as landslides are absent from the project.

- **Spontaneous combustion**

This is not expected to arise at significant levels during the storage of coal except to minor episodes of localized fires. The storage facilities and coal delivery/usage system will adopt a “First In” “First Out” scheme such that the stored coal will not cause accumulation of oxygen and heat, the elements for spontaneous combustion.

Even in events that spontaneous combustion could arise, these will be in the nature of “pockets” of small fires easily extinguishable by the fire-fighting system of the plant.

2.4.6.3. Mitigating measures implemented by the project to protect the community from exposure to potential hazards.

Discussed in **Section 4** are the potential hazards from the project which are basically the following:

Coal due to spontaneous combustion

Mitigation consists of use of quality coal including properties that could induce spontaneous combustion. Moreover, coal storage and handling are undertaken such that accumulation of molecular oxygen in the coal stored are minimized which would otherwise give rise to spontaneous combustion.

Hazardous wastes as shown below

Hazardous Waste Class	HW Nature / Cataloguing	HW generated (ton)	HW Treated (Ton)
Used Lead Acid Batteries	Solid / Toxic	0.02	1.60
Busted Flourescent Lamps	Solid / Toxic	0.03	0.229
Used Oils	Liquid / Flammable	0.00	27.01
Oil Contaminated Materials (sand, soil, rags, and absorbent pads	Solid / Flammable	0.20	8.2
Chemical containers (NH_4OH)	Solid / Toxic	0	0.1
Chemical containers (Hydrazine)	Solid / Toxic	0	0.1

Mitigation consists of compliance with RA 6969 on the handling storage and disposal of hazardous wastes although the quantities involved are not significant. It may be noted that the plant is not classified as a TSD (Transport, Storage and Disposal) facility requiring applicable permits for hazardous wastes.

Chronic Risks

Ambient Concentrations of Toxic/Hazardous Substances to be used (i.e. cyanide, mercury, etc.). These potential hazards are not of concern with the project because the feed coal contains only trace values of the metallic elements. This being the case these metallic elements will not be produced anywhere in the process cycle and hence not considered as hazards.

Hazards or risks arising from the plant operation i.e. spontaneous combustion, fire, accidents are confined to the plant premises and distant from communities/population centers. On accidents, the movements of vehicles to and from the project site passing through the communities are managed through the vehicle owners including contractors such that the communities are sufficiently protected from vehicular accidents.

With respect to natural hazards such as floods and seismic activities the project will not induce such risks.

It is noted that with respect to protection of the community from exposure to potential hazards, there has been no recorded incidents involving impact of the project on the community arising from the hazard.

2.4.7 Generation of Local Benefits from the Project

2.4.7.1 Enhancement of employment and livelihood opportunities.

In response to a question raised during the Public Scoping, and even without such being asked, the Proponent will give priority for employment to qualified residents under mutually acceptable employment terms and conditions and subject to compliances with the rules of the Department of Labor and Employment (DOLE). There are no issues on employment was raised since the operation of the power plant was started.

2.4.7.2 Increased business opportunities and associated economic activities

Electricity is one of the most basic need not only of the public but of business, industries and economic activities. The expansion project will provide such needs especially considering the looming power crisis and increasing needs in Mindanao.

2.4.7.3 Increased revenue of LGUs

Taxes will be paid the LGU the amount of which will be determined when all the parameters for the operation of the Plant shall have been established.

2.4.7.4 Employment rate/profile

Some local residents have been directly and indirectly employed by FDC Misamis leveraging the employment rate of the community. As of December 31, 2020 a total of 205 personnel were hired 67% of which were from different cities and municipalities, 23% were locally hired from Municipality of Villanueva and 10% from Municipality of Tagoloan both are the host community.

Table below shows the distribution of hired employees per Barangay and Municipalities

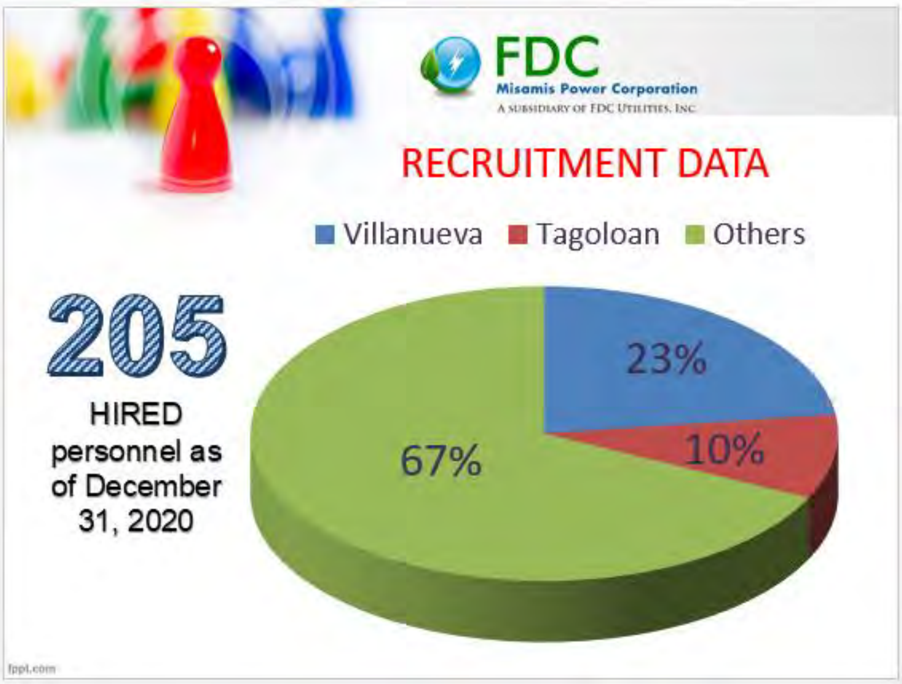


Figure 2.4-8 A chart showing the distribution of hired personnel as of December 31, 2020.

Table 2.4-12 Employee Distribution per Barangay and Municipalities

Villanueva	Hired Employees	Tagoloan	Hired Employees	Employees Hired from other Places
Brgy. Balacanas	1	Brgy. Natumulon	4	
Brgy. Dayawan	1	Brgy. Poblacion	6	
Brgy. Katipunan	6	Brgy. Santa Cruz	4	
Brgy. Looc	7	Brgy. Santa Ana	2	
Brgy. Poblacion1	8	Brgy. Baluarte	2	
Brgy. Poblacion2	8	Brgy. Casinglot	1	
Brgy. Poblacion3	2			
Brgy. San Martin	6			
Brgy. Tambobong	4			
Brgy. Imelda	4			
TOTAL	47	TOTAL	19	139

On the other hand, FDC Misamis contracted a total of 260 personnel as of December 31, 2020 from 4 different Employment Agencies.

Figure and Table below shows the distribution of contracted employees as of December 31, 2020.

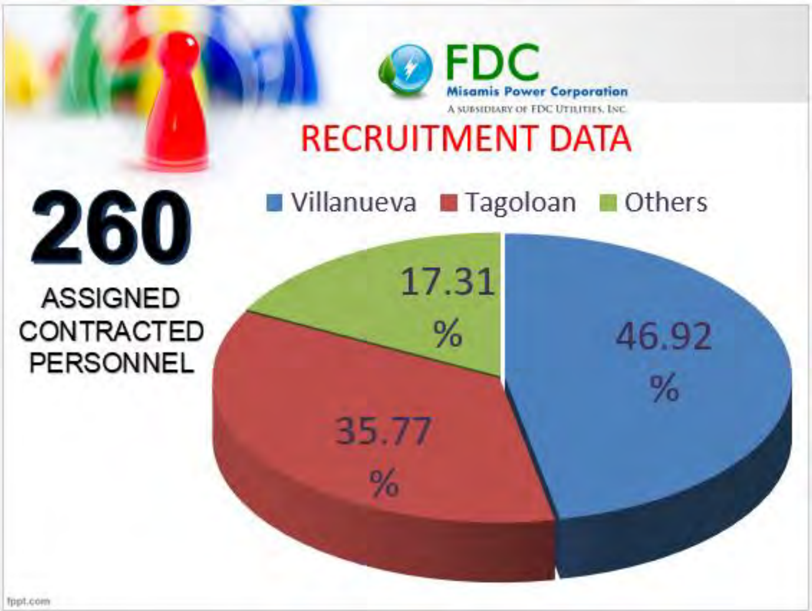


Figure 2.4-9 A chart showing the distribution of the Assigned Contracted Personnel as of December 31, 2020.

Table 2.4-13 Distribution of Contracted Personnel per Municipalities and Employment Agencies

Location	***MSIA***	***BBASI***	***VV Security***	***DMSI***
VILLANUEVA	***36***	***49***	***15***	***22***
TAGOLOAN	***16***	***22***	***40***	***15***
OTHERS	***12***	***19***	***5***	***9***
TOTAL	***64***	***90***	***60***	***46***

2.4.8 Traffic congestion

2.4.8.1 Existing Transportation/Traffic Situation/Road System

Infrastructure Profile
Road transport plays an important role in agricultural development. This is because it is the major means of transporting agricultural produce from the farms to the markets as well as to various urban communities. It has a significant impact on distribution of agricultural products.

The local government of Villanueva together with the Department of Agriculture aims to reduce poverty by providing infrastructure and by developing support services for agricultural enterprises.

With this aim, the LGU has launched a number of projects. Thus, a lot road was constructed and rehabilitated in the municipality. The longest road length recorded was the Imelda-Mambuaya-Kimaya Road which measures 8.70 kilometres while Madri-Banban-Lourdes Road with 2.50 kilometres was the shortest. When it comes to upgrading, there were four (4) roads upgraded, the FAMEX- Tuburan 2 with 0.20 kms, Madrid-Banban road- 0.20 kms, and the Mambuaya- Binacalan & Imelda- Mambuaya with 0.30 kms upgraded road.

2.4.8.2 Major Infrastructures-Roads and Bridges

Villanueva, with a total land area of 5,222.50 hectares is linked by a road network totalling 4.826 ln.kms. concrete and gravel roads of 10 and 8 meters wide municipal streets and a total of 39.288 ln.kms barangay roads of also 10 and 8 meters wide.

This road network is connected by thirteen (13) bridges, six concrete and 7 steel bridges. The two (2) concrete bridges are Tag-anga Bridge at Katipunan and Villanueva Bridge at Poblacion. Four (4) concrete spillways are found in Upper Dayawan, SRV Relocation, Kimaya and Looc. The seven (7) Foot Bridges are in Tuburan,Looc, Butigon, Poblacion 2,Baac Camp, Poblacion 1 and Famex-Soligao in Poblacion 2.

Ancillary roads supporting this road network are 12 pedestrian crossings, a sidewalk in Poblacion, 15 Waiting Sheds and Street Lights along theNational Road.

There are also land transportation terminal, one at Katipunan Public Market for jeepney and trisikad; a jeepney terminal in Poblacion 2 and a Motorela Terminal in Poblacion 1. There are also trisikad terminals in Poblacion 1, Poblacion 2, Katipunan and Dayawan.

Maharlika Highway is the main road artery to the Phividec and the project site. The access road to the site is within the Phividec property/land.

Traffic congestion is not a significant concern because:

a) Road vehicular movement directly related to the project is minimal during the operations phase. The feed coal will be transported by sea vessels.

b) The access road to the site is not a public road but is within an Industrial Estate.

Capacity of road system in terms of load/count

There are no existing information on this inasmuch as traffic in the project site area has not been a concern of the public and of the Municipality.

2.4.9 Perception Survey

The perception survey was conducted to identify the present socio-economic profile of the predetermined social impact areas and to know the level of awareness of the different people and their acceptance to the proposed project. The survey was conducted last October 4 to 8 2019 to the communities that are to be affected by the proposed expansion project, particularly **Barangays Balacanas and Tambobong** which is the closest to the project site. Sample Perception Survey is provided in **Annex 12b**.

The team selected respondents from 6 barangays who will be directly affected by the proposed project. A number representing households which will be in direct contact with the construction were given utmost priority in the survey.

The Proponent has taken initiatives to integrate the results of the perception survey in its plans and policies.

Demographic Characteristics

- ***Sex Distribution -*** The respondents were composed of 43 males or 35.54% and 78 females or 64.46% of respondents.

Table 2.4-14

GENDER	Tambobong		Mohon		Bacalanas		Baluarte		San Martin		Sta. Cruz		TOTAL	
	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%
Female	10	50.00	16	80.00	13	61.90	7	35.00	16	80.00	16	80.00	78	64.46
Male	10	50.00	4	20.00	8	38.10	13	65.00	4	20.00	4	20.00	43	35.54
No Answer	0	0	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	20	100	20	100	21	100	20	100	20	100	20	100	121	100

- ***Civil Status -*** Based on the table below, 75 out of 121 of the respondents or 61.98% are married followed by single on a percentage of 18.18% or 22 out of 121 respondents and the rest are widower and separated.

Table 2.4-15 Impact Barangays: Civil Status of the respondents

MARITAL STATUS	Tambobong		Mohon		Bacalanas		Baluarte		San Martin		Sta. Cruz		TOTAL	
	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%
Dalaga/Binata	1	5.00	2	10.00	9	42.86	8	40.00	0	0.00	2	10.00	22	18.18
May Asawa	13	65.00	11	55.00	11	52.38	11	55.00	17	85.00	12	60.00	75	61.98
Byuda/Byudo	3	15.00	4	20.00	0	0.00	1	5.00	3	15.00	2	10.00	13	10.74
Hiwalay sa asawa	1	5.00	2	10.00	1	4.76	0	0.00	0	0.00	1	5.00	5	4.13
Live-In	1	5.00	0	0.00	0	0.00	0	0.00	0	0.00	1	5.00	2	1.65
Others	0	0.00	1	5.00	0	0.00	0	0.00	0	0.00	2	10.00	3	2.48
No Answer	1	5.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.83
Total	20	100	20	100	21	100	20	100	20	100	20	100	121	100

Religion - **Table 2.4-13** shows that 61.98% of the total respondents interviewed are Protestant followed by 18.18% which are Roman Catholic and 10.74% are Aglipayan.

Table 2.4-16 Impact Barangays: Religious Affiliation of the respondents

Religious Affiliation	Tambobong		Mohon		Bacalanas		Baluarte		San Martin		Sta. Cruz		TOTAL	
	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%
Roman Catholic	1	5.00	2	10.00	9	42.86	8	40.00	0	0.00	2	10.00	22	18.18
Protestant	13	65.00	11	55.00	11	52.38	11	55.00	17	85.00	12	60.00	75	61.98
Aglipayan	3	15.00	4	20.00	0	0.00	1	5.00	3	15.00	2	10.00	13	10.74
INC	1	5.00	2	10.00	1	4.76	0	0.00	0	0.00	1	5.00	5	4.13
Islam	1	5.00	0	0.00	0	0.00	0	0.00	0	0.00	1	5.00	2	1.65
Christian	0	0.00	1	5.00	0	0.00	0	0.00	0	0.00	2	10.00	3	2.48
Others	1	5.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.83
Total	20	100	20	100	21	100	20	100	20	100	20	100	121	100

- ***Ethnicity -*** The City's dialect is mostly Visayan language. Table presented below that 95.04% or 115 out of 121 respondents in the impact barangays speaks Visayan. Others are Tagalog, Ilocano at 1.65%.

Table 2.4-17 Impact Barangays: Ethnicity of the respondents

ETHNIC GROUP	Tambobong		Mohon		Bacalanas		Baluarte		San Martin		Sta. Cruz		Sta. Cruz	
	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%
Tagalog	1	5.00	1	5.00	0	0.00	0	0.00	0	0.00	0	0.00	2	1.65
Visayan	18	90.00	17	85.00	20	95.24	20	100.00	20	100.00	20	100.00	115	95.04
Ilocano	0	0.00	2	10.00	0	0.00	0	0.00	0	0.00	0	0.00	2	1.65
Kapampangan	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Bicolano	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Others	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
No Answer	1	5.00	0	0.00	1	4.76	0	0.00	0	0.00	0	0.00	2	1.65
Total	20	100	20	100	21	100	20	100	20	100	20	100	121	100

- ***Income, Livelihood and Employment*** **-** The main source of income of the respondents is mostly through employment. 28.10% or 34 out of 121 respondents as regularly employed while 14.88% or 18 respondents out of 121 are in Contractual Job/Sub contractor, 20.66 % are through other source of income.

On the other hand 69.42% of the respondents stated that the husband is the primary earner in the household while 14.05% has the wife as the primary earner.

See **Table 2.4-18** and **2.4-19.**

Table 2.4-18 Impact Barangays: Main Source of Livelihood of Respondents

OCCUPATION	Tambobong		Mohon		Bacalanas		Baluarte		San Martin		Sta. Cruz		TOTAL	
	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%
Pagsasaka	0	0.00	3	15.00	5	25.00	1	5.00	2	10.00	4	19.05	15	12.40
Pangingisda	0	0.00	0	0.00	1	5.00	2	10.00	0	0.00	1	4.76	4	3.31
Empleyado	2	10.00	8	40.00	2	10.00	8	40.00	7	35.00	7	33.33	34	28.10
Kontraktwal	4	20.00	2	10.00	6	30.00	2	10.00	2	10.00	2	9.52	18	14.88
Nagtitinda/nagbebenta	0	0.00	1	5.00	0	0.00	3	15.00	1	5.00	1	4.76	6	4.96
Sariling Negosyo ng Pamilya	3	15.00	2	10.00	1	5.00	0	0.00	0	0.00	3	14.29	9	7.44
May OFW na kamag-anak	0	0.00	0	0.00	1	5.00	0	0.00	2	10.00	1	4.76	4	3.31
Others	8	40.00	1	5.00	4	20.00	4	20.00	6	30.00	2	9.52	25	20.66
No Answer	3	15.00	3	15.00	0	0.00	0	0.00	0	0.00	0	0.00	6	4.96
Total	20	85	20	85	20	100	20	100	20	100	21	100	121	100.00

Table 2.4-19 Impact Barangays: Primary Earner of Respondents

PRIMARY EARNER	Tambobong		Mohon		Bacalanas		Baluarte		San Martin		Sta. Cruz		TOTAL	
	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%
Asawang Lalake	14	70.00	14	70.00	17	80.95	12	60.00	12	60.00	15	75.00	84	69.42
Asawang Babae	1	5.00	2	10.00	1	4.76	4	20.00	8	40.00	1	5.00	17	14.05
Anak na Lalaki	1	5.00	2	10.00	0	0.00	1	5.00	0	0.00	1	5.00	5	4.13
Anak na Babae	2	10.00	0	0.00	0	0.00	1	5.00	0	0.00	0	0.00	3	2.48
Lalaking Kamag-anak	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Babaing Kamag-anak	0	0.00	0	0.00	0	0.00	2	10.00	0	0.00	0	0.00	2	1.65
Others	2	10.00	2	10.00	3	14.29	0	0.00	0	0.00	3	15.00	10	8.26
No Answer	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	20	100	20	100	21	100	20	100	20	100	20	100	121	100.00

In terms of income, most of the respondent or 38.84% or 47 respondents out of 121 are earning between Php 1,000 - 4,999; respondents earning between Php 5,000 to Php 9,999 are in 23.97%; while respondents earning between Php 10,000 - Php 19,999 make up 14.88% followed by 14.05% earning below Php 1,000. ***See Table 2.4-20*** below.

Table 2.4-20 Impact Barangays: Monthly Income of respondents

MONTHLY INCOME	Tambobong		Mohon		Bacalanas		Baluarte		San Martin		Sta. Cruz		TOTAL	
	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%
Below 1,000	2	10.00	1	5.00	4	19.05	8	40.00	2	10.00	0	0.00	17	14.05
1,000 - 4,999	8	40.00	8	40.00	11	52.38	7	35.00	11	55.00	2	10.00	47	38.84
5,000 - 9,999	7	35.00	4	20.00	2	9.52	3	15.00	6	30.00	7	35.00	29	23.97
10,000 - 14,999	3	15.00	6	30.00	1	4.76	1	5.00	1	5.00	6	30.00	18	14.88
15,000 - 19,999	0	0.00	0	0.00	1	4.76	1	5.00	0	0.00	2	10.00	4	3.31
20,000 - 24,999	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	10.00	2	1.65
25,000 - Above	0	0.00	1	5.00	0	0.00	0	0.00	0	0.00	1	5.00	2	1.65
No Answer	0	0.00	0	0.00	2	9.52	0	0.00	0	0.00	0	0.00	2	1.65
Total	20	100	20	100	21	100	20	100	20	100	20	100	121	100

- ***Educational Attainment* - Table 2.4-21** shows that the largest percentage or 40.50% of the respondents are high school graduates, followed by College graduate at 34.71% and 11.57 % of the total respondents completed Elementary. This is a good signs of high literacy in the community.

Table 2.4-21 Impact Barangays: Educational Attainment

EDUCATIONAL ATTAINMENT	Tambobong		Mohon		Bacalanas		Baluarte		San Martin		Sta. Cruz		Total	
	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%
None	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Elementary	3	15.00	2	10.00	2	9.52	3	15.00	2	10.00	2	10.00	14	11.57
High School	9	45.00	9	45.00	11	52.38	8	40.00	6	30.00	6	30.00	49	40.50
Vocational	3	15.00	2	10.00	3	14.29	1	5.00	1	5.00	1	5.00	11	9.09
College	3	15.00	7	35.00	5	23.81	7	35.00	10	50.00	10	50.00	42	34.71
Post Graduate	2	10.00	0	0.00	0	0.00	1	5.00	1	5.00	1	5.00	5	4.13
No Answer	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	20	100	20	100	21	100	20	100	20	100	20	100	121	100

- **Health Profile**

In the perception survey it revealed that 34.71% or majority of respondents had no response for the question which was intended to get results for the past five years. However the rest of the respondents have experienced one (1) or two (2) sick family members. Common sicknesses in the barangay as indicated by the household respondents are colds, fever, and gastrointestinal diseases. See **Table 2.4-22** and **2.4-23**.

Based from the result of the conducted survey, most of the respondents opted to consult to Brgy. Health Center then followed by Government Hospital and Private Clinic. See **Table 2.4-24.**

Table 2.4-22 Number of Family Member Who Got Sick for the Past 5 Years

NO OF FAMILY MEMBER WHO GOT SICK	Tambobong		Mohon		Bacalanas		Baluarte		San Martin		Sta. Cruz		TOTAL	
	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%
1	6	30.00	4	20.00	6	28.57	5	25.00	6	30.00	6	30.00	33	27.27
2	5	25.00	13	65.00	4	19.05	3	15.00	3	15.00	4	20.00	32	26.45
3	1	5.00	0	0.00	0	0.00	2	10.00	1	5.00	0	0.00	4	3.31
4	0	0.00	0	0.00	2	9.52	1	5.00	0	0.00	0	0.00	3	2.48
5	0	0.00	0	0.00	1	4.76	0	0.00	1	5.00	0	0.00	2	1.65
Morethan 5	0	0.00	0	0.00	3	14.29	2	10.00	0	0.00	0	0.00	5	4.13
No Answer	8	40.00	3	15.00	5	23.81	7	35.00	9	45.00	10	50.00	42	34.71
Total	20	100	20	100	21	100	20	100	20	100	20	100	121	100

Table 2.4-23 Common Illness in the Community

COMMON ILLNESS IN THE COMMUNITY	Tambobong		Mohon		Bacalanas		Baluarte		San Martin		Sta. Cruz		TOTAL	
	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%
Gastrointestinal	1	5.00	1	5.00	0	0.00	1	5.00	0	0.00	1	5.00	4	3.31
Cough/Cold	6	30.00	15	75.00	13	61.90	10	50.00	10	50.00	9	45.00	63	52.07
Fever	1	5.00	0	0.00	2	9.52	2	10.00	0	0.00	1	5.00	6	4.96
Skin Disease	0	0.00	0	0.00	0	0.00	1	5.00	0	0.00	0	0.00	1	0.83
Upper Respiratory	1	5.00	1	5.00	0	0.00	0	0.00	1	5.00	0	0.00	3	2.48
Hereditary	0	0.00	0	0.00	1	4.76	0	0.00	0	0.00	0	0.00	1	0.83
STD	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Heart Disease	2	10.00	0	0.00	0	0.00	1	5.00	0	0.00	0	0.00	3	2.48
Cancer	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Others	1	5.00	0	0.00	1	4.76	3	15.00	1	5.00	0	0.00	6	4.96
No Answer	8	40.00	3	15.00	4	19.05	2	10.00	8	40.00	9	45.00	34	28.10
Total	20	100	20	100	21	100	20	100	20	100	20	100	121	100

Table 2.4-24 Place of Treatment for illness of respondents

PLACE OF TREATMENT	Tambobong		Mohon		Bacalanas		Baluarte		San Martin		Sta. Cruz		TOTAL	
	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%
House	0	0.00	0	0.00	3	14.29	8	40.00	0	0.00	0	0.00	11	9.09
Barangay Health Unit	6	30.00	13	65.00	12	57.14	5	25.00	9	45.00	5	25.00	50	41.32
Government Hospital	3	15.00	2	10.00	5	23.81	5	25.00	2	10.00	4	20.00	21	17.36
Private Clinic	3	15.00	2	10.00	0	0.00	1	5.00	0	0.00	1	5.00	7	5.79
Herbalist/Traditional Med	0	0.00	1	5.00	0	0.00	0	0.00	1	5.00	0	0.00	2	1.65
Others	0	0.00	0	0.00	1	4.76	0	0.00	0	0.00	0	0.00	1	0.83
No Answer	8	40.00	2	10.00	0	0.00	1	5.00	8	40.00	10	50.00	29	23.97
Total	20	100	20	100	21	100	20	100	20	100	20	100	121	100

- ***Household's Perception about the Project***

Table 2.4-25 shows that majority of the respondents had prior knowledge and idea about the **Proposed Expansion of Coal-Fired Power Plant**. Out of the 121 respondents, 30 or 24.79% of them answered No, while 88 or 72.73% answered Yes, and the remaining 3 or 2.48% had no responses.

Majority of the respondents answered that their source of information about the Proposed Project was learned from their Barangay with a frequency of 47 or 38.84% while 3 respondents or 2.48% answered that they heard the project from the media, 11 respondents or 9.09% heard from the their Neighbor, 30 respondents or 24.79% heard from IEC and the remaining 27 respondents or 22.31% had no responses. See **Table 2.4-23.**

Table 2.4-25 Household Knowledge about the Proposed Project

KNOWLEDGE ABOUT THE PROPOSED PROJECT	Tambobong		Mohon		Bacalanas		Baluarte		San Martin		Sta. Cruz		TOTAL	
	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%
Yes	13	65.00	14	70.00	17	80.95	9	45.00	17	85.00	18	90.00	88	72.73
No	6	30.00	6	30.00	4	19.05	9	45.00	3	15.00	2	10.00	30	24.79
No Answer	1	5	0	0.00	0	0.00	2	10.00	0	0.00	0	0.00	3	2.48
Total	20	100	20	100	21	100	20	100	20	100	20	100	121	100

Table 2.4-26. Household Source of Information about the Proposed Project

SOURCE OF INFORMATION	Tambobong		Mohon		Bacalanas		Baluarte		San Martin		Sta. Cruz		TOTAL	
	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%	# of HH surveyed	%
Neighbour	0	0.00	1	5.00	2	9.52	3	15.00	4	20.00	1	5.00	11	9.09
Barangay	3	15.00	2	10.00	11	52.38	5	25.00	12	60.00	14	70.00	47	38.84
IEC of the proponent	10	50.00	10	50.00	6	28.57	2	10.00	1	5.00	1	5.00	30	24.79
Media	0	0.00	0	0.00	1	4.76	0	0.00	0	0.00	2	10.00	3	2.48
Other Source	1	5.00	1	5.00	0	0.00	1	5.00	0	0.00	0	0.00	3	2.48
No Answer	6	30.00	6	30.00	1	4.76	9	45.00	3	15.00	2	10.00	27	22.31
Total	20	100	20	100	21	100	20	100	20	100	20	100	121	100

Perceived Impacts

The respondents were also asked on their view on the possible beneficial and adverse impacts of the **Proposed Expansion of Coal-Fired Power Plant**. As far as the perceived benefits is concerned, top answers are on livelihood and business opportunities, improvement of roads and other infrastructure, additional tax, good service of the government and water services. On the other hand, perceived adverse impacts are traffic, water pollution, loss of job, tsunami, corruption, flood, death of marine species and loss of view.

Table 2.4-27 Possible beneficial impacts of the Proposed Expansion of Coal-Fired Power Plant

Answers	1	Livelihood and Business Opportunities
	2	Improvement of Water Service
	3	Land Taxes
	4	Improvement of Government Services
	5	Improvement of roads and other infrastructure

Data Source: EIA Perception Survey 2019

Table 2.4-28 Adverse Impacts of the Proposed Expansion of Coal-Fired Power Plant

Answer	1	Loss of Plant, trees and vegetation
	2	Health and Safety Hazard
	3	Air, Water and Land Pollution
	4	Generation of Waste
	5	Flooding
	6	Loss of existing Livelihood
	7	Increased traffic

Data Source: EIA Perception Survey 2019

Public participation was observed through the IEC, the Public Scoping and perception surveys.

- **IEC –** Discussed in Section ES and **Annex 11.1**.
- **Perception Surveys –** Discussed in **Section 2.4.9.** and an accomplished perception survey questionnaire in Annex 12
- **Public Scoping –** As discussed in **Executive Summary**, the Public Scoping conducted on 04 October 2019 at the Villanueva Multipurpose Gym was attended by participants from different sectors. The concerned stakeholders, especially those known to have opposition on coal power plant projects, as well as those located in the Impact Areas were invited to participate. The objective of the conducted Public Scoping is to ensure that the Environmental Impact Assessment (EIA) will address the relevant issues and concerns of the stakeholders and that it will be consistent with the Philippine Environmental Impact Statement System (PEISS).

A matrix summary of issues/suggestions raised during the public scoping is shown in **Table 2.4-29.**

Table 2.4-29 Summary Matrix of Issues and Concerns Raised in the Public Scoping

EIA Module	Issues/Suggestion Received by Stakeholder	Sector or Representative Who Raised the Issue/Suggestion	**Proponent's Response**
Land	Do you have Letter of Intent (LOI) base on RA8371 Sec 59 to determine whether if there is indigenous People (IP) affected or an over-lap to Ancestral Domain (AD)? If none the office (NCIP) will issue Certificate of Non-Overlap (CNO)	Engr. Chona NCIP	No IP recognized in the area affected by the project, as the project expansion is within FDCU premise. FDCU already secure CNO (Certificate of Non Overlapping) from their previous project which they will be using fot eh expansion project.
Air	During Project Construction, the Ambient Air Quality and Marine Environment might probably be affected by the expectedly increasing level of particulate matter for ambient air (dust and TSP, oil and grease, etc. For water somehow impact our ambient air and marine environment. STEAG's existing Ambient Monitoring Station are very close to the construction site and others have overlapped already, How to reconcile and handle records?	Jerome Soldevilla STEAG State Power Inc.	CORAL DEGRADATION: Dr. Alabastro: The DENR/MMT might come to a resolution of this. The only way that the corals could be degraded is by direct disturbance during construction of jetty, FDCMP's jetty has been constructed, therefore the MMT and DENR may consider that we, the preparer, do not see any further (if any) degradation of coral within the site of the construction because no construction will take place anymore. Air: DENR/MMT: There are n notable results made by the existing monitoring system. Dr. Alabastro: Air quality will be studied via air dispersion modeling and will be presented in the public hearing DENR: We wabt to clarify this public scoping is only to get concerns, and notable items will be answered in the public hearing.
	A. Suggestion to Preparer / Consultant to possibly answer issues raised based on facts from the operation of the existing FDC Power Plant considering the preparer of both project is the same	Dax Jara PHIVIDEC -1A	Dr. Alabastro (Preparer): Information to be included in the EIS
	B. Suggestion to LGU-Villanueva, FDC Misamis and other concerned stakeholder's to sit down together and formulate certain agreement and mechanism to address issues regarding priority employment and possibility such mechanism will be used for furture MMT (Multi-partite Monitoring Team) validation activities.		FDC NOC and HR to coordination for sit-down meeting with LGU/DENR to discuss improvement of local employment
	For Air mitigation, what is the percentage (%) of CO emitted by the current per generators /Boiler? What is the limit of CO_2	Engr. Walter Encinas, REE CAAP, Area 10	Results to be included in the EIS.

EIA Module	Issues/Suggestion Received by Stakeholder	Sector or Representative Who Raised the Issue/Suggestion	**Proponent's Response**
Water	For Water, currently, what is the exact status of corals? a. Directly on the area of FDC's water? b. 5 km from the Power Plant? c. Within Macajalar Bay?		Results to be included in the EIS
	What is the volume of sea water to be used in the operation?	Rendir Abrea MSU-N	Dr. Alabastro: The preparer was requested to answer the volume of sea water, but may I refer the answer to FDC, strictly there is no volume of sea water. There is a volume of river water. The volume of sea water is not really relevant because the volume of water is really circulating and no volume of water was used. EMP, DR. Myrna: requested to answer the question to quantify the volume Roy of FDCMPC: Volume of sea water being used which drastically below the limit allowed in our water permit from NWRB.
Air	Can you describe the percentage composition of flue gases that should emit from the smoke stack as a result of coal burning? And how do you mitigate it if it exceeds in DENR standard	Anshawer Bara-acal MSU-IIT	KIshler Pascual of FDCMPC: Provided flue gas composition which is within DENR regulation

SECTION 3. IMPACT MANAGEMENT PLAN (IMP)

To the current Impact Management Plan (IMP, as referred to in Annex 2-17 of the Revised Procedural Manual) of the existing and operational FDC MP 3 x 135 MW Circulating Fluidized Bed Coal-Fired Power Plant project, additional potential impacts are identified arising from the Proposed Expansion

As the existing project is already operational, discussions are made on the specific mitigating measures that are already being implemented by the project.

Concerning the MMT it has not made recommendations or revisions or changes in the EMP for the original 3 x 135 MW Project.

In the summary table of the IMP (Table 3-1) another column showing is added showing the Target Performance/Efficiency of the mitigating measures.

<u>KEY IMPACTS AND MITIGATING MEASURES</u>

3.1 During the Pre-Construction Phase

Since only non-destructive survey activities are conducted, and the securing of necessary clearances and permits are undertaken during this phase, there are no identified impacts. There are no settlers and no land use issues are associated with the Project.

3.2 CONSTRUCTION PHASE

3.2.1 Site Preparation. This is taken to mean prior to any activities at site that may cause impact.

3.2.1.1 The Land Environment

3.2.1.1.1 Land Use, Encroachment in an ECA, Tenurial / Land Issues

Being situated in an industrial estate and noting that there is already an existing and operating plant therein located, and further that these matters have been previously addressed in the application for the original ECC it is deemed that ***Land Use, Encroachment in an ECA, Tenurial / Land Issues*** are no longer relevant for the expansion project.

3.2.1.1.2 Changes in surface landform/topography/terrain/slope/ sub surface/underground geomorphology

The land is currently developed, essentially flat in terrain and is intended by PHIVIDEC for industrial establishments; hence further incremental changes will minimally result from the grading requirements of the plant. The grading invariable is associated with surface soil movements.

3.2.1.1.3 Pedology

The soil characteristics of the site, as evidenced from the soil investigation report, the experiences of several other large construction projects in PHIVIDEC, the flat terrain, and the absence of major excavation works suggest that erosion is not a significant impact.

3.2.1.1.4 Terrestrial Ecology

Vegetation removal and loss of habitat for the faunal community

Threat to extinction and/or loss of important local species
Threat to abundance, frequency, and distribution of important species
Hindrance to wildlife access

Loss/disturbance of flora and fauna are deemed minimal because of the absence of significant populations of floral and faunal species at the project site which is already developed.

3.2.1.2 The Water Environment

3.2.1.2.1 *Fresh water and Marine ecology*

Since the construction of the intake and outfall structure will be short term and will be run through a very small portion of the Tagoloan River, there will be no significant impacts on the freshwater ecology of the Tagoloan River.

Marine ecology may be temporarily disturbed and, to a small extent arising from sea bed silt dispersal.

The most significant potential impacts are disturbance or damages to the corals and other marine species resulting from the construction of support structures and pile driving.

(i) Disturbance in the middle portion as a result of canal mouth reinforcement (braces or struts) if the pipe is constructed above the seabed, or extensive damage due to overturning to corals if the pipe is laid directly on the seafloor.
(ii) Disturbance of silt currently sequestered in the sea bottom in front of the project site due to construction activities for the new intake pipes. Although temporary in nature and spatial extent, this may cause surges in silt loads in the water column and exacerbate water turbidity that can contribute to further coral polyp suffocation and drive away fish populations as well.

Mitigating Measures:

The underpinning strategic consideration in order to reduce potential damage to corals in front of the project site is to ensure that any construction activity, wastewater plume, and sediment intrusion will not result to extensive damages to the *coral colony in the middle of the coastal area* fronting the site. This coral patch of about 6000-8000 sqm should be the main conservation focal area and niche for coral recruitment and biodiversity values. To conserve and protect this area, the following measures are recommended:

1. The discharge point of the canal could be located past the slope of the coral colony (our estimate is 250 meters from mean tidal mark);

2. The intake pipe's location is appropriate as it passes through mostly dead corals with algae. Project engineers should study whether the outfall pipe can be located in the same area as the intake pipe. This area, however, is heavily silted.

3. The design of the outfall and intake pipe braces will consider the least disturbance to coral reef patches. Laying them in the seabed itself will result to extensive coral damage.

4. Measures to reduce noise level should be adopted.

Inasmuch as the jetty is already constructed and the previously existing corals at the site of the jetty have been transplanted (with due clearance from the BFAR) it is deemed that no damage nor relocation of the corals will occur.

In the absence of significant floral and faunal species and wildlife at the site, these impacts are not significantly relevant.

3.2.2 Actual Work at Site

3.2.2.1 Earthworks

There will be no major excavation or sub-surface works, except relatively minor earthworks to allow for foundation/piling, drainage and underground piping/electrical works. Unlike in extractive projects, e.g., mining, the geomorphology will not be altered.

- **Foundations**

- **Excavation and Backfilling**

Shall at least meet with the appropriate ASTM, AASHTO and BS Standards and procedures. Excavations and backfilling shall be carried out in accordance with applicable codes and approved procedures, in order to provide the required surface of contact between the structures and the bottom of foundations. All sub-grades shall be proven to be of adequate strength to support the works to be constructed upon it. Compaction of structural granular backfill materials shall be carried out within the range of the optimum moisture content to attain a maximum dry density.

The excavated soil will be returned as backfill.

Impacts / Mitigating Measures:

Generation of solid wastes from construction workers: Solid wastes, esp. garbage disposed by 3rd party. No hazwastes used, minor generation, e.g. spent electronics, batteries, etc.

Change in landforms - Essentially nil, land is already developed and essentially flat in topography.

Disturbance of floral ecology - Minimal; activities are outside the vegetative cover.
Disposal by 3rd party of generated wastes.

Potential transport of sediments/soil to Macajalar during period of rains
Sediment traps in work areas
No soil works during heavy rains

Potential air quality degradation from use of temporary generators
Short term only; Use of approved gensets. Use existing power sources

3.2.2.2 Structures

- **Columns and Beams**
  - The type of columns and beams is steel structure.
  - Steel surface required to fire protection should be coated using adequate materials

- **Cooling Water Pump Station and Discharge Structures**
  - *C.W. Pump Station*
  - *Discharge Structure*
  - *Tank Foundation*

- **Additional Coal Unloading Conveyor**

Power Block Buildings

Construction of Buildings/houses for the turbine generators, condensers, feedwater pumps, deaerator, storage tank and other equipment required for power generation. The building will be designed to withstand dead load, equipment load, live load, wind or seismic load.

The operating floor of the building is a concrete slab while the mezzanine floor is steel grating. Both floors are supported by structural steel framing. The floor drains should be connected to the wastewater treatment plant. The deaerator-storage tank is supported by structural framing and the floor is concrete. The building foundation is reinforced concrete spread footings in combination with continuous footings.

Turbine & Control Building

Turbine Building is closed type in fabricated structural steel including crane for the maintenance of turbine generator. The roof and floors shall be reinforced concrete slab and steel gratings on steel truss beam. Side claddings may consist of insulated metal sheet.

- Control Building shall be designed with the same concept above.

  - Main control room / Electronic room / Computer room
  - Electrical room / Battery room / Communication room
  - HVAC room / Firefighting room
  - Offices
  - Conference room / Storage
  - Kitchen
  - Toilet and Shower room with Locker room, etc.

  Building is comprised of the following, but not limited to:

  - Water treatment area
  - Wastewater treatment area
  - Electrical room / Control room
  - Chemical Storage
  - Laboratory
  - Offices
  - Toilet and Shower room with Locker room, etc.

- EP & Ash Electrical Building

  - Electrical / Control room
  - Coal Storage Shed

Ancillary Buildings

Ancillary building shall be consist of buildings to be included the service facility and ancillary facility for smooth operation of power plant.

Administration Building No additional works

Workshop & Main Warehouse For expansion to cater the additional requirements

Landscape works

Landscaping by means of gardening and planting with grass, decorative bush and trees shall be provided at around road, buildings.

Impacts:

Generation of spent construction materials, e.g. steel, wood, cement, paint. Contractor will be compelled to dispose through 3rd party. Spent electronic parts will be disposed by 3rd party TSD entity.

Mitigation:

Mitigation of solid wastes is by compliance with R.A. 9003 such as reuse, recycling and reduce. Aquise wastes will be confined in temporary toilet facilities for disposal by accredited 3rd party. There will be no significant generation of hazardous wastes as defined in R.A. 6969.

3.3 Pre-Operations Phase

Start-up/Commissioning/Plant Acceptance

Power grid tests (interconnection tests) will be performed to assure compliance to the requirements of the Philippines Grid Code.

Coal unloading jetty and transported in plant using coal conveyor.

The bottom ash generated will be impounded in an engineered land fill; fly ash will be transported to a third-party user.

Air pollution control devices principally electrostatic precipitators (ESP) will be continuously operated to keep PM and SOx emissions within DENR emission standards. A Continuous Emissions Monitoring System (CEMS) will be in operation.

Impacts:

Generation of bottom and fly ash,

Mitigation:

Bottom ash in ash repository pond; fly ash to 3rd party users
Generation of air pollutants
Operation of ESP and CFB technology
Compliances with permits to operate pollution generating equipments.

3.4 Operations - Normal Operations Phase

Ops 1 Start up of Boilers using Diesel Oil as Feed

Ops 2 Switching to Coal after reaching stable conditions

Ops 3 Simultaneously

- **Operation of the “Once through” Cooling Water System**

- **Operation of the River water process water system**
- **Transport of Coal by Conveyor to Boiler system**
- **Generation of bottom ash and disposal at repository pond**
- **Generation of fly ash and disposal to 3rd party user**
- **Operation of the Air Pollution Control Devices (APCD), i.e. ESP**

The APCDs are discussed hereunder providing specific mitigating measures, efficiencies and others.

Mitigating measures discussed in Section 2.3 are also cited herein, e.g. for specific APSI point source and Specific Air Pollutant. *Eg. ESP was installed for Which Unit , in order to control __% of PM. The use of CFB technology for SOX. Low NOx burnerfor NOx. Also regarding CO and Metals.*
.

An ESP unit will be dedicated for each steam generator, i.e. the boiler. It has an efficiency of approximately 99 % and expected resulting dust concenetration of ≤ 40 mg/Nm3 or as guaranteed by the ESP supplier. It is considered as an Air Pollution Control Device (APCD)

On the other hand SOx is controlled in the CFB system through direct Sulfur capture, while NOx is controlled through the low temperature operation of the CFB. Strictly the CFB is not considered as an APCD and is not subject to the securing of a Permit to Operate (PTO).

In the Circulating Fluidized Bed Combustion (CFBC) type of fluidized bed, the air velocity of the bed which is about 4.5-5 m/s causes the circulating action and the effect of fluidization. The combustion air is introduced to the boiler in several levels. The primary air flows upwards and fluidized the bed while the secondary air is injected above the bed. The combustion temperature in fluidized bed boiler is lower than in grate or pulverized firing, typically at 800 – 900 ^{0}C. At this relatively low combustion temperature, NOx which is invariably generated as a result of the mixture of Nitrogen and Oxygen in the air is maintained at lower emission levels.

Sulfur dioxide will be removed in the combustion process by adding limestone or dolomite to the bed, (if necessary) thus eliminating the need for an external desulphurization process and the problem of eventual disposal of sulfur. The calcium oxide formed from the calcination of limestone reacts with the SO_2 to form calcium sulfate which is removed from the flue gases together with fly ash. The low combustion temperature in fluidized bed systems is optimal for limestone requirements because the required calcium to sulfur ratio for a given SO_2 removal efficiency is low in this temperature range. The CFB has therefore built-air pollution control features.

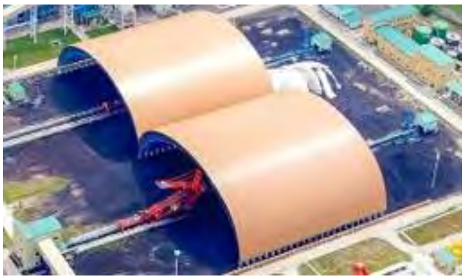
The best measure of performance of the CFB are in the resulting concentrations of the SOx and of the NOx rather than in absolute percentages of reductions.

Metals are not controlled by the APCD or by the CFB but instead are managed through the use of high quality coal fuel.

There are no other generator sets used except for start up purposes which are short term and infrequent.

Regarding the mitigating measure for Area and Volume Sources. Eg. Coal Yard, Conveyors

Coal yards are partically covered to prevent or minimize wind blown fugitive coal dust dispersal, shown in the image at the right side.



Conveyors are designed to be partially covered for the purpose of preventing fugitive dust dispersion.

On CO, by its nature it is a product of incomplete combustion, thus control is through the efficiency of the CFB and the combustion process. The circulating system allows the feed coal to be exposed to the heating elements thus preventing incomplete combustion.

Tabulation of the Air Pollution Source Installations (APSIs) with corresponding Air Pollution Control Devices (APCDs)

The APSIs or also termed as Air Pollution Source Equipment (APSEs) is considered to be the boiler itself because the products of combustion or air pollution parameters are formed in the boiler. However, the boiler itself is an Air Pollution Control System.

As to the APCD this is deemed to be the Electrostatic Precipitator although the system for Air Pollution Management also includes the stacks because of their function of dispersion of air pollutants, the CFB itself and the quality of coal.

A table of APSIs with corresponding APCDs is considered not relevant.

On spontaneous combustion

Causes/Sources of Potential Major Accidents

The possible source of potential hazards for the proposed project **is spontaneous combustion resulting in coal fires.** Other potential hazards arising from project activities are considered insignificant because:

Explosions- absence of flammable vapors and gases involved during the operations phase.
Release of toxic materials into the ground from ash leachates - ash is not classified as hazardous or toxic
Release of toxic materials to the atmosphere- essentially absent if the coal selected will be free of significant concentrations of metallic, e.g. mercury, lead, chromium, etc.

Coal is susceptible to spontaneous combustion, most commonly due to oxidation of pyrite or other sulfurous contaminants in coal. Coal reacts with atmospheric oxygen even at ambient temperatures in an exothermic reaction. If the heat liberated during the process is allowed to accumulate, the rate of the reaction increases exponentially and temperature further increases. When this temperature reaches the *ignition temperature* of coal, combustion proceeds and the phenomenon is called as *spontaneous combustion*.

Spontaneous combustion fires can be difficult to extinguish because of the amount of coal involved such as in the storage yards. Carbon monoxide is the toxic gas that may be produced during spontaneous combustion.

The major factors that cause of spontaneous combustion are:

Coal handling procedures that allowed long-time holding time of coal and thus the accumulation of oxygen in the intertices of the coal particles.

New coal inventory added on top of old coal stockpiles could create segregation of particle sizes thus creating spaces or voids in which oxygen may accumulate.

- **Operation of the Wastewater Treatment Facility**

The updated project timetable is given in table shown in the foregoing pages.

Summarized in Table 3.1 and outlined hereunder.

Impacts / Mitigation

Land:
Generation of Bottom and Fly Ash

Water:
Abstraction of Tagoloan River Water for Process Use Impact on Stream Flow
Potential Impacts on corals & marine ecology
Thermal Effects from Warm Cooling Water Return Discharge .
Potential seepage of ash leachate to Macajalar Bay

Air:
Potential degradation of ambient air quality due to operation of coal fired boilers –

People:
Generation of jobs, employment and livelihood.
Equivalent benefits from ER-194 and Company's SDP
Threat to public health and safety.

Mitigating Measures:
Bottom ash will be disposed directly to repository pond; Fly ash to be collected by 3rd party user
Optimization of water usage through process design.
Potential impactson corals & Marine ecology are insignificant based on updated marine survey
No insignificant impacts on marine ecology based on thermal plume modelling
Bottom ash encapsulated in engineered repository. Regular monitoring of test wells and reporting in SMRs and to MMTs.
Used of proven CFB technology. Evidenced by the years of operation of original project
Electrostatic Precipitator Air Dispersion Modelling results.
Continuing SDP which is also mentioned by the MMT.
Health and Safety aspects are confined to project operations not to public.

3.5 Decommissioning/Abandonment/Rehabilitation

A decommissioning or abandonment plan will be prepared and submitted for approval by the EMB when the plant operation shall cease. Cessation will be occasioned by factors such as reaching the end of project life and non-viability of plant operation, among others.

An Environmental Site Assessment (ESA) will be conducted and submitted to the EMB in partial support of the decommissioning plan.

The major aspects of the plan shall include the following:

- Identification of Possible Site Residual Contaminants principally
  Metallic elements
  Organic contaminants

Remedial Actions and Alternatives

Site Remediation if necessary.

3.6 SUMMARY MATRIX OF THE IMPACT MANAGEMENT PLAN

The Summary of Major Impacts per Key Activities is shown in Table 3-1. A column showing the Target Performance/Efficiency of the mitigating measures is added.

Inclusion of the baseline data of the project and not only monitoring results

Inclusion in the table of the actual activities being done by the project should be included in the tables and discussions

Matrix on the health and sanitation is included in the table.

The format of the table follows Annex 2-17 of the RPM. Baseline data and details of activities are discussed in other sections.

Table 3-1. Summary of Major Impacts per Key Activities

Project Phase / Environmental Aspect (Project Activity Which will likely Impact the Environmental	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation* or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee / Financial Arrangements**	**Target Performance**
I- PRE CONSTRUCTION PHASE							
No activities that would results in significant impacts.							
II- CONSTRUCTION PHASE (Site Preparation/ Structure & Bldg. Constuction)							
Environmental Aspect #1	A. The Land	Change in landform Disturbance of floral ecology	Nil to Minimal. Land already developed; flat terrain Avoidance of tree cutting or disturbance to the extent possible especially when endangered species may be affected.	Project Proponent / Contractor	Part of Project cost- To be determined	ECC conditions	100 % based on site preparation design and plans 100 % compliance with applicable permit to cut trees issued by the CENRO
		Generation of Domestic and Solid Wastes from construction workers	Monitoring of contractors and their compliance to RA 9003. Use of accredited third party contractors specializing in solid waste and garbage disposal	Project Proponent / Contractor	Part of Project cost- To be determined	Part of Management Plan	99-100 % compliance by EPC contractor.
			No hazwastes used; minor generation, e.g. spent electronics, batteries, etc	Project Proponent / Contractor	To be determined	Part of Management Plan	100 % compliance that hazwastes will be disposed by accredited TSD entity
		Generation of spent non-hazardous solid wastes (steel, wood, etc.)	Disposal by 3rd party	Project Proponent / Contractor	To be determined	Part of Management Plan	99-100 % compliance by construction contractor

Project Phase / Environmental Aspect (Project Activity Which will likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation* or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee / Financial Arrangements**	**Target Performance**
Environmental Aspect #2	B. The Water	Sediment carry overs to Bay during heavy rains	Maintain appropriate setback distances from Macajalar Bay for all construction activities that might increase stormwater runoff or cause erosion or sedimentation. Proper discarding of soil wastes. When feasible, avoid working during periods of extreme weather conditions, e.g. heavy wet and rainy conditions in consideration of safety. Install drainage ditches and sediment ponds/traps around the construction area to pump out runoff caused by heavy rainfall.	Project Proponent / Contractor	Part of Project cost - To be determined	Part of Management Plan ECC Conditions	100 % compliance to placement of sediment traps
Environmental Aspect #3	C. The Air	Potential degradation of ambient air quality from use of temporary generators	Site is energized and generators may only be used on occasion Regular and proper maintenance of generator sets	Project Proponent / Contractor	Part of Project cost- To be determined	Part of Management Plan ECC condition/MMT monitoring	100 % compliance by contractor

Project Phase / Environmental Aspect (Project Activity Which will likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation* or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee / Financial Arrangements**	**Target Performance**
		Noise from equipment and construction vehicles	Use of silencers and mufflers for heavy equipment Provision of PPEs to protect construction and plant personnel from noise Maintenance of existing buffer ones around the plant site	Project Proponent / Contractor	Part of Project cost- To be determined	To be included in contract	100 % compliance to standards for nuisance that may arise from project
Environmental Aspect #4	D. The People	Employment and Livelihood Opportunities (Short Term)	Priority employment of qualified local personnel by Construction Contractor Monitor commitment of EPC contractor on local hiring Coordination with LGU	Project Proponent / Contractor	Part of Project cost- To be determined	Part of Management Plan	100 % compliance
		Public Health & Safety	Implementation of occupational safety and health protocol for construction and plant personnel Monitoring of safety and health protocols	Project Proponent / Contractor	Part of Project cost- To be determined	Part of Management Plan	100 % to OHS
III- OPERATION PHASE (Expansion Project)							
Environmental Aspect #1	A. The Land	Generation of minimal amount of hazwastes (spent electronic parts, batteries, etc.)	Disposal by TSD entity	Project Proponent / Contractor	Part of Project cost- To be determined	Part of Management Plan	99-100 % compliance that disposal will be by 3rd party

Project Phase / Environmental Aspect (Project Activity Which will likely Impact the Environmental	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation* or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee / Financial Arrangements**	**Target Performance**
		Generation of bottom and fly ash	Bottom ash to repository pond Fly ash to 3rd party user	Project Proponent / Contractor	Part of Project cost- To be determined	Part of Management Plan	100 % compliance to disposal of bottom ash to repository pond and fly ash to 3rd party user
Environmental Aspect #2	B. The Water	Abstraction of Tagoloan River Water for Process Use Impact on Stream Flow	Optimization of water usage through process design NWRB Permit which will consider impact on stream flow	Project Proponent / Contractor	Part of Project cost- To be determined	Part of Management Plan	100 % compliance to NWRB permits
		Potential impacts on corals & marine ecology	Nil to insignificant impacts based on updated marine survey	Project Proponent	To be determined	Part of Management Plan	100 % compliance to mixing zone **guidelines**
		Thermal Effects from Warm Cooling Water Return Discharge	Based thermal plume modelling no significant impacts on marine ecology Further, revisit process design to further decrease cooling water requirements	Project Proponent	Part of Project cost- To be determined	Part of Management Plan	100 % compliance to mixing zone regulations
		Water use competition	NWRB Permit for Tagoloan River ensures no competition Project does not use Macajalar Bay water except for recirculated cooling water	Project Proponent	Part of Project cost- To be determined	Part of Management Plan	100 % compliance to NWRB permits
		Potential seepage of ash leachate to Macajalar Bay	Bottom ash encapsulated in engineered (with plastic membranes) repository pond	Project Proponent / Contractor	Part of Project cost- To be determined	Part of Management Plan	90-100 % compliance to encapsulation of bottom ash in

Project Phase / Environmental Aspect (Project Activity Which will likely Impact the Environmental	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation* or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee / Financial Arrangements**	**Target Performance**
			Regular monitoring of test wells and reporting in SMRs and to MMTs			ECC Condition	engineered repository pond
Environmental Aspect #3	C. The Water	Potential degradation of ambient air quality due to operation of coal fired boilers	Proven CFB technology Evidenced by the years of operation of original project Electrostatic Precipitator Air Dispersion Modelling results	Project Proponent / Contractor	Part of Project cost- To be determined	Part of Management Plan ECC Condition	90-100 % to emission limits guaranteed by EPC (during normal plant operations)
Environmental Aspect #4	D. The People	Benefits from the Company's SDP Benefits from ER 1-94 Threat to ***public*** health, safety and sanitation	Continuing SDP which is also monitored by the MMT Enhancement Nil Health Safety and sanitation aspects are confined to project operations not to public APCDs to mitigate air pollution and perceived health outcomes to the public Ash repository pond to prevent ash leachates from reaching ground waters Safety aspects relevant during construction period	Project Proponent	Part of Project operatomg cost budget Part of construction	Part of Management Plan Contracts with Contractors	100 % to SDP 100 % Mandated by law 100 % compliance to mitigating measures on public health, safety and sanitation 100 % compliance by Contrators

Project Phase / Environmental Aspect (Project Activity Which will likely Impact the Environmental Component)	**Environmental Component Likely to be Affected**	**Potential Impact**	**Options for Prevention or Mitigation* or Enhancement**	**Responsible Entity**	**Cost**	**Guarantee / Financial Arrangements**	**Target Performance**
			arising from construction works and during operations arising from possible vehicular accidents		costs of Contractor	Risk Insurances	
		Health, safety and sanitation appertaining to the project employees and personnel	Medical facilities and benefits for employees and personnel Compliances to safety protocol as prescribed in EPC's Manual of Operations Mandated sanitation practices, e.g. hygiene, housekeeping esp of toilets and in kitchens	Project Proponent	Integral of Proponent's operating budget	Company policies DOLE OSHS	100 %

SECTION 4 - ENVIRONMENTAL RISK ASSESSMENT (ERA) AND EMERGENCY RESPONSE POLICY AND GUIDELINE

INTRODUCTION:

The term **"risk"** is not explicitly defined because the word may carry two distinct meanings. It can mean in one context a hazard or a danger of an exposure to an accident, mischance or peril. In another context, risk is interpreted more narrowly to mean the probability or chance of suffering an adverse consequence from a fortuitous event. To illustrate, "flood risk" can refer to the presence of a danger of flooding while a "flood hazard" to a specific probability that such a flood event may occur and can be expressed in quantitative terms such as for example a "0.10% probability".

Environmental risk refers to actual or potential threats of adverse effects on living organisms (man, plants, animals, marine resources (e.g. fish), etc.) and the environment caused by effluents, emissions, wastes, resource depletion, etc., arising out of activities involved in a project (*Martin et al., 1977).*

Risk assessment is a systematic method of identifying and analyzing the hazards associated with an activity and establishing a level of risk for each hazard. The hazards cannot be completely eliminated, and thus, there is a need to define and estimate an accident risk level that can be prevented or minimized either in quantitative or qualitative way.

Figure 4-1 is an illustration of the risk assessment process.

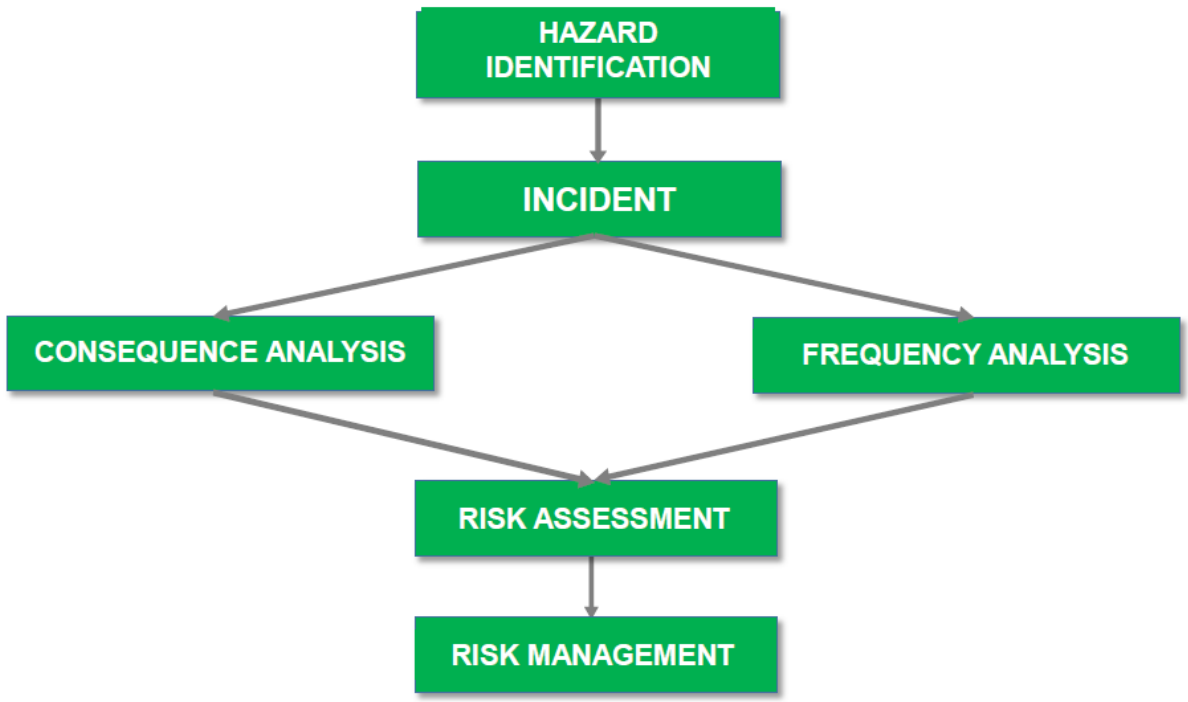


Figure 4-1. An Illustration of the Risk Assessment Process

Hazard identification involves the identification of all possible events or processes that could lead to disastrous or fatal incidents including potential hazards from substances, chemicals and materials (both physical and biological) used in the project process that could result in adverse effects on personnel/people and the environment.

Consequence analysis involves the assessment of the adverse or unacceptable **effects** or **results** of an incident or episode from a project activity. When applicable, mathematical models may be employed for consequence analysis.

Frequency analysis is the estimation of the likelihood of number of occurrences of the identified hazard and/or the time occurrences of such.

Risk management refers to the overall process of prevention and reduction, of the evaluated hazards, containment of the actual incident/episode, instituting response measures and the monitoring and communicating of the risks to stakeholders and project proponents.

The main objective of this section is to identify and analyze hazards, the event sequences leading to hazards, the risk of hazardous events and the management of the elements of risks.

4.1 LEVEL OF COVERAGE OF THE ERA

Reference is made to Annex 2-7e of the RPM for DAO 2003-30

I. LEVELS OF COVERAGE AND SCOPING REQUIREMENTS

The requirement for the conduct of ERA is defined at three (3) levels:

a) Level 2 – for facilities that will use, manufacture, process or store hazardous materials in excess of **Level 2** threshold inventory shall be required to conduct a Quantitative Risk Assessment (QRA) and prepare an Emergency/Contingency Plan based on the results of the QRA.

b) Level 1 – for facilities that will use, manufacture, process or store hazardous materials in excess of **Level 1** threshold inventory shall be required to prepare an emergency/ Contingency Plan based on the worst case scenario. The Plan shall be based on a Hazard Analysis study.

c) Risk screening level – specific facilities or the use of certain processes shall require the conduct of a risk screening study even if the projected or estimated inventory does not reach the threshold levels.

Projects or undertakings categorized as Level 2 shall be required to conduct a Quantitative Risk Assessment **(QRA)** and prepare an Emergency/Contingency Plan based on the results of the QRA. While projects or undertakings categorized as Level 1 shall be required to prepare an Emergency/Contingency Plan based on the worst case scenario (as a result of a Hazard Analysis study.)

The process for the determination of the need for a QRA is shown in **Figure 4-2**.

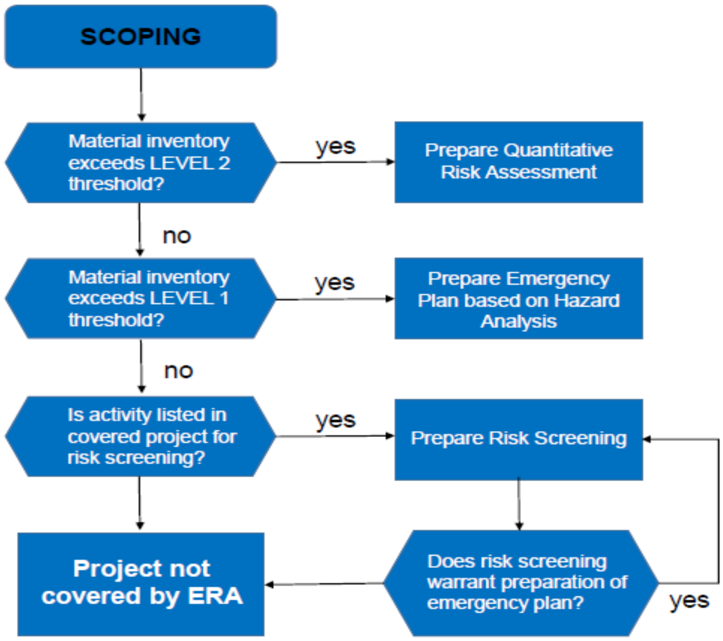


Figure 4-2 Process for Determination of Need for ERA

II. TECHNICAL GUIDELINES FOR THE CONDUCT OF ENVIRONMENTAL RISK ASSESSMENT

A. Determination of Risk Levels

Levels of Coverage and Requirements

a. **Risk Screening Level.** The following activities are required to undertake a risk screening exercise:

1) Facilities for the production or processing of organic or inorganic chemicals using:
   a) alkylation
   b) amination by ammonolysis
   c) carbonylation
   d) condensation
   e) dehydrogenation
   f) esterification
   g) halogenation and manufacture of halogens
   h) hydrogenation
   i) hydrolysis
   j) oxidation
   k) polymerization
   l) sulphonation
   m) desulphurization, manufacture and transformation of sulphur-containing compounds
   n) nitration and manufacture of nitrogen-containing compounds
   o) manufacture of phosphorus-containing compounds
   p) formulation of pesticides and of pharmaceutical products distillation
   q) extraction
   r) salvation

2) Installations for distillation, refining or other processing of petroleum products.

3) Installations for the total or partial disposal of solid or liquid substances by incineration or chemical decomposition.
4) Installations for the production or processing of energy gases, for example, LPG, LNG, SNG.
5) Installations for the dry distillation of coal or lignite.
6) Installations for the production of metals or non-metals by a wet process or by means of electrical energy.
7) Installations for the loading/unloading of hazardous materials as defined by RA 6969 (or DAO 29)

b. **Levels 1 and Level 2 Threshold Inventory.** The following threshold levels shall be used to determine whether a proposed project or undertaking shall be required to prepare a QRA and/or an emergency/contingency plan:

Table 4-1 Threshold Inventory Levels for QRA

CATEGORY	LEVEL 1 (tons)	LEVEL 2 (tons)
Explosives	10	50
Flammable substances	5,000	50,000
Highly flammable substances	50	200
Extremely flammable substances	10	50
Oxidizing substances	50	200
Toxic substances (low)	50	200
Toxic substances (medium)	10	50
Toxic substances (high)	5	20
Toxic substances (very high)	0.2	1
Toxic substances (extreme)	0.001	0.1
Unclassified (Type A)	100	500
Unclassified (Type B)	50	200

Definition of different categories of hazardous materials:

Table 4-2 Summary Table of Hazardous Materials Categories

Category	Definition
A. Explosives (Reactivity)	1. A substance or preparation which creates the risk of an explosion by shock, friction, fire, or other sources of ignition.
	2. A pyrotechnic substance (or mixture of substances) designed to produce heat, light, sound, gas, or smoke or a combination of such effects through non-detonating self-sustained exothermic chemical reactions.
B. Flammable Substances	1. Flammable substances are substances and preparations having a flash point equal to or greater than 21°C and less than or equal to 55°C, capable of supporting combustion.
(Highly flammable and extremely flammable substances)	2. Highly flammable substances are substances and preparations which may become hot and finally catch fire in contact with air at ambient temperature without any input of energy, or substances which have a flash point lower than 55°C and which remain liquid under pressure, where particular processing conditions, such as high pressure or high temperature, may create major-accident hazards.
-	3. Extremely flammable substances are liquid substances and preparations which have a flash point lower than 0°C and the boiling point (or, in the case of a boiling range, the initial boiling point) of which at normal pressure is less than or equal to 35°C; gaseous substances and preparations which are flammable when in contact

Category	Definition
	with air at ambient temperature and pressure, whether or not kept in the gaseous or liquid state under pressure; or, liquid substances or preparations maintained at a temperature above their boiling point.
C. Oxidizing substances	Substances which give rise to highly exothermic reaction when in contact with other substances, particularly flammable substances.
D. Toxic Substances	Low, medium, high, very high and extreme toxicity of substances or preparation are classified as follows:
	1. A substance shall be considered as a liquid if vapor pressure is less than 1 bar at 20°C.
	2. A substance shall be considered as a gas if vapor pressure is greater than 1 bar at 20°C.
	3. The sum of (a) and (b) as provided in Tables 2 and 3 shall determine the toxicity class as contained in Table 1.
E. Unclassified Substances	Substances or preparations that react violently with water (Type A), and substances or preparations which release or liberate toxic gas in contact with water (Type B).

Referring to the above guidelines:

1. The process involved in the project is electric power generation. None of the facilities listed under **Risk Screening Level** is involved.

2. The substances being handled are principally coal, which is not a hazardous material as defined in RA 6969. It is noted that the storage and transport of coal do not require TSD and Permit to Transport clearances from the EMB. Likewise coal ash is not categorized as hazardous requiring TSD and Permit to Transport.

3. The chemical/substances which fall under the category of "hazardous" are very small in quantities as may be gleaned from the SMR which for the 4th Quarter 2019 are listed in Table 4-3.

Table 4-3 Hazardous Waste Generation (4th Quarter 2019 SMR)

HW No.	HW Class	HW Nature	HW Cataloguing	Remaining HW from Previous Report		HW Generated	
				Quantity	Unit	Quantity	Unit
D406	Used Lead Acid Batteries	Solid	Toxic	1.58	ton	0.02	ton
D407	BFLs	Solid	Toxic	0.199	ton	0.03	ton
I101	Used Oil	Liquid	Flammable	27.01	ton	0.00	ton
I104	Oil contaminated materials (sand, soil, rags, and absorbent pads)	Solid	Flammable	8.0	ton	0.2	ton
J201	Chemical Containers (NH_4OH)	Solid	Toxic	0.1	ton	0.00	ton
J201	Chemical Containers (Hydrazine)	Solid	Toxic	0.01	ton	0.00	ton

4. Inventories

Substances	**Flash Point**	**Estimated Inventory**
Diesel Oil	</= 60^{0}C	Significantly lower than threshold of 50,000 li
Laboratory Test Reagents	For laboratory purposes only (Acids, Bases)	
Process Water Treatment Chemicals	Small volumes (For water Treatment Process Typical chemicals are Acids, Bases, Flocculants**)**	

Thus, based on the above guidelines, it is determined that a Quantitative Risk Assessment (QRA) is deemed not applicable for this project. Further QRA's are based on quantitative estimates or risk events or episodes based on experiences for which, however, there are no plant episodes.

Other aspects

- **NO2 Control**

For NO2 control and management, the denitrification process using SCR (Selective Catalytic Reduction) will be employed. There are no significant hazardous substances used in this process. The chemistry involved is the following:

With ammonia as a reduction agent:

4 NO + 4 NH3 + O2 ↔ 4 N2 + 6 H2O
6 NO2 + 8 NH3 ↔ 7 N2 + 12 H2O

With urea as a reduction agent:

4 NO + 2 (NH2)2CO + 2 H2O + O2 ↔ 4 N2 + 6 H2O + 2 CO2
6 NO2 + 4 (NH2)2CO + 4 H2O ↔ 7 N2 + 12 H2O + 4 CO2

One possible disadvantage of the SCR is related to the ammonia-slip which occurs due to the incomplete reaction of NH3 with NOx, when small amounts of NH3 leave the reactor with the flue-gas - known as ammonia slip (NH3 slip). Ammonia-slip increases with increasing NH3/NOx ratio and with decreasing catalyst activity.

High ammonia slip (NH3 break through) can lead to:

- formation of ammonium sulfates, which are deposited on downstream facilities such as the catalyst and air preheater
- NH3 in flue-gas desulfurization waste waters and air heater cleaning water
- Increased NH3 concentration in the fly ash.

The main advantages of the SCR technology are:

- the conversion of NOx does not create any secondary pollution components
- the emission of NOx can be reduced by 90 % or more

- to meet air quality requirements SCR can be applied with adapted NH3 consumption to reduce NH3 slip effects and to increase catalyst lifetime.

- **Coal as a Hazard**

Coal will be handled, stored, processed, and used by the power plant in large quantities and therefore considered as a source of potential hazards.

The physical and hazard characteristics of coal are shown below:

Table 4-3 Properties of Coal

Physical and Hazard Characteristics of Coal Property	Value/Details
CAS Number	129 521-66-0
Auto-ignition Temperature, deg C	>601 for cloud >200 for layer
Flammable Limits, %	Dust concentration range of 0.09-7.0 kg/m3 and oxygen concentration of 13%
Exposure Limits	OSHA PEL respirable fraction of coal dust: 2.4 mg/m3 TWA
Stability and Reactivity Information	Coal is stable at ambient temperatures. Conditions contributing to instability are heat, sparks, open flame, or other ignition sources. Formation of dust in enclosed spaces should be avoided prevent attaining explosive concentrations.
Hazards	Exposure to coal dust can occur through inhalation, ingestion, and eye contact. It is not considered as a serious respiratory hazard although heavy exposure dust causes symptoms of low grade breathlessness, wheeze and phlegm. Smoking appears to aggravate symptoms.
Coal may spontaneously self-heat in air over a period of hours or days leading to spontaneous combustion if not controlled. Dust explosion hazard is present if airborne coal dust concentration 0.09 to 7.0 kg/m3 and oxygen concentration >= 13% are met.	

- **Complete inventory of hazardous wastes, incorporating the inventory in the emergency response plan for hazardous wastes with high risks are stated at Table 4-4 below.**

Table 4-5 Actual Inventory of Hazardous wastes

Hazardous Waste Class	HW Nature / Cataloguing	HW generated (ton)	HW Treated (Ton)
Used Lead Acid Batteries	Solid / Toxic	0.02	1.60
Busted Flourescent Lamps	Solid / Toxic	0.03	0.229
Used Oils	Liquid / Flammable	0.00	27.01
Oil Contaminated Materials (sand, soil, rags, and absorbent pads	Solid / Flammable	0.20	8.2
Chemical containers (NH_4OH)	Solid / Toxic	0	0.1
Chemical containers (Hydrazine)	Solid / Toxic	0	0.1

Each material are properly labelled according to waste type and stored in proper storage facilities. Per SMR, the proponent is planning for construction of new Hazardous Waste Storage Facility in connection with the expansion of power plant facilities.

The storage and handling of the above listed hazardous wastes are monitored monthly and reported to EMB quarterly as part of the proponent's SMR. Findings and observation, as well as corrective action taken, were stated in the said SMR.

Ash is not listed as one of the hazardous wastes based on the above table. It may also be noted that the majority of the coal power plants in the Philippines are not registered as TSD facilities.

In view of the low risks and volumes from the above estimates of hazardous waste inventory, it is deemed that these need not be included in the Emergency Response Plan.

4.2 Risk Criteria for EIA Review

4.2.1 Individual Risk Criteria

a) Individual risk criteria have been developed based on the principle that involuntary risks due to industrial developments should not significantly increase the level of risk to individuals living or working near such industry.

b) *Location Specific Individual Fatality Risk (LSIFR)* is 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. It takes no account of the number of people affected by an event.

c) LSIR is normally represented in the form of risk contours. This is achieved by plotting and connecting all points (locations) of similar individual risk, thus forming risk contours (not dissimilar to isobars on a weather map). These contours can then be overlaid onto a land-use map to show the level of individual risk in the various land use planning areas.

d) Individual risk criteria may be applied and measures are taken to ensure that no person living near a hazardous activity bears an extreme level of risk.

4.2.2 Societal Risk Criteria

a) The greater public concern for events causing a large number of deaths is best reflected in terms of the societal risk criteria. The establishment of societal risk criteria is the recognition that multiple fatality events should be regarded as more serious than events capable of causing only a few fatalities.

b) Another point to be considered is the level of benefit society may derive from an existing or proposed development. Care must be taken to ensure that the local population does not suffer an unfair burden of risk with respect to the benefits of the population at large.

c) Societal risk is another suitable basis for review of hazardous facilities. This has a different emphasis from individual risk. Societal risk measures the number of fatalities caused by a full range of more or less frequent incidents. These are normally presented on a log-log plot of the cumulative frequency of incidents causing N or more fatalities versus the number of fatalities.

d) Societal risk criteria specify levels of societal (group) risk, which must not be exceeded by a particular activity. These should ensure that a hazardous activity does not impose a risk on society that is out of proportion to other types of hazards and with the benefits the activity brings, which individual risk does not address.

Even assuming worst accident triggers it is to be noted that there are societal risks brought about by the Project. This is because the population is located away from the project site as seen in the settlement map on Figure 2.4-2 page 2.4-13 of Section 2.4.

The most vulnerable people to risks are plant personnel. Evacuation is one of the front line procedures to reduce risks to plant personnel.

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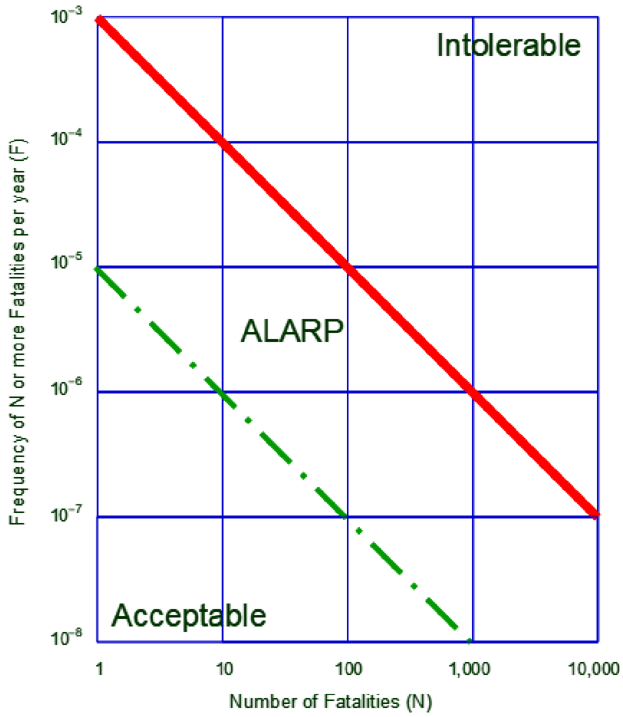
A graph depicting Societal Risks is shown in **Figure 4-3.**



(Source: Annex 2.78 RPM)

(ALARP = As Low as Reasonably Practicable)

Figure 4-3 Societal Risks

4.3 Project Specific Hazards and Risks

4.3.1 Potential Hazards from Coal

Spontaneous combustion

Causes/Sources of Potential Major Accidents

The considered possible source of potential hazards for the proposed project **is spontaneous combustion resulting in coal fires.** Other potential hazards arising from project activities are considered insignificant because:

a) Explosions- absence of flammable vapors and gases involved during the operations phase.

b) Release of toxic materials into the ground from ash leachates - ash is not classified as hazardous or toxic

c) Release of toxic materials to the atmosphere- essentially absent if the coal selected will be free of significant concentrations of metallic, e.g. mercury, lead, chromium, etc. “Significant” is reckoned from the levels prescribed in RA 6969”.

Coal is susceptible to spontaneous combustion, most commonly due to oxidation of pyrite or other sulfurous contaminants in coal. Coal reacts with atmospheric oxygen even at ambient temperatures in an exothermic reaction. If the heat liberated during the process is allowed to accumulate, the rate of the reaction increases exponentially and temperature further increases. When this temperature reaches the *ignition temperature* of coal, combustion proceeds and the phenomenon is called as *spontaneous combustion*.

Spontaneous combustion fires can be difficult to extinguish because of the amount of coal involved such as in the storage yards. Carbon monoxide is the toxic gas that may be produced during spontaneous combustion.

The major factors that cause of spontaneous combustion are:

1. Coal handling procedures that allowed long-time holding time of coal and thus the accumulation of oxygen in the interstices of the coal particles.

2. New coal inventory added on top of old coal stockpiles could create segregation of particle sizes thus creating spaces or voids in which oxygen may accumulate.

4.3.2 Chronic Risks

4.3.2.1 Ambient Concentrations of Toxic/Hazardous Substances to be used (i.e. cyanide, mercury, etc.)

In analyzing potential ambient concentrations of toxic/hazardous substances that will be discharged from the operation of the power plant, it is most basic to determine first if such substances may be generated.

The only substance that will be used in the **process** is limestone, which is mixed at the fluidized bed to capture Sulfur and convert the same to $CaSO_4$ thus reducing the concentration of SO_2 in the exit gas.

The chemical reactions involved are:

- **Sulfur Capture**

  $\mathbf{S + O_2 -> SO_2}$

- **SO_2 Absorption**

  - $\mathbf{SO_2(g) + H_2O \leftrightharpoons SO_2(aq) + H_2O \leftrightharpoons H_2SO_3 \leftrightharpoons H+ + H_2SO_3^-}$
  - $\mathbf{HSO_3\text{-} \leftrightharpoons H^+ + SO_3^{-2}}$

- **Limestone Dissolution**
    - $CaCO_3 + H_2O \leftrightharpoons Ca^{+2} + HCO_3^- + OH^-$
    - $HCO_3^- + H^+ \leftrightharpoons H_2CO_3 \leftrightharpoons H_2O + CO_2(aq) \leftrightharpoons H_2O + CO_2(g)$
- **Oxidation**
    - $HSO_3^- + \frac{1}{2} O_2 \leftrightharpoons H^+ + SO4^{-2}$
- **Precipitation**
    - $Ca^{+2} + SO_4^{-2} + 2\,H_2O \leftrightharpoons CaSO_4 + 2\,H_2O$ **(gypsum)**

As seen above, the final product of a complete reaction is a non-toxic substance, which is gypsum. Gypsum may be used in the form of boards for construction materials.

Other chemicals will be used in the offsite facilities (non-process), such as in the boiler water feed treatment, in the wastewater treatment, in the conditioning of start-up fuel, and the treatment of the raw water.

Care will be exercised on wet limestone being fed in the furnace because it could increase the SO_2 emission (there was an incident when SO_2 emission was above the emission standard

4.3.3 Toxic Metals in Air

There are perceptions among certain stakeholders of projects located elsewhere in the Philippines that coal power plants could be of risks to human health attributed to the generation of heavy metal elements principally mercury and lead.

These perceptions have been raised on account of the alleged presence of these elements in coal. Evaluation is thus made whether these metals would indeed find their way to the air, land, and water resources.

Metals in the air discharges may only be generated under the following conditions:

If these are initially present in significant concentrations in the feed coal and
If these are volatilized during the combustion process

The analyses of typical coal that are used in Philippine power plants is shown in Table 4-5. .

Table 4-6 Specifications of Typical Feed Coal

Specifications	Design	Range
High heating value (kcal / kg)	5280	5000 - 5560
Grind ability	44	43 - 45
Moisture (wt. %)	13, air dried basis	12 - 14
Volatile matter (wt %)	40, adb	38 - 42
Fixed carbon (wt %)	37, adb	32 -42
Ash (wt %)	10, adb	5 - 14
Carbon, ultimate wt. %	62.3, adb	57 - 67

Specifications	Design	Range
Sulfur content	0.65	1.0 max
Metals, Hg, Pb, As, etc.	**Trace**	

The above analyses should be sufficient to dispel concerns about mercury, lead, and chromium risks. In the case of chromium, this element is normally present in soil as total chromium and is even present in various foods. This statement is premised on the assumption that the prospective coal to be used is similar or better in quality than the above.

In addition, the volatilization temperatures of these elements are shown in Table 4-6 below. This suggests that since the maximum temperature at the combustion chamber in the boiler is 970^{0}C, in the case of lead, this will not be carried out to the atmosphere, assuming for the sake of discussion, that such would be present in coal.

Table 4-7 Boiling Points of Elemental Metals

Element	Boiling Point (°C)
Mercury	357
Arsenic	614
Lead	1749

It is also noteworthy that under the Philippine Clean Air Act the emission limits for stationary sources (new facilities) for mercury and lead are 5 mg/NcM and 10 mg/NcM respectively.

Under the Toxic and Hazardous Wastes Law (R.A. 6969) following are the limits for metallic elements.

Philippine Hazardous Waste Parameters

Elements	**Maximum Concentration**
Mercury & mercury compounds	Includes all wastes with a total Hg concentration > 0.2 mg/l Also include organ mercury compounds
Lead compounds	Includes all wastes with a total Pb concentration > 5 mg/l

4.3.4 Toxic Metals in Land (Ash generation)

Using the same explanation as above, the fact that there are no significant amounts of metals in the above-cited feed coal suggests that neither will there be in the ash. In particular, mercury, arsenic and selenium will be volatilized on account of their boiling points being higher than the boiler combustion temperature.

4.3.5 Toxic Metals in Water

These are considered to be absent for the same reason given above that, i.e., in the first place, there are no significant concentration of metals in the above-cited feed coal. Additionally, there is no contact in the process involved between coal and process water since the latter is used only for cooling purposes and also as boiler feed water.

Other chemicals used in the process

The current and already installed systems and the same chemicals will be used in the expansion project. No episodes of hazards have been recorded during the operation of the original project.

These include water treatment chemicals such as alum for flocculation. Wastewater effluents are treated in a waste treatment unit before the ultimate discharge to the drainage system.

The chemical systems to be employed for water treatment are yet to be firmed out and the services of local water treatment companies will be evaluated.

Initially, sodium hypochlorite is under consideration for disinfection purposes. Chemical usage is based on the residual chlorine in outfall as determined during actual operations. The MSDS will follow the standards from accredited suppliers. The active ingredient of this chemical is NaOCl while the potential toxic effects are:

- Irritation on contact with skin or eyes or even blindness at very high concentrations
- Burning sensation and pain when swallowed
- Decreased pulmonary function when inhaled over prolonged periods

CONCLUSION

Given the plan of the proponent to continue to use good quality coal, which will not contain significant concentrations of toxic elements – particularly Mercury and Lead – and the existing experiences with similar type of power plant, and more importantly, the absence of risk-related incidences, it is thus concluded that there are no risks from the project arising from these elements.

On the matter of risks/hazards from spontaneous coal combustion

Spontaneous combustion - Oxidation of coal is a normal process which produces heat and certain gases. Spontaneous combustion is the process by which certain materials can ignite as a result of internal heat which arises spontaneously due to reactions liberating heat faster than it can be lost Spontaneous combustion may occur during any stage of storage and handling.

The major management measures to prevent spontaneous combustion are:

- **Eliminating or minimizing molecular oxygen and confining the coal dust through covering and storage management, shown in the photograph below.**

- **First In First Out inventory policy. To prevent or minimize the accumulation of oxygen in the interstices of the stored coal rapid removal of coal, when feasible, should be observed. The longest stored coal should be the first batch to be used, "First In, First Out" policy.**

- **Monitoring as a preventative measure**

  The prevention of spontaneous combustion episodes could be effectively undertaken through the monitoring of gases, e.g. oxygen and conditions which indicate that a problem is developing. Figure 6 shows the process of a smouldering fire that never reaches the flaming stage. Figure 7 shows the

It may be significantly noted that from the start of the operation of the project, there has not been experienced any spontaneous combustion that needed emergency response e.g. fire-fighting.

Combustion Technology, Coal Usage and Quality vis-à-vis Risks.

The relevance of technology and coal usage/quality lies on the potential spontaneous coal combustion and on chronic risks associated with health as a result of chemical and metallic substances.

Nevertheless, a qualitative discussion of the combustion technology for CFB is made hereunder.

The main types of boilers used in utility plants are Circulating Fluidized Bed (CFB) and Pulverized Coal (PC) Boilers.

PC firing uses coal ground to a very fine powder sprayed into the furnace for combustion. CFBs use coal crushed to sizes of around 3 to 6 mm. The time, energy and facilities required to crush coal for a CFB is much less than what is required for a pulverized coal fired facility.

PC firing uses around 30% of the air as high pressure primary air for drying and transporting fuel.

CFBs use higher pressure primary air which is 60% of the combustion air for fluidizing. The total air for combustion and the balanced draught system is essentially the same for both the systems.

The furnace and the cyclones in the CFB boilers maybe subject to a lot of erosion due to the circulation of particles like ash and sand. To prevent this erosion a thin layer of refractory covers the lower half of the furnace, upper transition areas and the cyclone. PC fired boilers do not have refractory covering on the furnace tubes or other heat transfer areas.

In a PC boiler a Flue Gas Desulphurization unit is required for the reduction of Sulphur Dioxide. In CFB boilers limestone addition in the furnace reduces the Sulphur Dioxide during combustion itself. This requires only a simple limestone storage and handling unit.

In PC boilers around 15% of ash collects at the bottom of the furnace and the balance in the electrostatic precipitators. In CFB boilers the collection at the bottom is almost 50% lessening the load on the Electrostatic Precipitators.

It may be noted that at this higher pressure and temperature, water can be maintained as a fluid despite being above the atmospheric boiling plant, allowing greater efficiency. Efficiency ratings for supercritical coal plants range from 37% to 40%. In ultra-supercritical units the possibility of raising generating efficiency to the 44-46% range maybe achieved.

Various Ways for Reducing Emissions and Increasing Efficiency

Circulating fluidized bed (CFB) combustion is an important system toward increasing plant efficiency with the additional advantage of fuel flexibility, heat integration, and low emissions. It allows the use of low-quality coal.

In a circulating fluidized-bed unit, the bed material is comprised of fuel, fuel ash, sorbent, and other inert bed materials. The bed is supported within the furnace by air flowing into the bed from the bottom of the furnace. The air flow supports the bed and ensures complete combustion by providing close mixing of fuel and air.

This type of boiler is capable of burning low volatile content, typically 8 - 9%, fuel, e.g., pet-coke, and fuels with low ash-melting temperature, e.g., wood, biomass. It can also burn fuels with ash content as high as 70%, e.g., coal washery rejects. Fuels with high moisture content, such as lignite, can also be burnt in this boiler.

In a circulating fluidized-bed unit, combustion heat is absorbed from the gas by a conventional water-wall surface, by platens located in the upper region of the combustor, or by a heat transfer surface located in external heat exchangers.

The velocity of the gas in a CFBC boiler is relatively higher than that of the solids. The high slip velocity (the difference between the mean gas velocity and the mean solid velocity; in combination with long residence and contact times and intense mixing, results in higher heat and mass transfer rates and higher combustion efficiency in CFBC than are available with other technologies

The combustion zone extends beyond the furnace into the hot cyclone. The furnace heat release rate in a CFBC boiler is of the order of 3.5–4.5 MW/m^2, which is compatible with that of a pulverized coal-fired boiler. For a bed burning bituminous coal, the carbon content of the bed is only 1%, while the rest of the bed is made up of ash, together with sand and/or lime and calcium sulphate. Because of the small particle size and recycling of solids back to the combustor, the CFBC boiler is able to achieve a combustion efficiency over 98% and a Ca/S ratio of 2.5 for 90% sulfur capture (Figure 5.11). The fuel-feed size in this boiler can be as low as 1.5 mm to 10 mm top size.

The CFBC boiler is used in number of units around 250–300 MW in size. In a CFBC unit, heat losses from the cyclone(s) are considerable. Thus, the thermal efficiency of a CFBC boiler is 3–4% lower than an equivalent-size pulverized coal-fired boiler. The operating performance of the CFBC boiler shows that whenever there is a need to increase load on the boiler it can be achieved by raising the bed temperature and keeping the bed material height unchanged.

4.4 Quantitative Risk Analysis (QRA)

In the absence of adequate and documented/reliable historical data of industrial accidents in the country for this type of project, quantitative and definitive estimates on risks to the general public cannot be adequately evaluated.

The protocol commonly observed in the Philippine EIS System is based on the "Manual" (IAEA-TECDOC-727) jointly developed by the International Atomic Energy Association, the UNEP, UNIDO and the WHO titled *"Manual for the classification and prioritization of risks due to major accidents in process and related industries"* shall be used in obtaining indicative or preliminary risk estimates. It is noted that the method prescribed in the manual is based on the use of average values obtained from the investigation of the series of major industrial accidents experienced.

Illustration of Consequence Analysis

The empirical formula is as follows:

$$C_{a,s} = A \times \delta \times f_A \times f_d \times f_m$$

Where:

$C_{a,s}$	=	Number of fatalities/accident in a given area (a) caused by a specific activity (s)
A	=	affected area, hectares
δ	=	population density in defined populated areas, person /ha
fA	=	correction factor for populated areas
f_m	=	correction factor for mitigation effects

The relevance of this formula is that it suggests the significant aspects of risks consequences,

- The type of activity (e.g. transport of coals within the project site)
- The population, i.e. households near the route of the road transport
- The mitigation measure, e.g., road worthiness of trucks

4.5 Assessment of whether the project location is projected to have extreme climate events for 2020 and/2050 that could contribute to triggering identified scenarios.

Climate Change Induced Temperature Rises

It is generally accepted that one key adverse impact of Climate Change is the rise in temperatures.

Among the hazards from high-temperature events are:

- Heat Strokes
- Risks may be more pronounced at the isolated process area at which access to emergency treatment or health centers/hospitals may be difficult.
- Droughts may also induce erosion and landslide at steep slopes.

Other Climate-Change Induced Risks

Climate Change and Health Effects

People are generally accustomed and acclimatized to prevailing weather conditions in their places or residence. Extreme variations such as those that may be induced by Climate Change could potentially affect human health. Thus high temperatures could lead to heat waves, while abnormalities in rainfall patterns could bring about higher incidences of respiratory diseases. Further, higher ambient air temperatures could affect pollution levels.

Direct Impacts from Heat Waves

Heat waves can lead to heat stroke and dehydration, which are the most common cause of weather-related deaths. Young children, older adults, people with medical conditions, and the poor are more vulnerable than others to heat-related illnesses.

Higher air temperatures can increase cases of salmonella and other bacteria-related food poisoning because bacteria grow more rapidly in warm environments. These diseases can cause gastrointestinal distress and, in severe cases, death.

Changes in Allergens

Climate change may affect allergies and respiratory health.

Changes in life cycle of species causing diseases

Changes in climate may enhance the spread of some diseases. Disease-causing agents, called pathogens, can be transmitted through food, water, and animals such as birds, mice, and insects. Climate change could affect all of these transmitters.

There are limited studies in the Philippines in respect of clear or direct evidences of the relationship between climate change and health. However the c*ases of dengue* and malaria are worth noting.

Case of Dengue and Malaria

Focusing on the health impacts brought about by climate change focus needs to be placed on, dengue and malaria, two of the major health problems of the country and other tropical regions of the world.

"Climate change will influence the distribution and endemicity of these two diseases," said De Las Llagas, adding that "these two mosquito-borne diseases (MBD) are directly influenced by climate. Malaria and dengue are seasonal in nature; thus, there are high and low peaks in their transmission.

"Climate affects two major types of biological relationships in malaria and dengue transmission. The mosquito and the infectious agent, as well as humans and the infectious agent are the two systems that are linked together in a circuitous manner.

"Humans create the best environment for mosquito breeding, and the mosquito (infected and non-infected) requires humans to propagate its species. When these two relationships are at equilibrium, disease transmission follows. Equilibrium is achieved if the climatological factors of rainfall, temperature and relative humidity are optimum for a stable level of mosquito density and disease transmission."

To illustrate this, De Las Llagas pointed out that "mosquito population growth is at its highest, when relative humidity is between 80-84 percent; the temperature is 27 to 29^{o}C; and rainfall is not less than 5mm/day. With these empirical data one can predict that in localities where the fluctuation is happening; an increase or decrease in these climatological readings will directly affect the mosquitoes' biological activities such as developmental growth, emergence, mating, laying eggs and biting humans. (*Reference: Health Impacts of Climate Change, Dr. Lilian A De Las Llagas, University of the Philippines System Website*).

Food-borne Diseases

- Higher air temperatures can increase cases of salmonella and other bacteria related food poisoning because bacteria grow more rapidly in warm environments. These diseases can cause gastrointestinal distress and, in severe cases, death.

- Flooding and heavy rainfall can cause overflows from domestic wastes and garbage into fresh water sources. Overflows could contaminate certain food crops with pathogen-containing feces.

Water-borne Diseases

- Heavy rainfall or flooding can increase water-borne parasites such as *Cryptosporidium* and *Giardia* that are sometimes found in drinking water. These parasites can cause gastrointestinal distress and in severe cases, death.

- Heavy rainfall events cause storm water runoff that may contaminate water bodies such as the various beaches along Batangas Bay used for recreation with other bacteria. The most common illness contracted from contamination at beaches is gastroenteritis, an inflammation of the stomach and the intestines that can cause symptoms such as vomiting, headaches, and fever. Other minor illnesses include ear, eye, nose, and throat infections.

Animal-borne Diseases

Mosquitoes favor warm, wet climates and can spread diseases such as dengue fever. Dengue fever and dengue hemorrhagic fever are acute febrile diseases which occur in the many places in the Philippines, can be life-threatening, and are caused by four closely related virus serotypes of the genus flavivirus, family flaviviridae.

Cholera

An infectious and often fatal bacterial disease of the small intestine, typically contracted from infected water supplies and causing severe vomiting and diarrhea

Increases in Ozone

Warmer temperatures from climate change will increase the frequency of days with unhealthy levels of ground-level ozone, a harmful air pollutant, and a component in smog

- Ground-level ozone can damage lung tissue and can reduce lung function and inflame airways. This can increase respiratory symptoms and aggravate asthma or other lung diseases. It is especially harmful to children, older adults, outdoor workers, and those with asthma and other chronic lung diseases.

- Ozone exposure also has been associated with increased susceptibility to respiratory infections, medication use, doctor visits, and emergency department visits and hospital admissions for individuals with lung disease. Some studies suggest that ozone may increase the risk of premature mortality, and possibly even the development of asthma.

- Ground-level ozone is formed when certain air pollutants, such as carbon monoxide, oxides of nitrogen (also called NO_X), and volatile organic compounds, are exposed to each other in sunlight. Ground-level ozone is one of the pollutants in smog.

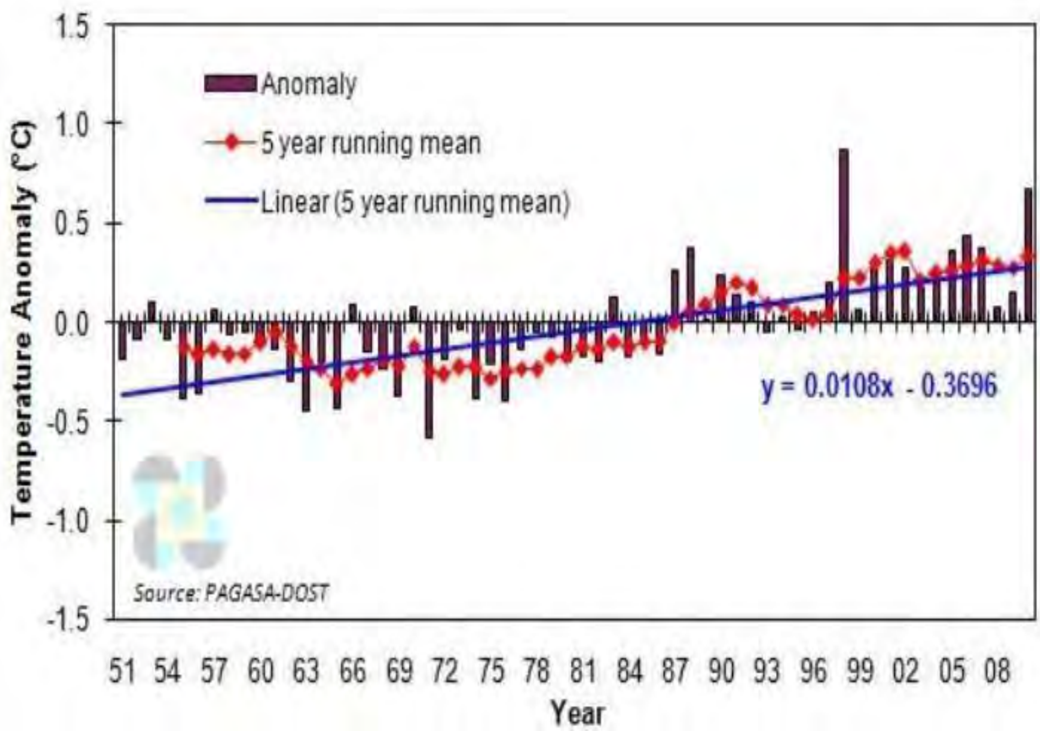
Evaluation of diseases that may be affected by climate change

The growing global experiences on climate change events have understandably raised concerns on the effects thereof on people's health. Although the Philippines as country as a whole is an insignificant contributor to global ghg's and the project in particular has much less contribution, the Philippines is receiving the adverse impacts of climate change.

Weather and climate play a significant role in people's health. Changes in climate affect the average weather conditions that people are accustomed to warmer average temperatures will likely lead to hotter days and more frequent and longer heat waves. This could increase the number of heat-related illnesses and deaths. Increases in the frequency or severity of extreme weather events such as storms could increase the risk of dangerous flooding, high winds, and other direct threats to people and property. Warmer temperatures could increase the concentrations of unhealthy air and water pollutants. Changes in temperature, precipitation patterns, and extreme events could enhance the spread of some diseases.

The impacts of climate change on health will depend on many factors. These factors include the effectiveness of a community's public health and safety systems to address or prepare for the risk and the behavior, age, gender, and economic status of individuals affected. Impacts will likely vary by region, the sensitivity of populations, the extent and length of exposure to climate change impacts, and society's ability to adapt to change.

Anomalies in temperature behavior are already observed to date in the entire country as gleaned from **Figure 4-4.**



SOURCE: http:/www.climateadapt.asia/upload/events/files/4f7565e804fdc2_PAGASA.pdf

Figure 4-4. Observed Temperature Anomalies in the Philippines

4.6 Safety Risks Type

Identification of conditions, events and circumstances which could be significant in bringing about identified safety risks

4.6.1 Fire

Documentation of actual experiences

The Safety Organization of the Philippines, Inc. (SOPI) informally advised the EIA Preparer that it has no records of fire incidences in Coal Power Plants. Confirmation letter has been sent on June 08 2020.

Through inquiry with former personnel involved in a major Coal Power Plant operation it was gathered that there are no known major fires causing loss of manpower due to fire.

The operation of the original project of FDCMP has the following records on fire incidences.

Description and assessment of the possible accident scenarios posing a risk to the environment

Major fires may likely occur under the following scenarios. Fire prevention and protection are discussed to make an accurate assessment of the scenarios.

- **Spontaneous Coal Combustion During Storage**

Coal contains volatile matters of up to 40 % by weight thus making it vulnerable to spontaneous combustion. When stored coal is exposed to air it absorbs oxygen at the uncovered surface. When the rate of oxygen absorption at certain fraction or portion of the stored coal is faster than in other fraction oxidation results with the formation of gases. Mainly CO, CO_2, water vapor. The reaction is exothermic thus heat is generated. If the heat is not dissipated the temperature may right the ignition point of coal thereby causing fire.

Coal is susceptible to spontaneous combustion, most commonly due to oxidation of pyrite or other sulfurous contaminants in coal. Coal reacts with atmospheric oxygen even at ambient temperatures in an exothermic reaction. If the heat liberated during the process is allowed to accumulate, the rate of the reaction increases exponentially and temperature further increases. When this temperature reaches the *ignition temperature* of coal, combustion proceeds and the phenomenon is called as *spontaneous combustion*.

Favorable conditions for spontaneous heating are accumulation of heat caused by a rise in temperature and hence an increase in the reaction rate. Although, at ambient temperature, the reaction can be so slow that it is unnoticed, when heat accumulates the temperature is raised and, the reaction rate increases exponential. During coal storage oxygen may accumulate in the interstices of the coal particles; such accumulation can lead to oxidation and eventually to fire.

Spontaneous combustion fires can be difficult to extinguish because of the amount of coal involved such as in the storage yards. Carbon monoxide is the toxic gas that may be produced during spontaneous combustion.

The major mitigation measures to prevent or minimize spontaneous combustion are:

1. Coal handling procedures that allow short-time holding time of coal and thus the accumulation of oxygen in the interstices of the coal particles.

2. Handling procedure by which coal inventory would create segregation of particle sizes in stockpiles thus creating spaces or voids in which oxygen may accumulate.

3. A “First In” “First Out” coal inventory/policy will be adopted to prevent excessive accumulation of oxygen.

4. As an emergency measure, firefighting facilities, principally fire water lines, fire extinguishers, and water hose stations and hoses will be installed at the coal storage. Alarms will also be installed. The coal storage area will be located at a separate location from the major equipment, seen below.

Fires from Flammable Substances

Diesel Oil used for start up operations have low flash point and of low level of inventory

	Flash Point	Inventory
Diesel Oil	</= 60^{0}C	Significantly lower than threshold of 50,000 li

4.6.2 Explosion

Identification of conditions, events and circumstances which could be significant in bringing about identified safety risks.

The elements for explosion are the extraordinary/release of energy accompanied by rapid increase in volume of explosive materials. Coal properties do not satisfy these conditions for explosion, primarily because it is solid which unlike gases can display rapid volume expansions.

Description and assessment of the possible accident scenarios

The possible accident scenarios and the affected population are related to the operation of the major plant equipment and auxiliaries as follows:

- Operation of high pressure/high-temperature equipment such as boilers and generators.
- The instrumentation system of the plant is provided with control, measurements, recording and response mechanism to prevent equipment failures that may result in accidents. Pressure relief valves are installed in sensitive points to cause release of gases away from personnel. Unit or equipment shutdowns are automatically built in the instrumentation system.
- Movement of personnel to high structures
- Plant operators and maintenance personnel may necessarily climb to high structures as routine part of their functions. Thus the potential for falling off from these structures exist.

Movement of vehicles

Delivery trucks for materials e.g. limestone, water treatment chemicals, etc. will necessarily enter the plant premises.

Only accredited vehicles and drivers may be allowed to enter the plant, Road signages will be posted conspicuously at strategic places.

Assessment of whether the project location is projected to have extreme climate events for 2020 and 2050 that could contribute to the triggering identified scenarios.

- **Climate Projections by PAG ASA in 2020 and 2050 in Provinces in Region 10**

The projected seasonal temperature increase, seasonal rainfall change and frequency of extreme events in 2020 and 2050 under the medium-range emission scenario in the provinces in Region 10 are presented in Table 4-4a, Table 4-4b and Table 4-4c, respectively.

To use the tables and arrive at values of seasonal mean temperature and seasonal rainfall in 2020 and 2050 in any of the provinces, the projections are added to the observed values (presented in each of the tables).

For example, in Bukidnon province, the projected values in 2020 are:

a. DJF mean temperature = (25.1 °C+1.0 °C)+26.1 °C;

b. DJF rainfall + {329.7mm+329.7(2.9%)mm} = (329.7+9.6)mm or 339.3mm;

c. number of days with Tmax > 35 °C in Malaybalay during the 2006 – 2035 period (centered at 2020 = 477;

d. number of dry days in Malaybalay during the 2006 – 2035 period (centered at 2020) = 3,977; and

e. number of days with rainfall > 300mm in Malaybalay during the 2006 – 2035 period (centered at 2020) = 1.

Table 4-7 Climate Projections for 2020 and 2050 by PAG ASA

Table 4-8a: Seasonal temperature increases (in °C) in 2020 and 2050 under medium-range emission scenario in provinces in Region 10

Provinces	OBSERVED BASELINE (1971 - 2000)				CHANGE in 2020 (2006 - 2035)				CHANGE in 2050 (2036 - 2065)			
	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON
Region 10												
BUKIDNON	25.1	26.5	25.8	25.7	1.0	1.2	1.2	1.0	1.9	2.3	2.4	2.1
LANAO DEL NORTE	24.4	25.5	25.4	25.2	1.0	1.1	1.0	1.0	1.9	2.2	2.1	1.9
MISAMIS OCCIDENTAL	25.6	26.7	26.6	26.4	1.0	1.1	1.1	1.0	1.9	2.2	2.2	1.9
MISAMIS ORIENTAL	25.4	26.8	26.9	26.5	1.0	1.1	1.2	1.0	1.9	2.3	2.4	2.0

Table 4-8b: Seasonal rainfall change (in %) in 2020 and 2050 under medium-range emission scenario in provinces in Region 10

Provinces	OBSERVED BASELINE (1971 - 2000) mm				CHANGE in 2020 (2006 - 2035)				CHANGE in 2050 (2036 - 2065)			
	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON
Region 10												
BUKIDNON	329.7	335.6	653.8	559.5	2.9	-10.3	-4.4	-0.3	-5.1	-13.0	-9.7	-5.8
LANAO DEL NORTE	337.5	350.3	662.5	621.1	9.6	-0.6	-2.2	6.9	2.5	-1.9	1.4	7.1
MISAMIS OCCIDENTAL	392.1	323.4	633.1	728.3	9.1	1.4	-6.1	6.1	5.2	0.3	-5.1	4.6
MISAMIS ORIENTAL	442.5	296.0	615.7	581.1	4.6	-10.4	-3.7	2.9	1.8	-17.8	-5.2	-0.1

Table4-8c: Frequency of extreme events in 2020 and 2050 under medium-range emission scenario in provinces in Region 10

Provinces	Stations	No. of Days w/ Tmax >35 °C			No. of Dry Days			No. of Days w/ Rainfall > 150mm		
		OBS (1971-2000)	2020	2050	OBS	2020	2050	OBS	2020	2050
BUKIDNON	Malaybalay	26	477	1441.0	6537	3977	4461	4.0	9	9
LANAO DEL NORTE	Dipolog	217	2155	4004.0	7481	5384	5470	3	6	1
MISAMIS ORIENTAL	Cagayan De Oro	383	4539	6180	8251	6413	7060	10	13	9
	Lumbia	106	2012	3759	6495	6290	6580	3	6	1

Note:
- For Western portion of Misamis Occidental, use values of Dipolog City.
- OBS-Observed Baseline

- **Temperature Extremes as Precursor to Accidents**

At worst case scenario, extreme temperature rise is predicted at 2.4°C for a short term period of June/July/August in 2050. At the peak ambient temperature at this time of 29.3°C the effect on operations and maintenance personnel is unlikely.

Indirect adverse effects even if unlikely have to be factored in the design of equipment and safety system, noting that process design take into consideration ambient conditions, e.g., temperature. Failure of systems (e.g. instrumentation) may in theory trigger accidents.

- **Rainfall Extremes as Precursor to Accidents**

Aberrations in predicted rainfalls are seen from the above table, certain months exhibit decrease in rainfalls while in other periods increase is predicted, the maximum being on December/ January/ February 2020 at +4.6 %.

These predicted increases are however, not expected to trigger accidents in the operation of the plant particularly relating to the transport of coal. Potential effects of heavy rainfalls is flooding. The plant however will be designed for appropriate drainage system.

- **Scenario of Failure of APCD**

In an event although unlikely that the ESP fails the instrumentation system described hereunder will automatically shut down the plant thus preventing uncontrolled discharge of PM to the atmosphere.

> **Typical ESP P&I Diagram:**
>
> To address the concerns of ESP failures, we will adapt the following standards in the design, installation and operations/maintenance of ESP to prevent total failure. This design and O&M philosophy will make total ESP failure improbable.
>
> **Field Sectionalization**
>
> High efficiency precipitators have more than one electrical field. Three or more fields are normally provided in the direction of the flue gas. The sectionalization of the precipitators improves both precipitator performance and reliability. At the inlet of the precipitator, the dust layer accumulates rapidly since 60 to 80 percent of the mass is collected rapidly. This makes this field more prone to electrical sparking due to the non-uniformities in the dust layer electrical fields which can result to electrical tripping. Sectionalization will ensure that failure one electrical field will not affect the operation of another field.
>
> **Independent Field Power Supply**
>
> By using a number of independent power supplies, the electrical disturbances in one field are isolated. The differences in electrical sparking which are normally moderate-to-frequent in the inlet fields and low-to-negligible in the outlet will be controlled by an automatic voltage controller in case of a field failure. These refined power supply and other standards was specified by the United States Electric Power Research Institute (EPRI) on State-of-the-Art Electrostatic Precipitator Power Supplies, Technical Update, October 2003 which will be adapted in our design of ESP.
>
> **Operation and Maintenance**
>
> The ESP design will enable troubleshooting of common cause of field failure while the boiler and other fields are online. The O&M philosophy will be based on United States Environmental Protection Agency (EPA) "Manual for Operation and Maintenance of Electrostatic Precipitators" and "Inspection Procedures for Evaluation of Electrostatic Precipitator Control System Performance" which failure of only one electrical field will be the extreme condition during boiler operations.

The system above described is illustrated in **Figure 4-5** below.

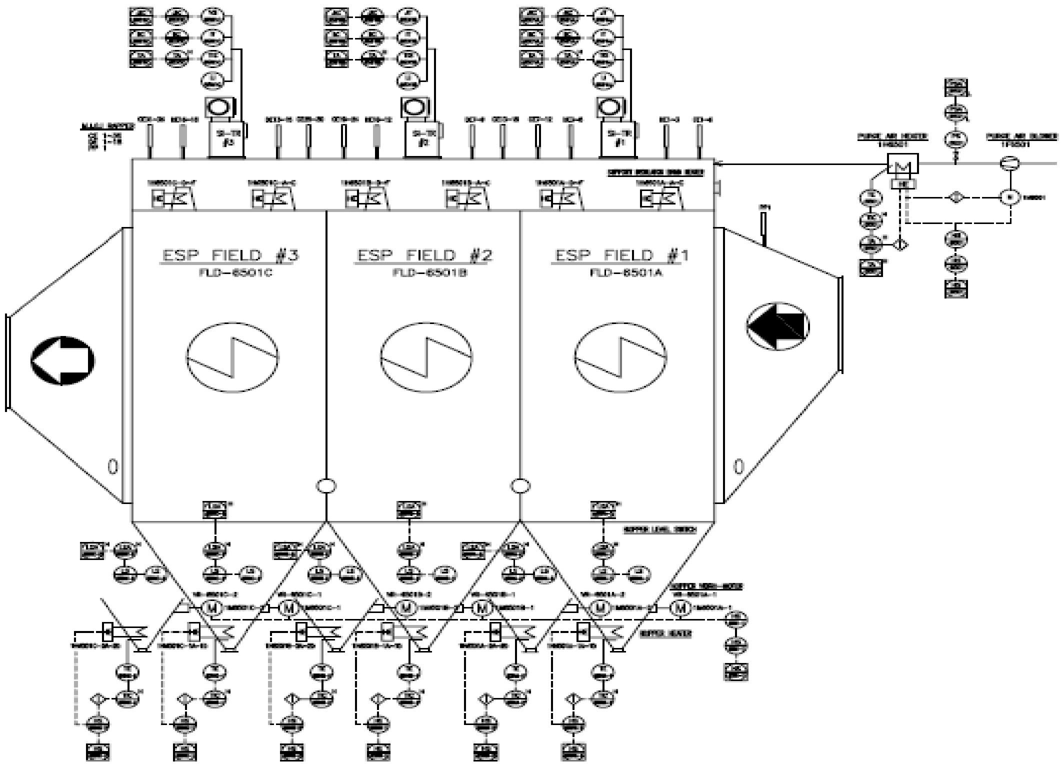


Figure 4-5 Schematics for Shutdown in Case of Failure of the ESP Fields.

4.6.3 Release of toxic substance

Description of the hazards both immediate (acute effects) and delayed (chronic effects) for man and the environment posed by the release of toxic substances (including unloading of raw materials/fuel), as maybe applicable

The release of toxic substances will depend on the quality of coal and is not considered a significant risk.

No toxic substances are released or involved during the unloading of the raw materials/fuel because no combustion process is involved during unloading operations.

Quantitative Risk Assessment (QRA)

Description/Qualitative Risk Assessment

QRAs must necessarily require existing data from similar operation in the Philippines. The Report will be submitted prior to operation as prescribed in the checklist.

4.7 Physical Risks

(Failure of Structures which could endanger life, property and/or the environment) Description of conditions, event and “trigger” which could be significant in bring about identified physical risks. Description and assessment of the possible accident scenarios. Assessment of whether the project location is projective to have extreme climate events for 2020 and/or 2050 that could contribute to the triggering identified scenarios. Description of the hazards both

immediate (acute effects) and delayed (chronic effects) for man and the environment posed by the failure of structure, as maybe applicable

Engineering interventions shall be applied in the design and construction of foundation, structures and other equipment that may be vulnerable to failures. Failures could be triggered by natural hazards such as seismic activities, volcanic eruptions, tsunamis and floods.

These hazards are discussed in Section 2.1.

- **Seismicity and liquefaction risks to equipment failure.**

Soil studies have been undertaken by the Proponent's Consultant. On the basis of the details of the equipment to be purchased and installed which shall be determined post ECC, design factors such as PGA (Peak Ground Acceleration) shall be incorporated.

- **Volcanic eruptions**

Volcanic ashfall is considered unlikely at the project site.

- **Tsunamis**

As discusses in **Section 2.1.2.3** Tsunami hazard is dependent on natural factors and hence, the proposed project shall not induce such hazard but may be affected by it.

A tsunami can create run-up waves and cause inundation to the site. The force of waves and horizontal currents such as drawdown can damage structures. It can create a wall of turbulent water with rocks and debris. Wave-related damages may also induce erosion and deposition. Furthermore, the water pressure and debris impact can cause overturning of roofs, sliding of walls and scouring of the base.

- **Floods**

Even assuming extreme flooding, the drainage system should be able to address this concern and at worst condition, the equipment/structures are not expected to fail/collapse as a result of floods.

4.8 Safety Procedures and Emergency Response Plan, Policy & Guidelines

The generic emergency and response plan for the Project is provided hereunder consistent with the guidelines of the RPM.

It may be noted that the more final emergency response plan shall follow after the detailed design. To illustrate the exact plan configuration will impact on the appropriate response plan, the detailed fire protection scheme will address fire incidences, etc.

4.8.1 EMERGENCY RESPONSE POLICY AND GUIDELINES

Framework

This is illustrated in **Figure 4-6** below.

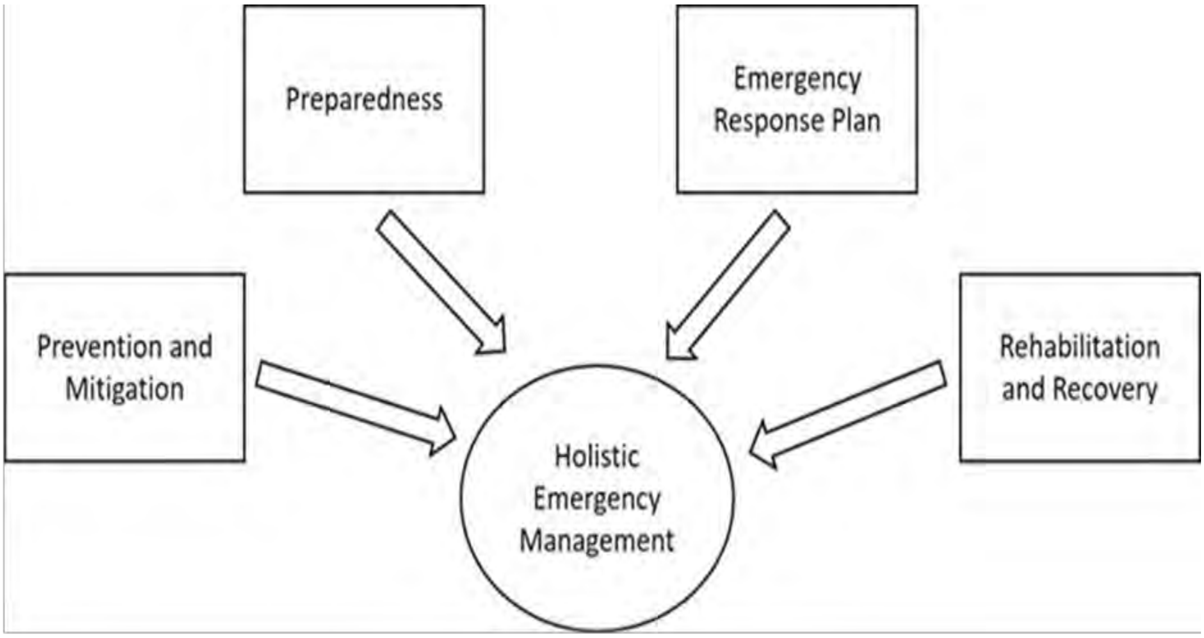


Figure 4-6 Framework for Emergency and Risk Management

Objective: To maintain life, property, facility and resources preservation during events of emergencies and disasters through an effective Emergency Response Plan (ERP).

The ERP provides for key actions during actual emergency response operations which includes assessment, search and rescue, relief operations and recovery activities.
Success Indicators: A quick response and functional Incident Command Team (ICT)
Availability of timely, accurate and reliable information during the response

A Framework

Embodied in this framework are:

- **The guidelines of the National Disaster Risk Reduction and Management Plan (NDRRMP) 2011-2018**

- **The Incident Action Plan of the Proponent "MPC-HSE-PRO-001-01-01-2019-003"**

Scope:

Pre-Emergency – The period before the occurrence of disastrous evens wherein disaster preparedness, activities and programs are undertaken as prevented measures which will likewise enhance response capabilities to emergencies.

Emergency – The period wherein emergencies occur and the preparedness plans and programs are put in to effect.

Post Emergency – The period wherein short or long term recovery procedures are undertaken to restore the vital support systems to normal. During this period, assessment of the emergency situation is made to make audit of the facilities affected and to gather experiences that would serve as guidelines for future incidences.

The Incident Management Team (IMT)

This is clearly identified prior to emergencies and put into action during emergencies.

The Overall Organizational Plan for Emergency Management is shown in **Figure 4-7**.

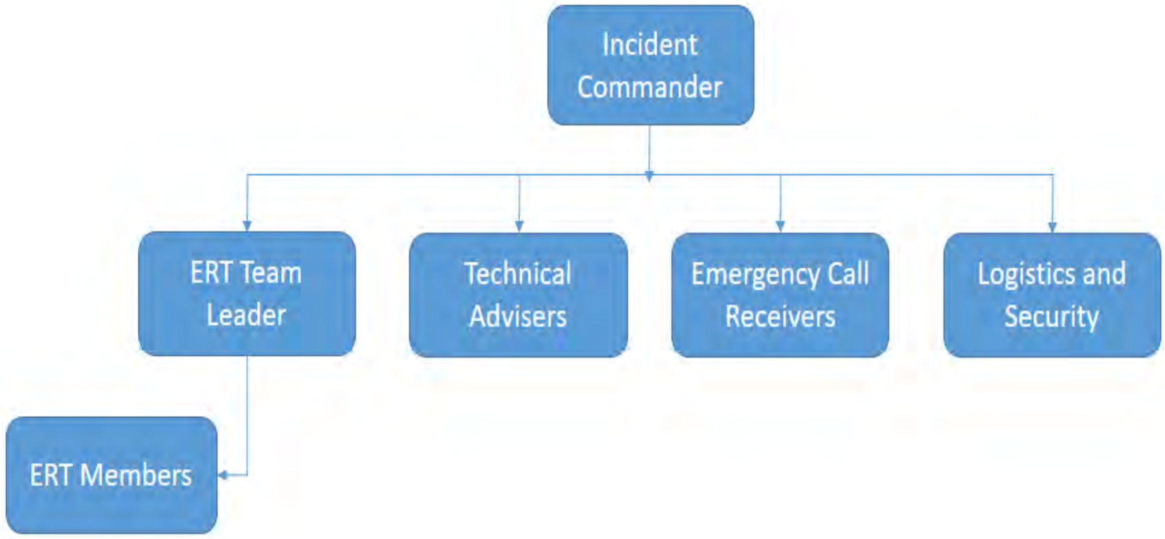


Figure 4-7 The Overall Plant Organization for Emergency Management.

The IMT is composed of

In house:

- The Plant Operator (or delegate) as per the Emergency Management System (EMS) has statutory responsibility for the management and control of the emergency operation.
- The Safety Inspector has the authority to suspend or limit the intervention where the Inspector deems that persons are being exposed to unacceptable levels of risk.

On-the-spot Coordinator

The most senior member of the IMT who is available during the emergency episode will temporarily take charge of the response action.

He will be replaced by the designated official of the IMT when the latter reaches the site of emergency.

The IMT will be composed of:

The OPM Division Head
The Facility Group Head
Operations and Maintenance Department Heads
Security Manager
Safety Manager
Shift Superintendent
Shift Supervisor
Control Engineer

Outside Support Team:

- The MRS Regional Manager (or delegate) can provide specialist knowledge and expertise on rescue, control, exploration and recovery/restoration techniques and in particular, the deployment of the Rescue Brigade.
- In the event of an incident involving the loss of life or lives, Police Officers act as the Coroner's representative and have statutory responsibilities for investigation and interviewing, reporting, and the removal of bodies.
- The Local Emergency Management Officer (usually the Regional Police Commander) can also access and resource ancillary equipment from other sources.

Communication Lines

Key to the effectivity of the ERP is communications. The contact numbers of both plant personnel and outside support team must be known to all members of the IMT especially those at the emergency site.The use of mobile phones is most effective communication line.

Table 4-9 shows the communication lines of key IMT personnel:

Table 4-9 Names and Contact Numbers of Key IMT Personnel

ROLE	NAME	OFFICE PHONE	LOCATION	CELL PHONE
Incident Commander	Shift Superintendent	2181 (local)	CCR	09178279063
Deputy Incident Commander	Shift Supervisor	2181 (local)	CCR	09178279063
Emergency Call Receiver	Control Room Engineer	2181 (local)	CCR	09178279063
Safety Officer	Darwin Talusan	2130 (local)	Site	09167486828
Security Officer	Marco Lopez	2127 (local)	Site	09177139686
Technical Advisers	Department Managers • PLANT • OPERATIONS • MAINTENANCE • HSSE • HR • ADMIN	(Local Lines) 2161 2171 2172 2128 2143 2152	Site	
Emergency Response Team	O&M Employees		Site	

General warnings will be sounded, e.g. by alarms. The alarms will be coded to signify the nature and intensity of the emergency and should be audible

The IMT will consider the following:

Nature of the emergency / incident:

- Ignition
- Explosion
- Spontaneous combustion

- Fire
- Fall of ground/entrapment
- Fall of ground/wind blast
- Outburst
- Inrush
- Unknown or unidentified?

Static incidents such as a fall of ground, outburst or flash ignition are unlikely to develop into an uncontrolled event and may enable a fast resolution and early intervention.

Dynamic incidents such as fires, spontaneous combustion or explosions may develop into uncontrolled events. They warrant extreme caution and the detailed evaluation of all relevant factors utilizing data that is accurate, reliable (timely, valid location/s, correctly interpreted), and trended.

Intensity of the emergency/ incident?

- Colour and extent of smoke
- Visible flame
- Type and level of gases produced
- Ventilation
- Information from survivors
- Poor visibility

Determination of the nature of the emergency/incident and an evaluation of its intensity will enable an assessment to be made of the:

- Extent of disruption to essential services such as ventilation
- Degree of confinement to a specific face, heading, panel or district
- Nature and extent of injuries to survivors Potential for escape, rescue or re-entry.

Action Required

What action or response is required to remedy the emergency/incident?

- Escape, rescue or extrication of persons?
- Control of a situation (e.g.; firefighting, sealing)?
- Exploration and recovery of bodies?
- Exploration and restoration of operations? Surface emergency procedures.

Establishing the desired outcomes provides a framework for determining the type, extent, reliability and accuracy of data required to identify and evaluate potential strategies. It will be a factor in determining acceptable risk levels and also provide a framework for evaluating overall logistics.

Re-entry and exploration within the power plant for the recovery of bodies or restoration of operations should be a pre-planned operation using a risk management approach. A vital aspect of minimizing risks is the appropriate education, orientation and preparation of the plant personnel on the various aspects of emergency preparedness and response programme.

An institutional set up is considered integral to the power plant organization. A dedicated personnel/officer in charge of Safety (which may include related functions such as Health and

Environment) should be appointed and should take responsibilities for safety and emergency response functions.

It may be noted that the final emergency response plan shall follow after the detailed design. To illustrate the exact plant layout and configuration will impact on the appropriate response plan; the detailed fire protection scheme will address fire incidences, etc.

Escape Plan

This will be clearly identified prior to occurrence of emergencies. Maps showing the escape plan will be posted at conspicuous places at the plant offices and facilities

Components/Aspects of the ERP

Conduct of Tests and Drills

Periodic test and drill response activities will be determined and conducted with post drill evaluations conducted to improve the response procedures. Frequency of conduct of the various drills will depend on whether they have low, medium or high vulnerability scores or whether they are required for legal purposes only.

Record Keeping, Documentation and Plan Revisions

All developed plans and instructions will be documented. All incidents shall be recorded according to the specific instructions and post incident evaluations will signify whether plans and instructions need to be revised to improve efficiency of implementation.

Others:

Before Calamities

a. Conduct community disaster awareness educational campaign
b. Assess the ‘at-risk’ communities, structures and facilities
c. Prepare and conduct community evacuation plans and drills
d. Convene the Municipal Disaster Risk Reduction Management Council (MDRRMC) to plan for the impending calamity and establish Incident Command Center.
e. MSWD to establish and provide for the strategic evacuation centers
f. PNP, and other identified Groups to assist and implement preventive evacuation and warning procedures. Force evacuation where necessary.

During Calamities

a. Respond safely to individual/communities on case to case basis
b. Incident Command Center on stand-by for search and rescue calls
c. Rescue Teams on stand-by for possible dispatch

After Calamities

a. PNP to secure the affected areas to maintain order in the community
b. Proceed with search, rescue and recovery effort. Utilize the triaging system where necessary.

c. Municipal Social Welfare and Development to facilitate the continuous operation of evacuation centers.
d. Municipal Health Office (MHO) to treat those injured and facilitates the collection and identification of cadavers.
e. Municipal Engineer to start damage assessment and reconstruction. Give priority to the flow of relief goods, water and sanitation, temporary shelter for displaced families, and electricity.

4.8.2 RESPONSE PLANs FOR NATURAL HAZARDS

A number of potential emergency situations may arise such as from Natural Hazards, among the potential hazards are:

- Earthquakes and seismic-induced disasters e.g. liquefaction
- Strong cyclones
- Man-made Hazards, such as
    - Fire
    - Accidents

Whether natural or man-made the accidents or consequences of hazards will not be societal in scope but mostly confined to the plant personnel.

Notwithstanding that there are preventive measures to be undertaken, e.g. in the design and construction of major equipment, in the storage and management of coal and of start-up diesel oil, it is prudent for operating companies to develop their internal response plans.

The response and procedure will depend on the nature of the emergency and will include the following generic guidelines:

- Establishment of official detailed specific responses per type of emergency

Thus each plan would be relevant to such emergency situations such as fire, earthquake, and even from attacks of criminal elements.

- The plan should include the contact agencies and offices outside of the plant that would need to be contacted for assistance depending on the type of emergency

- The assistance of the Disaster Reduction and Management Coordinating Council could be sought

- Emergency drills should be conducted. Emergency evacuation is integral to such drills.

- Installation or securing of necessary emergency response facilities/equipment, e.g. firefighting system, oil spill containment boom (in an event of accidental oil spill at the jetty), vehicles to be used in emergency cases, etc.

- Setting up of communication lines, e.g. with barangay, fire department, police department, clinics or hospitals.

COORDINATION WITH AND ASSISTANCE FROM THE NATIONAL DISASTER AND RISK AND REDUCTION MANAGEMENT ORGANICATION

This will be set in place before and during emergency episodes.

Earthquakes

As example, the PHILVOCS could be asked to help in earthquake drills.

Typhoons

Definitions:

The following definitions are from PAGASA (Philippine Atmospheric, Geophysical & Astronomical Services Administration).

Tropical Cyclones

- Intense low pressure system
- Winds rotating in counter-clockwise direction (Northern Hemisphere)
- Originates from tropical oceans
- Minimum winds of 35 kilometers per hour (kph)
- Generally moves westward then poleward

Categories of Tropical Cyclones According to Wind Speed

- Tropical Depression - maximum winds near the center is less than 63 kph
- Tropical Storm - maximum winds near the center is from 63 to 117 kph
- Typhoon - maximum winds near the center is equal or greater than 118 kph
- Super Typhoon – maximum sustained winds near the center is more than 220 kph

Public Storm Warning Signals

In 2014, PAGASA adopted the Super Typhoon (STY) category.

Procedures

1. Field Wide administrative controls to be taken to mitigate and minimize the impact of typhoon

The administrative and maintenance activities listed should be in place and included in the asset risk mitigation plans. Asset management, at its discretion, can require additional activities as deemed necessary.

Administrative Control

1. Trimming of tree branches;
2. Repair of facilities vulnerable to rain/wind (e.g. Maintenance Shop Building, Office Roofing, etc.); preparation of materials for boarding-up of windows;
3. Installation of window covers/shutters that will prevent the glass from shattering during typhoon;
4. Regular cleaning of storm canals;
5. Inventory of spare units/parts of critical equipment (e.g. generators, compressors, etc.)
6. Prepare operability of Satellite phone and/or other emergency telephones.

2. Preparatory activities when in danger of being hit by a typhoon

The preparatory activities listed are only the minimum requirements. Asset management, at its discretion, can require additional activities as deemed necessary. The activities are classified per typhoon signal to calibrate the level of proactive response.

4.8.3 Others

4.8.4 HAZARD OPERABILITY PLAN (HAZOP)

Identification of critical equipment and process which can be risk and hazard vulnerable.

The compressed air system
The handling and use of petroleum oil
The electrical power distribution system

Table 4-10 summarizes the hazard scenarios for the Project.

Table 4-10 Summary matrix of the power plant operations hazard scenarios

Item	Facility	Description	Hazards	Remarks
1	Steam Turbine Generator			Housed in concrete building
2	Boiler		Steam Blowing	Noise not a concern, housed in concrete building
3	Coal silos Coal Specifications See Below	Semi covered 	Spontaneous combustion	
4	APCD	Electrostatic Precipitators w backup	TSP fall out	ADM for this scenario shows GLCs
5	Fuel Oil Fuel Specifications See below	High flash point	Fuel spills/leaks	

Table 4-11 Coal Specifications

Physical and Hazard Characteristics of Coal Property	Value/Details
CAS Number	129 521-66-0
Auto-ignition Temperature, deg C	>601 for cloud >200 for layer
Flammable Limits, %	Dust concentration range of 0.09-7.0 kg/m3 and oxygen concentration of 13%
Exposure Limits	OSHA PEL respirable fraction of coal dust: 2.4 mg/m3 TWA
Stability and Reactivity Information	Coal is stable at ambient temperatures. Conditions contributing to instability are heat, sparks, open flame, or other ignition sources. Formation of dust in enclosed spaces should be avoided prevent attaining explosive concentrations.
Hazards	Exposure to coal dust can occur through inhalation, ingestion, and eye contact. It is not considered as a serious respiratory hazard although heavy exposure dust causes symptoms of low grade breathlessness, wheeze and phlegm. Smoking appears to aggravate symptoms.
Coal may spontaneously self-heat in air over a period of hours or days leading to spontaneous combustion if not controlled. Dust explosion hazard is present if airborne coal dust concentration 0.09 to 7.0 kg/m3 and oxygen concentration >= 13% are met.	

Table 4-12 Coal Analysis

Coal Fuel Analysis	Units	Design Coal Envelope		
		Guaranteed Coal	Low Quality	High Quality
Al_2O_3	% wt	22.0	15 - 30	
Fe_2O_3	% wt	4.1	≤ 20	
CaO	% wt	8.3	≤ 13	
MgO	% wt	5.0	≤ 7	
TiO_2	% wt	1.5	≤ 3	
Na_2O	% wt	1.5	Note	
K_2O	% wt	0.8	Note	
Mn_3O_4	% wt	-		
P_2O_5	% wt	-		
SO_3	% wt	-		
Other	% wt	9.8		

Note: $Na_2O + K_2O < 2.5\%$

Coal Fuel Analysis	Units	Design Coal Envelope		
		Guarantee Coal	**Low Quality**	**High Quality**
High Heating Value (HHV)				
Air Dried Basis (ADB)	kcal/kg	5400	5100	≥ 5100
As Fired Basis (ARB)	kcal/kg	4500	4000	≥ 4000
Proximate Analysis (ADB)				
Moisture	% wt	15.0	≤ 25.0	≤ 25.0
Ash	% wt	8.0	≤ 12.0	≥ 1.0

Volatile Matter	% wt	39. 0	≤ 47.0	≤ 47.0
Fixed Carbon	% wt	38.0	≥ 30.0	≥ 30.0
Ultimate Analysis (DAF)				
Carbon	% wt	73.0≥ 70.0		
Hydrogen	% wt	5.7	≤ 10.0	
Nitrogen	% wt	1.4	≤ 2.0	
Sulphur	% wt	0.9	≤ 1.2	
Oxygen	% wt	19.0		
Ultimate Analysis (AFB)				
Carbon	% wt	46.3		
Hydrogen	% wt	3.5		
Nitrogen	% wt	0.9		
Sulphur	% wt	0.6		
Oxygen	% wt	12.1		
Ash	% wt	6.6	≤ 12.0	≥ 1.0
Total Moisture	% wt	30.0	≤ 37.0	
HGI		55	≥ 40	≥ 40
Nominal Sizing	mm	≤ 50	≤ 50	≤ 50
	% <2mm	≤ 20	≤ 20	≤ 20

Fuel Specifications

Design Interventions as maybe guided by HAZOP and based local and internationally-acceptable standards and practices

Installation of stand-by generators for "black start" for emergency electricity supply when complete power failure occurs. Critical system/s which needs continuous power supply should be identified and be protected including:

Coal silos

Compressed Air System

- Supplies power to valves and gates wherein electrical power is unsafe or impractical (dusty or environment with flammable gases subject to sparking).

Fluidized bed furnace

- Back-up blowers to maintain fluidized bed condition and avoid clogging

Ash withdrawal and separation system from furnace
- Avoid clogging and pressure build-up
- Pressure sensors/alarms to detect and prevent pressure build-up

ESP blowers & electro-static precipitator electrodes (failure from brown-out)
- Avoid clogging and pressure build-up
- Pressure sensors/alarms to detect and prevent pressure build-up

Fire fighting equipment including ample supply of water should be operational and available during power failures.

Proximity, safe distances between facilities

- It is recommended that a review of the plant layout and spacing among the facilities (particularly location of diesel fuel tank and ash silo) to consider the accident scenario (e.g. fire and explosion) and work spaces during emergency response (spill and fire).

Dust Sources and Accumulation

- Sources of dust which can interfere with sensitive plant machineries should controlled. Dust accumulation should prevented.
- Dust filters should be checked periodically as to prevent pressure build-up and possible explosion.
- Dust generation in confined spaces at/near the ash handling system, silo, electrostatic precipitator should be monitored and prevented from accumulation in order the explosive limit is not reached.

Grasses and brush overgrowth and drainage canals

- The plant facilities, including drainage canals shall be maintained and cleared for overgrown grasses and brushes which may cause fire particularly during dry summer season. This condition is sometimes overlooked and neglected.
- Drainage canals, particularly those connecting the oil/water separator discharge, fuel oil and waste oil storage areas should be regularly checked for presence of vegetation and spilled oils which can easily catch and travel to other facilities.

Animals and other Fauna

- Drainage canals, particularly those that are covered, were found to be the entry route of animals such as rats, lizards, snakes, etc. which find their into the plant premises and into sensitive electrical instrumentation and controls including breakers.
- A review of the biological surveys is recommended to determine what animals and insects are dominant/present in the area.

Insects Infestation

- Control and instrumentation panels particularly those located outside should be checked for presence of insects which can cause interference and equipment failure. The affected areas should be identified as the cause of the presence of insects and cleaned as often as necessary.

Recognition of the plant experiences vis-à-vis accidents, fires, failures of air pollution control devices, (APCDs).

Design Engineering and Standards and Sound Engineering Practices

The EPC contracted to be selected shall be compelled to comply with international and local standards and sound engineering practices, in particular with the DOLE Safety standards, building codes and standards for high pressure vessels

Summary and Conclusions

As has been successfully demonstrated in its current operations of similar project and in the same project site, it is concluded that there are no environmental risks involved that would merit extra ordinary measures by the Proponent and on the other hand, any complaints from third parties.

Table 4-14 Table Summary of Emergency Response Plan

PREPARATION	RESPONSE	RECOVERY	Responsible Personnel
A. Fire			
• Orientation and training of person on fire safety • Conduct regular fire drills • Installation and regular testing of fire fighting devices (i.e. fire hoses, fire extinguishers, smoke detectors, sprinkler system) • Electrical equipment and lines are inspected and replaced as necessary for any defects or malfunctions • All flammable items are secured in proper containers and storage facilities • A "No Smoking Policy" will be implemented in the whole project area or a safe zone for smoking personnel and occupants will be designated • Emergency numbers and communication equipment are placed in conspicuous areas for easier notification • Emergency exits and evacuation procedures shall be put in place, and kept free from any obstructions. • Regular maintenance of genset and other related equipment	• All personnel are advised not to panic to prevent further injuries • Personnel are advised to follow emergency evacuation procedure. Report immediately any presence smoke, sparks, or open flame authorized personnel • If the fire can still be contained, use fire extinguishers immediately Disconnect electrical or fuel connections, and shut-down all affected equipment If possible, remove all flammable materials from the fire scene from getting contact • For responders, wear the proper protection attire (i.e. fire suit, boots, breathing apparatus) Avoid using or pouring water over fuel or alcohol fires, and electrical fires	• Avoid returning to the fire scene, as long as necessary, unless declared for safe entry • Check all personnel to find out if there are injuries or trapped/injured persons that may need assistance • Report any important incidents that require immediate attention • Secure important items and equipment from unauthorized access from outsiders, after the building is declared safe for re-entry • If the fire damage is minimal, or facility is recoverable, make necessary corrective measures to prevent the accident from recurring.	
B. Earthquakes			
• Make necessary preparations, which includes equipment and facility checks to	• All personnel and administrative officers are advised not to panic to prevent further	• If there are no threats of aftershocks, check other personnel that may be	

PREPARATION	RESPONSE	RECOVERY	Responsible Personnel
prevent injuries in an event or an earthquake • All loose items must be secured to prevent falling • Heavy materials are placed near the ground • Flammable items are stored in designated safe areas • Personnel are familiarized to safe locations, emergency response equipment and • evacuation routes	injuries Personnel are advised to protect themselves • by getting under sturdy structures Personnel are advised to stay away from sharp, flammable, or heavy items Personnel are advised to prepare immediate • evacuation of the facility if • necessary • All gas and electric equipment are shut down	trapped, injured, or needs further assistance. • Avoid returning to the facility if it is deemed structurally unstable, or declared unsafe Check for possible fires and advice authorities for appropriate response. • Secure important items and equipment from unauthorized access from outsiders, after the building is declared safe for re-entry Inspect the facility for any major structural defects, cracks, and unstable items, other potential hazards • If the earthquake damage is minimal, or facility is recoverable, make necessary corrective measures to prevent the further hazards from affecting personnel and property	
C. Occupational Hazards			
• Formation of emergency response teams for each department • Provision of first-aid kits and emergency equipment on critical areas • Regular supervision of production personnel especially on the operation of machinery • Training of personnel on proper equipment handling and other safety practices • Posting of safety reminders on critical areas and equipment	• Report immediately any accidents, especially those considered life threatening Immediate application of first-aid • Removal of the affected personnel on the accident site • Bring the affected personnel to the nearest first aid station or hospital if necessary • Report immediately to the management • Funds should be made available always	• Perform corrective measures on equipment and procedures • Provision of additional safety procedures, equipment, and training	

PREPARATION	RESPONSE	RECOVERY	Responsible Personnel
• Provision of safety features such as adequate lighting, guide rails, and safety signage			
E. Risk Associated By Natural Calamity such as Typhoon and Earthquake			
• In case of typhoon, listen to the radio, media on the update of the storm • Announcement to all workers and employees on the weather update • Conduct disaster prepared drill • Removal and relocation of important documents in the office • Distribution of safety gears, gadget and other emergency kits	• All personnel and administrative officers are advised not to panic to prevent further injuries. • Personnel are advised to protect themselves by getting under sturdy structures • Personnel are advised to stay away from sharp, flammable, or heavy items. • Personnel are advised to prepare immediate evacuation of the facility if necessary	• Avoid returning to the facility if it is deemed structurally unstable, or declared unsafe • Secure important items and equipment from unauthorized access from outsiders, after the building is declared safe for re-entry	

SECTION 5. SOCIAL DEVELOPMENT PLAN/FRAMEWORK (SDP) AND IEC FRAMEWORK

5.1 Social development Program (SDP)

The framework herein presented is premised on community development or livelihood programs/activities, projected beneficiaries, partner institutions, timeframe of implementation as well as source and amount allotted per activity/component (**Based on Annex 2-18 of RPM for DAO 2003-03**)

FDC Misamis Power Corp (FDCMPC) conducted a 4-year Strategic Planning for the 4th Cycle of the Social Development and Management Program (SDMP) covering the years 2017-2020 over the active operations in ClaJaViTa municipalities (Claveria, Jasaan, Villanueva and Tagoloan). This is in compliance with the requirements of the Department of Energy under Energy Regulation 1-94 (ER 1-94) to ensure that the project proponent is doing its role to provide support to host communities.

The SDMP aims to contribute to the achievement of progress and prosperity under a sustainable framework of development and promote and enhance the living conditions of the inhabitants through the implementation of relevant company programs, projects, and activities in the host community (Tambobong, Bacalanas, San Martin) and neighboring barangays (Sta. Cruz, Mohon, Tagoloan Baluarte and San Martin), including the host Municipality of Villanueva and Tagoloan.

To aid in the conduct of this planning workshop, FDCMPC provides and delivers services through their own Corporate Social Responsibility (CSR) program.

The conduct of Social Development Programs is anchored on the CSR Framework for FDCMPC which has four (4) program categories: (1) Environmental Stewardship, (2) Economic Enhancement (3) Enhanced Health Care Initiatives, and Education for Empowerment, respectively.

Provided in **Table 5-1** is the list of all indicative and existing Social Development Projects of FDCMPC

Table 5-1 SDP Indicative and Existing Social Development Plan

PROGRAM CATEGORY	COMMUNITY NEEDS BEING ADDRESSED	SDP/CSR ACTIVITIES FOR IMPLEMENTATION	INDICATIVE TIMELINE/ REQUENCY
Environmental Steward	• Environmental Compliance as per ECC • Community Capacity for Resiliency on Emergency Disaster and Natural Calamities	• Buffer Zone Reforestration / Tree Growing at Site • Adopt-A-Waterbody Program • Carbon Sink Program (CSP) • Strengthening Capacity Development on Disaster Risk Reduction and Management (DRRM) • Coastal Clean-Up and Mangrove Planting	• At least 1 buffer zone program per semester • At least 1 DRRM training in a year • CSP as per ECC Compliance • DRRM capacity building at least 1 in a year • At least 1 Mangrove Planting Program in a year • At least 2 coastal cleanup in a year
Economic Enhancement	• Poverty Incidence Rate • Unemployment Rate	• Livelihood/Skills Training and Assistance Program • Rice Duck Egg Enterprise Development Program (RCEEDP)	• Update of employees hired locally • At least 1 training and assistance program • Continuation of the phase for RDCEEP • As needs arises

PROGRAM CATEGORY	COMMUNITY NEEDS BEING ADDRESSED	SDP/CSR ACTIVITIES FOR IMPLEMENTATION	INDICATIVE TIMELINE/ REQUENCY
		• Other Livehood / Kills Training Program	
Enhanced Health Services	• Malnutrition Rate • Capabilities of Barangay Health Workers (BHWs/Women) for Improved Health Services	• Feeding/Nutrition Supplemental Program • BHWs/wpmen's Capability Enhancement Program • Medical Missions • Blood Donation Program	• At least 1 Feeding/Nutrition Supplemental Program in a year • At least 1 BHW/Women's Capacity enhancement program in a year • At least 1 medical mission in a year • At least 1 blood donation program
Education for Empowerment	• Supplemental Reading Enhancement • National Achievement Test Result • XU-ALGCIT	• Tutorial to Grade School Pupils • Schools Infrastructure Improvement (SII) • Senior High School Preparation Support SHSPS (K-12 Program)	• A year round program in one Elem. School at least once a week tutorial activity • SSI during Brigada Eskwela at the 2nd Quarter of the year • SHSPS during Brigada Program at 2nd Quarter of the year • Assist in promoting XU-ALGCIT Program in the host communities
ER 1-94: Benefits to Host Communities	• The Generation Company and/or energy resource developer should set aside one centavo per kilowatt hour (P0.01/kWh) of the total electricity sales as financial benefits to host communities of such generation facility.	• Host communities were able to utilize ER 1-94 fund to support Covid-19 responses and interventions	•

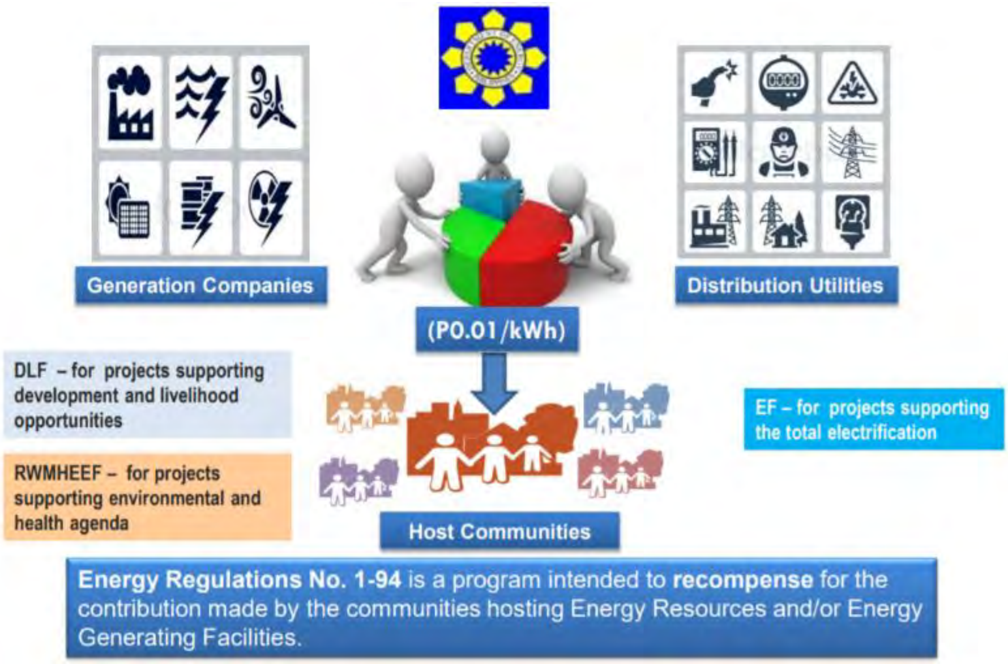
Since the current operation of the project already includes a comprehensive SDP as reported in the SMRs, e.g. in "Annex 10.2. 2020 SDP Implementation Report" the SDP for the expansion project will essentially be extension/improvements in the existing programs.

5.1.1 SDPs from ER I 94

Through the expansion project, additional benefits would be extended to the stakeholder via the implementation of the DOE Mandated ER 1-94. This is because the financial value is directly related to the capacity generation, i.e. kWh per year. Higher capacity results in higher generation and thus of higher financial values.

The framework of ER 1-94 is illustrated below.

The management of ER 1-94 is now with the LGUs. The above table shows the general initiatives of the LGU on this respect.



5.2 Information, Education and Communication (IEC)

IEC aims to educate and inform both the community and stakeholders that may be affected by the company's operation, which is in line with Philippine laws and regulations. It will help both the communities and the Proponent understand each other's perspective on the project and will assist in undertaking effective programs for the benefit of the communities.

Target sector, key messages, scheme/strategy/methods, Information medium, timelines and frequency, cost (See Annex 2-19 of RPM for DAO 2003-03).

The IEC programs of FDCMPC are already in place and operational for the existing project, as manifested in Annex G , the 3rd Quarter Self- Monitoring Report (SMR).

The expansion project will likewise continue the IEC programs, and enhancement initiatives.

Table 5-2 below shows the indicative and implemented IEC programs.

With respect to the projects implemented as well as the funds thereof, these are managed by DOE.

Table 5-2 Indicative and Implemented IEC Project Plan

Target Sector	Major Topic/s of concern in Relation to Project	IEC Scheme/ Strategy/ Method	Information Medium	Indicative Time/ Frequency	Indicative Cost
PRIMARY STAKEHOLDER:					
Directly impacted Families (Barangay Tambobong, Balacanas and San Martin) In Villanueva; and Barangays Sta. Cruz and Mohon in Tagoloan)	• IEC through SDP o Mangrove Rehabilitation Program o Marine Summer Camp for Sr. High School o Brigada Eskwela o The Duck-Egg Project o Fly Ash as a component to Hallow Blocks production	• Responsive Social Development Program • Interpersonal/Community Organizing Approach • *CSR & CRA visits for continuing information dissemination and gathering • Hosting of educational tours	• Flyers/fact sheets Information materials in local dialect • Project presentation/Group discussion in dialect • Tarpaulins, pull-up banners, fans and other materials • Community/home visits • IEC Caravan in all barangays • Audio Video Presentation	• Anchored on Socail Development Programs (SDP) Implementation • Important Community Celebrations/ Events • IEC Caravan at least once per semester • Based on request and as need arises	
SECONDARY STAKEHOLDER:					
A. LGU (Provincial, Municipal and Barangay Units) B. Sectoral Groups (NGOs, POs BHWs, Teachers, etc.) C. Concerned Agencies (DOE, DENR, DAR, DA, DSWD, DepEd, etc.)	• Information Campaign and awareness on FDC Company Profile, Technology and Environmental Measures to all SK officials the direct and indirect affected barangays of 2 host municipalities.	• Regular Coordination Meeting • One-on-one and group consultation meetings • Interpersonal/Community Organizing Approach • CSR & CRA visits for continuing information dissemination and gathering • Hosting of educational tours	• Update reports • Flyers/fact sheets information materials in local dialect • Project presentation/Group discussion • Community/home visits • Tarpaulins, pull-up banners, fans and other materials • Audio Video Presentation	• Quarterly and as the need arises (for municipal level) • Quarterly and as the need arises (for provincial level) • As the need arises (for cultural activities being sponsored)/ based on request	
TERTIARY STAKEHOLDERS:					
Co-locators, Business Organization, Media	• Climate change • Clean Air Act and Solid Waste Management	• Memberships to select organizations • Attendance to regular meetings • Participation/sponsorship in selected events and activities • Hosting of educational tours	• Flyers/fact sheets information materials in local dialect • Project presentation (as needed) • Group discussions • Tarpaulins and other materials • Audio Video Presentation	• Monthly (for co-locators) • Quarterly (for business groups) • As the need arises (for selected media events)/ based on request	

SECTION 6. ENVIRONMENTAL COMPLIANCE MONITORING (ECM)

6.1 Environmental Performance

General : FDCMP is committed to 100 % compliance with environmental laws and regulations.

6.1.1 Results of compliance monitoring in matrix and graphic forms. Trends in environmental conditions.

On Complaints Redress Mechanism (CRM), a vehicle for ventilating issues on environmental compliances, FDCMP has been employing a complaints redress mechanism based on the following :

Framework

Under its policy of effective but realistic social responsibility, FDCMP has instituted a redress mechanism. The intent is to allow legitimate complaints to be ventilated and for FDCMP to responsibly and transparently respond thereto.

Organizational Unit

Under the Office of the Plant Manager through the Community Relations designated personnel tasked with handling complaints.

Procedural Mechanics

1. Inform the Communities, stakeholders of the existence of this mechanism.

2. Receipt of complaints
   These are to be officially received by FDCMP-designated personnel or unit.

3. Validation of complaints
   The FDCMP in-charge personnel/unit will validate the complaints and categorize such, e.g. violation of ECC conditions?
   Related to Health and Safety? Related to employment?

4. Meeting will be held between FDCMP and Complainant and recording of such.

5. Negotiations and discussions for amicable and mutually acceptable resolution

6. Implementation of action for resolution

7. Quit Claim between the Parties

8. In case complaints are lodged with the EMB, DENR and other government agencies, FDCMP will not interfere with the actions of these Entities except to provide needed information relevant to the Complaint. It will, however, attempt to have any issues resolved expeditiously.

9. In case complaints are lodged to the MMT, FDCMP will defer to the MMT Organization for its independent resolution.

6.1.1.1 Compliances to various environmental quality standards:

The results of compliance monitoring for 2017-2018 based on Annex 2-20 of the Revised Procedural Manual and on the official SMRs are shown in **Tables** and the trends shown in graphic form in **Figures below.**

The referenced standards for the monitoring and the EQPL are shown in **Tables 6.1 and 6.2.**

Table 6-1A Guidelines on Ambient Water Quality Primary Guidelines (DAO 2016-08)

Parameter	Unit	Water Body Classification								
		AA	A	B	C	D	SA	SB	SC	SD
BOD	mg/L	1	3	5	7	15	n/a	n/a	n/a	n/a
Chloride	mg/L	250	250	250	350	400	n/a	n/a	n/a	n/a
Color	TCU	5	50	50	75	150	5	50	75	150
Dissolved Oxygen[a] (Minimum)	mg/L	5	5	5	5	2	6	6	5	2
Fecal Coliform	MPN/100r	<1.1	<1.1	100	200	400	<1.1	100	200	400
Nitrate as NO_3-N	mg/L	7	7	7	7	15	10	10	10	15
pH (Range)		6.5 - 8.5	6.5 - 8.5	6.5 - 8.5	6.5 - 9.0	6.0 - 9.0	7.0 - 8.5	7.0 - 8.5	6.5 - 8.5	6.0 - 9.0
Temperature [b]	mg/L	<0.003	0.5	0.5	0.5	5	0.1	0.5	0.5	5
Total Suspended Solids	°C	26 - 30	26 - 30	26 - 30	25 - 32	25 - 32	26 - 30	26 - 30	25 - 31	25 - 32
Note:	mg/L	25	50	65	80	110	25	50	80	110

MPN/Q00mL - Most Probable Number per 100 milliliter
n/a - Not Applicable
TCU - True Color Unit
[a] Samples shall be aken from 9:00 AM to 4:oo PM.
[b] The natural background temperature as determined by EMB shall prevail if the temperature is lower or higher than the WQG; provided that the maximum increase is only up to 10 percent and that it will not cause any risk to human health and the environment.

Table 6-1B Water Quality Guidelines for Secondary Parameters

Water Quality Guideline for Secondary Parameters-Inorganics

Parameter	Unit	Water Body Classification								
		AA	A	B	C	D	SA	SB	SC	SD
Ammonia as NH_3-N	mg/L	0.05	0.05	0.05	0.05	0.75	0.04	0.05	0.05	0.75
Boron	mg/L	0.5	0.5	0.5	0.75	3	0.5	0.5	5	20
Flouride	mg/L	1	1	1	1	2	1.5	1.5	1.5	3
Selenium	mg/L	0.01	0.01	0.01	0.02	0.04	0.01	0.01	0.1	0.2
Surfate	mg/L	250	250	250	275	500	250	250	275	500

Water Quality Guideline for Secondary Parameters-Metals

Parameter	Unit	Water Body Classification								
		AA	A	B	C	D	SA	SB	SC	SD
Arsenic	mg/L	0.01	0.01	0.01	0.02	0.04	0.01	0.01	0.02	0.04
Barium	mg/L	0.7	0.7	0.7	3	4	0.7	0.7	1	4
Cadmium	mg/L	0.003	0.003	0.003	0.005	0.01	0.003	0.003	0.005	0.01
Chromium as Hexavalent Chromium	mg/L	0.01	0.01	0.01	0.01	0.02	0.05	0.05	0.05	0.1
Copper as Dissolved copper	mg/L	0.02	0.02	0.02	0.02	0.04	0.02	0.02	0.02	0.04
Iron	mg/L	1	1	1	1.5	7.5	1.5	1.5	1.5	7.5
Lead	mg/L	0.01	0.01	0.01	0.05	0.1	0.01	0.01	0.05	0.1
Manganese	mg/L	0.2	0.2	0.2	0.2	2	0.4	0.4	0.4	4
Mercury	mg/L	0.001	0.001	0.001	0.002	0.004	0.001	0.001	0.002	0.004
Nickel	mg/L	0.02	0.02	0.04	0.2	1	0.02	0.04	0.06	0.3
Zinc	mg/L	2	2	2	2	4	0.04	0.05	0.8	1.5

Note:
(c) Unless otherwise specified, the above parameters are expressed as total metals.

For National Ambient Air Quality Standards for Source Specific Air Pollutants from Industrial Sources/Operations:

Table 6-2 Ambient Air Quality Guidelines (Phil Clean Air Act)

Pollutants[1]	Concentration[2]		Averaging time (min.)	Method of Analysis/ Measurement[3]
	µg/NCM	ppm		
1. Ammonia	200	0.28	30	Nesselerization/Indo Phenol
2. Carbon Disulfide	30	0.01	30	Tischer Method
3. Chloride and Chlorine compounds expressed as Cl_2	100	0.03	5	Methyl Orange
4. Formaldehyde	50	0.04	30	Chromotopic acid Method of MBTH Colorimetric Method
5. Hydrogen Chloride	200	0.13	30	Volhard Titration with iodine Solution
6. Hydrogen Sulfide	100	0.07	30	Methylene Blue
7. Lead	20		30	AAS
8. Nitrogen Dioxide	375	0.2	30	Greiss-Saltzman
	260	0.14	60	
9. Phenol	100	0.03	30	4-Aminoantiphyrine
10. Sulfur Dioxide	470	0.18	30	Colorimetric-
	340	0.13	60	Pararosaniline
11. Suspended Particulate	300	-	60	Gravimetric
12. Matter - TSP - PM10	200	-	60	do

[1] Pertinent ambient standards for Antimony, Arsenic, Cadmium, Asbestos, Nitric Acid and Sulfuric Acid Mists in the 1978 NPCC Rules and Regulations may be considered as guides in determining compliance

[2] Ninety-eight percentile (98%) values of 30-minute sampling measured at 25°C and one atmosphere pressure.

[3] Other equivalent methods approved by the Department may be used.

6.1.1.2 Trends in environmental conditions

In general terms:

From the start of the plant operations (for 3 x 135 MW Power Plant) to current, the environmental performances have remained compliant with regulations and applicable standards. These are reflected in:

- ✓ The SMRs/CMVRs
- ✓ Absence of legitimate major complaints
- ✓ The absence of NOVs
- ✓ Compliances with the MMT

FDCMP is compliant with all MMT requirements including provision of EMF and EGF.

It is thus concluded that the environmental performance has been acceptable over the period starting from start of plant operations to present. Additionally as a lessee to the PHIVIDEC industrial estate it is also incumbent on the Proponent to comply with environmental laws which compliance and performance the Proponent has complied with faithfully.

The above general statements are further supported by “snapshots” of the monitoring activities based on SMRs and CMRs provided hereunder.

On the AMBIENT AIR RESOURCES

The important environmental performance is reckoned from the **ambient** air and noise trends and deemed more relevant than the stack emissions from the Air Pollution Source Equipment (APSEs), although the latter also provide useful information. This is because the ESRs (Environmentally Sensitive Receptors) are located at the ambient locations, e.g. at communities and population centers.

The SMRs from 2016 to 2020 are hereunder summarized.

From these summaries it is evident that the key parameters PM10, SOx, NOx, and CO are complied with.

Exceedances were observed with respect to TSP. These are deemed of secondary significance because:

(a) TSPs are contributed largely by fugitive dusts from the soil/land and not from the power plant emissions. Additionally, there were earthmoving activities and construction at the site in the last quarter of 2016.

(b) PM10 and not TSP is the more relevant parameter accepted internationally on the basis that the finer particles PM10 have more direct impact on human health.

(c) Moreover, there were earthmoving activities and construction at site contributing to fugitive dusts (TSP) generation. These activities were short term in tenure until the last quarter of 2016 when commercial operation thenced commenced.

Trends of Ambient Air Quality Performance for the last 5 years is shown below.

Table 6-3. Trends of Ambient Air Quality for the last 5 years

Location of Monitoring Station	TSP					PM-10 (µg/Ncm)						No_x (µg/Ncm)					So_x (µg/Ncm)					CO (µg/Ncm)				
	2016	2017	2018	2019	2020	2016	2017	2018	2019	2020	R Stand	2016	2017	2018	2019	2020	2016	2017	2018	2019	2020	2016	2017	2018	2019	2020
DENR Standard	230					150						150					180					10				
Brgy. San Martin, Villanueva Misamis Oriental	524						25		31	30	150	0.002	23		6	0.9	4	4		4.4	4		1	1	1	1
Brgy. Sta.Cruz, Tagoloan Misamis Oriental							25	28	36	24	150		0.4	2.80	7	0.5		4	4	5	4		1	1	1	1
Zone 6A Brgy. Baluarte, Togoloan Misamis Oriental							35	50	51	21	150		0.4	2.90	5	0.4		4	4	7	4		1	1	1	1
Jetty Area near Transfer Tower 1	459						21	19	33	26	150	0.002	0.4	2.00	4.3	0.5	4	4	2	7	4		1	1	1	1
Ash Yard South Side	443						24	41	42	12	150	0.002	0.4	0.40	2.5	0.4	4	4	4	7	4		1	1	1	1
Balacanas Elementary School, Villanueva Misamis Oriental							16	25	42	20	150		21	2.00	5	0.4		4	2	4.5	4		1	1	1	1

Table 6-4. Trends of the Results of Noise Levels Monitoring for the last 5 years

Location of Monitoring Station	Morning					Daytime					Evening					Nighttime				
	2016	2017	2018	2019	2020	2016	2017	2018	2019	2020	2016	2017	2018	2019	2020	2016	2017	2018	2019	2020
DENR Standard	70					75					70					65				
Jetty Area near Transfer Tower 1	55	54	59	59	54	53	53	58	58	49	55	54	59	59	53	49	52	60	60	59
Ash Yard South Side	52	46	51	51	50	59	47	49	49	47	64	46	50	50	50	53	45	48	48	49
Balacas Elementary School, Villanueva Misamis Oriental	50	57	52	52	47	60	60	53	53	49	56	55	49	49	45	51	41	41	41	41
Brgy. San Martin, Villanueva Misamis Oriental	49	48	41	41	44	59	48	58	58	47	53	47	51	51	47	48	48	42	42	44
Brgy. Sta.Cruz, Tagoloan Misamis Oriental		48	49	49	49		48	51	51	46		45	50	50	47		46	42	42	41
Zone 6A Brgy. Baluarte, Togoloan Misamis Oriental		53	56	56	55		55	54	54	50		50	52	52	50		47	42	42	45

Figure 6-1. Trends for Air Quality for the last 5 years

Ambient Noise Level Monitoring

The trends for ambient noise (sound levels) are provided in the graphs below. Compliances with the DENR standards are evident from these graphs. It also noted that ambient noise levels are deemed as of secondary significance because of the distance from the project to the population centers.

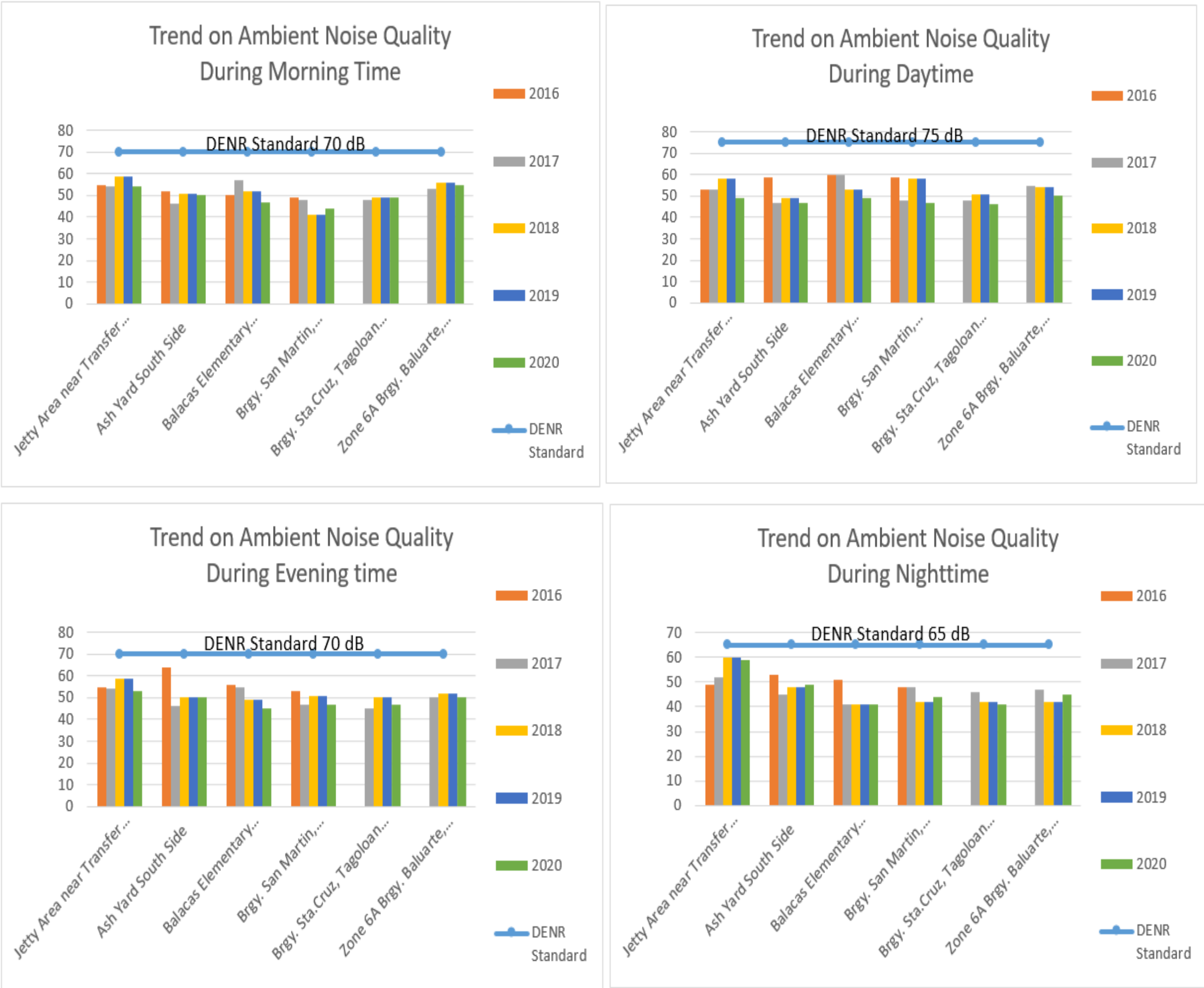


Figure 6-2 Trends in Noise Levels for the last 5 years

Figure 6-3. The Sampling Stations for Ambient Air and Noise Monitoring

Additional parameters and sampling stations based on the results of the impact assessment.

It is deemed that **no** additional parameters and sampling stations are needed based on the impact assessments thus far undertaken which show general compliances with standards prescribed in the Clean Water and Clean Air Acts.

ON GROUND WATER

Strictly, ground water is not relatively a significant surface water resource because:

(a) There are no activities such as water abstraction that involve ground water
(b) Thus ground water is not used for critical services such as for domestic purposes and
(c) The only potential contamination of ground water may be occasioned by seepage of leachates from the ash pond.

Nevertheless, ground water monitoring works have been conducted as part of the SMR and MMT reports. Below are results for the last 4 years (2017-2020) which was reported in the SMR.

Table 6-5. Trends on the Results of Ground water Quality Monitoring for the last 4 years

Location of Monitoring Station	pH				Temperature (°C)				Color (TCU)				TSS (mg/L)			
	2017	2018	2019	2020	2017	2018	2019	2020	2017	2018	2019	2020	2017	2018	2019	2020
DENR Standard	6.5 - 8.5				26 - 30				50				65			
Ash Yard 1 N -8181447.245441; E 11793422.205953	0.00			6.90	0.00			32.00	0.00			5.00	0.00			65.00
Ash yard 2 N -8181787.993760; E 11792130.886342	7.30	7.20	7.00	6.80	23.07	31.00	32.00	32.00	5.00	5.00	5.00	5.00	62.00	272.00	420.00	8.00
Ash yard 3 N -8181509.213071; E 11792766.605580	7.50	7.40	7.40	7.30	12.53	30.00	31.00	31.00	4.00	5.00	5.00	5.00	10.00	21.00	26.00	109.00
Ash yard 4 N -8181867.558214; E 11793454.082825	7.83	7.50	7.80	7.20	30.67	30.00	32.00	30.00	5.00	5.00	5.00	5.00	62.00	11.00	59.00	62.00
Ash yard 5 N -8181867.558212; E 11793454.082823	7.30	7.00	7.30	7.10	30.00	30.00	31.00	31.00	6.67	5.00	5.00	5.00	200.67	227.00	1252.00	18.00
Ash Yard 6 N -8181867.558214; E 11793454.082825	7.07	7.60	7.30	7.10	31.67	32.00	32.00	31.00	11.67	10.00	5.00	5.00	24.33	18.00	12.00	15.00

Location of Monitoring Station	Chorides, Cl (mg/L)				Nitrate, No_3 (mg/L)				Phosphates, PO_4^3 (mg/L)				Fecal Coliform (MPN/100mL)			
	2017	2018	2019	2020	2017	2018	2019	2020	2017	2018	2019	2020	2017	2018	2019	2020
DENR Standard	250				7				0.5				100			
Ash Yard 1 N -8181447.245441; E 11793422.205953	0.00			17.00	0.00			0.09	0.00			0.05	0.00			1.80
Ash yard 2 N -8181787.993760; E 11792130.886342	23.00	35.00	8.20	18.50	0.09	0.41	0.33	0.01	0.02	0.12	0.02	0.05	136.50	33.00	17.00	12.00
Ash yard 3 N -8181509.213071; E 11792766.605580	18.67	45.00	15.00	18.00	0.33	0.16	0.42	1.20	0.02	0.05	0.01	0.03	191.50	49.00	24.00	34.00
Ash yard 4 N -8181867.558214; E 11793454.082825	28.00	30.00	9.20	22.00	0.12	0.43	0.42	0.04	0.07	0.02	0.01	0.06	445.00	350.00	79.00	48.00
Ash yard 5 N -8181867.558212; E 11793454.082823	18.67	25.00	132.40	11.00	0.22	0.11	0.40	0.07	0.22	0.03	0.09	0.06	484.50	79.00	350.00	22.00
Ash Yard 6 N -8181867.558214; E 11793454.082825	21.00	48.00	19.70	68.00	0.14	0.16	0.32	0.01	0.12	0.03	0.01	0.08	181.50	350.00	2.00	17.00

Source: FDCMPC SMR 2016 to 2019

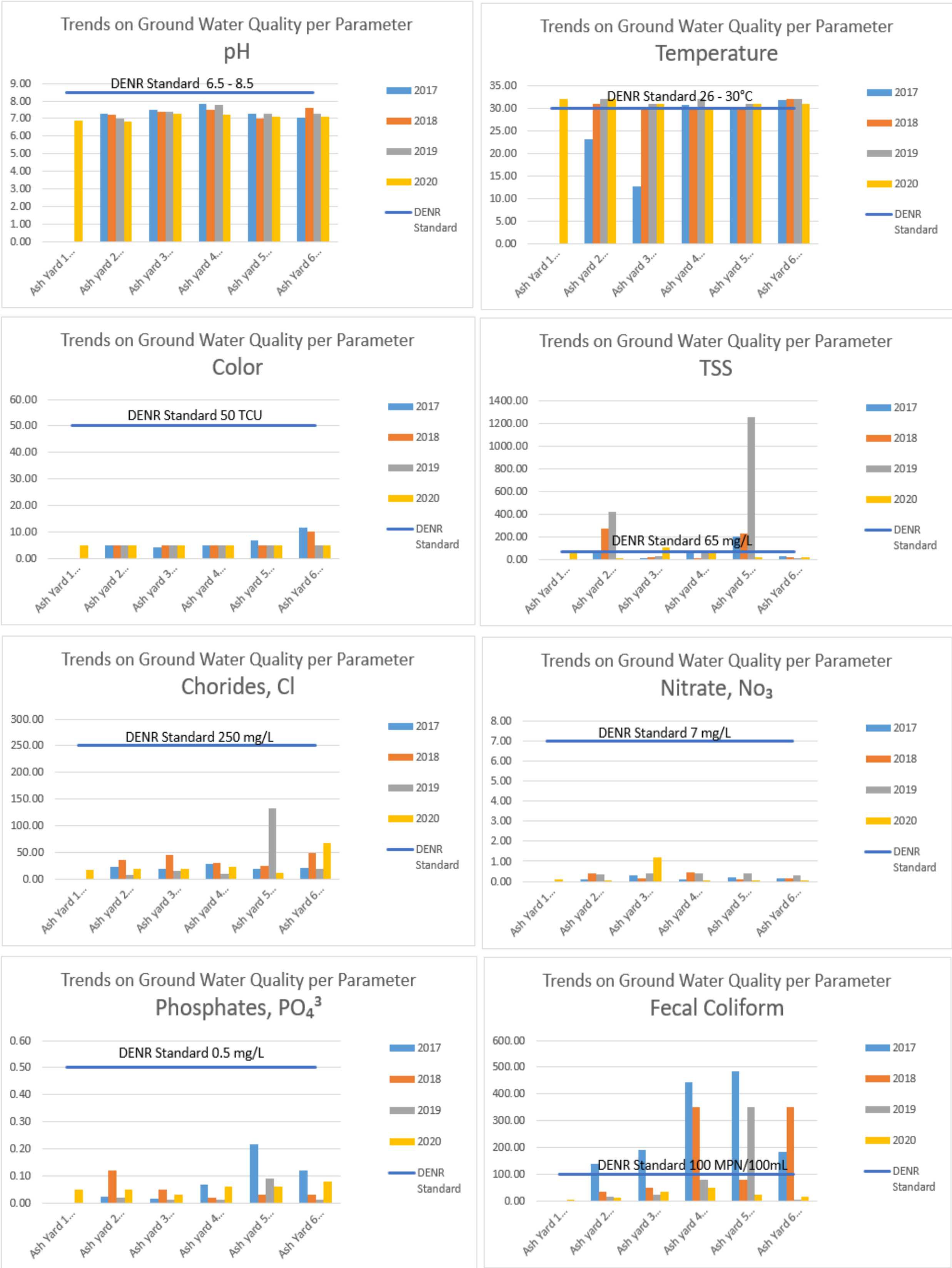


Figure 6-4 Trends in Ground Water Quality

Figure 6-5. Map of Sampling Stations for Ground Water Monitoring

The most recent monitoring works are deemed more significant than the trend over the years because if indeed there could have been contamination this would be reflected in the current monitoring results noting that the underground water is not treated for contamination. The isolated exceedances in TSS are deemed not significant because (a) even if used for drinking purposes (which is not the case) TSS is not a priority parameter per ADMINISTRATIVE ORDER No. 2007-0012 the PNS for Drinking Water (b) The Groundwater Quality Guidelines under DAO 2016-08 are for beneficial uses such as for domestic, recreational, agriculture and fishing purposes which are not applicable to the Project. Although Tagoloan River is used for fishing purposes, The TSS reported in Table 6-6 for Tagoloan River is contributed to by discharges from surface run offs from other sources than the Project.

Table 6-6. Monitoring Results of Ambient Water Quality (Tagoloan River) for the last 4 years

Location of Monitoring Station	pH					Temperature (°C)					BOD (mg/L)					TSS (mg/L)					Color (TCU)				
	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021
DENR Standard	6.5 - 8.5					26 - 30					5					65					50				
Tagoloan River Upstream N -8181867.558214; E 11793454.082825	7.7	8.5	8.3	7.9	7.9	29	28	27	28	28	2	2	2	1	2	47	64	241	160	152	5	5	10	10	10
Tagoloan River Downstream N -8181600.634597; E 11794107.006988	7.90	7.7	7.7	7.8	7.8	29	30.00	30	28	28	3	2	1	1	1	333	44	264	170	165	5	5	10	10	10

Location of Monitoring Station	Dissolved Oxygen (mg/L)					Chorides, Cl (mg/L)					Nitrate, No$_3$ (mg/L)					Phosphates, PO$_4^3$ (mg/L)					Fecal Coliform (MPN/100mL)				
	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021
DENR Standard	5					250					7					0.5					100				
Tagoloan River Upstream N -8181867.558214; E 11793454.082825	6	9	8	6	8	11	12	5.2	19	4.5	0.5	0.25	0.61	0.38	0.36	0.12	0.17	0.29	0.11	0.06	35	350	2.4	39	430
Tagoloan River Downstream N -8181600.634597; E 11794107.006988	5	9	9	9	7	3	10	4.7	20	3.5	0.5	0.19	0.62	0.33	0.21	0.08	0.1	0.28	0.13	0.06	35	23	180	180	84

Source: FDCMPC SMR Q1 to Q4 2019

Table 6-7. Monitoring Results for Ambient Water Quality (Macajalar Bay) for the last 4 years

Location of Monitoring Station	pH					Temperature (°C)					COD (mg/L)					TSS (mg/L)					Color (TCU)				
	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021
DENR Standard	6.0 - 9.0					25 - 31					200					100					150				
Macajalar Bay Station No. 1 N -8180612.503774; E 11795600.759068	6.9	8.2	8.6	7.8	7.4	31	30	31	28	27	119	147	70	266	245	13	22	8	42	49	2	5	5	5	10
Macajalar Bay Station No. 2 N -8180612.503774; E 11795600.759068	7.2	8.2	8.7	7.8	7.1	30	30	31	28	26	179	98	140	231	200	13	18	10	45	51	2	5	5	5	5
Macajalar Bay Station No. 3 N -8180612.503774; E 11795600.759068	7.2	8.1	8.2	7.6	7.1	30	30	26	28	26	167	108	72	236	80	8	20	66	52	68	2	5	5	5	10
Macajalar Bay Station No. 4 N -8180980.633559; E 11796204.985285	7.3	7.7	8.5	7.6	6.9	29	30	30	29	25	144	157	120	295	320	11	16	10	40	62	2	5	5	5	5

Location of Monitoring Station	Dissolved Oxygen (mg/L)					Nitrate, No_3 (mg/L)					Phosphates, PO_4^{3} (mg/L)					Fecal Coliform (MPN/100mL)				
	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021
DENR Standard	NA					20					1					400				
Macajalar Bay Station No. 1 N -8180612.503774; E 11795600.759068	5	8	9	8	6			0.45	0.13	0.28	0.18	0.07	0.02	0.06	0.07	350	7.8	23	1600	39
Macajalar Bay Station No. 2 N -8180612.503774; E 11795600.759068	5	7	8	8	8	0.19	0.11	0.21	0.12	0.3	0.03	0.01	0.01	0.06	0.07	170	2	23	24	540
Macajalar Bay Station No. 3 N -8180612.503774; E 11795600.759068	5	8	8	8	7	0.15	0.1	0.18	0.13	0.29	0.01	0.02	0.01	0.08	0.06	110	1.8	21	24	39
Macajalar Bay Station No. 4 N -8180980.633559; E 11796204.985285	5	8	8	8	7	0.12	0.1	0.32	0.08	0.31	0.01	0.02	0.01	0.04	0.08	35	4.5	12	39	13

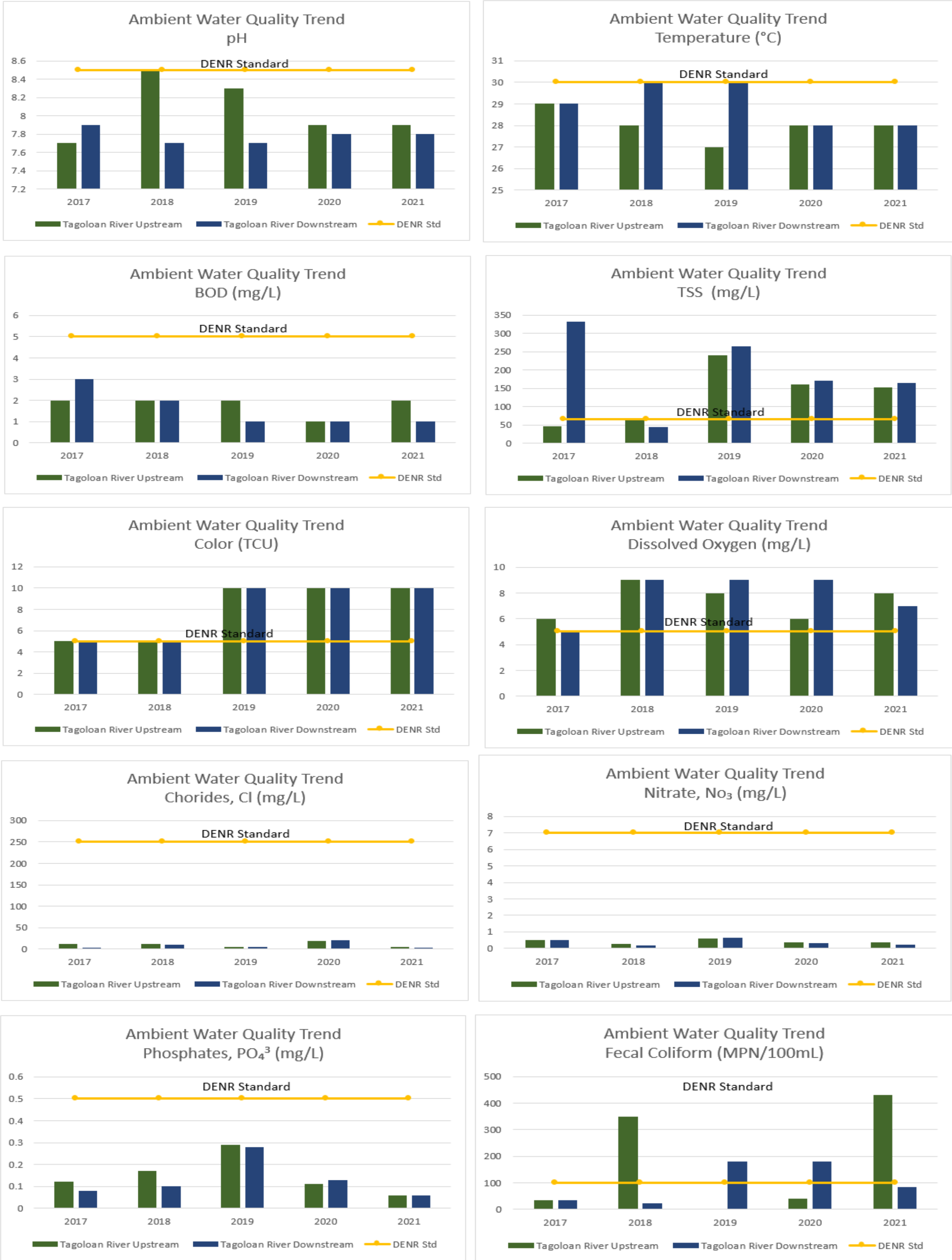


Figure 6-6. Trend of Ambient Water Quality Monitoring at Tagoloan River for the past 4 years up to Q1 of 2021.

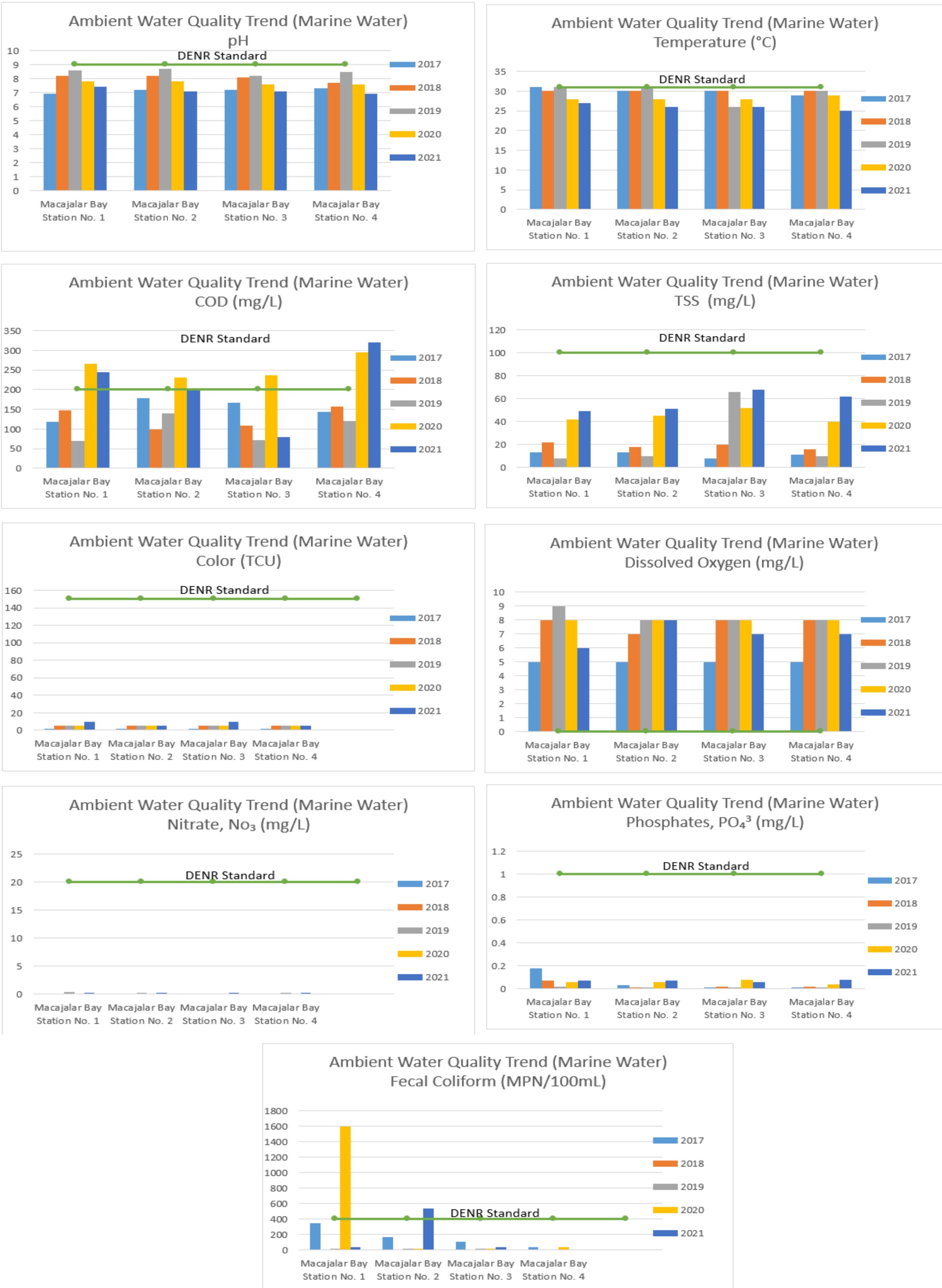


Figure 6-7. **Trend of Ambient Water Quality Monitoring at Macajalar for the past 4 years up to Q1 of 2021.**

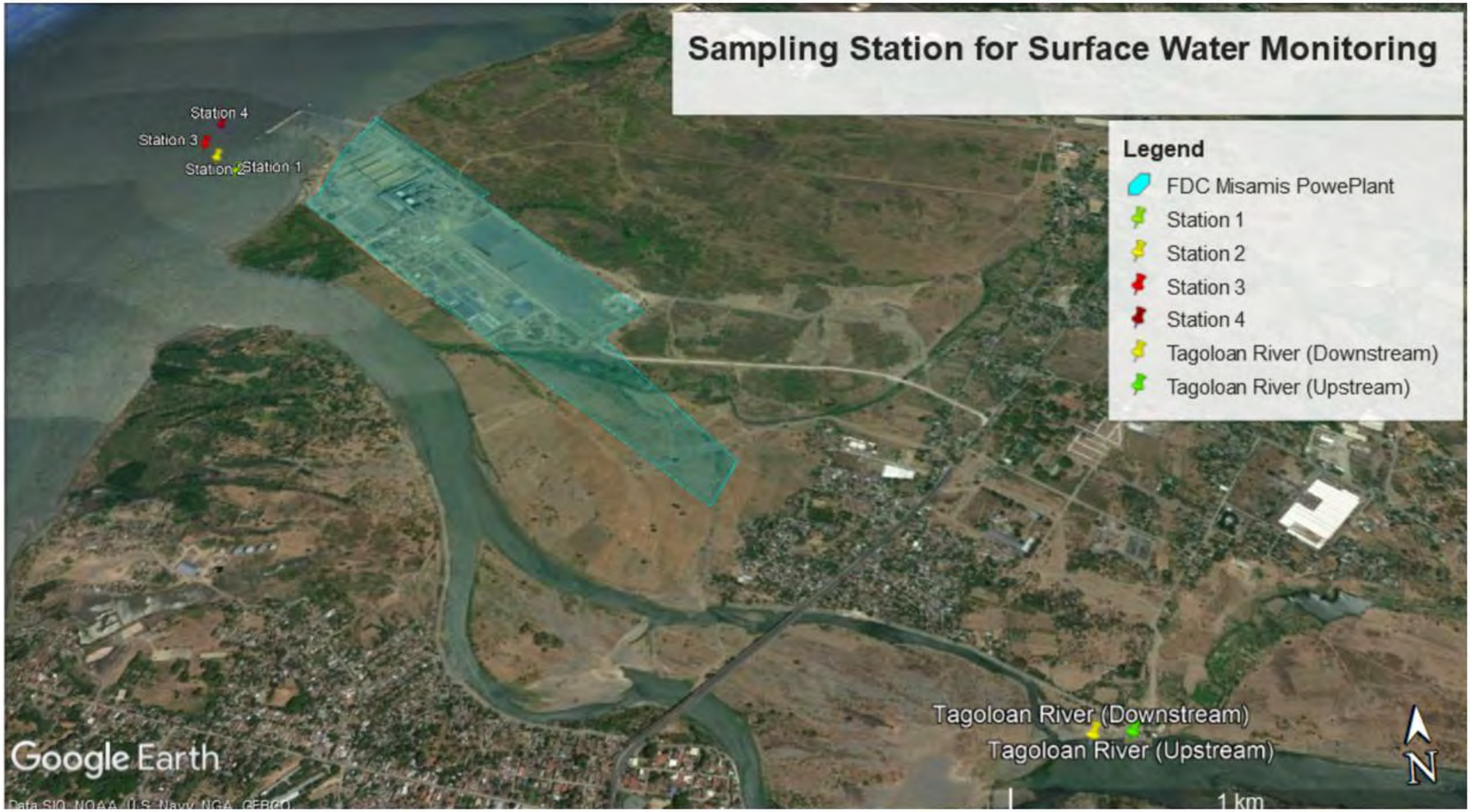


Figure 6-8. Map of Sampling Stations for Surface Water Monitoring (Tagoloan River and Macajalar Bay)

ON LAND RESOURCES

The trends in environmental conditions on the land resources are deemed appropriately reflected in (a) changes in landform/topography (b) terrestrial (faunal) ecology and (c) soil quality. It is noted, however, that these parameters are not included in the SMRs; hence trending analysis is limited,

Changes in landform/topography

The changes reckoned from the start of the original power plant to the present are deemed of secondary importance because (a) The land for the project is essentially flat in topography (b) The expansion project will be located at the same site as the original project and moreover, (c) there will be no significant construction activities that would alter the landform/topography. The access roads are located in flat terrains.

Changes in soil fertility

Although there have not been monitoring of the quality of soil vis-à-vis fertility, the fertility parameters are deemed of secondary importance only because (a) the project site is not intended for agricultural or other purposes for which fertility is a significant aspect. (b) the site is within the PHIVIDEC Estate which is basically intended for industrial purposes.

Changes in terrestrial (flora and fauna) ecology

The Project Proponent has not undertaken the monitoring of the faunal ecology and neither is such monitoring required by the MMT. From the start of construction in 2003? of the original project through the present, major land-based activities have been undertaken. As a result of these already completed activities, principally the land clearing and construction works, the site has been rendered already developed. No major disturbances of the terrestrial ecology would therefore result. The current conditions reflecting the terrestrial communities would serve as the baseline for the expansion project.

Plates xxx through xxx show the photographs of the existing site conditions relative to the floral and faunal resources.

The current baselines are characterized as follows:

Key floral species at the project site

Species	Classification
Ipil-ipil	
Mansanitas / Aratilis	
Gemelina	

On “People” Resources

Economic Benefits

Funds provided ER 1 – 94

Employment provided by the Project

Major SDP Programmes

The economic benefits above listed from the original and expansion projects are “enhancement” and not adverse impacts.

6.1.2 Performance based on the Environmental Quality Performance Levels (EQPLs)

Below is the definition of EQPL-Environmental Quality Performance Level:

- **Alert or Red Flag** : Early warning
- **Action Level** : Point where management measures must be employed so as not to reach the regulated threshold or limit level, or to reduce deterioration of affected environmental component to pre-impact or optimum environmental quality
- **Limit Level** : Regulated threshold of pollutant (standard that must not be exceeded); point where emergency response measures must be employed to reduce pollutants to lower than standard limit.

Table 6-8. Summary of the ENVIRONMENTAL MONITORING PLAN (EMoP) with ENVIRONMENTAL QUALITY PERFORMANCE LEVELS (EQPLs)

Key Environmental Aspects per Project Phase Activities	Potential Impacts Per Environmental Sector	Parameter 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
I. PRE-CONSTRUCTION PHASE - Activities undertaken and being undertaken at the project sites are confined to survey works and non-destructive tests and thus do not impact in any way to the above environmental resources													
PEOPLE													
Determination of settlers and/or properties that may be affected will be made during this phase		Not Applicable											
II. CONSTRUCTION PHASE													
LAND													
Land Clearing Removal of vegetative and forest cover in the area	Loss of vegetation	Trees and vegetation	**TREE INVENTORY BY THE CENRO, IF NECESSARY**					30% reduction in the abundance and diversity index based on baseline data		70% reduction in the abundance and diversity index based on baseline data	Provide artificial nesting areas for avifaunal species and monitor quarterly. Conduct IEC activities on significance of biodiversity to stakeholders		Temporary stoppage until corrections made

Key Environmental Aspects per Project Phase Activities	Potential Impacts Per Environmental Sector	Parameter 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
	Soil disturbance	Volume of excavation	Grab sampling	Quarterly monitoring upon the start of plant construction	At the construction site	Project Proponent / Contractor	Part of lump sum construction costs	Detection of noticeable soil erosion in active construction sites			Investigate and report the areas with increased occurrence of soil erosion. Identify the cause of soil erosion and improve control measures		Temporary stoppage until corrections made
WATER													
Land Clearing and Earth-Moving Activities	Increase in siltation/sedimentation in loading coastal waters	TSS	Solid Methods	During rainy days/ wet season	Bay fronting construction works	Project Proponent / Contractor	Part of lump sum construction costs	70 mg/L	80 mg/L		Inspection of activities Identify the cause of siltation and improve control measures	Temporary stoppage until corrections made	
AMBIENT AIR QUALITY													
During road construction, heavy equipment and vehicles will be used to transport construction materials	Potential Impacts on Air Quality	TSP	Graseby High Volume Sampler	Quarterly	Project site and baseline stations	Project Proponent	Php 400,000 @ Php 100,000 per quarter and 1 and 24-hour sampling	100 µg/Ncm^3	120 µg/Ncm^3	150 µg/Ncm^3	Review the protocol	Inspection of activities Proponent to address the issue	Temporary stoppage until corrections made
During road construction, heavy	Potential Impacts on Air Quality	Sulfur Dioxide	Gas Bubbler Sampler	Quarterly	Project site and baseline stations	Project Proponent		50 µg/Ncm^3	70 µg/Ncm^3	100 µg/Ncm^3	Review the protocol	Inspection of activities Proponent	Temporary stoppage until

Key Environmental Aspects per Project Phase Activities	Potential Impacts Per Environmental Sector	Parameter 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
equipment and vehicles will be used to transport construction materials												to address the issue	corrections made
During road construction, heavy equipment and vehicles will be used to transport construction materials	Potential Impacts on Air Quality	Nitrogen Oxide	Gas Bubbler Sampler	Quarterly	Project site and baseline stations	Project Proponent		30 µg/Ncm^3	70 µg/Ncm^3	100 µg/Ncm^3	Review the protocol	Inspection of activities Proponent to address the issue	Temporary stoppage until corrections made
During road construction, heavy equipment and vehicles will be used to transport construction materials	Potential Impacts on Air Quality	PM10	Hi-Vol Sampler w/ PM-10 separator	Quarterly	Project site and baseline stations	Project Proponent		40 µg/Ncm^3	60 µg/Ncm^3	100 µg/Ncm^3	Review the protocol	Inspection of activities Proponent to address the issue	Temporary stoppage until corrections made
During road construction, heavy equipment and vehicles will be used to transport	Potential Impacts on Air Quality	TSP PM10 SOx NOx Hg Pb Cr	Non-dispersive Infra-red Spectrophotom e Try	Quarterly	Project site and baseline stations	Project Proponent		TSP – 200 µg/Ncm^3 PM10 - 100 µg/Ncm^3 SO^2 – 150 µg/Ncm^3	TSP – 220 µg/Ncm^3 PM10 - 125 µg/Ncm^3 SO^2 – 165 µg/Ncm^3	As per DENR National Ambient Air GuidelineV alues (NAAGV) Limit	Review the protocol	Inspection of activities Proponent to address the issue	Temporary stoppage until corrections made

Key Environmental Aspects per Project Phase Activities	Potential Impacts Per Environmental Sector	Parameter 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
construction materials								NO^2 – 100 µg/Ncm^3 Pb – 10 µg/Ncm^3	NO^2 – 125 µg/Ncm^3 Pb – 15 µg/Ncm^3	TSP – 230 µg/Ncm^3 PM10 – 1250 µg/Ncm^3 SO^2 – 180 µg/Ncm^3 NO^2 – 150 µg/Ncm^3 Pb – 20 µg/Ncm^3			
During road construction, heavy equipment and vehicles will be used to transport construction materials	Potential Impacts on Air Quality	Noise Generation	Digital Noise Meter – Extech Instruments	Quarterly	Project site and baseline stations	Project Proponent		**Daytime:** 63 dB **Morning/Evening:** 59 dB **Nighttime:** 54 dB	**Daytime:** 67 dB **Morning/Evening:** 62 dB **Nighttime:** 57 dB	**Daytime:** 70 dB **Morning/Evening:** 65 dB **Nighttime:** 60 dB	Review the protocol	Inspection of activities Proponent to address the issue	Temporary stoppage until corrections made
PEOPLE													

Key Environmental Aspects per Project Phase Activities	Potential Impacts Per Environmental Sector	Parameter 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
Employment and Business Opportunities	In-Migration Attract Workers and Entrepreneurs from Adjacent Barangays and Municipalities Increased Business and Livelihood Opportunities Increase in indirect revenues	Number of employed	Record of contractors	Quarterly	At the Plant Site	Project Proponent	**N/A**	No regulatory requirements Based on internal company policy			Increase employability of local residents by undertaking construction skills training prior to job hiring.		
III. OPERATIONS PHASE													
LAND													
Ash Disposal	Soil Contamination	Metallics	Standard Spectrophotometry	Semi Annually	At test wells	PCO	Php 500 000	To be determined by the MMT. Presently no specific standards					
Earth/land spoils, domestic solid wastes and other solid materials.	Improper Waste and/or Garbage Disposal	Debris and scraps Domestic Waste / Garbage	Visual – RA 9003. Based on volume pick up by disposal firm	Weekly	All work areas	Project Contractor	Depending on the total waste generated	Regular waste / garbage collection Wastes are non-hazardous					
WATER MACAJALAR BAY													

Key Environmental Aspects per Project Phase Activities	Potential Impacts Per Environmental Sector	Parameter 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
Generation of Domestic Wastes and Sewage Waste water discharge	Improper management could tend to increase the BOD loading and coliform level of nearby waterbodies	pH TSS DO BOD Total Coliform	Glass Electrode Gravemimetric Azide Modification	Quarterly		Proponent	Php 500 000	**pH:** 6-2 – 8.6 **TSS:** Not more than 75 mg/L **DO:** 4.0.mg/L **BOD:** N.A. **Fecal Coliform:** >300 MPN	**pH:** 6-3 – 8.7 **TSS:** Not more than 80 mg/L **DO:** 4.5 mg/L **BOD:** N.A. **Fecal Coliform:** >375 MPN	**pH:** 6-0 – 8.5 **TSS:** Not more than 27 mg/L **DO:** 6 mg/L **BOD:** N.A. **Total Coliform:** 3500 MPN	Review the protocol	Inspection of activities Proponent to address the issue	Temporary stoppage until corrections made
Cooling Water Return to Macajalar Bay	Thermal rise at outfall	Temperature	Temp device	Monthly	Outfall	PCO	To be determined w the MMT	Will depend on presence or absence of marine species at outfall			Will depend on presence or absence of marine species at outfall		
Thermal and wastewater discharges	Jellyfish swarms	Temperature	Temp Device	Monthly	At Cooling Water Intake and Outlet	PCO	To be determined w the MMT	Installation of jellyfish screens and fish exclusion devices in intake pipe; Monitoring of abrupt jellyfish population increases.					
TAGOLOAN RIVER													

Key Environmental Aspects per Project Phase Activities	Potential Impacts Per Environmental Sector	Parameter 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
Generation of Domestic Wastes and Sewage Waste water discharge	Improper management could tend to increase the BOD loading and coliform level of nearby waterbodies	pH TSS DO BOD Total Coliform	Glass Electrode Gravemimetric Azide Modification	Quarterly		Proponent	Php 500 000	**pH:** 6-2 – 8.6 **TSS:** Not more than 50 mg/L **DO:** 5.5.mg/L **BOD:** N.A. **Fecal Coliform:** >300 MPN	**pH:** 6-3 – 8.7 **TSS:** Not more than 60 mg/L **DO:** 5 mg/L **BOD:** N.A. **Fecal Coliform:** >350 MPN				
Abstraction of underground water	Depletion of water resources / competition in water use Potential water resource completion with the adjacent residences.	TBD	TBD	Quarterly	Deepwell	Proponent	To be determined	To be established by the NWRB					
AMBIENT AIR QUALITY													
Combustion in CFB	Degradation of air quality	TSP	Graseby High Volume Sampler	Quarterly	Project site	Project Proponent	Part of the Php 1 M annually budget / semi-annual	100 μg/Ncm^3	120 μg/Ncm^3	150 μg/Ncm^3	Review the protocol	Inspection of activities Proponent to address the issue	Temporary stoppage until corrections made

Key Environmental Aspects per Project Phase Activities	Potential Impacts Per Environmental Sector	Parameter 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
Combustion in CFB	Degradation of air quality Quality	Sulfur Dioxide	Gas Bubbler Sampler	Quarterly	Project site	Project Proponent	Part of the Php 1 M annually budget / semi-annual	50 µg/Ncm³	70 µg/Ncm³	100 µg/Ncm³	Review the protocol	Inspection of activities Proponent to address the issue	Temporary stoppage until corrections made
Combustion in CFB	Degradation of air quality	Nitrogen Oxide	Gas Bubbler Sampler	Quarterly	Project site	Project Proponent	Part of the Php 1 M annually budget / semi-annual	30 µg/Ncm³	70 µg/Ncm³	100 µg/Ncm³	Review the protocol	Inspection of activities Proponent to address the issue	Temporary stoppage until corrections made
Combustion in CFB	Degradation of air quality	PM10	Hi-Vol Sampler w/ PM-10 separator	Quarterly	Project site	Project Proponent	Part of the Php 1 M annually budget / semi-annual	40 µg/Ncm³	60 µg/Ncm³	100 µg/Ncm³	Review the protocol	Inspection of activities Proponent to address the issue	Temporary stoppage until corrections made

Key Environmental Aspects per Project Phase Activities	**Potential Impacts Per Environmental Sector**	**Parameter 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**
Combustion in CFB	Degradation of air quality	TSP PM10 SO^2 NO^2 Hg Pb Cr	Non-dispersive Infra-red Spectrophotometry	Quarterly	Project site	Project Proponent	Part of the Php 1 M annually budget / semi-annual	TSP – 200 $\mu g/Ncm^3$ PM10 – 100 $\mu g/Ncm^3$ SOx – 150 $\mu g/Ncm^3$ NOx – 100 $\mu g/Ncm^3$ Pb – 10 $\mu g/Ncm^3$	TSP – 220 $\mu g/Ncm^3$ PM10 – 125 $\mu g/Ncm^3$ SOx – 165 $\mu g/Ncm^3$ NOx – 125 $\mu g/Ncm^3$ Pb – 15 $\mu g/Ncm^3$	As per DENR National Ambient Air GuidelineValues (NAAGV) Limit TSP – 230 $\mu g/Ncm^3$ PM10 – 1250 $\mu g/Ncm^3$ SO^2 – 180 $\mu g/Ncm^3$ NO^2 – 150 $\mu g/Ncm^3$ Pb – 20 $\mu g/Ncm^3$	Review the protocol	Inspection of activities Proponent to address the issue	Temporary stoppage until corrections made
Combustion in CFB	Degradation of air quality	Particulate Matter Carbon Monoxide SOx as SO2 NOX as NO2 Hg , As, Sb, Cd, Cu, Ni, Zn	Stacks Monitoring CEMS	Continuous	At Stacks	PCO	N A	**90% of stds Note 2**	**95 % of stds Note 2**	**100 % of stds Note 2**	Check Boiler for SOx ESP for PM	Adjust Boiler operation Adjust ESP	Temporary shutdown until corrected Temporary Shutdown

Key Environmental Aspects per Project Phase Activities	Potential Impacts Per Environmental Sector	Parameter 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
Combustion in CFB	Degradation of air quality	Particulate Matter Carbon Monoxide SOx as SO2 NOX as NO2 Hg , As, Sb, Cd, Cu, Ni, Zn	3rd Pasrty Monitoring	Quarterly Note 1	At designated points in stacks	PCO	Php 100 000	**90% of stds Note 2**	**95 % of stds Note 2**	**100 % of stds Note 2**	Check Boiler for SOx ESP for TSP	Adjust Boiler operation Adjust ESP operation	Temporary shutdown until corrected Temporary shutdown
Operation of Heavy Equipment	Increase of noise level	Noise Generation	Digital Noise Meter – Extech Instruments	Quarterly	Project site	Project Proponent	Part of the Php 1 M annually budget / semi-annual	**Daytime:** 63 dB **Morning/Evening:** 59 dB **Nighttime:** 54 dB	**Daytime:** 67 dB **Morning/Evening:** 62 dB **Nighttime:** 57 dB	**Daytime:** 70 dB **Morning/Evening:** 65 dB **Nighttime:** 60 dB	Review the protocol	Inspection of activities Proponent to address the issue	Temporary stoppage until corrections made
Generation of GHGs	Contribution in terms of greenhouse gas missions	CO2 emission in ghg per year	IPCC inventory method	Yearly	Project site	Project Proponent	TBD	No regulatory requirements					
PEOPLE													
Employment and business opportunities will attract workers and entrepreneurs from adjacent barangays and municipalities	In-migration	Number of employed	Record of contractors	Entire operation phase	N.A.	Plant Manager	N.A.	Employment and business opportunities will attract workers and entrepreneurs from adjacent barangays and municipalities.					

Key Environmental Aspects per Project Phase Activities	Potential Impacts Per Environmental Sector	Parameter 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
Various activities of workers	Safety and Health Risks	Number of Plant Accidents	Check Daily Safety Records	Weekly	N.A.	HSSE Manager	To be determined	One recorded plant accident			Evaluation of safety procedures		
Various activities of workers	Physical injuries arising from accidents such as being hit by falling weak structures, being overrun by heavy equipment may be considered as attendant to works	Number of Plant Accidents	Check Daily Safety Records	Weekly	N.A.	HSSE Manager	To be determined	One recorded plant accident			Evaluation of safety procedures		

Note 1 Methods Stack Monitoring:
Particulate Matter – US EPA Methods 1 to 5
Carbon Monoxide- USEPA Method 10
SOx as SO2:USEPA Method 6/8
NOX as NO2 : USEPA Method 7
Heavy Metals (Hg , As, Sb, Cd, Cu, Ni, Zn) ; USEPA Method 29

Continuous Emissions Monitoring Systems (CEMS)
PM: USEPA Performance Specification (PS-11)
CO: USEPA Performance Specification (PS-4)
"NOx as NO2" and "SOx as SO2". USEPA Performance Specification (PS-2)

Quarterly 3rd party monitoring adequate inasmuch as there is parallel CEMS monitoring

Note 2 Standards are per Section 19 of RA 8749

1.5 gm/NCM as SO_2
150 mg/NCM TSP
1,500 mg/NCM as NO_2
5 mg/NCM Hg
10 mg/NCM Pb

Additional Notes: The indicative cost is estimate only and will be firmed up with the MMT and the 3rd party service provider.
** Parameters for Air are regulated pollutants
** Similarly for Water, ultimately it will be the MMT that will specify the specific parameters to be included as well as the standards to use.
BOD stated as “Not Applicable” because there are no standards in DAO 2016-08 for marine waters

The key performance parameters are reckoned from the results of the SMRs and compared with the EQPLs for the operations phase and referred to the “Alert” and “Action” levels. By nature of its operations involving combustion of coal, Air is the relatively most important parameter and basis for performance levels. For the water resources the main discharges to the surface water body is circulating water which does not contain pollutants.

Table 6-9. Ambient Air Quality

AIR	DENR Standard	Alert	Action	Performance/Result from SMRs
TSP	**150 µg/Ncm**	**100 µg/Ncm**	**120 µg/Ncm**	**Exceedances observed attributed to fugitive dusts**
PM10	**150 µG/Ncm**	**40 µg/Ncm**	**60 µg/Ncm**	Excellent performance
NOx	**150 µg/Ncm**	**30 µg/Ncm**	**70 µg/Ncm**	Excellent performance
SOx	**180 µg/Ncm**	**50 µg/Ncm**	**70 µg/Ncm**	Excellent performance
CO	**10 µg/Ncm**	< 1 **µg/Ncm**		Excellent performance

CONCLUSIONS:

On the Ambient Air Resources, there were observed excellent performance except for episodes of exceedances on TSPs. These are however, attributed to fugitive dusts which are not emitted by the power plant.

On the Surface Water Resources : Tagoloan River

The results of compliance monitoring for 2017-2018 based on Annex 2-20 of the Revised Procedural Manual and on the official SMRs are shown in **Tables** and the trends shown in graphic form in **Figures** in the foregoing.

Macajalar Bay

Temperatures were recorded to be well within standards. These are key parameters because of discharge of cooling water return to the Bay at elevated temperature.

TSS values and Fecal Coliform were observed to exceed standards in certain isolated periods; however these are not attributable to the power plant but from various discharges from industries and the communities.

For Groundwater
The most recent monitoring works are deemed more significant than the trend over the years because if indeed there could have been contamination this would be reflected in the current monitoring results

noting that the underground water is not treated for contamination. The isolated exceedances in TSS are deemed not significant because:

1. Even if used for drinking purposes (which is not the case) TSS is not a priority parameter per ADMINISTRATIVE ORDER No. 2007- 0012 the PNS for Drinking Water

2. The Groundwater Quality Guidelines under DAO 2016-08 are for beneficial uses such as for domestic, recreational, agriculture and fishing purposes which are not applicable to the Project.

Although Tagoloan River is used for fishing purposes, TSS is not a major parameter affecting fish population. The TSS reported in **Table 6-7** for Tagoloan River is contributed to by discharges from surface run offs from other sources than the Project.

6.1.3 Compliance to ECC conditions and performance against the original approved Environmental Management and Monitoring Plan, MMT and third-party audits

Compliances to the ECC conditions are integral entries in the SMR reports and are discussed in the MMT meetings.

For the 4th Quarter, 2019, the compliances are shown in **Table 6-7.**

Table 6.10. Compliance Report for 2019

Condition/Rerquirement/ Commitment	COMPLIANCE STATUS & SUMMARY OF ACTION TAKEN	COMMITMENT FOR THE NEXT REPORTING PERIOD
Compliant with ECC	FDCMPC has complied with the ECC conditions required for the monitoring period	FDCMPC shall maintain its compliance status to its ECC conditions during its entire operational phase.
Compliance with EMP	FDCMPC has complied with approved EMP conditions required for this monitoring period	FDCMPC shall maintain its compliance status with EMP conditions during its entire operational phase
Complaints Management	There are two (2) pending legal issues concerning land disputes on the area where the transmission lines are erected	FDCMPC shall continue to monitor complaints during the reporting period
Realistic and sufficient budget for conducting the environmental monitoring and audit activities	MMT and EMF are established	FDC Misamis Power Corporation shall ensure that the Environmental Monitoring Fund is properly allocated.
Accountability – qualified personnel are charged with the routine monitoring of the project activities in terms of education, training, knowledge and experience of the environmental team	FDCMPC has established an Environmental Unit which comprises of the following personnel: HSSE Manager – Darwin Talusan PCO – Kristine Tiziana Janolino Environmental Assistant – Brenda M. Quinol	FDC Misamis Power Corporation has ensured accountability of its environmental compliance through its Environmental Unit.

6.1.4 Implementation of appropriate and effective environmental impact remedial actions in case of exceedances

***Table 6-11. Cases of exceedances are isolated and short term*.**

Item	Date	Exceedance	Remedial Actions
`1	Feb 14, 2017	SOx exceedance. Inability in automatic mixing of limestone	Ramp-up of boiler to increase the limestone manually
2	June 20 2018	SOx, exceedance. Due to load generation increase and inconsistent loading of coal	Adjustment in operating conditions
3	May 14 2019	SOx exceedance during ramp-up Clogged standby limestone delivery mechanism	Temporary stoppage of boiler operation unclogging of limestone mechanism

It is observed from the above that the short term exceedances were results of boiler operations and were readily corrected.

6.1.5 Operationalization of complaints management system

Complaints are addressed through the Grievance Redress Mechanism (GRM)

The Grievance redress mechanism (GRM) is the instrument or procedure by which grievance is ventilated and resolved.

The GRM herein discussed is for the communities and/or stakeholders noting that there is instituted GRM for internal purposes, i.e. for employees of FDCMP.

The key elements of the GRM are:

- ✓ Informing stakeholders that there is an instituted GRM
- ✓ Informing stakeholders of the procedure that they can observe
- ✓ Receiving and recording by FDCMP of the grievances
- ✓ Forwarding to the responsible personnel
- ✓ Verification of legitimacy of grievance
- ✓ Establishing nature of grievance, e.g. legal, environmental aspect, employment related?
- ✓ Referral to concerned company personnel or executive, e.g. to PCO, to legal, to Human Resource Unit
- ✓ Discussion by the concerned personnel handling the grievance with Complainant
- ✓ Resolution through negotiation if possible
- ✓ Advising complainant of action
- ✓ Either amicable settlement or further action by complainant to be recognized and respected
- ✓ The timeline from receipt of complaint to the resolution shall be noted. A period for resolution shall be established which will depend on the nature of the complaint.

The above is reflected in the diagram below.

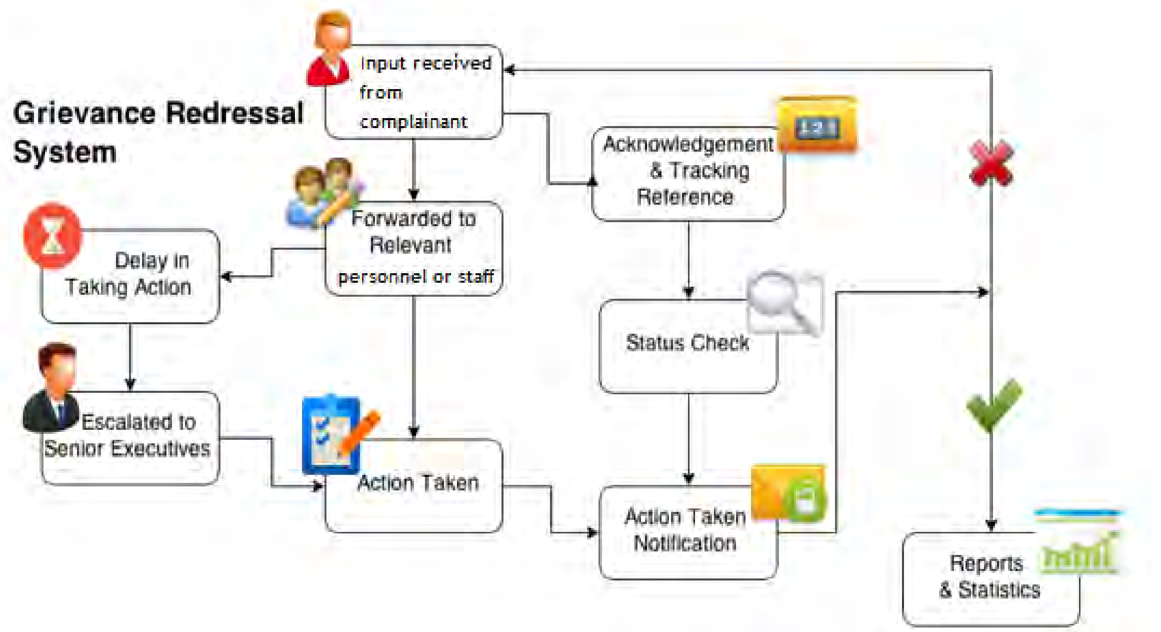


Figure 6-9. FDCMP Grievance Redressal System

6.3 Multi-Sectoral Monitoring Framework

Creation of a Multi-Partite Monitoring Team (MMT), Responsibilities and Activities
List of stakeholder-members and basis of selection and proposed role.

The existing MMT will be used for the expansion project because:

1. Nature of the Project is the same, i.e. Coal Fired Power Plant
2. The site is the same being in the PHIVIDEC land
3. The environmental concerns, risks and hazards are the same
4. The government, private and NGO stakeholders are the same

Below are the current members of the created Multi-Partite Monitoring Team (MMT) of the existing project and for the proposed expansion as well.

Chairperson (Interim)	Jose Oliver Ello	MENRO Villanueva
Members	Dir. Nilo Geroche	DOE
	For. Ferdinand Dagulo	PENRO – DENR
	For. Conrado Mahinay	CENRO – DENR
	Engr. Prisco Valmoria	ENRO Misamis Oriental
	Engr. Dax Jara	PHIVIDEC
	Gertude Garcia	Xavier University
	Engr. Jeffrey Elogsong	MENRO Tagoloan
	Hon. Regene Ello	Barangay Tambobong
	Hon. Jan Bagani Casiño	Barangay Sta. Cruz
	Hon. Nila Pagaling	Barangay Balacanas
	Hon. Agustin Sabio	Barangay San Martin
	Hon. Francis Jerson Sabio	Barangay Mohon
	Jorgino Caronia	Kimaya Farmers Association

	Robinson Miñoza	Fisherfolks Association
	Cecilia Nain	Municipal Federation of Purok
	Richard Rejas	Balay Mindanaw
Secretariat	Augie Mae Vanguardia	Office of MENRO Villanueva
	Jade Cassandra Ejem	Office of the Municipal Mayor -Tagoloan

* The MMT member composition is based on the original MMT MOA. The new MOA which follows the DAO 2017-15 is currently under review by the EMB Central Office.

General Functions

a. Monitor project compliance with the conditions stipulated in the ECC and commitments made in the Environmental Monitoring Plan (EMP) using checklist form and mainly secondary technical information and primary observations;
b. Prepare, integrate, and disseminate simplified monitoring reports and submit recommendations to the DENR;
c. Monitor implementation of community information, education, and communication (IEC) plan/program and social development programs (SDP);
d. Interface with the technical third party audit group to understand and be updated on Monitoring and Evaluation results;
e. Initiate popularization of Monitoring and Evaluation results for community consumption; and
f. Officially receive complaints/requests from the public-at large for transmittal to the proponent and EMB-DENR and be able to recommend immediate measures against the complaint.

Roles, Duties and Responsibilities

MMT Secretariat

a. Coordinate and inform the MMT members of the schedule of its meetings, monitoring activities and deadlines for report submission;
b. Provide documentation of minutes of MMT meetings and consolidate monitoring findings, including actions taken/generated from the discussions;
c. Ensure the safekeeping of MMT documents, materials and properties; and
d. Provide logistics for all MMT activities
e. To inform the SMT members on any changes, if any, that may be adopted by the Execom members on any matter for decision.

MMT Sectoral Monitoring Team

a. Organize and carry out the field monitoring activities of the MMT in their respective areas of jurisdiction:
    i. Air and noise monitoring
    ii. Water monitoring
    iii. Toxic and chemical and hazardous waste monitoring
    iv. Information, Education and Communication / Social Development Program
    v. ECC Compliance monitoring
b. Conduct field monitoring activities in accordance with the approved Annual Work and Financial Plan;
c. Consolidate data and observations from the conduct of field activities (including but not limited to monitoring, IEC, trainings, etc.) for the submission of quarterly SMT activity reports to the Execom. SMT shall submit within 30 days after monitoring activity;

d. Submit semestral compliance monitoring validation report (CMVR) for review and approval of the Execom prior to submission to DENR –EMB. SMT shall submit CMVR within 30 days after the semester;
e. Advice the Execom on the need for additional monitoring activities and/or requirements to employ assistance from other relevant government agencies and other sectors to provide necessary expertise and participate in the actual monitoring activity.

All monitoring activities shall be based on the applicable guidelines for the conduct of monitoring stipulated under DENR Rules and Regulations, the MMT MOA and the annual monitoring work plan.

6.4 Environmental Guarantee and Monitoring Fund

The Environmental Monitoring Fund (EMF) is a fund that FDC Misamis shall commit to establish in support of the activities of the MMT. The EMF is specified in the ECC issued to the project.

The EMF shall be exclusively utilized to cover all costs attendant to the operation of the MMT.

The EMF is established initially at 500,000 pesos or as based on the approved Annual Work and Financial Plan. It must be replenished if the amount is lower than 500,000 pesos.

Purpose of the EGF

The creation of an Environmental Guarantee Fund (EGF) is part of the post conditions in the ECC issued to the project. The EGF shall be composed of two (2) components, the EGF Trust Fund and the EGF Cash Fund.

The Trust Fund will be used to compensate aggrieved parties for any damages to life or property, undertake community-based environmental programs, conduct environmental research aimed at strengthening measures to prevent environmental damage and to finance restoration and rehabilitation of environmental quality of the project-affected area.

The Cash Fund, on the other hand, shall be earmarked for immediate rehabilitation and compensation of affected communities in case of damage or accidents directly attributable to the fault of the Proponent. It shall also be used to cover the operational costs of the EGF Committee, which shall be established for EGF Management and Administration.

The EGF Trust Fund is established with the amount of 2 Million pesos and the EGF Cash Fund of 1 Million pesos. Both are replenishable if the amount is below 500,000 pesos.

Inasmuch as the MMT is operational and the EGF and EMF are already in place, it may be expected that for the expansion project, the EGF and EMF will be an extension of the current levels of funds, but are to be confirmed by the existing and operational MMT.

SECTION 7. DECOMMISSIONING / ABANDONMENT / REHABILITATION POLICY

Statement on proponent's policies to implement the abandonment plan and to formulate and submit procedures for Rehabilitation/Decommissioning/Abandonment within a timeframe to be specified in the ECC.

A decommissioning or abandonment plan will be prepared and submitted for approval by the EMB when the plant operation shall cease. Cessation will be occasioned by factors such as reaching the end of the project life, non-viability of the operation, environmental disasters, among others.

An Environmental Site Assessment (ESA) will be conducted and submitted to the EMB in partial support of the decommissioning plan.

The policies for the abandonment plan for the expansion project are essentially the same as those for the original project noting that the same type of operations are involved. Moreover, the plant expansion shall be within the existing plant compound; hence, the environmental resources, principally the land, shall have the same features.

FDCMP has set a framework for action and setting of objectives that includes plans for decommissioning and rehabilitation of each component of the whole plant and its facilities including the additional units, social plan for the workers, host and neighbouring communities, and with appropriate funding mechanism to ensure availability of sufficient funds to implement the plan completely.

Its primary concerns for the decommissioning and closure are to ensure public safety and health, environmentally stable conditions compatible with the surrounding environment are achieved and to minimize environmental impacts caused by the power plant operation. The overall objective is to provide social, economic, and environmentally sustainable development. It is the intention of the Project Proponent that the land and other facilities will be of beneficial use to the host communities after the project closure.

Specifically, this decommissioning plan is prepared with the following objectives:

- To prevent or eliminate long-term environmental impacts by returning disturbed land to a physically and chemically stable; visually acceptable; productive or self-sustaining condition, taking into consideration the beneficial uses of the land and the surrounding areas and as agreed with the stakeholders; and

- To ensure that alternative livelihood opportunities are established and left behind to the host/neighboring communities.

Key Aspects of the Decommissioning and Abandonment Phase

- **Social plan for workers:**

Fair and equitable retrenchment packages. By the time of closure, the workers shall have gained sufficient knowledge, skills, and experience that shall make them highly employable in similar industries. A livelihood-training program is also planned for residents so that upon closure, the residents would become self-reliant on their new livelihood activities.

- **Social plan for the host and neighboring communities:**

FDCMPC shall continue the implementation of its Social Development and Management Program (SDMP). During the decommissioning phase, there shall be livelihood programs, educational assistance, health care programs, and infrastructure projects. These programs are intended to address the need of the communities even after the closure period.

Decommissioning strategy includes:

- Formation of the Closure Team and start of IEC campaign;
- Inventory and assessment of conditions of all equipment and facilities;
- Planning and review of decommissioning procedures vis-à-vis the standard operating procedures;
- Cross-matching of Company personnel and residents with the decommissioning tasks; with training activities provided, if necessary;
- Consultation with stakeholders and strengthening of IEC;
- Site investigation for residual impacts;
- Site remediation if necessary;
- Removal, disposal, and cleanup of unused chemicals and wastes;
- Decommissioning of stockyards;
- Decommissioning of solid waste dumps;
- Decommissioning of the Project's water supply and sewage system;
- Decommissioning of plant, offices, and workshops; and
- Post-assessment by the Closure Team.

7.1 Identification of Possible Site Residual Contaminants principally

Metallic elements

The metallic elements, if present, will be in the soil and also in the portion of Macajalar Bay fronting the project site. Tests will be conducted for Hg, Pb and As. The sampling stations will focus on points near the ash repository pond.

7.2 Remedial Actions and Alternatives

Site Remediation, if necessary.

Based on the results of the tests cited in 7.1 a program for site remediation will be developed, submitted to the EMB for their review, suggestions, and approval and thence for implementation.

In the event of findings from the tests of environmental degradation, the MOA appertaining to the EGF shall be invoked accordingly.

7.3 Discussions on the rehabilitation and decommissioning / dismantling of project components of the power plant

The dismantling process will first involve the removal of the balance of materials used for the plant operation, principally:

- Feed Coal, residual chemicals, resins, assorted media, lubrication oil etc. This can be sold to third party users.
- Startup Bunker or Diesel Oil. Likewise, these will be sold to third parties.

Equipment and components that may still be usable by third parties.

The entire power plant facility may be transferred to another site for similar operation. Piecemeal sale may also be opted to include major equipment such as transformers, electronic (i.e. cabling, wirings, computers, control systems, batteries, etc. steam turbine, pumps, compressors and even the boilers.

Scrap materials.

Pipes, building materials and similar scraps will be disposed through scrap dealers or recyclers.

On the Abandoned land

Since the land is under the ownership of a third party, i.e. the PHIVIDEC, it is deemed appropriate for the PHIVIDEC to formulate its plan for the alternative use of the land to be abandoned.

SECTION 8. INSTITUTIONAL PLAN FOR EMP IMPLEMENTATION

Presented herein is the organizational scheme of the proponent including line of command and reporting procedures as well as manpower complement and relationships with other operating departments.

General Notes:
The Institutional Plan applies to the Expansion Project but is inherently based on the existing Institutional Plan for the Original Project.

- **During the Construction Phase**

The Construction Activities will be operationally and legally under the responsibilities of the various Construction Contractor(s) that the Proponent will engage.

The various works to be involved are:

Site Preparation
Minor land development in preparation for Construction of buildings and structures in accordance with the approved Plans

Installation of Facilities and Structures, e.g.

The 3 x 135 MW Additional Power Plant Units
Support facilities such as the stacks, the Air Pollution Control Device (APCD) which primarily is the Electrostatic Precipitator (ESP)
Ash Repository Pond
Buildings
Others

The Scope of these works will be spelled out in details in the Contract(s) to be entered into with the Contractor(s).

The organizational complement, i.e. "Institutional Plan" with the Contractor(s) will also be delineated in details in the Contract(s) to be signed.

Lines of Command

The Construction Company represented by its duly authorized Officer or Personnel shall report directly and be responsible to FDCMP.

The internal organization including manpower complement of the Contractor(s) will be internal to them but subject to the Agreement(s) in the prospective Contract(s).

It may be expected that among the organizational units of the Contractors are:

Civil Work Unit
Horizontal Development (drainage, electricals, water distribution, communication lines, etc). Unit
Installation
  Structures, .e.g stacks
  Boiler Plants
  Cooling Water System
  Other Utilities

Protocol for Hiring of Construction Workers

Inherently the Contractor(s) will have to be responsible for the hiring policy, otherwise it may find excuse for non-compliance to the Contract(s) if external intervention is made.

- **During the Operations Phase**

Table 8-1 depicts a likely schedule of personnel requirements for the plant during the Operations Phase. The actual number will depend on the final Design and Engineering Details (DED) which will firmly establish the operational requirements of the Project. On the other hand the DED will depend on the conditions of the ECC for the expansion project and on the choice of the Contractor. For example, a particular Contractor will have its own Maintenance Protocol which FDCMP will adhere to.

The proponent has committed during Public Consultations that locally qualified residents will be given priorities in the hiring of personnel. The hires and the Company will necessarily agree to the terms of employment which will observe the regulations and requirements of the DOLE.

Contractual hiring will not be practiced which involve the intentional hiring of qualified personnel but the pre-planned laying off of them after a short period of employment of less than 6 months.

There will be no prejudice as to sex, religion or even age but the job descriptions which are to be made to fit the requirements of a particular function will have to be met. The job descriptions are not arbitrary but are determined by the technical requirements as laid out by the EPC and in accordance with international protocol for the operation of coal power plants of this capacity.

Table 8-1 Preliminary Estimate of Plant Personnel Requirements FDCMP

Functions	Personnel Required	Est. Numbers
Plant Management and support	Plant Manager, Secretary, Driver	**3**
Operations & Logistics	Operations Manager, Operations Superintendent, Control Engineer, Turbine/Gen Aux Operator, Boiler Equipment Operator, Coal and Ash Handling Operator, Chemical Engineer, Water Treatment Operator	**97**
Maintenance & Engineering	Maintenance Manager, Mechanical Superintendent, Electrical Superintendent, I&C Superintendent, Technical Service Superintendent, Mechanical Engineer, Mechanic, I&C Engineer, Technician, Planning Engineer, Efficiency Engineer, Safety Engineer, QA Engineer, Pollution Control Engineer, Property Custodian, Security Officer	**37**
Total		**137**

Note the above table indicates that there will be a Pollution Control Engineer among the organizational units.

Note: estimated that on average about 100 - 120 temporarily contracted staff will be required on an as-and-when-required basis.

Relevance of the **Final Design and Engineering to the Firm Organizational Set up:**

- The instrumentation system will give guidance as to what operational variables will be controlled by instrumentation and control system. The more extensive is the I & C (Instrumentation & Control) the less is the requirements for personnel

- The Maintenance Programme that will be provided by the EPC contractor will guide on the organizational requirements for maintenance and engineering departments.
- The extent the monitoring is provided by automatic and continuous monitoring systems will influence the requirements for the environmental and safety unit.
- The Pollution Abatement Systems as provided by the EPC contractor shall guide the choice, role and qualifications of the unit/personnel to be tasked with environmental protection.

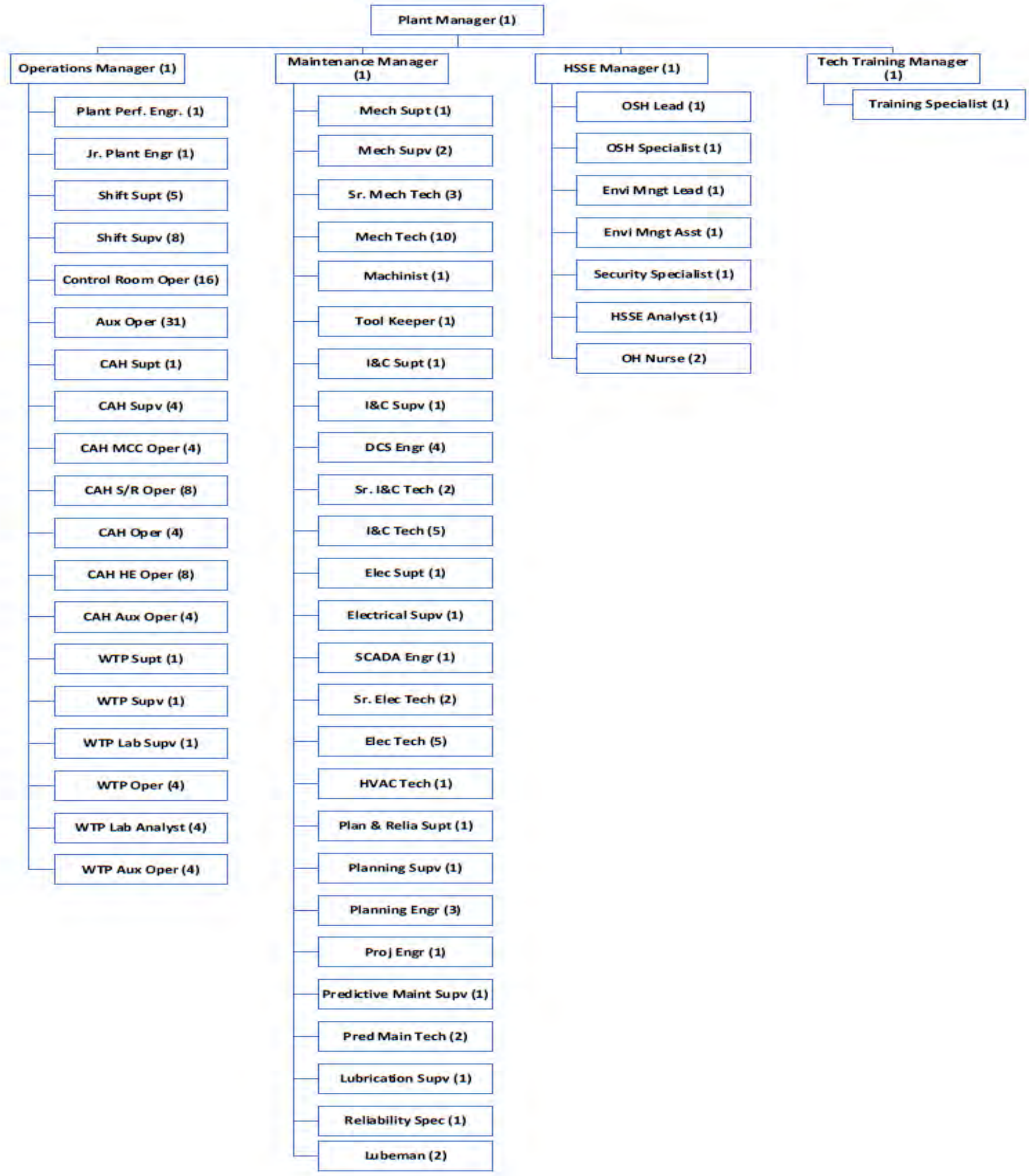


Figure 8-1 Conceptual Institutional Plan for the Proposed Project

The final Institutional Plan will be based on experiences from the existing (original) Project and on the Final DED from the EPC.

The relationships among department and units are indicated in Figure 8.1.

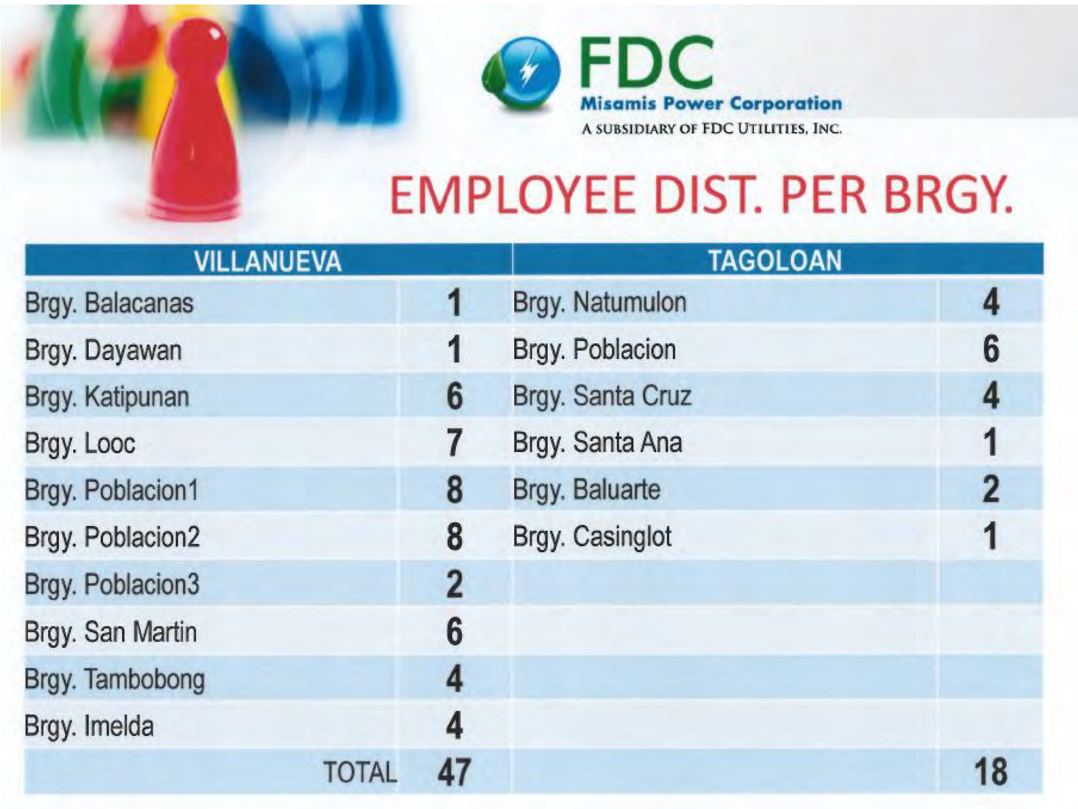
Other Considerations:

Hiring Policy and Scheme:

- Qualified local residents will be given priority. Opportunities for skill development will be provided to enhance the chances of local residents in being employed.
- There will be no discrimination with respect to sex and to senior citizens.
- Contractualization will be avoided to the extent practical and in accordance with laws existing at a given time.

The SMRs e.g. the 4th Quarter report includes information on employment.

Annex I of the 4th Q SMR provides information on employment, partially given below.



VILLANUEVA		TAGOLOAN	
Brgy. Balacanas	1	Brgy. Natumulon	4
Brgy. Dayawan	1	Brgy. Poblacion	6
Brgy. Katipunan	6	Brgy. Santa Cruz	4
Brgy. Looc	7	Brgy. Santa Ana	1
Brgy. Poblacion1	8	Brgy. Baluarte	2
Brgy. Poblacion2	8	Brgy. Casinglot	1
Brgy. Poblacion3	2		
Brgy. San Martin	6		
Brgy. Tambobong	4		
Brgy. Imelda	4		
TOTAL	47		18

Figure 8-2 Employees Distribution per Barangay

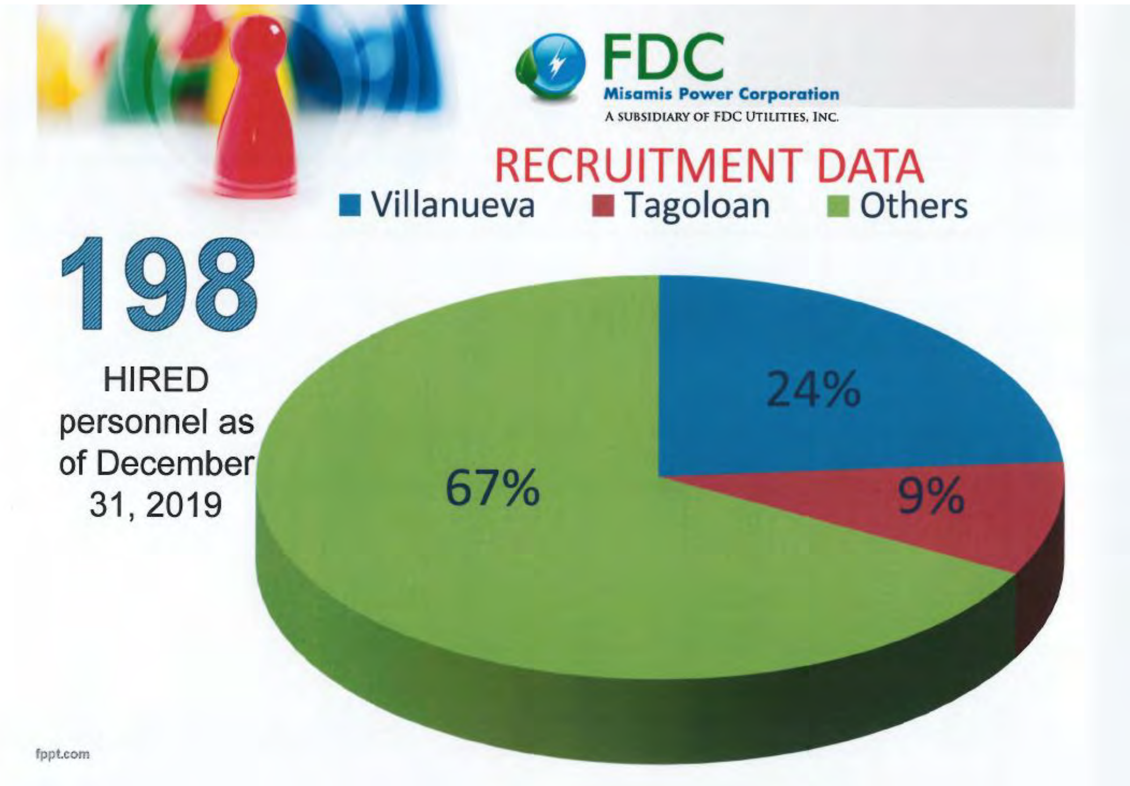


Figure 8-2 FDCMPC Recruitment Data