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MAIN REPORT – VOLUME 1

PROPOSED BAYAOAS SMALL RESERVOIR IRRIGATION PROJECT (BSRIP)

Aguilar, Pangasinan

NATIONAL IRRIGATION ADMINISTRATION 1963

NATIONAL IRRIGATION ADMINISTRATION
PANGASINAN IRRIGATION MANAGEMENT OFFICE (PIMO)
Brgy. Bayaoas, Urdaneta City, Pangasinan

July 2019

INTEGRATIVE COMPETITIVE INTELLIGENCE, INC
& ORIENT MANAGEMENT CONSULTANTS

ENVIRONMENTAL IMPACT STATEMENT

TABLE OF CONTENTS

List of Tables

List of Figures

List of Annexes

EXECUTIVE SUMMARY

A. PROJECT FACT SHEET

Name of Proponent	National Irrigation Administration (NIA) Region I - Pangasinan Irrigation Management Office
Office Address	Barangay Bayaoas, Urdaneta City, Pangasinan
Authorized Signatory/ Representative	Engr. Gaudencio M. de Vera, PIMO Division Manager A
Contact Details	Telefax No. (075) 632 2776; RIM OFFICE (075) 632 2776; PIMO - (075) 632 2775

EIA Preparer	Integrative Competitive Intelligence Asia, Inc. (ICI-Asia)
Address	Unit 3301 One Corporate Center, Meralco Avenue corner Julia Vargas Avenue, Ortigas Center, Pasig, Philippines
Contact Person	President V. Vargas, BSRIP SEIA Project Manager
Contact Details	pvvargas@ici-asia.com, (02) 7063292
Project Name	Bayaoas Small Reservoir Irrigation Project (BSRIP)
Project Location	Aguilar, Pangasinan, Philippines
Project Type	Dam and Irrigation System

Dam Reservoir Surface Area	103.79 ha (at extreme flood condition, 46.8-m high from river bed) 77.68 ha (at maximum operating level, 39.5-m high from river bed
Dam Reservoir Volume	18.03 million m^3 (at extreme flood condition level) 11.51 million m^3 (at maximum operating level)
Irrigation Service area	1,400 ha (existing, for improvements and repairs)
Project Technology	Zoned Embankment Gravity, closed supply canal with siphon crossing Bayaoas River, concrete closed and open main canals, concrete and earthen lateral canals
Major Physical Components of the Project	dam and appurtenances, new access road for dam, new main supply canal, connecting main canal of existing irrigation intakes, maintenance repair and improvement of segments of existing irrigation canals

Project/Investment Cost	P759.69 million (Indicative as of 2015)
Project Construction Period	3 years

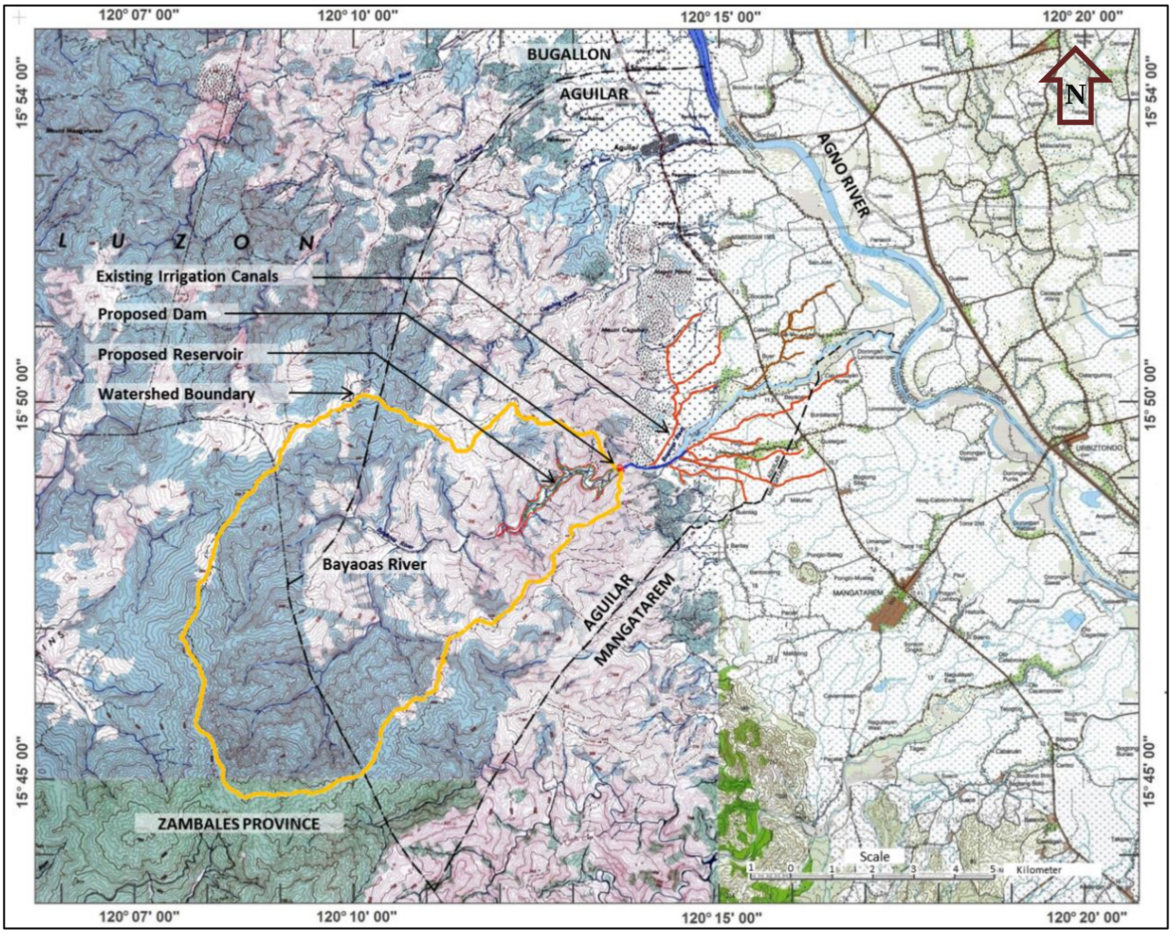


Figure ES-1. Municipal Location of the Proposed Project on a NAMRIA Topographic Map

B. EIA PROCESS DOCUMENTATION

B1. EIA Team

The EIA Study was conducted by a multidisciplinary team of specialists and consultants of the ICI-Asia, Inc., in coordination with PIMO staff (**Table ES-1**).

Table ES-1. EIA Study Team Composition

Name	Position/ Module
President V. Vargas	SEIA Project Manager
Vanderleaf C. Capalungan	Technical Team Leader, Integrator, Project Description, Land Classification and Use, Pedology, Water Quality, Air Module, Environmental Risk Assessment (ERA)
James Paul H. Esguerra	The People Module, Public Participation, Overall Reviewer
Napoleon D. Villanueva Jr.	Geology
Leizel G. de la Cruz	Terrestrial Flora
Myka S. Allam	Terrestrial Fauna
Silvino M.Lambino Jr.	Hydrology
Westly R. Rosario	Freshwater Ecology
Joseph V. Jovellanos	Right-of-Way
Joveil C. Jovenal	Research Assistant
Resty A. Alvarado	Research Assistant
Ian Midrick M. Delos Santos	Administrative Support
Francis B. Aquino	NIA SEIA Coordinator
Karl S. Geslani	NIA Support Staff
Dave M. Lagundi	NIA Support Staff

B2. EIA Study Schedule

The EIA started in August 2018 with the 2015 Feasibility Study Report to define the proposed Project for screening with the EMB EIA regulatory requirements. This was followed by compliation of environmental information in the FS usable for the EIA, with an initial impact assessment, in preparation for the IEC and initial perception survey done in September 24, 2018. Results were converted into a supporting document for the request for Public Scoping which was carried out on December 11, 2018. This was followed by a Project Briefing and Technical Scoping with EMB and EIA Review Committee (EIARC) on January 23, 2019. Thereafter, primary data gathering activities for the applicable modules were done. Together with the compiled data from the 2015 FS, government documents, and from internet searches, the primary data were used to prepare modular reports. They were integrated as basis for preparing the rest of sections of the EIS. The sequence of events is in compliance with the requirements of DAO 2017-15. **Table ES-2** shows the major EIA activities.

B3. EIA Study Area

The study area covered Bayaoas Watershed (for the proposed access road, dam site, area, reservoir), and the beneficiary irrigation canals in the barangays of Aguilar (Laoag, Bayaoas, Pogonsili, Buer, Calsib, Bocacliw, Niñoy), and Mangatarem (Quetegan, Bunlalacao, Linmansangan, Calomboyan Norte). Area covered by flora and fauna surveys covered farther upstream of the proposed reservoir.

Table ES-2. EIA Study Schedule

Date	Activity
August – September 2018	Preparation of Initial Project Description
August 14, 2018	Project Screening with NIA
September 24, 2018	Initial Perception Survey
September 24, 2018	IEC with the Barangay Residents
October 26, 2018	IEC for Pangasinan, Aguilar, Mangatarem LGUs
November 30, 2018	EMB Posting of Public Scoping
December 11, 2108	Public Scoping, Aguilar and Mangatarem
January 23, 2019	Project Briefing and Technical Scoping
February – May 2019	Primary Data Gathering and EIS Writing

B4. EIA Methodology

Basically, the EIA followed the topics and methodology for the baseline and impact assessment stipulated in the Technical and Screening Form (**Annex ES-1**), the Revised Procedural Manual for DAO 2003-30 and DAO 2017-15. Applicable methodologies or approaches were applied for Project Description, Land Classification and Use, Geology, Pedology, Terrestrial Flora, Terrestrial Fauna, Hydrology, Water Quality, Freshwater Ecology, Climate and Meteorology, Air Quality, Noise, and People. Data and information for the Project Description, land classification and use, geology, pedology and hydrology were compiled from existing 2015 Feasibility Study for BSRIP. Many data including maps on natural environment were obtained government websites (e.g. NAMRIA, DENR, EMB, FMB, BMB, MGB, PHIVOLCS, Manila Observatory, PhilRice, PAGASA,). Documents related to the Bayaoas Watershed like on the National Greening Program, were made available from DENR CENRO Dagupan. A number of maps for land and water modules were obtained from DENR-R1 Development of Climate-Responsive Integrated Master Plan for Agno River Basin, Comprehensive Report on the Studies Conducted (Phase 1), which situates the condition of BSRIP with the Agno River Basin. Secondary data for The People Module were obtained from CLUP of Aguilar, CLUP of Mangatarem, NCIP, PSA, NSO, LMB, PhilAtlas, Pangasinan LGU, among others. Other websites contain supplemental information from literature for the various modules.

Primary data on natural environment were obtained by sampling of soil, terrestrial flora, terrestrial fauna, river eater, groundwater, freshwater organisms, air quality (TSP), noise. Methodology, maps and photos for the sampling of the natural environment are provided in each section. Primary data on people module were botaied from IEC, perception survey, key informant interviews, and focus group discussions.

The Google Earth Pro was used in map development and analysis of the project and environment characteristics, planning the primary data gathering and impact assessment. As possible, the results of the baseline data were compared the established regulation (RA 9275 Clean Water Act, RA 8749 Clean Air Act, PD 984), and criteria (like International Union for Conservation of Nature (IUCN) Red List of Threatened Species 2016 and DENR Administrative Order No 01 of 2007 “Establishing the National List of Threatened Philippine Plant and Their Categories). Computational techniques were applied for terrestrial flora diversity analysis, Bayaoas River flow, reservoir simulation, flood simulation, and noise attenuation by distance from source.

B5. Public Participation

In accordance with DAO 2017-15, various stakeholders participated in a number of activities,, including the following:

Activity	Date	No. of Participants
1. Initial Perception Survey	September 24, 2018	49
2. 1st IEC, with the AGuilar Barangay Residents	September 24, 2018	50
3. 2nd IEC/KII for Pangasinan, Aguilar, Mangatarem LGUs	October 26, 2018	9
4. 3rd IEC, houset- to-house with Barangay Bayaoas Residents	October 27, 2018	30,
5. Public Scoping, Aguilar and Mangatarem	December 11, 2108	70
6. Perception Surveys and FGDs (Aguilar and Mangatarem)	April 22-25, 2019	145

The public participation activities included the local residents from Aguilar and Mangatarem and respective municipal and provincial representatives. Communication tools used include slides, form, leaflets and tarpaulin.

A copy of the Initial Perception Survey Report is provided in **Annex-ES-2** and the Information Education and Communication Report in **Annex ES-3.** These were undertaken under the initiative of the proponent to introduce the project by inviting a number of stakeholders for the IEC, and the IPS. The IEC was meant to introduce the project to the community. While so, some community members were already raising issues about the project. These reports were filed with the request for Public Scoping, Technical Scoping, and became part of the material for the FGD. The Public Scoping Report is presented in **Annex ES-4**.

The most recurring concerns identified were possible flooding, dam breakage, watershed management, and reduction in supply of water. These issues became the focal themes across a number of target barangays were the issues were most felt, through Focus Group Discussions, with guide questions provided in **Annex ES-5.** A summary of the key points from the FGDs was included in the People Module, along with the results of the Socio-Economic Survey, which also included a Perception Survey. A listing of the key variables of the survey is provided. In general, both the Initial Perception Survey and the Perception Survey have socio-demographic data, though the latter is more extensive, and more nuanced. The discussions on the socio-economic survey and perception focused on key elements discussed in this EIA Module.

For the IEC, details of the sample size and profile of participants is in the IEC Report, likewise for the IPS. For the Initial Perception Survey, a small number of respondents was targeted (n=30) was used, but as implemented used n =50. For the socio-economic survey and perception survey, the sample size was set at 90% confidence level with and a margin of error of 10%. The required minimum sample size for beneficiary/ affected barangays of 67 for Mangatarem and 63 for Aguilar (=130 respondents). The sample size for the actual survey was 145.

C. EIA SUMMARY

C1. Summary of Project Alternatives Considered for Siting, Technology Selection/Operation and Design

The alternatives are guided mainly by the objectives of collecting and distributing sufficiently dependable irrigation water to rice fields in the project area. Bayaoas River is the only river present in the area that can reasonably provide irrigation water by gravity to the target existing irrigation systems. The proposed dam of choice is basically due to the abundance of rock and earth fill materials in the area. Generically, the trapezoidal cross section along the river segment of an embankment dam has an impermeable clay core, with upstream and downstream protective filter zones and outer shells.

Siting of water source from the downstream Agno River would require costly pumping, or long right-of-way for piping of water at higher elevation of the river. Basically, the technology adopted for the siting of the water source uses gravity which is more economical in the long term than the use of pumps. This also requires a water reservoir. One siting and technology alternative is the construction of lined multiple lowland reservoirs on the left (north) bank and right (south) bank of Bayaoas higher than the rice fields. However, this would also require a diversion dam and vast tract of private lands. A dam may be an embankment dam or concrete dam that the construction of the latter is more costly.

C2. Summary of Main Impacts and Residual Effects After Applying Mitigation

Land Classification and Use. The proposed dam site and reservoir are located in the general area of wooded grassland forest reserve. However, its location along the river channel is identified as alienable and disposable land by Aguilar CLUP 2013-2022. The footprint partly overlaps with the Enhanced National Greening Project in the area. The proposed access road starts from titled agricultural areas with patches of trees, avoiding built up areas. The proposed site is not located in any of the following: protected area, key biodiversity area (KBA), tenurial instrument, IP area, mining tenement, volcanic activities, tested significant groundwater, flood prone area (for the dam site). The proposed area is within Petroleum Service Contract Area of the Department of Energy (DOE). The location of dam site and reservoir is within the channel of water body (Bayaoas River), which is highly susceptible to landslide, with critical slopes, and frequently visited or hard hit by typhoon, but not prone to flood. The potential quarry site is an old quarry site.

The proposed Project would therefore cause partial conversion of NGP area to dam and reservoir area, and from the titled private land to right-of-way for the new access road to dam site. These would however provide ease for NGP activities due to improved access and water supply. Additional benefit includes opportunity for flood control, buffer area for KBA, fishery industry, tourism, educational tour, and increase frequency and volume of water supply during the dry season, with consequent increase in rice production.

Geology/Geomorphology. The proposed dam is located in the rugged topography in the northeastern part of Zambales Mountain consisting of Ophiolite Complex an east-dipping complete sequence of oceanic crust and mantle material, generally sound and massive rock, consisting of a series of basic to ultrabasic or ultramafic rocks. It is a mineral district of chromium, nickel, platinum, copper, and gold. The nearest active fault is the East Zambales Fault which is about 3.7 km east of the dam site. The maximum credible earthquake (MCE) is 7.4 for East Zambales Fault, based on possible surface rupture length. In consideration of the East Zambales Fault, the estimated PGA for the dam design by deterministic approach is

0.21g which is equivalent to PEIS VII, and already considered in the conceptual design of the dam.

The dam site has shear zones and two northwest trending vertical faults are located approximately 75 meters downstream and 500 meters upstream of the proposed dam. A more detailed geotechnical investigation will be done for detailed engineering design of the proposed Project. At the dam site, the joint systems within the rocks are generally tight and are filled with secondary alteration such as quartz and calcite. The nature of the joints and a lack of through-going structures suggest no problem regarding water seepage. The dam site is highly susceptible to landslide. The dam site provides sufficient quantity and good quality construction materials. The dam would prevent the natural channel replenishment of earth materials downstream. The service areas or the rice farms are located in alluvial plains with high susceptibility to liquefaction.

Pedology. The project site has an upland or mountainous Alaminos series soil, where the dam and reservoir are located, and the lowland San Manuel series soil where rice fields are located. In between them is the intermediate upland Alaminos Series, formed on moderately dissected residual fan terrace located near and along foot slopes of hills and mountain. They are characteristically fine loamy and fine clayey ranging from fine sandy loam to clay which is well suited to a wide range of climatically adopted agricultural crops. Majority of the soils have moderate depth to deep solum thus indicating a greater water holding capacity. The soils are moderately weak granular, sub-angular and angular blocky structures. The soil in the project area is considered medium fertility based on pH, cationic exchange capacity (CEC) and the content of organic matter (OM) or nitrogen source, phosphorus, and potassium. Addition of nutrients is recommended to increase crop production.

The upland soil is recorded as having severe soil erosion, although the banks of Bayaoas River at the damsite appear stable and the channel is dominated by sand, gravel, cobbles and boulders. Excavation of soil during the dam construction would cause severe soil erosion during the wet season. The physical nature of the proposed Project would not cause significant deterioration of soil quality, although measures to prevent oil and fuel spillages will be put in place during construction. Soil fertility in the rice field decreases with the increase in the frequency of planting to two seasons in most areas, and this would require the addition of fertilizers. The additional use of banned non-biodegradable pesticides would pose a risk of accumulation of pesticide residues on rice soils.

Terrestrial Flora. The flora environment in the project site was grouped as upland where the dam and reservoir are located, and the lowland where the ricefields are located. The dam site and reservoir is located in wooded grassland northeast of the Key Biodiversity Area (KBA) of the Zambales mountain and site for the continuing implementation of the National Greening Program (NGP) with different kinds of trees are planted by 10 operators mostly based in the Municipality in Aguilar. The lowland flora within the proposed road route is sparse of economically valuable trees. On the conservation status, 17 from the 59-species identified are listed under the IUCN (2-Critically endangered (1-Endangered, 9-Least Concerned and 5-Vulnerable), while only three species are categorized under DAO-2017-11, two of which are threatened species, and one is vulnerable).

The vegetative layers exhibited low species richness based on Shannon-Wiener H' biodiversity index: 0.65 in the canopy, 0.43 in the understorey, and 0.72 in the groundcover. The Pielou’s (J’) Evenness Index measured 0.45 or moderate in the canopy, 0.38 or moderate in the understory, and 0.55 or high in the groundcover. Incidence of grassfire was noted in the area, which will be considered in the project design, construction, and operations. In preparation for the construction works, a thorough inventory of the trees will be done together with the NGP operators and DENR CENRO Dagupan. At the minimum, lost trees will be replaced according DENR Memorandum Order 2012-05 “Uniform

Replacement Ratio for Cut or Relocated Trees. The overall impact mitigation and monitoring on the flora will be part of the Watershed Management Plan for the proposed Project, which will be prepared with the stakeholders.

Terrestrial Fauna. The terrestrial fauna covered in this study were amphibians, reptiles, birds and mammals. The survey covered three areas from the proposed access road, to dam site and further upstream of the maximum reservoir level, for about 10 km channel segment of Bayaoas River at elevations 330-150 masl. Recorded were 11 species of herpetofauna (amphibians, and reptiles), 19 of avifauna (birds) and 7 of mammals (mouse, rat, bat, dee, pig). The species are not classified as Threatened and/or Endangered. There were endemic and native species ranging from Least Concern to Near Threatened and low in abundance and biodiversity.

An existing threat to wildlife is the recurrence of grass fire causing habitat destruction and limits the forest to regenerate and grow despite efforts to nurture trees in the area. Illegal wildlife hunting for bushmeat and livelihood also limits the increase in wildlife population. Loss of species is unlikely to occur since most of the recorded species are endemic and/or native, mostly of least concern and widespread within Zambales Mountain Range. Mitigation measures would include replacement tree planting and continuing support to the national greening program. A wildlife conservation program will be put in place, in coordination with the various stakeholders.

Hydrology. The proposed Project is within Bayaoas River Catchment which is one of the subwatershed or tributaries out of 19 of the Agno River Basin in the central plains of Region 1. The river system is dendritic, 4th stream order, and has a drainage area of 79.15 km2. The drainage area upstream of the proposed dam is 64 km2. The river channel measures 25.9 km long from Agno River (at 3 masl), going southwest and south at the headwaters in Sta Cruz Zambales (at maximum 840 masl). The longitudinal slope of the channel is low at the proposed reservoir. The river bed width varies and wide about 30 m at 180 masl upstream of the proposed reservoir to 250 m maximum at the lowland.

From the 2015 Feasibility Study (FS) Report for the proposed Project, the estimated mean monthly flow at the damsite is from the lowest 0.34 m^3/s in March to the highest 12.41 m^3/s in August. The observed peak flow ranged 18 to 258 m^3/s. In consideration of the climate projection for Panagasinan, the recommended design flood is 1,321.61 m^3/sec (100-year return period), while the check flood is 1,819.08 m^3/sec (1,000-year return period). At flood condition for a 100-year return period and reaching the 36 m wide and 6 m high spillway, estimates showed a water depth of 48.8 m at the dam axis, 103.79 ha water surface area, and 18.03 million m^3 water stored. The damsite would serve as a flood control measure, provide significant irrigation water during dry season, and reduce pumping frequency of groundwater for irrigation.

Uplands have rocks without any known significant groundwater, largely untested, while the lowland have rocks with limited potential, to moderate permeability. The damsite is not susceptible to flood, but the lowland have low to very high flood susceptibility. The area is susceptible to drought.

Water Quality. The surface water Bayaoas River has good water quality at the uninhabited dam site area but with lower quality down the irrigated and populated area. Quarrying activities along the river did not show significant increase in total suspended particulates due to low flow, ponding and absence of significant soil sediment. (A groundwater sample from a shallow 3-year old tube well in a residential area in Barangay Bayaoas exhibited low quality exceeding relevant water quality guidelines for Class C waters.) Construction's main impact will be limited to significant but temporary increases in total suspended solids in Bayaoas River. The use of Coffer dam is one measure to avoid excessive soil erosion.

During the operation phase, water quality of the reservoir will be different from other segments of Bayaoas River, which may arise from thermal stratification and nutrient enrichment in the water column of the reservoir. This will be monitored. The increase in frequency irrigation water supply would lead to an increase frequency in the use of fertilizers and pesticides. A continual IEC shall be implemented, plus spot-check monitoring of groundwater quality.

Freshwater Ecology. This study involved the determination of the distribution and abundance of the organisms in the food chain such as floating and drifting planktons (phytoplankton and zooplankton), bottom dwelling macrobenthos, and mobile fishes. Five baseline sampling sites were established in the dry season of February and March, 2019 along a 4-km shallow channel length Bayaoas River from the proposed dam site (uninhabited) down to the intake area of the Buer-Calsib irrigation system (populated area). The four lowland sampling sites are expected to become highly disturbed by the presence of quarrying activities, maintenance of channel barriers to divert irrigation water, sustenance fishing, inputs from agricultural and domestic activities. The potential significant impact during the construction phase of the proposed Project on freshwater ecology along Bayaoas River would be limited at the damsite, decreasing downstream. During the project operations phase, a new ecology would develop in the reservoir, which will be continually monitored.

Climate and Meteorology. The proposed Project is located in an area with Type 1 climate characterized as having two pronounced dry season in November to April and wet season during the rest of the year, with August as the rainiest month. April is the hottest month, while January is the coolest month. Prevailing winds is south and southeast at an average of 2 m/s. The strongest was 56 m/s from WNW direction on October 11, 1974. The project area is high risk to typhoon, about 5 cyclones in 3 years. Under a medium range scenario on climate change projection, Pangasinan would experience temperature increase, and rainfall decrease in March, April and May and increase in the rest of the year. Such rainfall projections were already incorporated in the dam design. Greenhouse gas (GHG) emissions would not appear to be significant from the temporary construction equipment. However, the GHG sequestration capacity of the dam and reservoir area would decrease due to submersion of vegetation. This calls for replacement tree planting as a mitigating measure. Emissions of methane from reservoir might happen but which adverse new emissions shall be offset by avoided emissions from decommissioned of diesel-pumps used for irrigation during dry season.

Air Quality. The proposed Project is located in a rural agricultural and woody grassland area with good air quality. The increase in total suspended particulates (TSP) is the main air quality issue for the proposed project and only during earthmoving activities at the construction phase of the proposed access road near a low density populated area. High dust emission will be mitigated by avoidance of earthmoving activities during high wind conditions, water sprinkling, and reduced speed of vehicles in unpaved roads in residential areas.

Noise. The baseline noise levels for the proposed Project were measured together with TSP measurements. On the average, noise levels located in low populated area measured were within respective standards in the morning, daytime, evening and nighttime. Noise sources were people, vehicles and animals. The increase in noise levels in populated areas would be felt only during the construction phase of the project. Nighttime operation and excessive use of vehicle horns, and vehicle accelerations will avoided near residential areas. Significant noise levels will occur at the damsite during construction driving away the wildlife which may return after construction

The People. The proposed Project will be located in a rural setting. The proposed dam and reservoir will be located in upland in Barangay Laoag, Aguilar, with no residential area, but visited by the operators of the National Greening Program. The immediate receipients of irrigation waters will be the ricefarms eastward in the following barangays: Bayaoas, Pongonsili, Buer, Calsib, Bocacliw and Niñoy, all in the Municipality of Aguilar, a third class municipality. Farther east will be the Barangays Quetegan, Bunlalacao, Linmansangan, and Calomboyan Norte of the Municipality of Mangatarem, a first class municipality

Various stakeholders participated in a number of activities in the EIA process. A number of activities were undertaken under to introduce the project to various stakeholders for the IEC, and the IPS. Community members early on raised issues about the project, without yet understanding the technical details of the project, which documented and informed the FGDs. The FGD themes were the following: possible flooding, dam breakage, watershed management, and reduction in supply of water. FGDs were conducted across target barangays were the issues were most felt. The socio-economic, and perception survey, subsequently conducted, showed a general appreciation of project benefit for the farmers. While rather few perceived possible flooding risk, flooding itself, flooding from dam breakage, these were perceived to be not likely to happen. When probed for the need to be relocated given the risks, and the need for support, the respondents generally declined the need for relocation, and support for relocation. Nonetheless, specific monitoring programs shall be put into place for ascertaining proper maintenance, state of health of the dam and the various parts of the irrigation system.

C3. Risk and Uncertainties Relating to the Findings and Implications for Decision Making

Three risks or uncertainties were identified from upstream to downstream: (i) nature and emergence of a reservoir ecology; (ii) dam failure with flash flood; and (iii) equitable distribution of irrigation water supply to farmers. The nature of ecology of the reservoir is difficult to predict but be likely similar to the other dams in the Philippines which is a tropical country. The dam design allows continuous flow and shall not induce population growth of disease-causing organisms. The dam would serve as a flood control measure during the rainy season. It would also serve as a water source for the NGP operations in the area, and prevention of wide-area grass fire.

Dam failure is a major issue raised by the residents. In the FS, a simplified worst-case simulation model for an instantaneous dam collapse at maximum operating setup estimates flash flood occurrence downstream with about 1.6 m flood over the banks of Bayaoas River. Literature shows a low chance of dam collapse for earth-filled dams and is not instantaneous. There is no record yet of dam collapse in the Philippines. A detailed simulation study would be part of the preparedness program to be formulated with the residents.

Lastly, the equitable distribution of irrigation water supply is not raised as a major issue by the communities, but it would be important to consider it as uncertainty as a change in farming practices and in the absence of an existing federation of irrigators association. This could cause negative perceptions among the farmers. NIA will ensure preventive measure from the start.

1. PROJECT DESCRIPTION

1.1 Project Location and Area

The proposed Project will be located in Luzon, Administrative Region 1, Province of Pangasinan (**Figure 1-1**) and in the southern part of the Municipality of Aguilar (**Figure 1-2**). The municipality is bounded on the northwest and north by the Municipality of Bugallon, Pangasinan; on the east by San Carlos City, Pangasinan and Agno River; on the south by Municipality of Mangatarem; and on the southwest by Municipality of Sta. Cruz, Zambales. The dam and its reservoir is proposed to be located in a Public Forest at the southeastern part of Barangay Laoag, the western and largest barangay of Aguilar, (**Figure 1-3**), and to the west of Barangays Buer, Bayaoas and Pogonsili, based on the 2013-2022 Comprehensive Land Use Plan of Aguilar.

A closer view of the location of the proposed Project and its direct and indirect impact areas for identifying stakeholders is presented in **Figure 1-4.** The geo-coordinates of the proposed access road, dam, siphon, supply canal, and reservoir (at maximum flood level) and the existing irrigation canals are presented in **Annex 1-1.**

The Proposed Project footprints which are the direct impact areas covers dam appurtenances, river water reservoir, access road to damsite and patches of improvements (**Figure 1-5**) of the existing irrigation systems in areas to be served. The proposed dam and reservoir are located in Barangay Laoag. The existing irrigation canal networks and rice farms with separate intakes in Bayaoas River are largely located in five (5) barangays of the Municipality of Aguilar, namely: Pogonsili, Bayaoas, Buer, Calsib, and Bocacliw. Irrigation water may reach some rice farms in Barangay Niñoy. In addition, the networks extend in short segments in the northernmost barangays of Mangatarem, such as Malunec, Quetegan, Bunlalacao, and Calumboyan Norte, according to municipal boundary indicated in the NAMRIA topographic map. The potential sand and gravel source is an old quarry site located just southeast of the proposed dam. The quarry site buffer zone to the project is preliminarily designated about 100 m from the perimeter of the dam and reservoir; for the proposed access road it will be about 10 m both sides of the road. The final buffer zones will be designated during project implementation.

In terms of natural features, the proposed area for the dam and reservoir is within Bayaoas River, a feeder tributary of Agno River, at elevations 55 to 100 m of the northeastern part and largely open areas of Zambales Mountains, according to NAMRIA 1:5000 topographic map. The proposed dam is 7.3 km aerial distance, and 9.4 km channel distance from Agno River. The dam axis is located at WGS 84 geographic coordinates of 15º49’0.658”N, 120º13’43.371”E, or PRS92 geographic coordinates of 15º49’6.41”N, 120º13’38.576”E. The mountain area of the Bayaoas Watershed which covers the dam site is highly susceptible to landslide based on the mapping by the Mines and Geosciences Bureau (MGB). Parts of the watershed are covered under the Enhanced National Greening Program of the government. The area has low to moderate susceptibility to flooding (less than 1.0-m flood height). It usually gets inundated during prolonged and extensive heavy rainfall or extreme weather condition. A satellite image of the area is presented in **Figure 1-6**. A panoramic view of the dam site is presented in **Photo 1-1.**

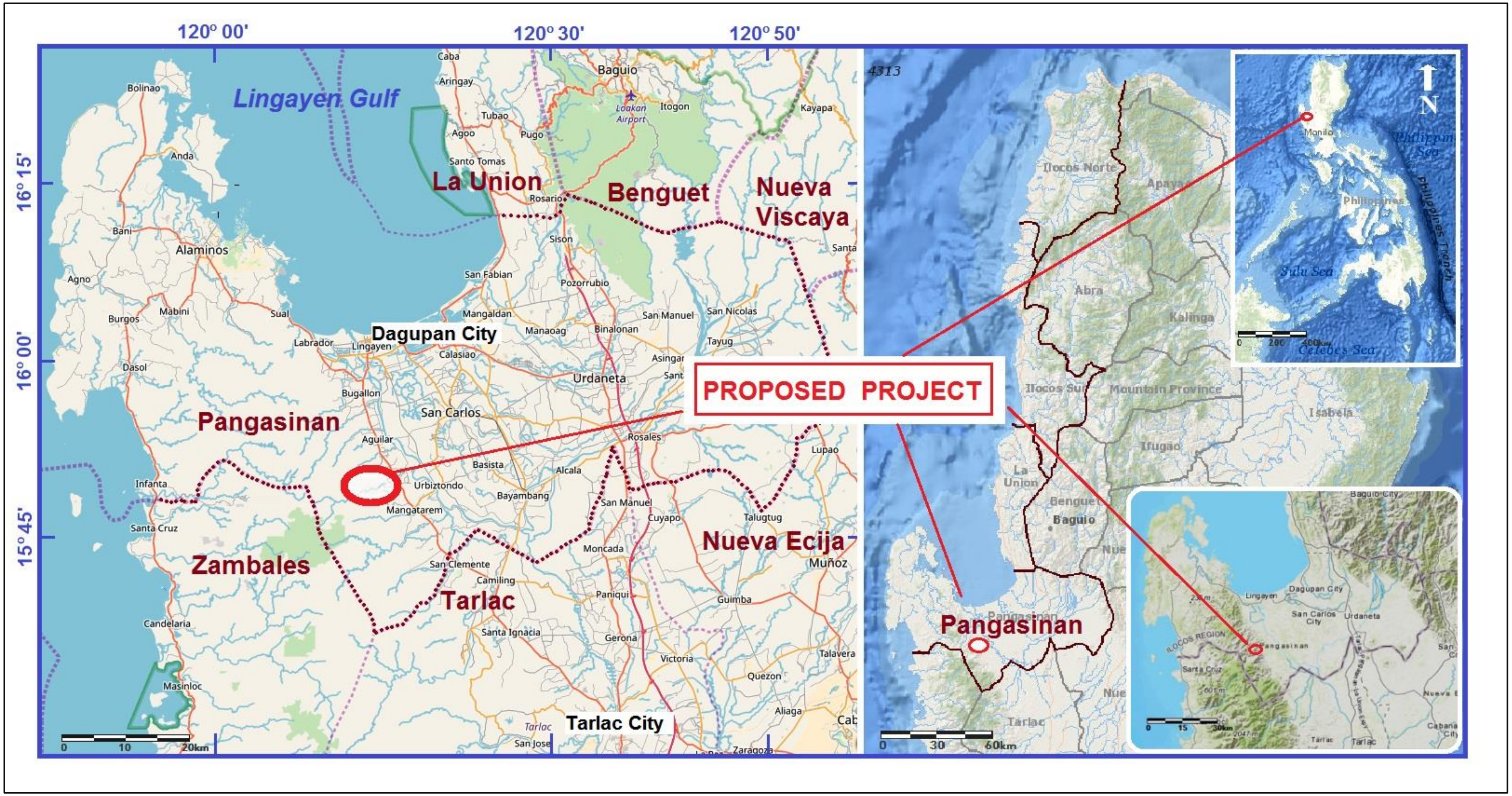


Figure 1-1. National, Regional and Provincial Location of the Proposed Project

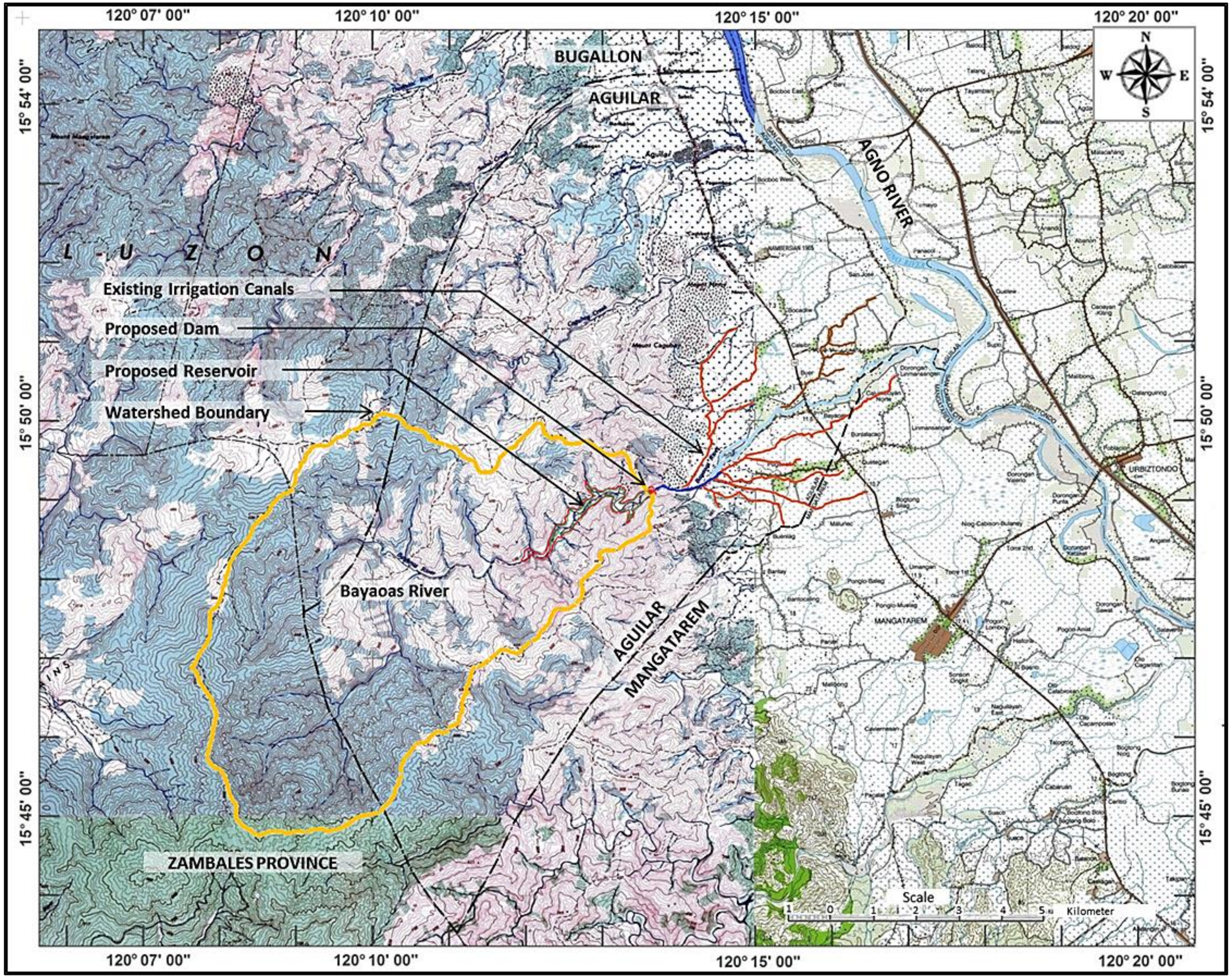


Figure 1-2. Municipal Location of the Proposed Project on NAMRIA Topographic Map

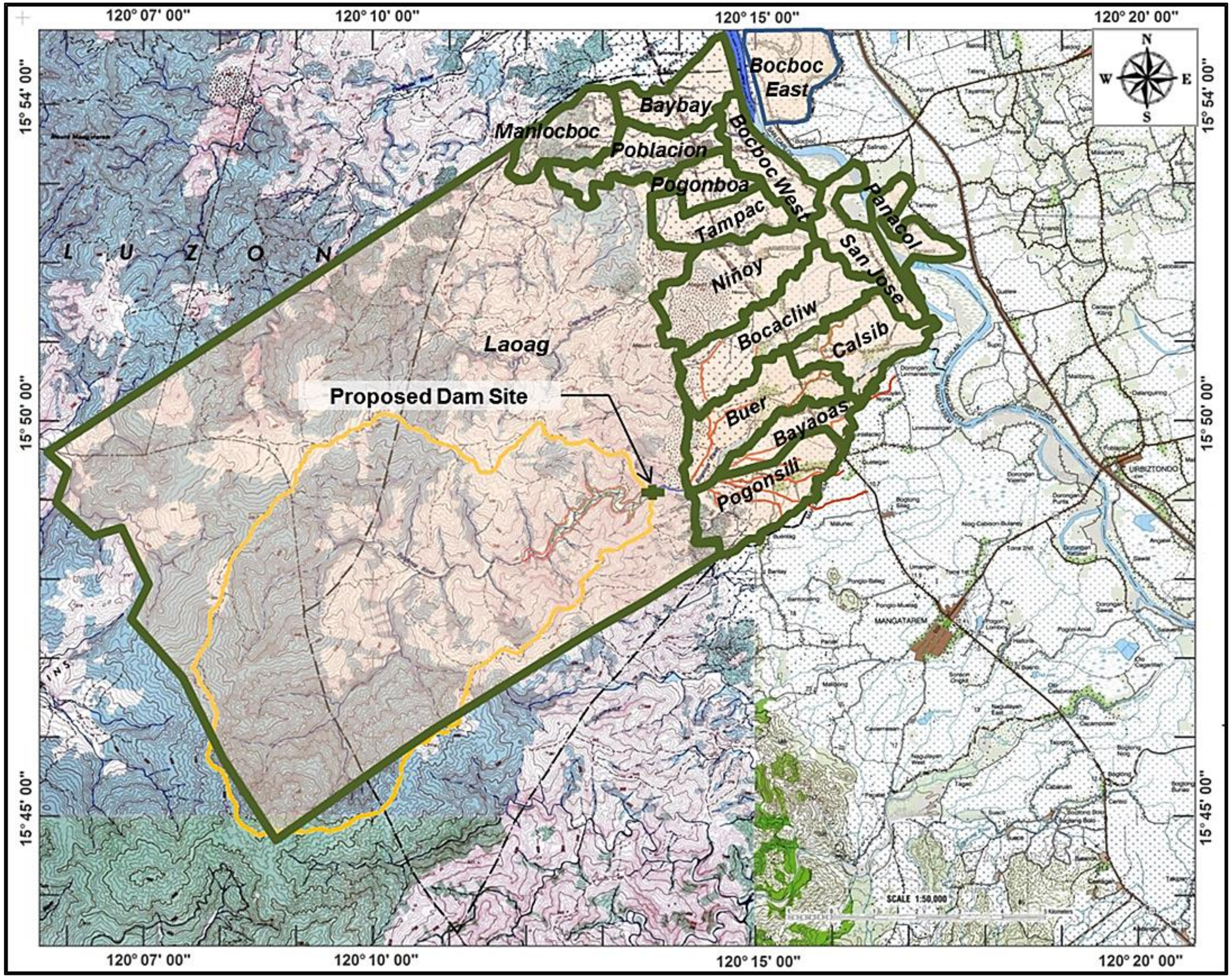


Figure 1-3. Plot of Barangay Boundaries of Municipality of Aguilar on NAMRIA Topographic Map (Source: Aguilar 2013-2022 CLUP). Note that the barangay boundaries in the CLUP does not match with the municipal boundary in NAMRIA Map.

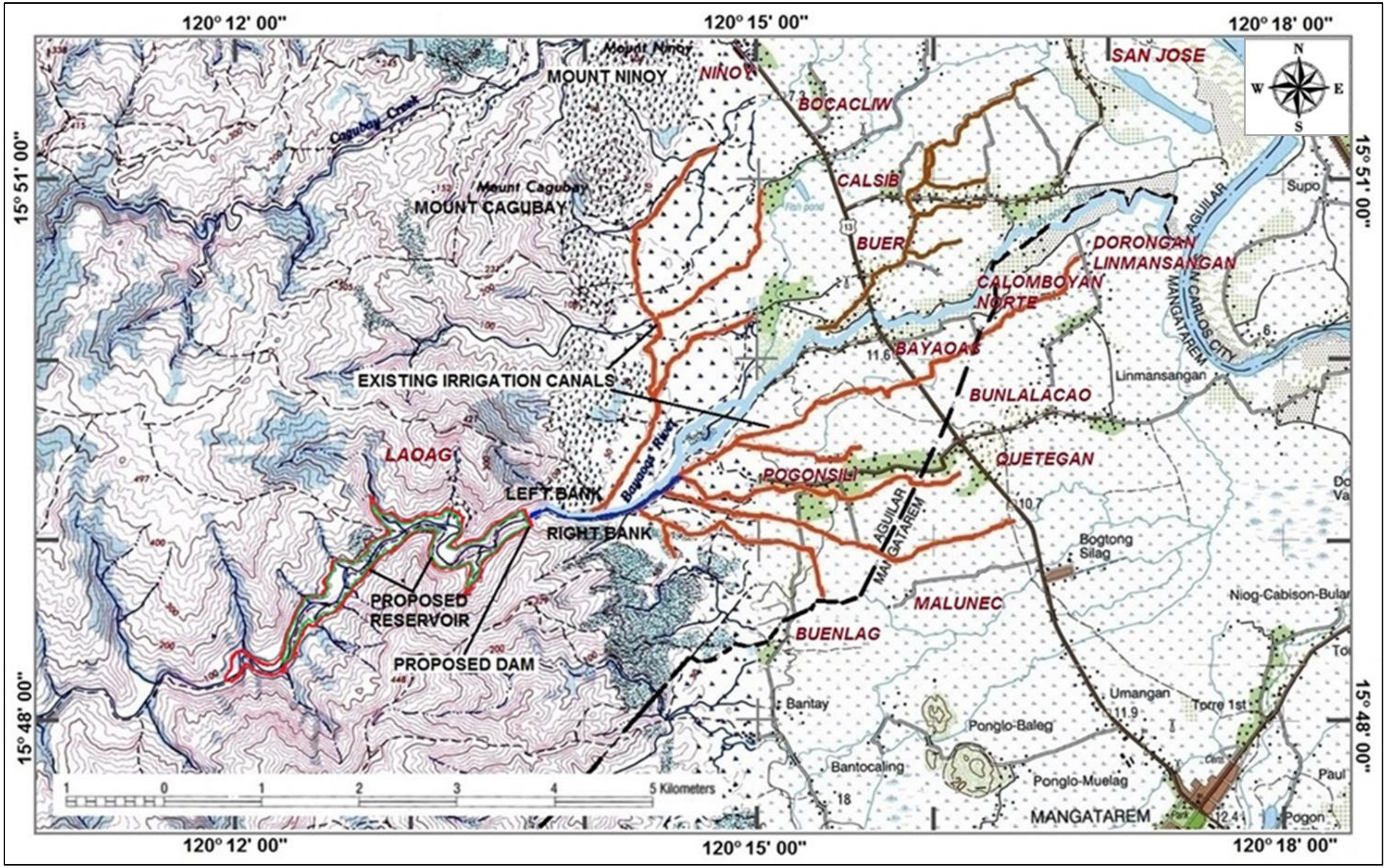


Figure 1-4. Closer View of the Location of the Proposed Project Showing the Potential Impact Barangays for the Identification of Stakeholders. The direct impact areas are the reservior and dam (red lines), existing irrigation canal, and the rice farms.

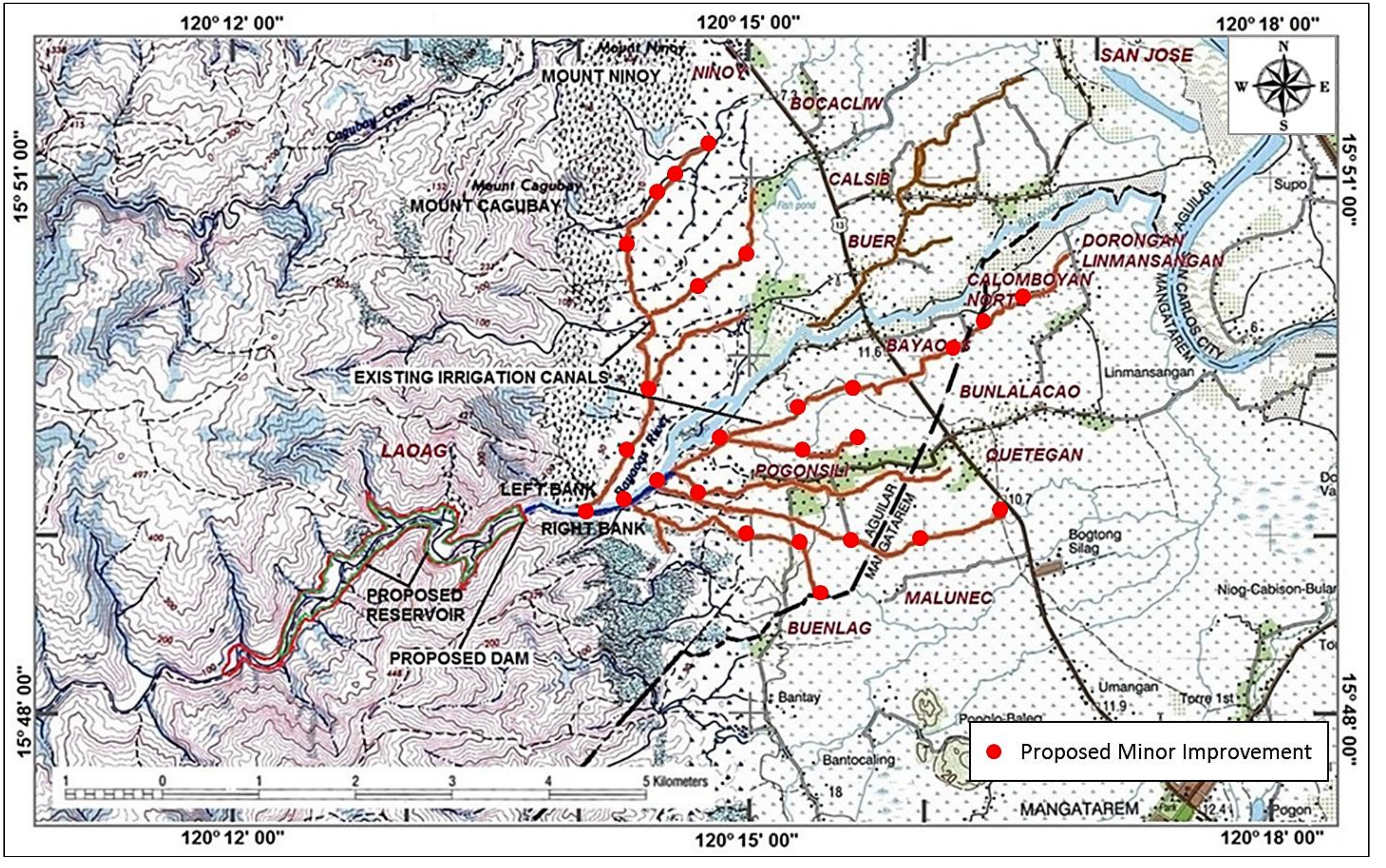


Figure 1-5. Location Map of Proposed Minor Improvement Works (red dots) in Existing Canals and Service Areas

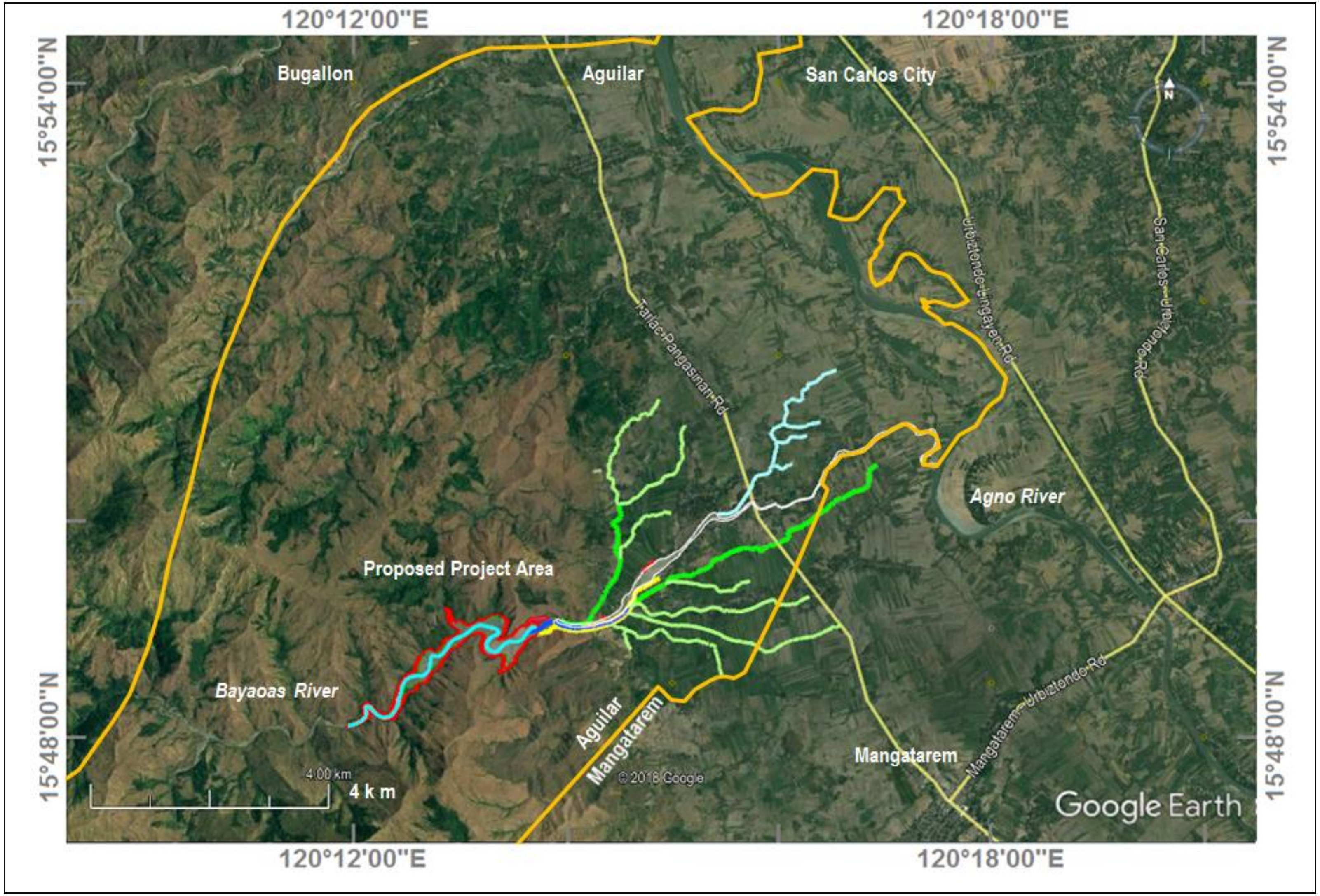


Figure 1-6. Satellite View of the Location of the Proposed Project

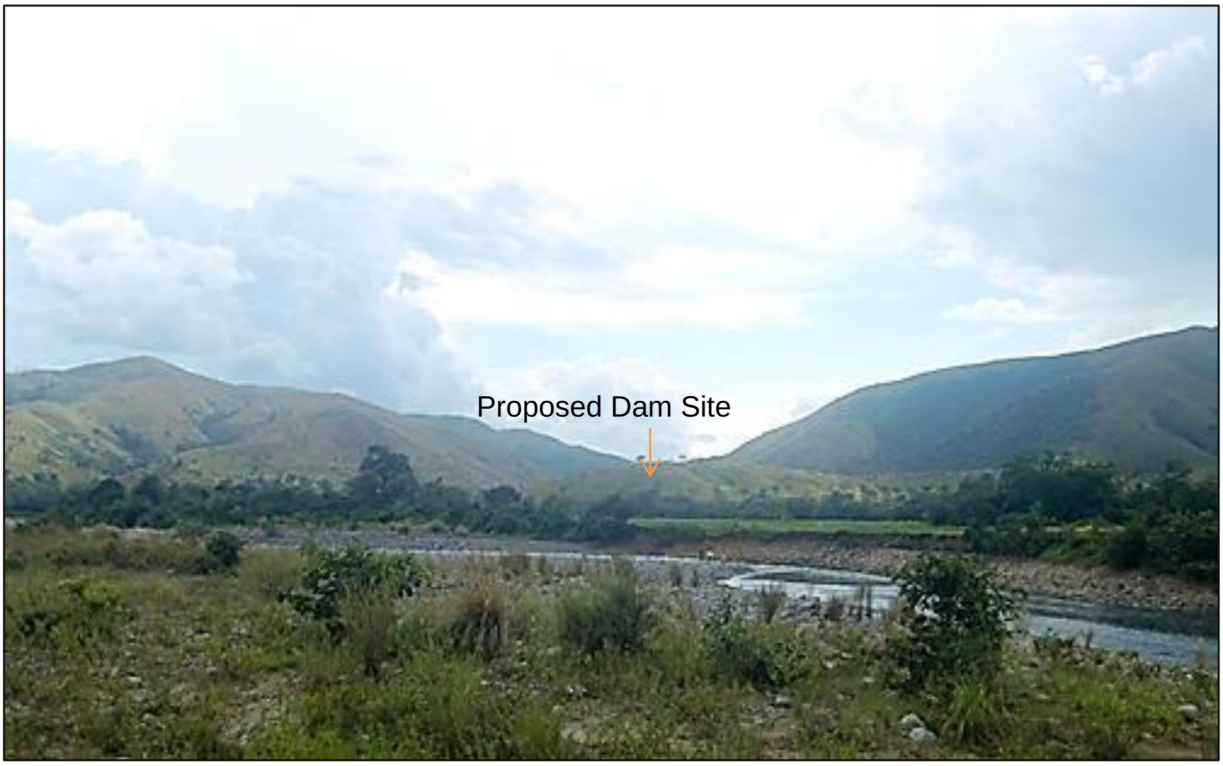


Photo 1-1. Panoramic View of the Damsite, Bayaoas River, and Left Bank Irrigation System taken from the Proposed Access Road Area (looking west)

The Proposed Project is accessible by land. The dam site is accessible from Tarlac-Pangasinan Road, either through Barangay Bayaoas in Aguilar, or Barangay Quetegan in Mangatarem. The Bayaoas (north) route consists of 2.4 km concrete road which converge just south of Baoyaoas River in Y-intersection with the 3.0 km concrete road of the Quetegan (south) route, which traverses Barangay Pogonsili. From the intersection, a new 3.0 km access road to dam site will be constructed parallel to Bayaoas River. The new access road will pass through lowland existing dirt road and orchard.

Table 1-1 shows the accessibility of the Bayaoas and Quetegan routes from Quezon City, Metro Manila (188 km); Urdaneta City, Pangasinan (55 km); Dagupan City, Pangsinan (36 km) and San Fernando City, La Union (109 km).

Table 1-1. Accessibility of the Project Site from Different Points of Origin

Origin	Destination	Distance, km	Approx Travel Time, hr	Road and Direction
Quezon City Hall, Metro Manila	Barangay. Quetegan, Mangatarem	188	4	Quezon Ave (SW), EDSA (NNW-W), NLEX-SCTEX-TPLEX (N), Paniqui-Ramos Road (W), Paniqui-Camiling Road(WNW), Tarlac-Pangasinan Road (WNW-NW)
Urdaneta City Town Hall	Barangay. Quetegan, Mangatarem	55	1.5	Calasiao-Urdaneta Road (W), Malasiqui-Urdaneta (SW), Malasiqui-Urdaneta (W), Basista-San Carlos (SE), Basista-Urbiztondo (SW), Mangataren-Urbiztondo (SW), Tarlac Pangasinan (NW)
Dagupan City, Town Hall	Barangay Bayaoas, Aguilar	36	1.5	Dagupan City Town Hall in AB Fernandez Avenue (W), Binmaley-Dagupan Regional Road (W-NW), Quibaol-Nansangaan Regional Hi-way (WSW), Tarlac-Pangasinan Road (S)
Dagupan City, Town Hall	Barangay Bayaoas, Aguilar	36	1.0	Dagupan to San Carlos City San Carlos to Aguilar
San Fernando City, La Union	Barangay Bayaoas, Aguilar	109	3.5	McArthur Hi-Way (S), Pangasinan-La Union Road (SSE-SSW-SW), Judge Jose De Venecia Extension (SW), Binmaley-Dagupan Regional Road (W-NW), Quibol-Nanansangan Regional Hi-way (WSW), Tarlac-Pangasinan Road (S)

1.2 Project Rationale

Water is used in the rice farming cycle, in: land preparation, the nursery, transplanting, and crop management, which are followed by drainage and harvesting. The main physical objective of the Proposed Project is to build a dam to impound the water of Bayaoas River with necessary improvements in the existing irrigation systems downstream. Based on the BSRIP 2015 Feasibility Study Report, the Proposed Project can provide dependable dry season supply of irrigation water from the present area of 200 ha to 1,238 ha. This is coupled by a significant increase in rice production from an estimated low of 2.5-3.6 tons/ha to a maximum 5.2 tons/ha, and from 5,013 tons/year to 13,718 tons/year, as presented in **Table 1-2.**

Table 1-2. Summary of Comparison Without the Project and with Project Scenarios on Rice Production

Crop	Present (2015)			Future with Project		
	Area ha	Yield Rate tons/ha	Total Yield tons	Area ha	Yield Rate tons/ha	Total Yield tons
Paddy Rice						
Dry Season						
Irrigated	200	3.2	640	1,238*	5.2	6,438
Wet Season						
Irrigated	710	3.6	2,556	1,400	5.2	7,280
Rainfed	640	2.8	1,792			
Third Crop						
Pump Irrigated	10	2.5	25			
Total			5,013			13,718
Corn						
Rainfed Dry Season	25	4.0	100			

Source: NIA, 2015. BSRIP Feasibility Study Report. p 4-6.

* Plus 162 ha in slightly elevated ricefields for adoption of pump irrigation with the available diverted surface water

The proposed area is part of agricultural area of 6,347.31 ha or 32.54% of the total land area of Aguilar. This is distributed as 3,605 ha for SAFDZ/NPAAD, 885 ha for lowland rainfed areas, and 1,857 has for upland (100 m and below) rainfed areas.[1]

By Republic Act No. 8435 otherwise known as the Agriculture and Fisheries Modernization Act of 1997, "Strategic Agriculture and Fisheries Development Zones (SAFDZ)" refers to areas within the NPAAD identified for production, Agro-Processing and marketing activities to help develop and modernize, either the support of government, the agriculture and fisheries sectors in an environmentally and socio-cultural sound manner.

"Network of Protected Areas for Agricultural and Agro-industrial Development (NPAAD)" refers to agricultural areas identified by the Department (of Agriculture) through the Bureau of Soils and Water Management in coordination with the National Mapping and Resources Information Authority in order to ensure the efficient utilization of land for agriculture and Agro-industrial development and promote sustainable growth. The NPAAD covers all irrigated areas, all irrigable lands already covered by irrigation projects with firm funding commitments; all alluvial plain land highly suitable for agriculture whether irrigated or not;

[1] *Source: 2013-2022 Aguilar CLUP, pp. 62, 64*

agro-industrial crop lands or lands presently planted to industrial crops that support the viability of existing agricultural infrastructure and agro-based enterprises, highlands, areas located at an elevation of five hundred (500) meters or above and have the potential for growing semi temperate and high-value crops; all agricultural lands that are ecological fragile, the conversion of which will result in serious environmental degradation, and mangrove areas and fish sanctuaries.

1.2.1 Current Situation on Rice Farm Irrigation

Based on BSRIP 2015 Feasibility Study Report (Chapter 3), the arable area is primarily cultivated to rice and corn crops. The area is around 1,400 ha, which is distributed as follows: as about 700 ha to the north (left bank), and 700 ha to the south (right bank) of Bayaoas River. The irrigation canals were indigenously constructed, as such they benefitted from local knowledge, and BSRIP project provides the complementary technical knowledge for it.

Two irrigation intakes are in the left (north) bank (for Don Queron CIS[2] and Buer-Calsib CIS), and four in the right (south) bank (for Patapaya CIS, Pogonsili CIS, and Quetegan). In consultation with the irrigators associations (IAs) during the detailed engineering design, field validation will be done the names and location of intakes as the FS also mentions Cali-Baro and Bayaoas Irrigation Systems in the right bank.

Table 1-3 shows a summary of the use arable lands in the dry and wet season, while the **Table 1-4** expands such summary by location. The areas will also be validated with the farmers, starting at the pre-construction stage. **Figures 1-7 and 1-8** provide visualization of these areas on maps.

During the dry season, the mean decadal (10 days) daily discharge of Bayaoas River water is 1.36 m^3/s in November down to 0.16 m^3/s in March, taken from 1983 to 2007 daily streamflow data of the Bureau of Research and Standard of DPWH (with missing data). In this season, only around 200 ha or 14.3% of the total arable area are irrigated by gravity and planted with rice. Additional 10.0 ha for rice and 25.0 ha for corn are supported by pumping water from nearby creeks, ponds or shallow tube wells. This leaves an idle land of 1,165 ha or 58.2% of arable land. Rice production in irrigated area is 3.2 tons/ha. A third crop by pumping yields an average of only 2.5 t/ha. The reasons for the low productivity include: (i) insufficient supply of irrigation water due to the low flowrate of Bayaoas River during dry season, (ii) frequent repairs, and (iii) low amount and untimely application of fertilizer and other farm inputs.

During the wet season irrigated areas increases to 1,350 ha. This includes the increase of irrigated areas by existing communal irrigation system to around 710 ha or 50.7% due to the increase in water flowrate in Bayaos River. The rainfed areas total 640 ha or 45.7% of the total arable area. An area of around 50 ha is flooded. Rice yield stands 3.6 tons/ha for irrigated areas and 2.8 t/ha for rainfed areas.

[2] *communal irrigation system*

Table 1-3. Summary Use of Arable Lands in the Dry and Wet Seasons

Arable Land	Dry Season Area has.	Dry Season Arable Land Share, %	Wet Season Area has.	Wet Season Arable Land Share, %
Rainfed Paddy Rice			640	45.7
Irrigated Paddy Rice	200	14.3	710	50.7
Pump-irrigated Paddy Rice, 3rd crop	10	0.7		
Corn	25	1.8		
Fallow/Idle (flooded)	1,165	83.2	(50)	3.6
Total	1,400	100.0	1,400	100.0

Source: NIA, 2015. BSRIP Feasibility Study Report. p 3-8

Table 1-4. Use of Arable Land by Location in the Dry and Wet Seasons (in hectare)

Location with Respect to Bayaoas River	Dry Season Paddy Rice Irrigated	Dry Season Paddy Rice Pump Irrigated, 3rd crop	Dry Season Corn	Dry Season Fallow	Dry Season Total	Wet Season Irrigated	Wet Season Rainfed	Wet Season Flooded	Wet Season Total Area
A. Left (north) Bank									
Don Queron CIS	25	5		258	288	150	138		288
Calsib CIS (NIA)	125	5		132	262	200	62		262
Other Areas				150	150		100	50	150
Subtotal	150	10		540	700	350	300	50	700
B. Right (south) Bank									
Patapaya CIS	15			35	50	50			50
Pogonsili CIS	25			395	420	190	230		420
Quetegan	10		25	195	230	120	110		230
Subtotal	50		25	625	700	360	340		700
Total	200	10	25	1,165	1,40 0	710	640	50	1,40 0

Source: NIA, 2015. BSRIP Feasibility Study Report. p 3-9

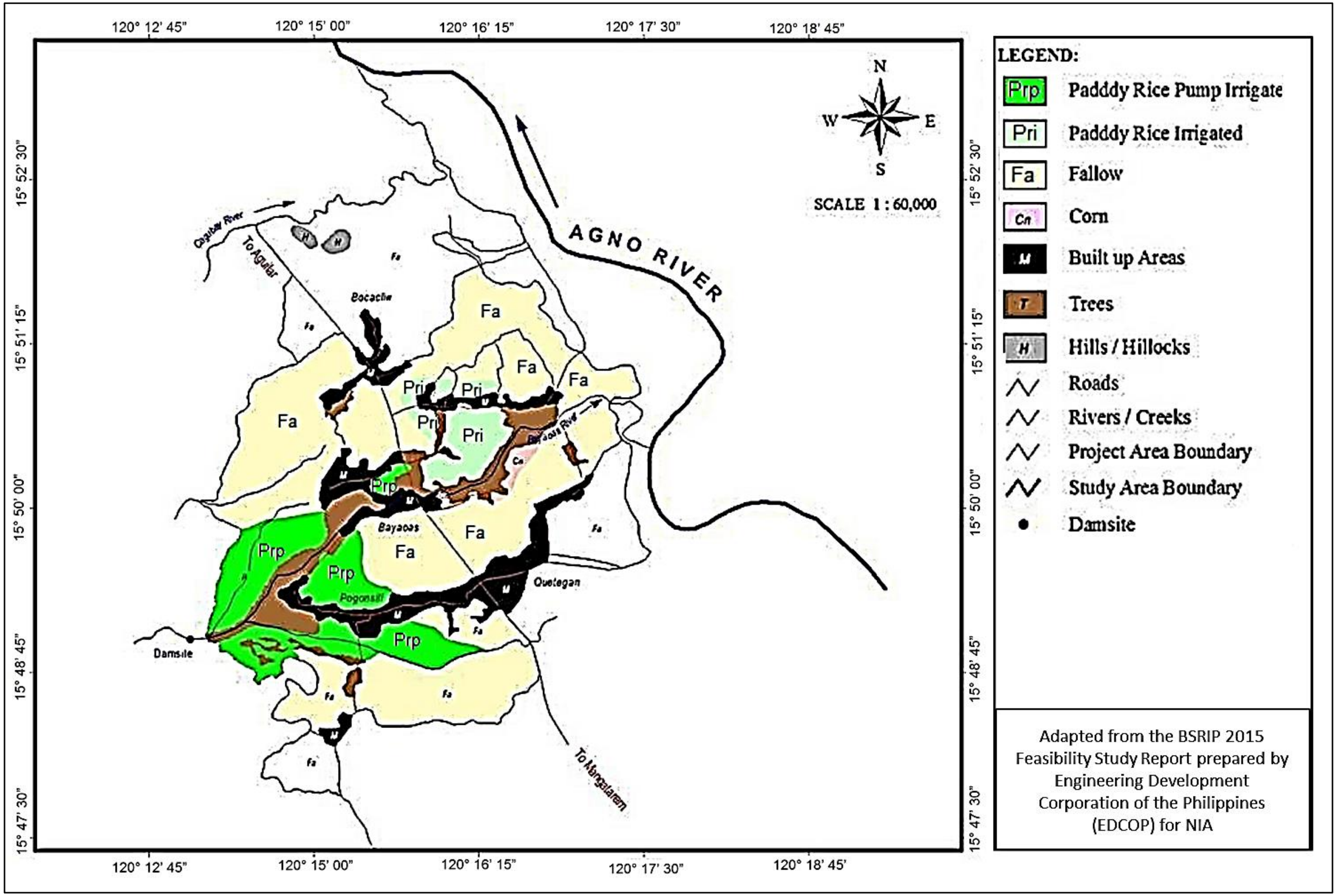


Figure 1-7. Representation of Dry Season Cropping Condition of Arable Areas

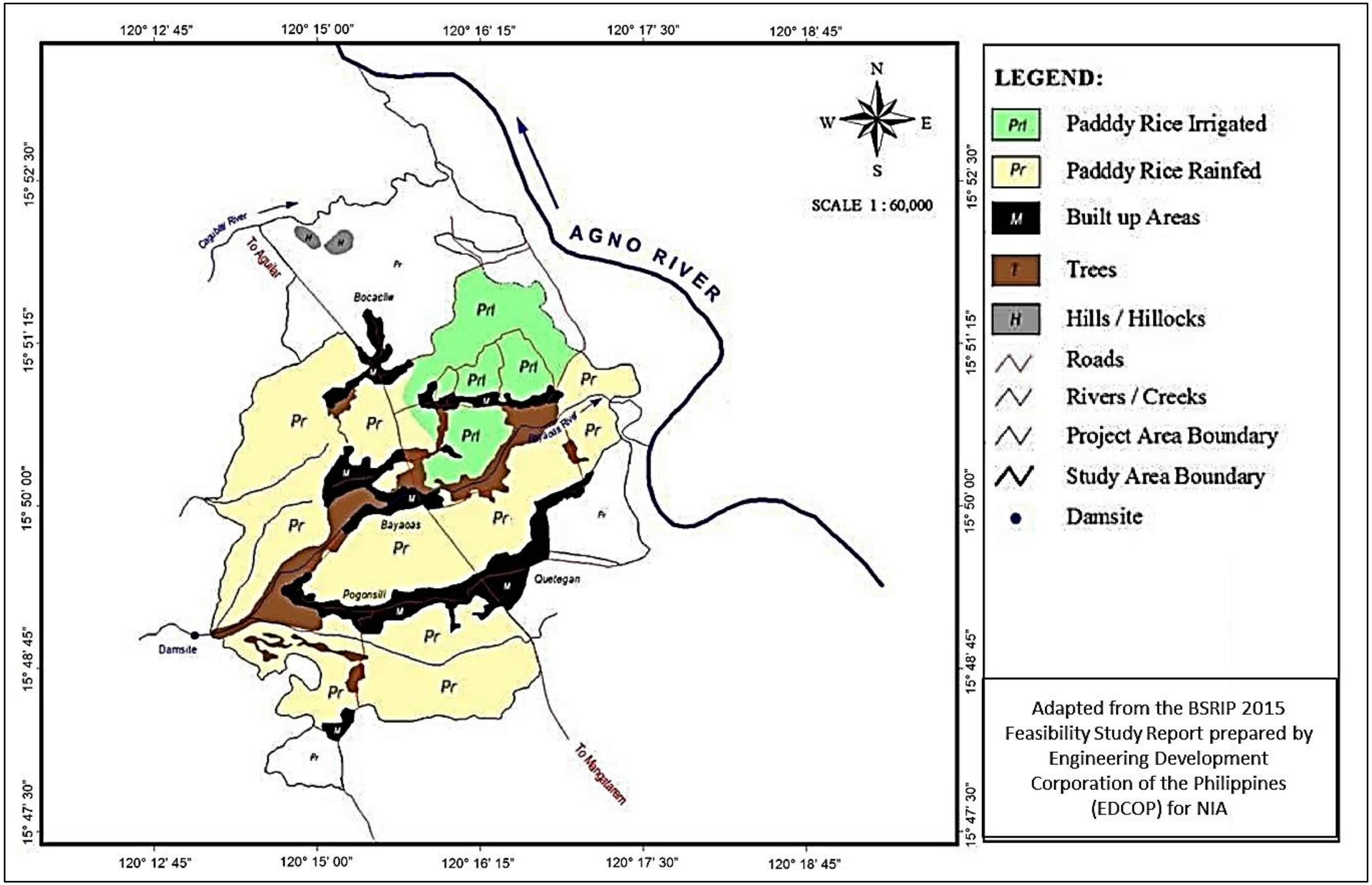


Figure 1-8. Representation of Wet Season Cropping Condition of Arable Areas

1.2.2 Future Scenarios with the Proposed Project

With dependable irrigation water from the reservoir at 2.4 m^3/s or 2.1 L/s/ha, and with improvements in the irrigation canals, the BSRIP 2015 Feasibility Study shows a potential, irrigation of 1,238 ha (with 162 has idle) during the dry season, and during the wet season the whole 1,400 ha. Paddy yield is expected to increase 5.2 t/ha in both seasons for a total annual paddy rice production increase from 5,013 tons to 13,718 tons, or a potential net increase of 8,715 tons.

For the cropping pattern in dry season, paddy rice transplanting would be in the 3rd week of October to 3rd week of November and harvesting from 1st week of February to 1st week of March. The wet season paddy rice transplanting would be from 2nd week of June to 2nd week of July and harvesting from 3rd week of September to 3rd week of October. Terminal drainage will occur ten (10) days before harvest for both wet and dry season.

Labor requirements would be 82 person-days in the dry season and 79 person-days in the wet season. In addition, the present labor requirement of 116.1 thousand person-days annually is expected to increase to about 210.4 thousand person-days with the project scenario due to an increase in cropping intensity from 113% to 188%. With the projected available farm labor of 749 thousand person-days, there would still be a surplus labor of 538.6 thousand person-days.

The Proposed Project would eventually contribute to the provincial, regional and national efforts in rice production. As of 2017, Pangasinan has a service area of 110,553 ha or 63.11% of potential irrigable area of 175,180.29 (**Table 1-5**). In 2014, Pangasinan contributed 65% of the total rice production in Region 1.[3]

The Department of Agriculture reports that the country's rice production in 2017 is at a record high of 19.28 million metric tons. In 2018, the target production is projected to stand at 20 million metric tons of palay or 12.9 million metric tons of rice.[4]

Table 1-5. Status of Irrigation Development Based on Inventory as of December 31, 2017

Attribute	Pangasinan	Region 1	National
Estimated Total Irrigable Area, Ha (3% Slope Land)	175,180.29	264,491.00	3,128,631.00
Service Area, Ha			
National Irrigation System	31,280.00	61,499.44	867,902.74
Communal Irrigation System	32,262.00	57,519.40	563,230.28
Private Irrigation System	16,325.00	20,788.45	184,869.79
Other Government Agency Assisted Irrigation System	30,686.00	50,575.83	171,983.68
Total of Service Area	110,553.00	190,383.12	1,887,986.49
% of Irrigable Areas	63.11	71.98	60.35
Total remaining area to be developed	64,627.29	74,107.88	1,240,644.51

Source: http://www.nia.gov.ph/sites/default/files/pdf_reader/CY2017_status-of-irrigation-development.pdf

[3] *Source: http://pangasinan.gov.ph/wp-content/uploads/2014/02/Region1.jpg.*
[4] *Source: http://www.pna.gov.ph/articles/1042884*

1.2.3 Induced Benefits

Induced benefits (positive impacts) from BSRIP on agricultural economy include opportunities for increase in agricultural labor, improved agricultural commerce, aquatic industry, improved access to upland greening projects, education and recreation such as boating and fishing.

Generically, the brochure of the Bureau of Soils and Water Management claims that small water impounding project (SWIP) is more than providing irrigation to marginal upland areas. Multiple uses have been outlined, as follows:

i. provides water for supplemental irrigation, domestic purposes and livestock production in critical, less accessible upland areas and isolated, vulnerable resource-poor communities;

ii. enhances upland productivity with strong sense of responsibility among farmers while ensuring environmental sustainability;

iii. facilitates inland fish production through the culture of freshwater fish, shrimps, eels and other native freshwater species;

iv. contributes in combating local malnutrition problems and helps in alleviating poverty in the uplands;

v. serves as strategic small-scale upland structure of flood prevention and control in high rainfall areas to ensure whole-year round agricultural production, and for soil and water conservation in areas with distinct wet and dry seasons to increase cropping intensity and enhance crop diversification;

vi. enhances and facilitates recharging of groundwater and spring sources for domestic and other uses;

vii. provides other environmental impacts such as maintaining important habitat for wildlife and biodiversity, thus, augmenting government efforts in protecting our environment; and

viii. provides recreational facilities as swimming and picnic grounds for local rural communities.

The long-term benefits of SWIPs to the environmental and ecological stability are flood control, reduced soil erosion/sedimentation and water moisture conservation through agro-forestry development in the watershed.

1.3 Project Alternatives

Project alternatives for BSRIP under the Philippine EIS system refers to project siting, development design, process/technology selection, and resource utilization. In terms of technical, commercial, social and natural environmental aspects, such alternatives are guided mainly by the objectives of collecting and distributing sufficiently dependable irrigation water to rice fields in the project area.

1.3.1 Siting of Source of Irrigation Water Supply

Bayaoas River is the only river present in the area that can provide irrigation water by gravity. Aside from Bayaoas River, the alternative supply of irrigation water includes the groundwater and Agno River Water which are below the level of the irrigated fields. The use of groundwater and Agno River would be less technically, commercially, socially and environmentally feasible. For example, these sources would require pumps and larger storage facilities, which are more expensive in the long term. There is much uncertainty on the available groundwater volume for a 2.1 L/s/ha of water requirement. This would also cause significant groundwater draw down during the dry season. Agno River is 6.6 km away and about 37 m lower than the highest elevation irrigable areas.

1.3.2 Technology Selection/Operation Processes

Basically, the technology adopted for the siting of the water source is gravity which is more economical in the long term than the use of pumps that will use liquid fuels which emit greenhouse gases during combustion. As a water source that is gravity powered, specific requirements were addressed during feasibility study stage on the siting of components of the irrigation system particularly the reservoir and appurtenances.

1.3.3 Siting of Water Reservoir

Harnessing of Bayaoas River would involve construction of water reservoir. One alternative is the construction of lined multiple lowland reservoirs in the left (north) bank and right (south) bank of Bayaoas higher than the rice fields. However, this would also require a diversion dam and vast tract of private lands. For 1,238 ha of ricefield to be irrigated in 50 days at 2.1 L/s/ha, the volume of water to be stored should be 11,231,136 m^3, without buffer for evapotranspiration. Thus, for a 3-meter deep reservoir, this would require a land area about 3,743,712 m^2 or 374 ha.

Siting of dam in Bayaoas River is site-specific for the covered existing irrigation systems. The proposed location of the dam has the following advantages: (i) the optimum location for collecting the required large amount of water in the watershed, (ii) closest to the irrigation systems of larger area, and (iii) in narrow channel for stability and minimum construction materials. Further upstream would mean longer supply canal and longer access road that will add to the cost of the project. Moving downstream would mean larger area and higher cost of the dam. So that the current location balances and resolves the cost of infrastructure system components between that of: 1) supply canal and access road, against that of 2) the larger area and the dam.

1.3.4 Dam Type and Design

A dam may be an embankment (earth or rock fill) dam or concrete dam (gravity, arch and buttress), the latter requires a higher cost of construction. The proposed dam is an embankment dam basically due to the abundance of rock and earth fill materials in the area. Generically, the trapezoidal cross section along the river segment (bank view) of an embankment dam has an impermeable clay core, with upstream and downstream protective filter zones and outer shells. The impermeable core prevents water from seeping through the dam. The filter serves as transition and cushion in-between zones to prevent the loss of fines in the central core. The shell provides stability for the dam.

Table 1-6 shows the attributes of two alternative dams. The proposed dam is a 48.4-m high (93.9 masl) zone embankment type, with central clay core, with fine/coarse/fine filter, with random fill outer shell 1, and rockfill outer shell 2. The random fill outer shell 1 and rock-filled outer shell 2 represent the sequence of an onsite available material from soil to rock level. The dam height is inclusive of a normal freeboard of 8.90 meters, broken down as 7.30 m for 1000-year flood surcharge, 0.60 m for wave due to wind, and 1.00 m for minimum freeboard. The maximum normal operating height is at 85 masl or 39.5 m from the river bed of 45.5 masl.

The alternative dam is 35-m high (80.5 masl) zone embankment type, with central clay core, with fine/coarse/fine filter, with random fill outer shell, and a rock toe downstream. The height only considers a 100-year design flood. The minimum freeboard provided is only 2.85 meters, enough to protect against wave run-up. The crest of the dam is also cambered to a maximum of 1.5 meters to allow for foundation settlement.

Table 1-6. Bayaoas Dam Alternative Attributes

Dam Attributes	Proposed Dam	Alternate Dam
Dam Height (meter)	48.40	35.0
Dam Type	Zone Embankment	Zoned Embankment
Clay Core	Central Clay Core	Central Clay Core
Filter	fine/coarse/fine upstream and downstream embankment filters	fine/coarse downstream embankment filter
Outer Shell 1	Random fill	Random fill
Outer Shell 2	U/S and D/S rockfill	none
Rock Toe	None	Rockfill

On the issue of dam safety, a slope stability analysis was conducted for the two alternative outer shell materials but with similar height of 48.4 m (at 93.90 m top elevation) **(Figures 1-9 and 1-10).** Results show a higher safety of factor for the proposed type, even under an earthquake condition. The indicative dam has an upstream and downstream slopes of 1.00 V : 2.60 H to effect a dam base of 264 m from upstream to downstream. The alternative dam has an upstream slope of 1.00 V : 3.00 H downstream slope of 1.00 V : 2.65 H, and base of around 285 m. Note that the indicative dam with 21-m shorter base would require lesser volume of materials.

The slope stability analysis was done using RocScience Slide software, which requires material properties, loading conditions, peak ground acceleration, and seismic coefficient among others. The material properties used in the stability analyses are listed in **Table 1-7**. The 45 kPa and 20-degree friction angle for the clay core and unit weights were adopted. All other properties were based on triaxial test and generally accepted material properties established in other similar dam projects elsewhere. **Table 1-8** shows loading conditions and corresponding widely accepted minimum factors of safety were adopted in the stability analyses.

From the seismic hazard analysis under the earthquake condition, the peak ground acceleration corresponding to the maximum credible earthquake (MCE) was placed at 0.21g. For the earthquake loading, a seismic coefficient of 0.5 PGA/g was derived from pseudo-static analysis which is generally acceptable for preliminary design. Here, the seismic forces acting on the dam is expressed by a static horizontal force expressed as product of the seismic coefficient and the weight of the potential sliding mass in the dam body. Unacceptable deformation is avoided with this value of seismic coefficient, as long as the factor of safety is above 1.0.

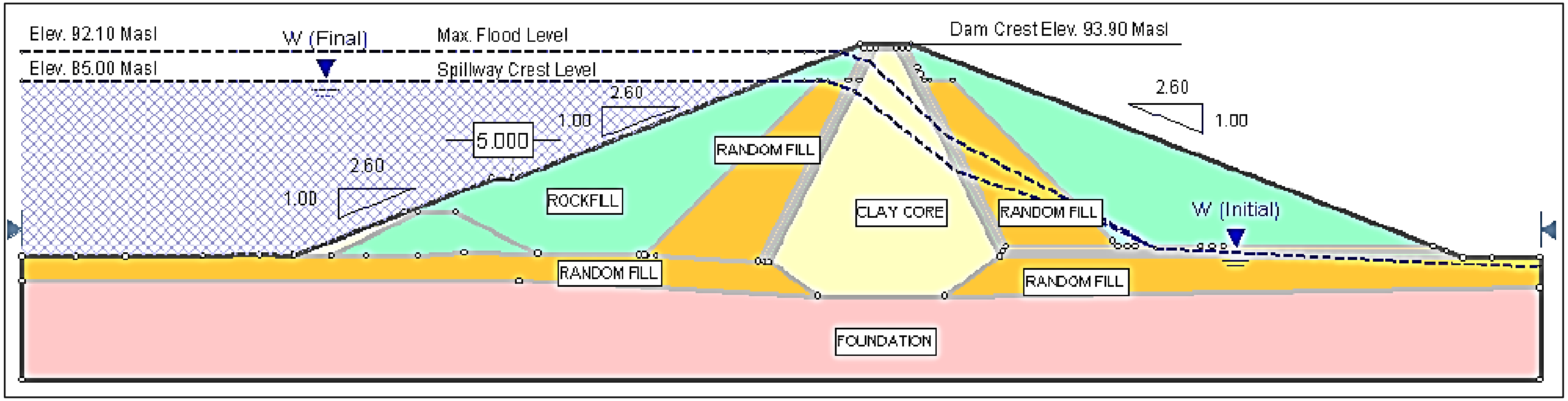


Figure 1-9. Embankment Section of Proposed Indicative Dam

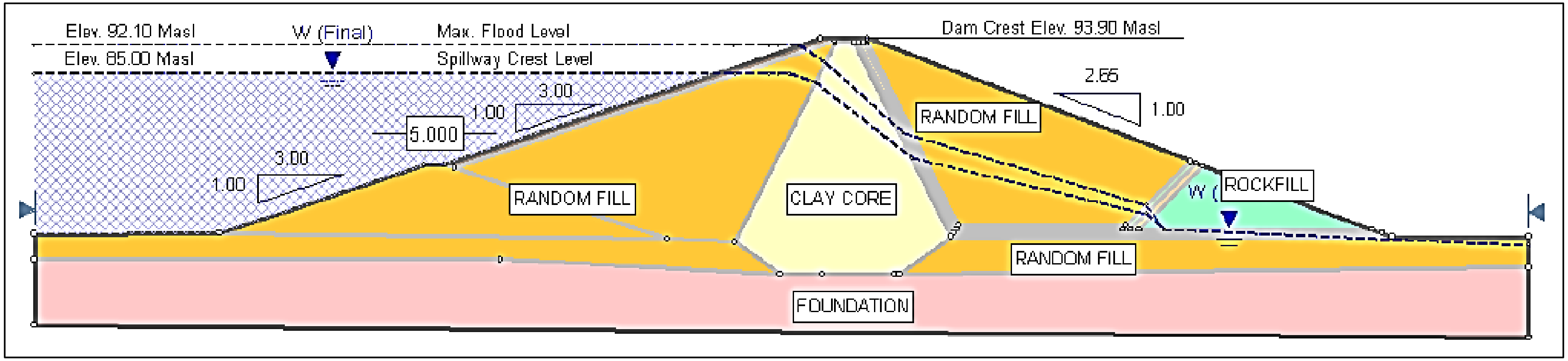


Figure 1-10. Embankment Section of Alternative Dam

Table 1-7. Properties of Dam Materials

Material	Cohesion (kPa)	Friction Angle (degree)	Bulk Unit Weight (kN/m^3)	Saturated Unit Weight (kN/m^3)
Clay Core	45	20	17	19
Fine filter	0	35	23	24
Coarse filter	0	45	23	24
Random fill	20	25	20	22
Boulder rip-rap	45	20	17	19
Foundation	0	35	23	24
Rockfill	0	40	28	28

Table 1-8. Stability Analyses Criteria on Loading Conditions

Loading Conditions (LC)		Minimum Factor of Safety	Slope
LC1	Steady state seepage with max. storage pool	1.5	Downstream
LC2	Partial rapid drawdown (from max. storage pool to min. storage pool)	1.2	Upstream
LC3	Storage Pool (with earthquake)	1.2	Downstream and upstream

A summary of the computed factors of safety (FoS) is given in **Table 1-9,** which shows the slopes of the indicative dam meet the minimum factor of safety for LC1 and LC3 (with earthquake loading), as compared with the slopes (original) of the alternative dam materials. The latter would meet the minimum factor of safety by revising the upstream slope to 1.0 V : 2.00 H, and downstream slope to 1.0 V : 2.65 H.

Table 1-9. Computed Factors of Safety by Dam Loading Conditions for Two Alternative Designs

Loading	EDCOP	Study	NIA FS	(original slopes)	NIA FS	(revised slopes)
Condition	D/S	U/S	D/S	U/S	D/S	U/S
LC1	1.571		1.467		1.652	
LC2		1.638		1.678		1.698
LC3	1.203	1.218	1.117	1.199	1.209	1.207

D/S = downstream; U/S = upstream

1.3.5 Design of Headworks

The headworks refer the structure that will supply water to the left (north) and right (south) banks irrigation system. The present proposal is the installation of the supply canal from the dam located at the right bank, with a siphon towards the left bank (Don Queron CIS).

The alternative as presented in an earlier feasibility study is a diversion dam about 900 meters below the storage dam, is just about below the current intake of the Don Queron CIS (Left Main Canal). The proposed diversion weir is ogee-shaped, 60 meters long. The reasons for not adopting this alternative are the following

i. the estimated construction cost of the structure, as designed, including the intakes to the left and right main canal at 2015 prices is P43.3 million, higher than the P22.9 million of proposed scheme;

ii. the left bank is unstable with loose materials, and would require for anchorage and protection features such as spur dikes, gabions, higher depth of cut-off walls, steel sheet piles, etc. that will increase further the development cost; and

iii. the earlier design only considers an 850 m^3/sec 100-year flood discharge, in contrast to the current estimate of 1,318 m^3/sec 100-year flood that adds a safety factor.

1.4 Project Components

1.4.1 Overall Physical Plan

The physical components and indicative sizes are presented in **Table 1-10**. The initial visualization of the location of the dam is a plot on Google Earth Satellite map presented in **Figure 1-11,** which is based on the dam site development plan in **Figure 1-12** taken from 2015 BSRIP 2015 Feasibility Study.

Table 1-10. Indicative Spatial Requirements for the Proposed Project Physical Components

	Physical Component	Indicative areas	
1.	Dam Site	17 ha	(approx 550 m x 310 m operating area within the dam site and access road)
		3.5 ha for dam; 2.5 ha for spillway for the footprint	
2.	Dam Water Reservoir Surface Area	104 ha	at dam maximum flood condition
		78 ha	at normal water level
		16 ha	at minimum water level
3.	Administration office and other support facilities during operation	to be determined	
4.	New Main Supply Canal from Dam to Main Irrigation Intakes	0.024 ha	(462 m x 2 m)
5.	New Access Road to Dam Crest	2.4 ha	(3.0 km x 8 m)
6.	Siphon Crossing Bayaoas River	0.006 ha	(80 m x 0.8)
7.	New Left Main Canal Construction	0.13 ha	(353 m barrel long x 1 m wide + 950 m CHB long x 1 m wide)
8.	New Right Main Canal Construction	0.18 ha	(250 m barrel long x 1.3 m wide +1.1 km CHB long x 1.3 m wide)
9.	Main Canal Access Road	to be identified in the future	
10.	Construction Temporary Facilities	to be determined	
11.	Construction Batching Plant	to be determined	
12.	Construction Quarry Site	to be determined	
13.	Earth Spoil Disposal Area	to be determined	
14.	Minotr repair and improvement of irrigation canals	to be determined (variable within the network)	

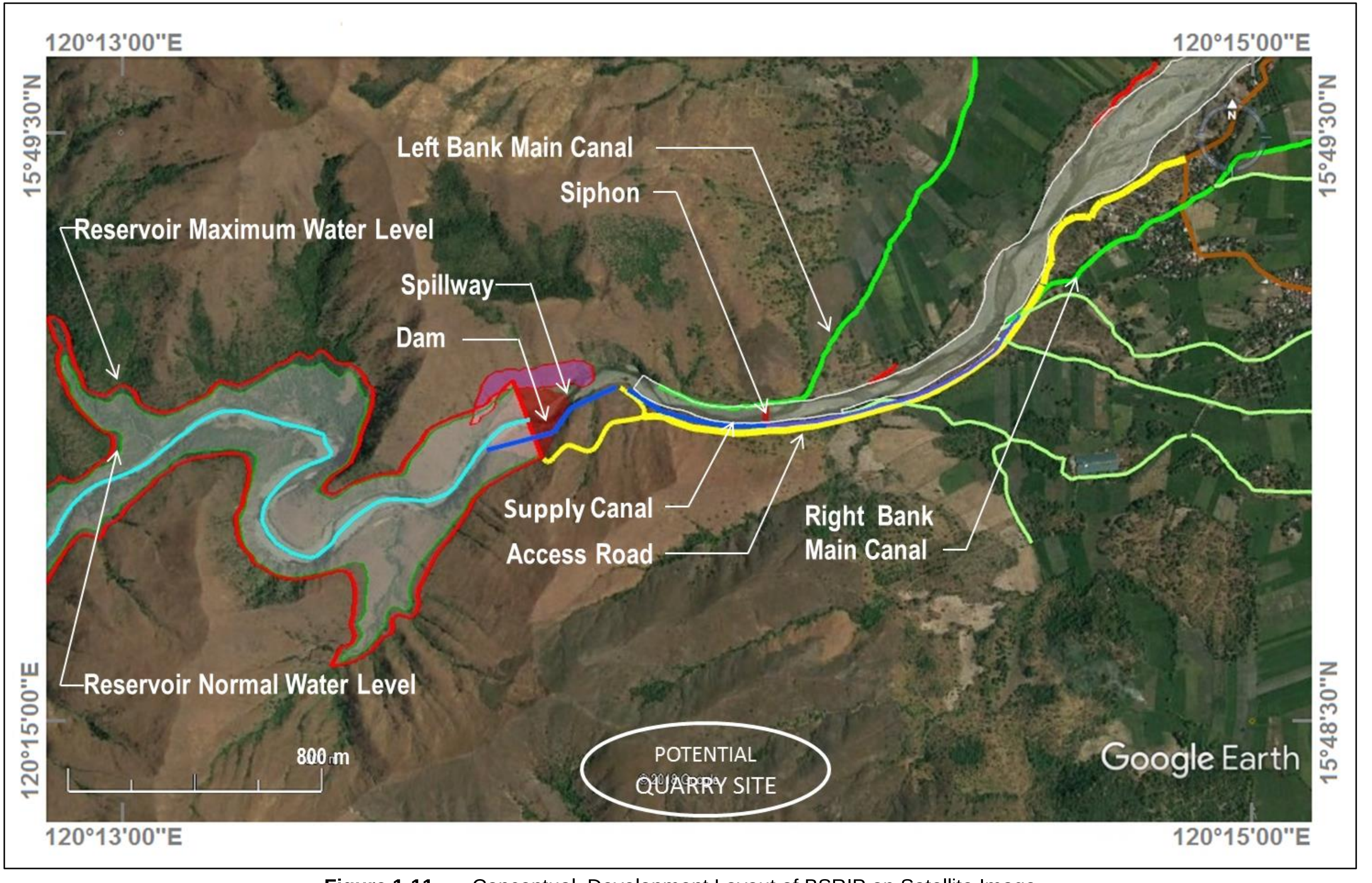


Figure 1-11. Conceptual Development Layout of BSRIP on Satellite Image

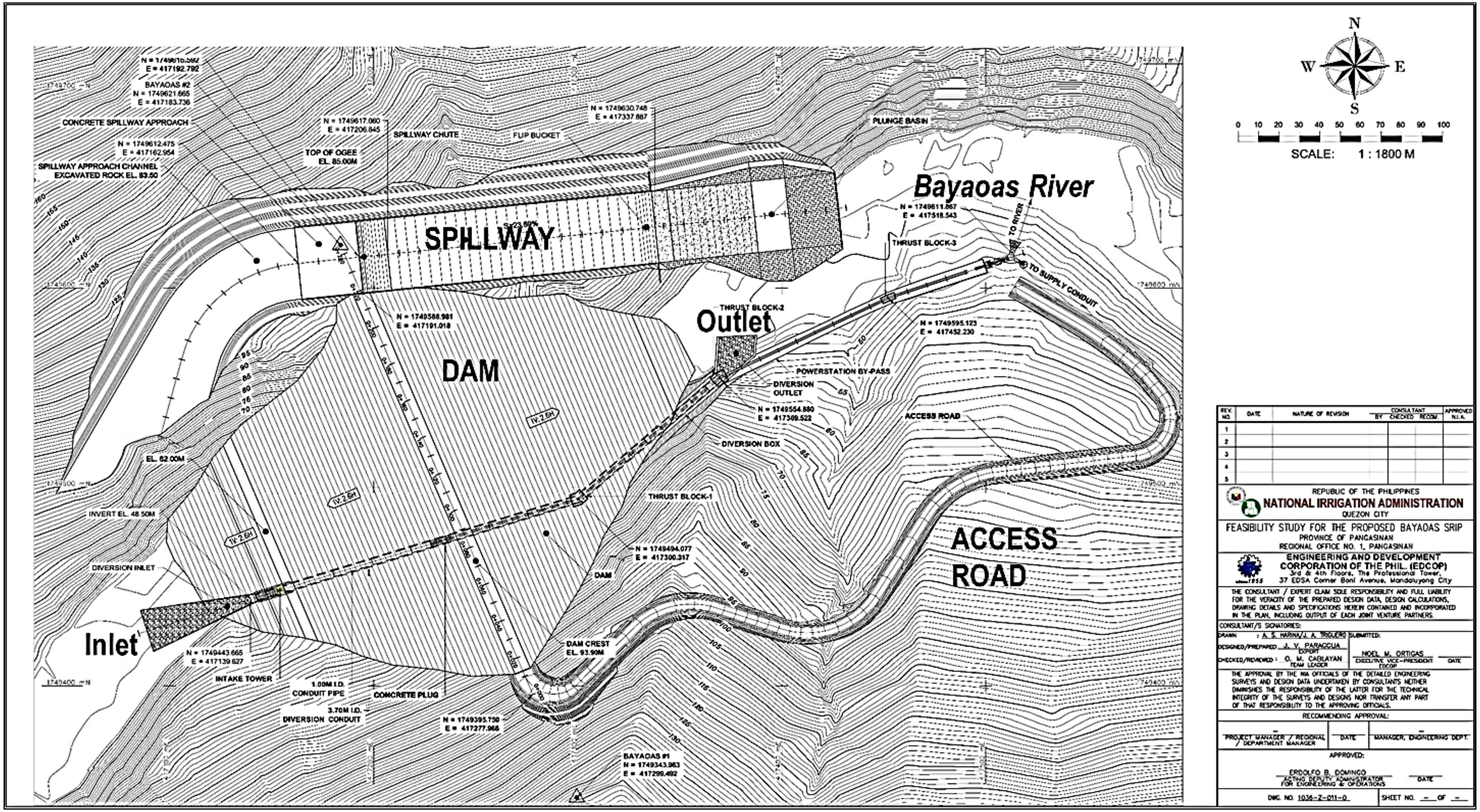


Figure 1-12. Engineering Version of Damsite Development Layout (Source 2015 BSRIP FS)

1.4.2 Indicative Dam Attributes and Appurtenant Structures

The dam will have the following attributes and structures which are discussed in detailed in the BSRIP 2015 FS Report:

i. dam type,
ii. dam dimensions (height, core trench width, widths of the crest and top of core),
iii. dam slope stability analysis (material properties, loading conditions),
iv. spillway and appurtenances (approach channel, control structure, chute, flip bucket and plunge basin),
v. diversion conduit and cofferdam,
vi. outlet works and its appurtenances (intake shaft, outlet pipe and stilling pool, and
vii. dam instrumentation.

1.4.2.1 Dam Type

The typical section of the recommended dam type is shown on **Figure 1-13.** The complete dam attributes are given in **Table 1-11.**

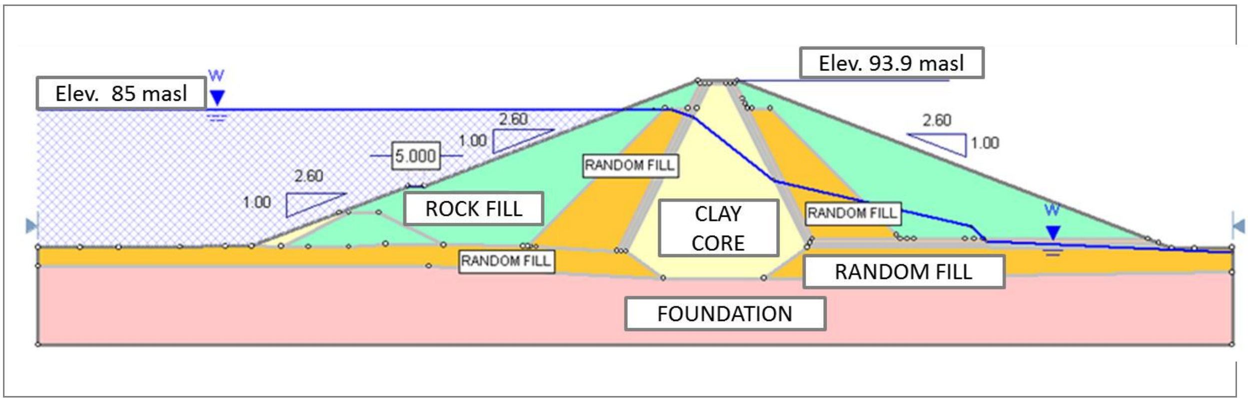


Figure 1-13. Typical Section of Embankment Dam

Table 1-11. Some Dam Attributes

Dam Attributes	Description
Dam Height from River Bed	48.40 meter (93.9 masl elevation)
Maximum Operating Level from River Bed	39.50 meter (85 masl elevation)
Dam Type	Zone Embankment
Clay Core	Central Clay Core
Filter	U/S and D/S – fine/coarse/fine filter
Outer Shell 1	Random fill
Outer Shell 2	U/S and D/S rockfill
Rock Toe	None

U/S – upstream embankment; D/S= downstream embankment

The recommended dam is a zoned embankment type (central impervious core supported by a more pervious material). However, the supporting shell will be made of zones of rock fill and random material. This type of dam was considered primarily because:

i. there will be large volume of rockfill from excavations along the spillway, or if needed, quarry areas in the vicinity of the dam location; and

ii. a rock fill supporting shell will mean steeper outer slopes (refer to the stability analysis conducted) compared to a random fill supporting shell thereby requiring lesser volume of materials.

1.4.2.2 Dam Dimensions

Dam Height. The crest of the dam or top of the dam without camber is set at elevation 93.90 masl, about 48.40 meters above riverbed elevation of 45.50 meters, measured from topographic survey.

The normal water surface is set at 85.0 masl (or 39.5 m from river bed) to provide a normal freeboard of 8.90 meters, broken down as 7.30 m for 1000-year flood surcharge, 0.60 m for wave due to wind, and 1.00 m for minimum freeboard. It was assumed that earthquake will not occur at the same time as the 1,000-year flood. Note that the 8.90-meter freeboard due to flood governs.

Crest Width. With reference to the USBR criteria as a function of the height of the dam, the will have a width of 8 meters, which is also enough for traffic access.

Impervious Core. The impervious core will have top width of 5 meters to meet the construction requirements. The impervious core will have a 1.0V:0.5H slopes extending to about 1 meter below the crest. At the centerline of the dam crest, the core will also have a positive cutoff to bedrock level 11.5 meters below the riverbed. The bottom will have a width of about 30 meters with sides sloping of 1V:1.4H to provide adequate contact with the rock foundation but also accounting for the loss of head as the water travels vertically through the foundation. Three lines of grout curtains with spacing of 6 meters will be provided for the rock foundation to control seepage.

Water Conduit Diameter. Within the upstream face of the dam, river water will pass through a 1.00 m inside diameter intake tower at 62.2 masl then down to a 3.7-m diameter conduit.

1.4.2.3 Spillway and Appurtenances

A spillway is the structure where excess water flows when the reservoir is full. The spillway is located at 85 masl of the true left abutment (northside) adjacent to the embankment dam. It is about 36-meter wide to accommodate a 1000-year flood. The recommended scheme consists of an approach channel, an overflow ogee crest, a chute terminating with a flip bucket, and a plunge basin.

The spillway alignment is situated as near the mountain slope as possible to minimize excavations. As a result however, the upper 9 meters of the right wall (which is above the max. normal water level at 85 masl is immediately adjacent to the embankment dam. This height is selected as the threshold for situating the alignment so that the joint between the concrete wall and the dam embankment will only be exposed to water pressure during flood events thereby lessening the risk of unwanted seepage. The foundation of the right side wall of the spillway is founded on firm rock.

1.4.2.4 Cofferdam

Coffer dam is a temporary structure built upstream from a dam to prevent stream flow around the excavation for a dam, minimizing the downstream flow of excavated earth materials. Eventually, the cofferdams will become integral part of the main dam. The design of the coffer day will depend on the gaging station records from 1983 to 2007, which showed a maximum peak discharge of 258 m^3/s in 1988. A gauged river hydrograph analysis showed the 5-year peak discharge of 652 m^3/s, inclusive of the base flow.

1.4.2.5 Outlet Works and its Appurtenances

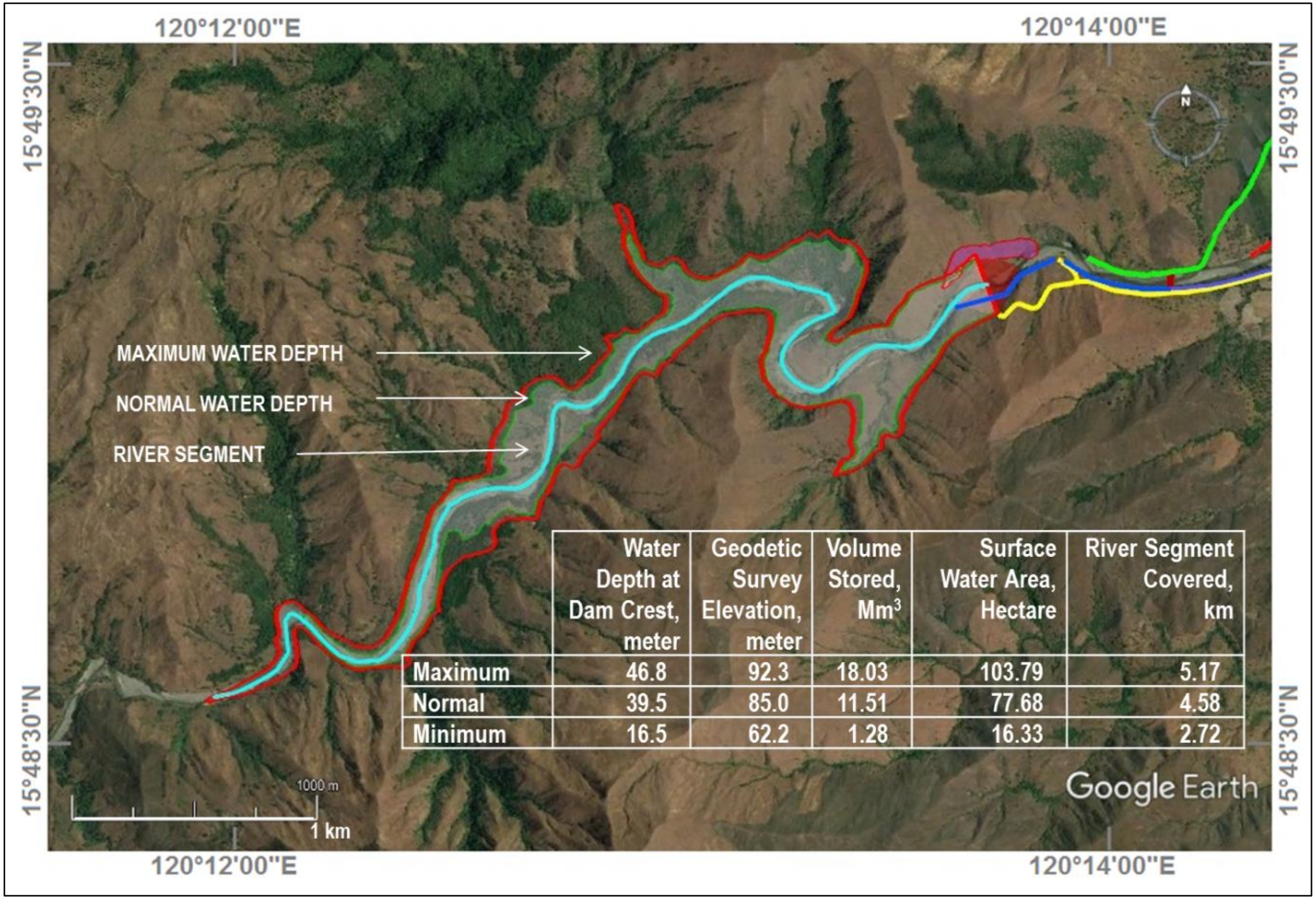
The outlet works are located at the right bank. They include the diversion conduit as access for inspection, a vertical intake shaft with a bellmouth inlet, an outlet pipe with upstream and downstream control valves, and a stilling pool which will also serve as a junction box to the irrigation supply conduit. A bypass channel provided at the stilling pool will enable diversion of water back to the Bayaoas River to satisfy irrigation requirements of the Calsib CIS and environmental requirements.

1.4.2.6 Dam Instrumentation

Minimum dam instrumentation shall be installed to include piezometer surface measuring points and permanent benchmark.

1.4.2.7 River Water Reservoir

The reservoir indicative covered area, maximum water depth, normal operating water depth and river segment of the reservoir is shown in **Figure 1-14.** The maximum water depth (red line) is a flood condition that would be at 92.3 masl or 46.8 m high from the dam crest river bed (45.5 masl) , with volume stored of 18.03 million m^3 and surface area of 104 ha, covering about 5.17 km of upstream segment of Bayaoas River. The normal (maximum) operating water depth (green line) would be at 85 masl (also the floor level the spillway ogee) or 39.5 m from the dam crest river bed, with volume stored of 11.51 million m^3 and surface area of 78 ha covering about 4.58 km of upstream segment of the river. The minimum level at 62 masl, would be at 16.5 m deep from the dam crest river bed, with volume stored of 1.28 million m^3, and surface area of 16 ha, covering about 2.72 km of the upstream segment of the river. Additional information on elevation is presented in **Table 1-12.** The relationship of reservoir surface area and cumulative capacity with respect to reservoir surface water elevation is shown in **Table 1-13**. The difference in volume between the maximum normal operating level at 85 mas and the minimum operating level at 62 masl is 10.23 million m^3 for the irrigation and environmental flow.



	Water Depth at Dam Crest, meter	Geodetic Survey Elevation, meter	Volume Stored, Mm^3	Surface Water Area, Hectare	River Segment Covered, km
Maximum	46.8	92.3	18.03	103.79	5.17
Normal	39.5	85.0	11.51	77.68	4.58
Minimum	16.5	62.2	1.28	16.33	2.72

Figure 1-14. Close-up View of the BSRIP Reservoir

Table 1-12. Reservoir Data

Reservoir Water Level	Water Depth m	Volume Stored Mm^3	Surface Water Area ha	Bayaoas River Segment Length, km	Ground Survey Elevation m	Google Earth Elevation m	NAMRIA Map Elevation m
Maximum	46.8	18.03	103.79	5.17	92.3	107	102
Normal	39.5	11.51	77.68	4.58	85.0	99	94
Minimum	16.5	1.28	16.33	2.72	62.2	77	72

Note: Dam river bed elevation is 45.3 m by ground survey; 47 m in Google Earth; and 55 m in NAMRIA topographic map.

Table 1-13. Reservoir Surface Area and Cumulative Capacity by Reservoir Surface Water Elevation

Reservoir Surface water Elevation, masl	Area, ha	Cumulative capacity, million m^3
45.5	0	0
50	2.79	62.85
60	11.79	791.48
70	32.01	2,981.16
80	60.84	7,623.36
90	94.52	15,391.37
100	134.84	26,859.81
110	181.73	42,688.39
120	231.36	63,342.70
130	280.13	88,917.29
140	336.63	119,755.62

The BSRIP 2015 FS Report also presents a simulation of reservation operation under decadal (10 days) accounting of reservoir inflows and releases including potential evaporation and other losses at the reservoir (10% of evaporation). The simulation was set to meet the requirements for irrigation water diversions through gravity. This involves the computation of changes in stored water using basic continuity or conservation of volume equation for a reservoir taking into account the relationship of the elevation versus storage volume and surface area. The dead storage was determined based on sedimentation rate and normal water surface elevations to be assumed and determined were used.

The following operations criteria were set:

i. Maximum annual shortage should be less than 25% of average annual demand.
ii. Maximum cumulative shortage for ten (10) consecutive years should be less than 50% of the average annual demand.
iii. Reservoir reliability should not be less than 95%.
iv. Shortage should not be exhibited in three (3) successive years.
v. Allowable carryover storage should not be higher than 24 months.

The following cases were in effect in the simulation:

i. Spillage occurs when the water level reaches the maximum operating level.

ii. Water is drawn within the active reservoir storage when water level is above the minimum water level.

iii. When the reservoir is below the minimum operating level: firstly, inflow is utilized to replenish the deficit first; secondly, excess inflow, if any, is used to satisfy irrigation demand; and, thirdly, storage to increase water level but not higher than the normal water surface.

The simulation covered the 1961-2013 decadal stream flow data estimated for Bayoas River (as presented in the Hydrology Module, and the varying normal water surface elevations from 80 to 85 masl. The result of the 85 masl run is presented in **Table 1-14**, which shows conformance with all of the operations criteria. Details of simulation table are presented in **Annex 1-2**. The simulation provides a 98% reliability in providing irrigation water supply. There are cases of 28% frequency of spills.

Table 1-14. Results of Reservoir Operation Simulation @ 85 masl

	Parameter	Description
1.	Simulation Period	1961-2013
2.	Number of Decades (10 days)	1908
3.	River Bed Elevation	45.49 masl
4.	Irrigated Rice Area during Wet Season	1,400 ha
5.	Irrigated Rice Area during Dry Season	1,238
6.	Ending Storage at Maximum Water Level of 85 masl	11.507 million m^3
7.	Ending Storage at Minimum Water Level of 62.25 masl	1.284 million m^3
8.	Frequency of Spills	529 or 28%
9.	Frequency of Deficit	24
10.	Reliability	98%
11.	Maximum Annual Deficit	3.860 million m^3 or 15% of diversion requirement
12.	Maximum Cumulative Shortage: 10 successive years	9.660 million m^3 or 37% diversion requirement
13.	Maximum Number of Decades (10 days) reservoir is full every year	15
14.	Minimum Number of Decades (10 days) reservoir is full every year	5
15.	Maximum Carry-over period	10 months
16.	Number of 3 successive years with deficit	0
17.	Number of times storage below minimum	0

Source: BSRIP 2015 FS Report. Chapter 7

The dam is designed to contain river and rainwater at maximum level of about 39.5 m during the wet season, making the dam a flood control structure. Water depth will be largely variable to minimum level as the season goes to the dry season. The control of water flow will be at the distribution channel at the right and left bank of Bayaoas River, maintaining the necessary environmental flow that will also serve the separate irrigation intake in Barangay Buer. The equitable flowrate distribution will be arranged with the irrigators' associations.

1.4.2.8 Access Road

Access to the dam site would either be from barangay Quetegan, Mangatarem or from barangay Bayaoas, Aguilar. The Quetegan route starts from the national highway then on westward direction along the concrete barangay road going to Pogonsili. The Bayaoas route is also from the national highway just south of the Bayaoas Bridge then traversing the barangay road alongside the Bayaoas River then to Pogonsili. The two routes converge to a Y-shape intersection somewhere at Pogonsili, thus the Quetegan and Bayaoas routes is 2.4 kilometers and 2.7 kilometers respectively.

To illustrate the areal coverage of the new access road to the damsite, the starting point is set at the intersection of the Quetegan and Bayaoas barangay roads. The example access road negotiates an existing cart track/trail, near Bayaoas River, on a south-westerly direction of about 0.9 kilometer then to a westerly direction of about 1.6 kilometers, then it will connect to a 0.5 kilometer new section leading to the main dam crest. The proposed access road length is about 3.0 kilometers. The development cost of this new access road was included in the project cost estimate.

The exact location and length of the new access road to be constructed will be determined during the detailed engineering design stage of the project and arrangement with the residents and concerned stakeholders. The stated location and distance of road alignment is just an estimate which is acceptable for site-specific environmental impact assessment. An order of magnitude of earth spoil would be adequate as a basis of locating the spoil disposal site and additional access road. Significant volume of earth spoils may be generated. Spoil disposal site would just be nearby to the south. Soil was estimated to be 2 meters deep. Cut-and-fill is expected to be done during road construction.

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1.4.2.9 Covered Irrigation Canal Network

The covered irrigable area is 1,400 ha of ricefields, however only 1,238 ha could be served during the dry season. The remaining 162 ha that could not be irrigated in the dry season is projected to be idle. There are existing canal networks within the area which farmers traditionally use but most are indigenously constructed. The same canal alignments were mostly adopted in the BSRIP 2015 FS Report, but repair and improvements have to be undertaken to effectively improve the conveyance of irrigation water to the rice paddies. An annotated closer view of the irrigation network is presented in **Figure 1-15.**

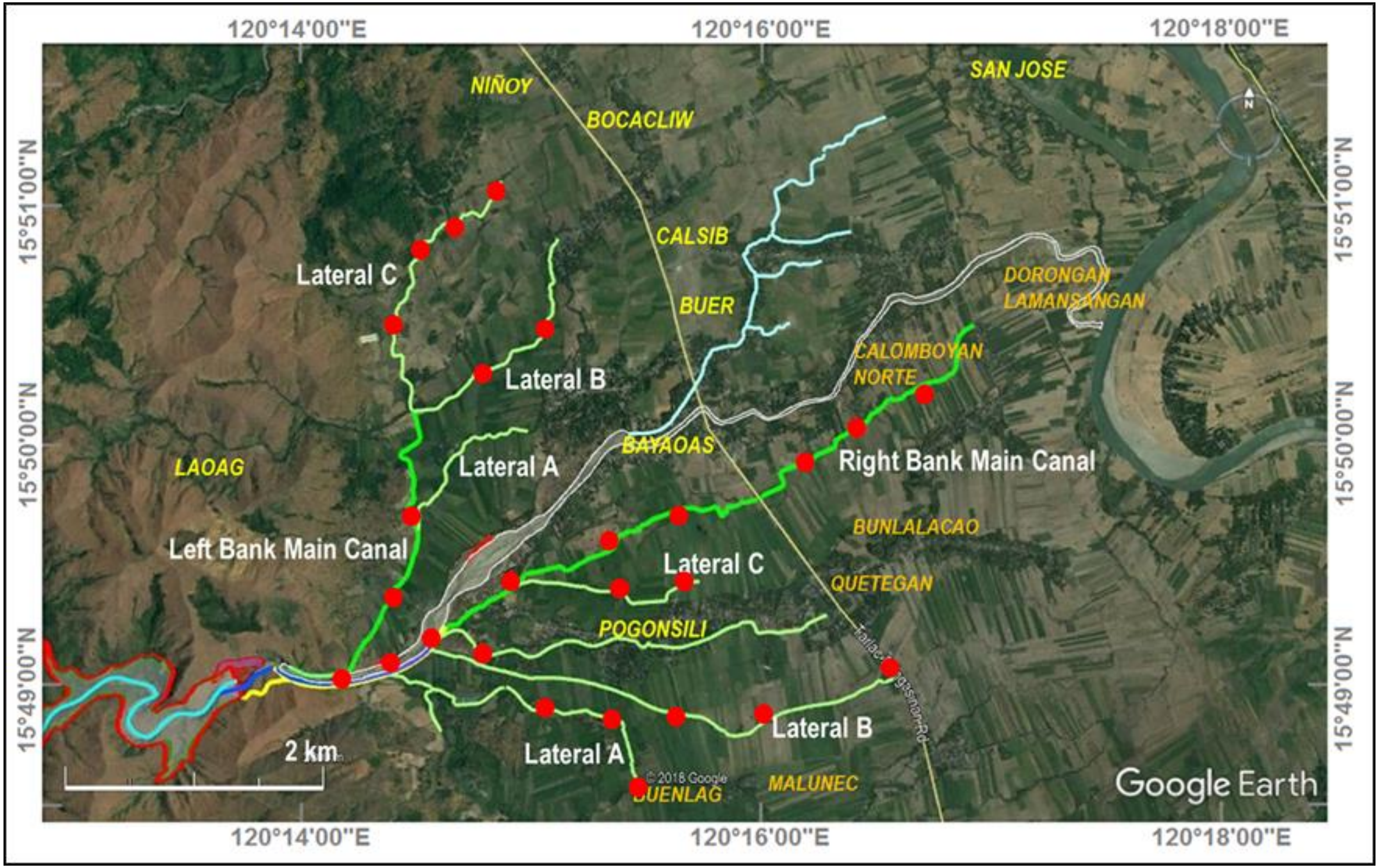


Figure 1-15. Location Map of patches of Improvements (red dots) along the Existing Irrigation Canals and Covered and Neighboring Barangays in Aguilar (in yellow text) and Mangatarem (in gold text)

The proposed irrigation network shall involve the following activities:

i. Construction of a main supply canal from the outlet works of the reservoir, traversing along the right bank of Bayaoas River with a length of about 461.70 meters. The scheme along this segment is to provide a cut and cover by installing a 1.30 meters x 1.30 meters box conduit to accommodate the total irrigation discharge requirement of 2.427 m^3/sec. Manholes will be installed at 30 meters interval for operation and maintenance.

ii. Construction of a 1.00m. x 1.00m barrel along left main canal with a length of about 353 meters, and vertical lining (CHB sidewalls) with a length of about 950 meters. The total length of the left main canal would be about 2.40 km, serving an area of 438 hectares. Three laterals take off from the left main canal.

iii. Construction of a 1.30m x 1.30m barrel along right main canal with a length of about 250 meters, and vertical lining (CHB sidewalls) with a length of about 1.10 km. The total length of the right main canal would be about 6.30 km serving an area of 717 hectares. The existing canal runs to a stretch of about 6.20 km that needs to be improved, because the canal prism is already deformed and could not accommodate the discharge requirement. Three laterals take off from the Right Main Canal. The lateral canals also need to be improved. Existing canals are Lateral A with length of 2.60 km, Lateral B with 3.90 km and Lateral C with 1.40 km.

iv. Construction of a 0.80m x 0.80 section siphon crossing Bayaoas River to supply the irrigation discharge requirement of the Left Main Canal. The siphon will convey a discharge of 0.921 m^3/sec.

v. Construction of turnouts, pipe crossings and other conveyance and control structures along the main canals and laterals.

vi. Construction of on-farm and drainage facilities.

Distribution of irrigation water is by gravity. The water duty used in the delivery of irrigation water is, 2.10 liters/sec/hectare, normally required during the months of May and June, where rainfalls seldom occur. At the initial segments of the right and left main canal including the supply canal, cut and cover structures (conduits) were provided as these stretches traverse slopes and side of hills. Manholes are provided at strategic points, intended for the operation and maintenance.

Vertical linings are also considered which normally connect at the outlet of these conduits. Grouted riprap on some canal stretches was considered with the abundance of potential source of stones at the vicinity of the site. This is to ensure delivery of irrigation water to the last lateral of the main canals controlling the effect of losses on the delivery of irrigation water. These losses include among others, percolation and seepages that will lead to wastage. All conveyance and control structures are hydraulically designed as free flowing except for siphons. All structures shall have a concrete mix of 211kg/cm^2.

Farm drains shall be provided to discharge floodwater or run-off from irrigation into the existing creeks. Good drainage will facilitate removal of excess water during rains and prevent water logging that would be damaging to the rice crops resulting to poor yields Drainage discharges were derived from Gumbel method, to determine the design discharges for paddy fields with 100 mm flood retained. Based on the land classification and soil investigation, the lowland area are deep, fine loamy soils with good internal drainage, with fair to good external (or surface) drainage, subject to moderate flooding. The upland with fine clayey soils has poor internal drainage but good surface drainage.

Construction of maintenance access road to the Left Main Canal may be considered in the future.

1.4.2.10 Estimated Earth Materials Excavations and Sourcing

In visualizing the degree of land disturbance by the construction dam and its appurtenances, the estimates of the quantities of earth excavations, use and sourcing from quarry sites are presented in **Table 1-15**. From the BSRIP 2015 FS, the total quantity of earth excavation at the dam site is around 436,943 m^3. Part of this or around 426,385 m^3 will be used in coffer dam, dam embankment, spill way, diversion weir, and supply canal. Part of the requirement of 274,203 m^3 would come from quarry site. For one-meter depth of quarrying works, this would require around 2.74 ha of quarry site.

Table 1-15. Estimated Quantity (m^3) of Earth Materials for Excavation, Sourcing, and Disposal

Use / Material	Excavation	From Excavation	From Quarry	For Disposal
I. DAM				
A. Diversion and Care of River during Construction				
1. Cofferdam				
a. Clay		4,465		
b. Rockfill		26,342		
B. Dam Foundation				
1. Excavation	40,950			
a. Common	18,935			
b. River Material Excavation (alluvial)	18,935			
c. Waste disposal				5,615
C. Dam Embankment				
1. Impervious Clay Core (from quarry)			157,105	
2. Random Fill		106,587	33,038	
3. Filter Drain (from quarry)				
a. Sand			19,243	
b. Gravel			18,996	
4. Rockfill		266,718	45,101	
D. Spillway				
1. Excavation				
a. Common	71,252			
b. Rock	247,783			
c. Alluvial (from. river)	12,392			
2. Structure backfill		4,088		
II. DIVERSION WEIR				
A. Diversion and Care of River During Construction				
1. Excavation				
a. Common	6,060			
b. Structure Excavation	630			
B. Structure Backfill		2,135		

Use / Material	Excavation	From Excavation	From Quarry	For Disposal
C. Sand and Gravel Filter		64		
III. SUPPLY CANAL (Combined Closed Conduit and Siphon)				
A. Diversion and Care of River				
1. Cofferdamming		720		
2. Waste Disposal				720
B. Structure Excavation (common)	14,169			
C. Structure Excavation with Dewatering	5,837			
D. Structure Backfill (with compaction)		15,783		
E. Gravel Bedding		203		
Total	436,943	426,385	274,203	6,335

Source: BSRIP FS (2015). Table 11-6: Comparative Costs of Modified NIA Dam Design vs. EDCOP Design. page 11-15, and Table 11-8: Comparative Cost, Supply Conduit with Siphon vs. Diversion Weir, p 11-17

1.5 Process/ Technology

The supply of irrigation water from the reservoir will be by continuous flow gravity type.

1.6 Project Size

As mentioned above (Section 1.4.1 and Section 1.4.3), the impounded water during flood condition would have maximum depth of 48.8 m depth at the dam, volume of 18.03 million m^3, and surface area of 104 ha. At normal operations the impounded water has a depth of 39.5 m at the dam, volume of 11.5 million m^3, and surface area of 78 ha. The service irrigation area is 1,238 ha during the dry season, and 1,400 ha during the wet season.

1.7 Development Plan, Description of Project Phases and Corresponding Timeframes

1.7.1 Project Phases and Timetable

Under favorable conditions, the Proposed Project will be completed in four (4) years from the pre-construction, construction and operation phases **(Figure 1-16**). Pre-construction activities, allotted for one-year will include arrangements with the farmers and landowners, surveying, right-of-way acquisition, and government permitting. Construction of the dam and improvements in irrigation facilities will be done in parallel.

Timing and sequencing of construction activities will dependent on weather conditions. The area is dry from November to April and wet during the rest of the year. For example, critical activities such as concreting of outlet works and spillway and placement of impervious core materials and random fill for dam embankment should only be done during the driest months of the year. For the irrigation facilities, the first two to four (2-4) months shall be allotted to survey and profiling of canal locations.

Activity	Year 1	Year 2				Year 3				Year 4			
		1	2	3	4	1	2	3	4	1	2	3	4
I. PRE-CONSTRUCTION	■												
II. CONSTRUCTION													
A. MAIN DAM AND APPURTENANT STRUCTURES													
1. Mobilization		■	■										
2. Diversion and Care of River				■	■	■	■	■	■	■	■		
3. Dam Foundation			■	■	■								
4. Dam Embankment				■	■	■	■	■	■	■	■		
5. Spillway							■	■	■	■	■	■	
6. Dam Instrumentation					■		■		■		■		
7. Outlet Works					■	■	■	■	■	■	■	■	
B. IRRIGATION AND DRAINAGE WORKS													
1. Mobilization		■	■										
2. Irrigation Facilities			■	■	■	■	■	■	■	■			
3. Terminal Facilities							■	■	■	■	■	■	
4. Drainage Facilities										■	■	■	
III. Operation													■

Figure 1-16. Project Timetable

1.7.2 Pre-Construction Phase

The pre-construction work of 1-year entails the completion of necessary preparation for the proposed construction works. This covers the bidding, obtaining government permits and social preparation. The construction of the access road and dam will be done by a contractor through the national bidding procedure provided for by the R.A. 9817 Revised Procurement Act. Environmental considerations will form part of the contract, including orienting personnel, ensuring compliance and monitoring compliance of personnel of environmental safeguards at various stages of the project. A Contractor's Social and Environmental Operations Manual will be required.

Government permitting requirements includes Special Land Use Permit from DENR, Tree-cutting Permit from DENR, and Water Rights from NWRB, though this can be obtained after the issuance of the Environmental Compliance Certificate (ECC) from DENR. Right-of-way arrangements will be completed. The pre-construction assumes a complete engineering design and construction layout which incorporate environmental considerations identified in this EIS. A thorough geotechnical investigation of the dam footprint and a detailed mapping of the impact areas would have been conducted as input to the final engineering design. The location and span of the spoil disposal area will be included in the engineering design.

The social preparation will be done by NIA with the local government units, the nearest residents and farmers. There will be an a courtesy meetings with introduction of contractors, workers and staff, and orientation about the project and consultation on the issues to be addressed at lease a two months prior to the staging activities and during the staging activities.

1.7.3 Construction

The construction phase entails the mobilization of the personnel and equipment of contractors and the establishment of contractor area, base camp or staging facilities, which will be located away from the residential area. The risk of grass fires will be taken into consideration. Local arrangements, as regard the impact on the community will be done for this activity. The basecamp and equipment staging area will be provided with appropriate containment, treatment and disposal of liquid, solid, and hazardous waste for the protection of soil, groundwater and Bayaoas River., according to the environmental laws, rules and regulations (RA 9003, RA 9275, RA 6969), as well as local ordinances.

Project contractors will be required local hiring of qualified residents, including females, in accordance with the labor laws, rules and regulations. **Table 1-16** shows around 122 skilled personnel needed for construction.

Table 1-16. Manpower for Construction

Position	No. of Personnel
Lead Man	2
Chief Mechanic	1
Operator	20
Driver	20
Carpenter	20
Mason	10
Steelman	10
Laborer	30
Welder	5
Drilling Operator	4
Total	122

The proposed construction organization will be patterned from the existing set-up of the implementing management office, SRIP-PMO of the NIA Central Office. A task force will be formed that will handle and supervise the construction which consists of a Resident Engineer, Office Engineer, Material Testing Engineer, Construction Engineer and Geologist (on call basis), complemented with support staff (**Figure 1-17**). The Pangasinan Provincial Irrigation Management Office (PIMO) together with the Regional Irrigation Office 1 (RIO) will supervise all construction activities and the Environmental and Institutional aspects of the project.

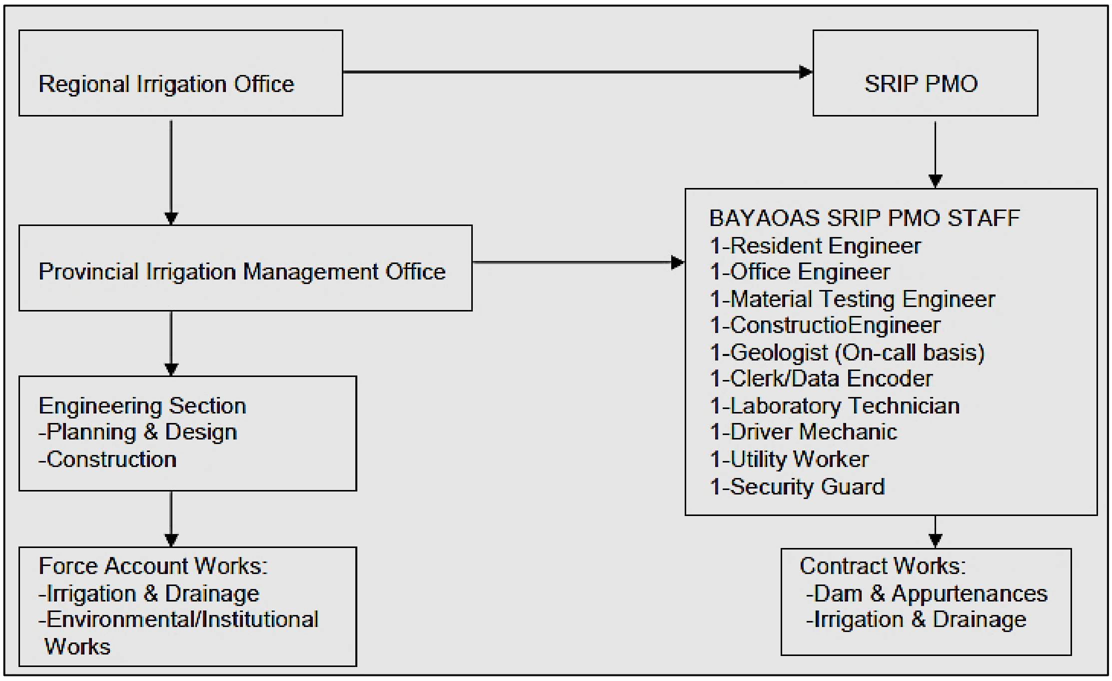


Figure 1-17. Organization for Project Implementation and Construction Supervision

Construction works practically consists of a series and parallel works for the accesses road, dam, spill way, instrumentation, and others. Construction will entail land clearing and earth moving activities. The minimum requirement for equipment is presented in **Table 1-17.** Electric **g**enerators will be the main source of power supply. River water may be used as a water supply.

Table 1-17. Minimum Equipment for Construction

	Type of Equipment	Quantity	
1.	Trailer Truck	1	unit
2.	Dozer w/ Ripper, 320 HP	2	units
3.	Dozer, 180 HP	2	units
4.	Wheel Loader, 1.53 cu.m. bucket capacity	2	units
5.	Self-Propelled Vibratory Tamping Foot, 10 Tonner capacity	1	unit
6.	Self-Propelled Vibratory Smooth Drum, 10 Tonner capacity	1	unit
7.	Road Grader, 125 HP	1	unit
8.	Backhoe Hydraulic Crawler, 1.50 cu.m. bucket capacity	4	units
9.	Backhoe Hydraulic Crawler, 1.50 cu.m. bucket capacity with Breaker	2	units
10.	Portable Concrete Batching Plant, 8.00 cu.m./hr. capacity	1	unit
11.	Hydraulic Crane, 30 Tons capacity	1	unit
12.	Dump Truck, 12 cu.m. capacity	12	units
13.	Transit Mixer, 4.0 cu.m. capacity	2	units
14.	Water Truck, 500 – 1,000 Gal. capacity	1	unit
15.	Cargo Truck	1	unit
16.	Concrete Bagger Mixer, 1 bagger capacity	4	units
17.	Welding Machine, 300 Amp	4	units
18.	Survey Equipment (Total Station)	1	unit
19.	Air Compressor, 160 CFM	1	unit
20.	Grout Pump (Agitator, Central Mixer, Air Compressor)	5	units
21.	Water Pump, 4"diameter	4	units
22.	Material Testing Equipment	1	lot

1.7.4 Commissioning Operation and Maintenance

The commissioning will involve the initial operation of the dam and filling up of the reservoir to normal operating level. The operation will be supported with an administration, instrumentation, and workshop buildings, with telecommunication capability. The power supply will come from the national grid and back-up generator. River water will also be used for a source of water. A system will be put in place to handle solid and liquid wastes.

Upon completion of the Bayaoas SRIP, the entire project will be turned over to the Pangasinan Provincial Irrigation Management Office (PIMO). Under the direction and supervision of the Regional Irrigation Office, the operation and maintenance of the dam and its appurtenant structures will be the responsibility of the Pangasinan PIMO, while the operation and maintenance of the irrigation facilities will be performed by the Irrigators Associations with technical assistance from NIA-PIMO.

The operation and maintenance of the irrigation system will be a joint responsibility of NIA and the irrigators associations. The Dam and Reservoir, the Diversion Dams and Main Canals will be managed by the PIMO. The laterals and secondary facilities shall be turned over to the IA, uder contract maintenance. The IAs will therefore be strengthened by giving them the whole package of IA development training programs on capability building in systems O & M, including financial management.

Figure 1-18 shows the PIMO organization for O & M. Bayaoas SRIP shall be lodged under one (1), of the four (4) O & M Sections under the PIMO.

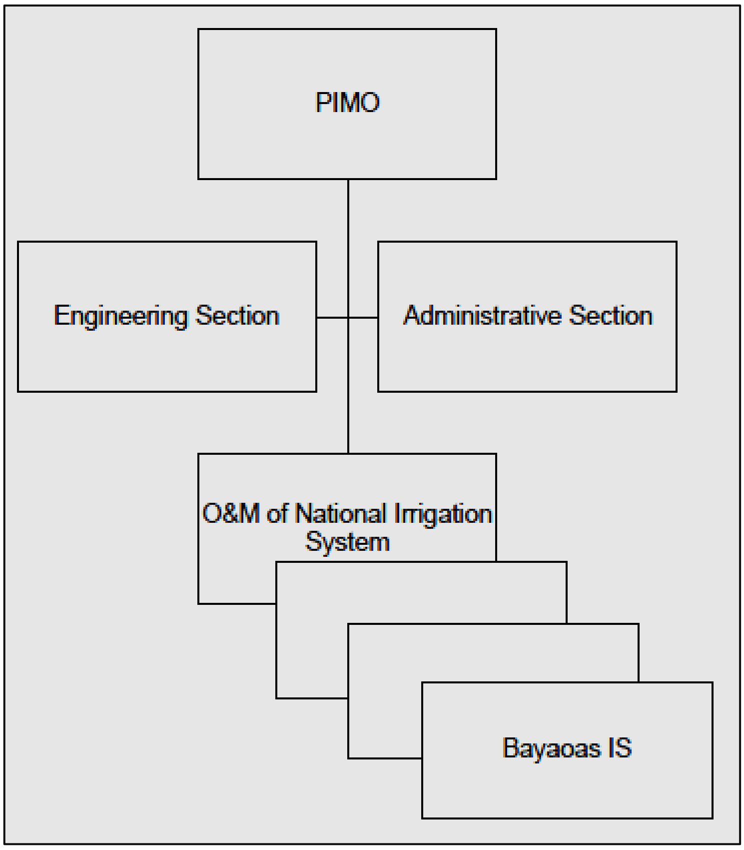


Figure 1-18. Pangasinan Irrigation Management Office Organization

The indicative number of manpower requirement for during project operations is about 11 (**Table 1-18**).

Table 1-18. Indicative Manpower During Project Operations

Position	Number of Personnel
Project Manager	1
Field Engineers	2
Office Engineers (staff)	2
Institutional Development	3
Utility Worker	1
SWRT	1
Driver	1
Total	11

Under NIA Memorandum Circular 15 series of 2009, there is an Irrigation Management Transfer Program of NIA. The IAs shall be developed to gradually progress from Model 1 Contract to Model 4 Contract. The IMT Program aims to completely transfer to the IA the management of the entire system with NIA retaining only monitoring and evaluation function and extend periodic technical assistance whenever requested by the IA. The sharing of responsibilities in O & M under the different Models (Model 1 to Model 4) are provided in the circular.

For such a scheme, an institutional development will be implemented for the irrigators associations, as in the NIA-assisted irrigator association in Calsib. The plan will involve: reorganizing the IAs; retraining the IA officers and members on the various aspects of their business operating system management, and mobilization of resources to improve their financial standing; and linking them to extension and credit services.

This will encourage IAs to duly register with the government either with the Securities and Exchange Commission (SEC), Cooperative Development Authority (CDA) and other entities to obtain its legal personality. This will provide the IAs to a legal personality to enter into contracts with government and private institutions. NIA has a policy to enlist the participation of farmers, in project planning, implementation and operation and maintenance of the irrigation system. An example of organization for the AIs is presented in **Figure 1-19**.

NIA has internal protocol in the maintenance of dams. This includes MC 18 series 2012 or the Monitoring / Upkeeping the Structural Safety of Small Reservoir Dams **(Annex 1-3)**. Topics include the following:

i. Dam Instrumentation Systems Maintained / Observed
ii. Dam Observation Data-Analyzed and Verified
iii. Dam Instrumentation Maintenance
iv. Dam Instrumentation Monitoring
v. Data Observation Analysis
vi. Dam Spill Situations

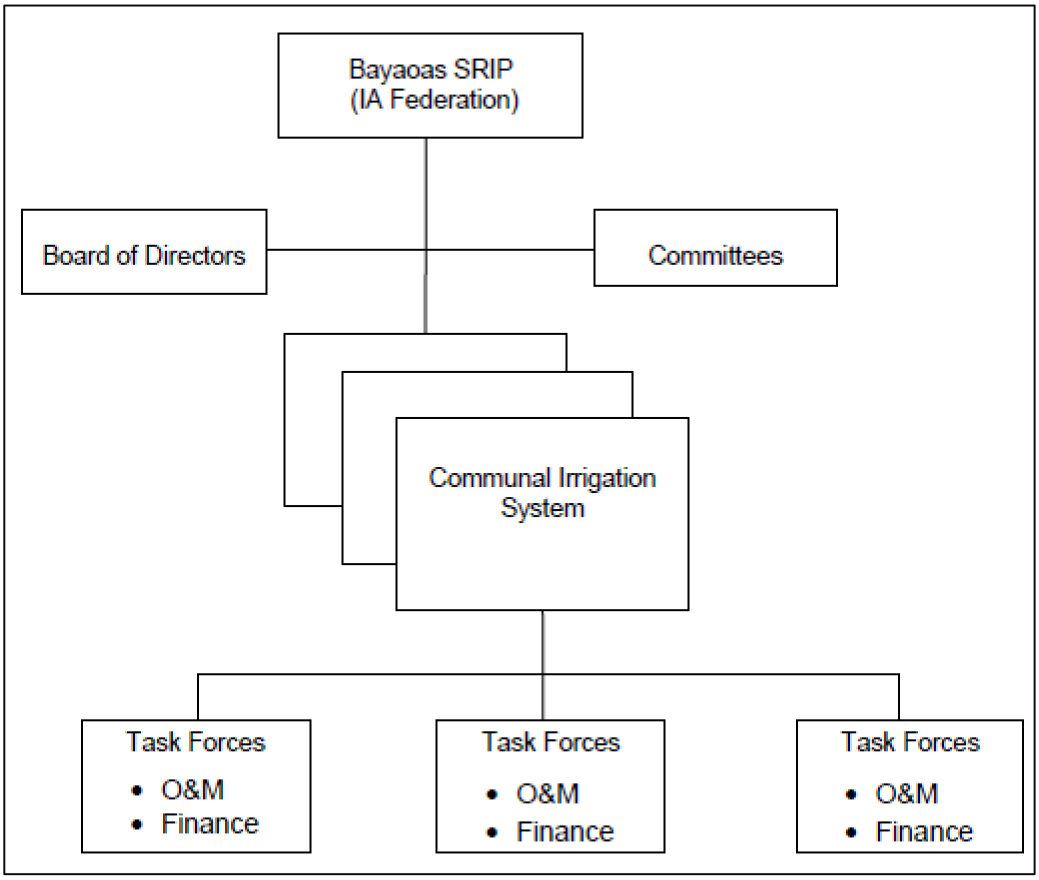


Figure 1-19. Irrigators Association (IA) Organization

Watch person will be deployed to ensure the observation of the gauges / parameters of the dam instrumentation systems and ensure functionality of testing / measuring tools and equipment. With a dam oversight team, the data will be analyzed on dam performance and detection of abnormalities. Physical inspections and necessary prompt repairs will be done. An emergency preparedness plan (EPP) will be formulated.

In addition, NIA has a Quality Management Manual (ISO 9001: 2008) presenting the following provisions

"4.2.3 National Irrigation System (NIS) Operation & Maintenance (O&M)

"The Operation and Maintenance (O&M) of NIS monitored in the central office by the Systems Management Division (SMD) under the supervision of the Operations Department (OD) and carried out through the Regional Offices down to the Irrigation Systems guided by the following objectives to its level:

- To maintain a financially viable system – this can be realized by increasing the efficiency of the Irrigation Service Fee (ISF) collection above the total operating and maintenance expenses without sacrificing the quality of services to farmer beneficiaries.
- To maintain physical facilities in good operating conditions – the field offices should implement a continuing preventive maintenance program to avoid higher repair and maintenance cost in the future.

- To supply adequate irrigation water to farmer-beneficiaries and avoid wastage of irrigation water and conflicts arising from the farmers discontent and other similar irrigation related causes.
- To encourage increased participation of farmer-beneficiaries in the O&M of the system. The field offices should continually engage in the organization and development of the Irrigators Associations (IAs) and extend technical and managerial assistance to keep them viable.

"The Irrigation Engineering Center (IEC) under the supervision of the OD acts as the Research, Development and Extension (RDE) unit of NIA which prioritizes effective, appropriate and efficient irrigation and water management through irrigation research activities to upgrade performance of irrigation structures and facilities; improve performance of irrigation systems; and promote modern irrigation technology to support the operation & maintenance of NIS.

"Equipment used in the O&M of NISis also monitored in central office through the Equipment Management Division (EMD) under the supervision of the OD guided by the following objectives:

- To provide timely and adequate equipment support for the maintenance, repair, rehabilitation and restoration of NIS.
- To provide adequate equipment support for repair of irrigations canals and brass dam in times of calamities.
- To provide transportation vehicle in monitoring implementation of on-going irrigation construction and/or rehabilitation projects.
- To generate additional income to the agency thru equipment rental."

1.7.5 Decommissioning/ Abandonment/ Rehabilitation

By literature, a well-designed, well-constructed and well-maintained and monitored embankment dam can reach 100 years. The Decommissioning, Abandonment and Site Rehabilitation Plan with environmental impact assessment will be prepared in consideration of the structural integrity of the dam, public safety, cost of maintenance, replacement and other decision factors. This will be done in coordination with experts and stakeholders, in accordance with best international practices and regulatory requirements. The discussion is expanded under **Section 7.**

1.8 Project Cost

The Indicative Project Investment Cost (Philippine Peso) stands at P759.69 million as of 2015.

2. ASSESSMENT OF ENVIRONMENTAL IMPACTS

This section contains the land, water, air, and people module with statements on baseline, impact assessment and mitigation measures.

2.1 THE LAND

2.1.1 Land Classification and Use

2.1.1.1 Summary

The proposed dam site and reservoir are located in the general area of wooded grassland forest reserve according to DENR map. However, the location along the Bayaoas River channel is further identified as alienable and disposable land, according to the Comprehensive Land Use Plan 2013-2022 of Aguilar. The footprint partly overlaps with present area of the Enhanced National Greening Project of DENR. The potential quarry site to the SSE of the dam and north of the Mangatarem CBFM is an old quarry site. The proposed access road at the lowland starts from the titled agricultural areas with patches of trees avoiding built up areas. The proposed site is not located in any of the following: protected area, key biodiversity area (KBA), tenurial instrument, IP area, mining tenement, volcanic activities, tested significant groundwater, flood prone area (for the dam site). The proposed area is within Petroleum Service Contract Area of Department of Energy (DOE) SC 70. The location of dam site and reservoir is within the channel of water body (Bayaoas River), highly susceptible to landslide, with critical slopes, not prone to flood, frequently visited or hard hit by typhoon.

The proposed Project would therefore cause partial conversion of NGP area to dam and reservoir area, and from the titled private land to right-of-way for the new access road to dam site. These would however provide ease for NGP activities due to improved access and water supply. Additional benefit includes opportunity for flood control, buffer area for KBA, fishery industry, tourism, educational tour, and increase frequency and volume of water supply during the dry season, with consequent increase in rice production.

2.1.1.2 Thematic Coverage of Impact Assessment

This section covers the following issues related to land use and classification according to the Technical Screening Form:

i. impact in terms of compatibility with existing land use;
ii. impact on compatibility with classification as an Environmentally Critical Area (ECA);
iii. impact in existing land tenure issue/s;
iv. impairment of visual aesthetics; and
v. devaluation of land value as a result of improper solid waste management and other related impacts.

2.1.1.3 Methodology for Baseline Data Gathering

The baseline data for land classification, land use and environmental critical areas were obtained for the following sources:

i. Aguilar Comprehensive Land Use Plan 2013-2022, SB Resolution No. 001-2015;

ii. DENR Region 1, Development of Climate-Responsive Integrated Master Plan for Agno River Basin, Comprehensive Report on the Studies Conducted (Phase 1) (undated, 2018?)[5];
iii. DENR CENRO, Dagupan, Enhanced National Greening Project (ENGP)[6];
iv. DENR CENRO, Dagupan, Tenurial Instruments Maps[7];
v. DENR R1 CENRO Dagupan;
vi. PHIVOLCS Website;
vii. Mines Geosciences Bureau website;
viii. Manila Observatory website; and
ix. National Commission on Indigenous People Region 1 website.

2.1.1.4 Land Classification

DENR classifies land in the Philippines as Forestland, and Alienable and Disposable Land (A&D). There are two versions of the land classification maps obtained for the proposed Project: one, from Agno River Basin (ARB) Report of DENR R1 (**Figure 2.1.1-1**), and the other from the 2013-2022 Comprehensive Land Use Plan of Aguilar (**Figure 2.1.1-2**). The ARB version indicates the dam site is located in a Forest Reserve, while the municipal version indicates the site is located in alienable disposable land with neighboring Production Forest. In both cases, the lowland where the irrigation service areas are located is classified as Alienable and Disposal Land and consistent with the agricultural use.

The 2015 Feasibility Study Report further classified the lowland agricultural areas as shown in **Table 2.1.1-1** and **Figure 2.1.1-3**.

Table 2.1.1-1. Areal Extent of Major Land Classes in the Lowlands

	Land Class	Area, ha	% of Total	% of Arable
A.	Arable Land			
	Class 2R Riceland	475.0	23.8	34.0
	Dual Class Land 1R(1)	730.0	36.5	52.1
	Dual Class 2R(2)	145.0	7.2	10.4
	Dual Class 3R(2)	50.0	2.5	3.5
	Subtotal	1,400.0	70.0	100
B.	Non-Arable Land			
	M Residential/Built-up Area	315.0	15.8	
	Class 6 River / Creek	30.0	1.5	
	Right-of-Way (ROW)	25.0	1.2	
	Class 4 (Special and use, coconut, trees & orchard)	230.0	11.5	
	Subtotal	600.0	30.0	
	Total	2,000.0	100	

[5] *http://r1.denr.gov.ph/index.php/87-regional-articles-default/213-agno*
[6] *http://r1.denr.gov.ph/images/2017-updates/GIS-map-final-2017/engp-pangasinan.pdf*
[7] *http://r1.denr.gov.ph/images/2017-updates/GIS-map-final-2017/tenurial-pangasinan.pdf*

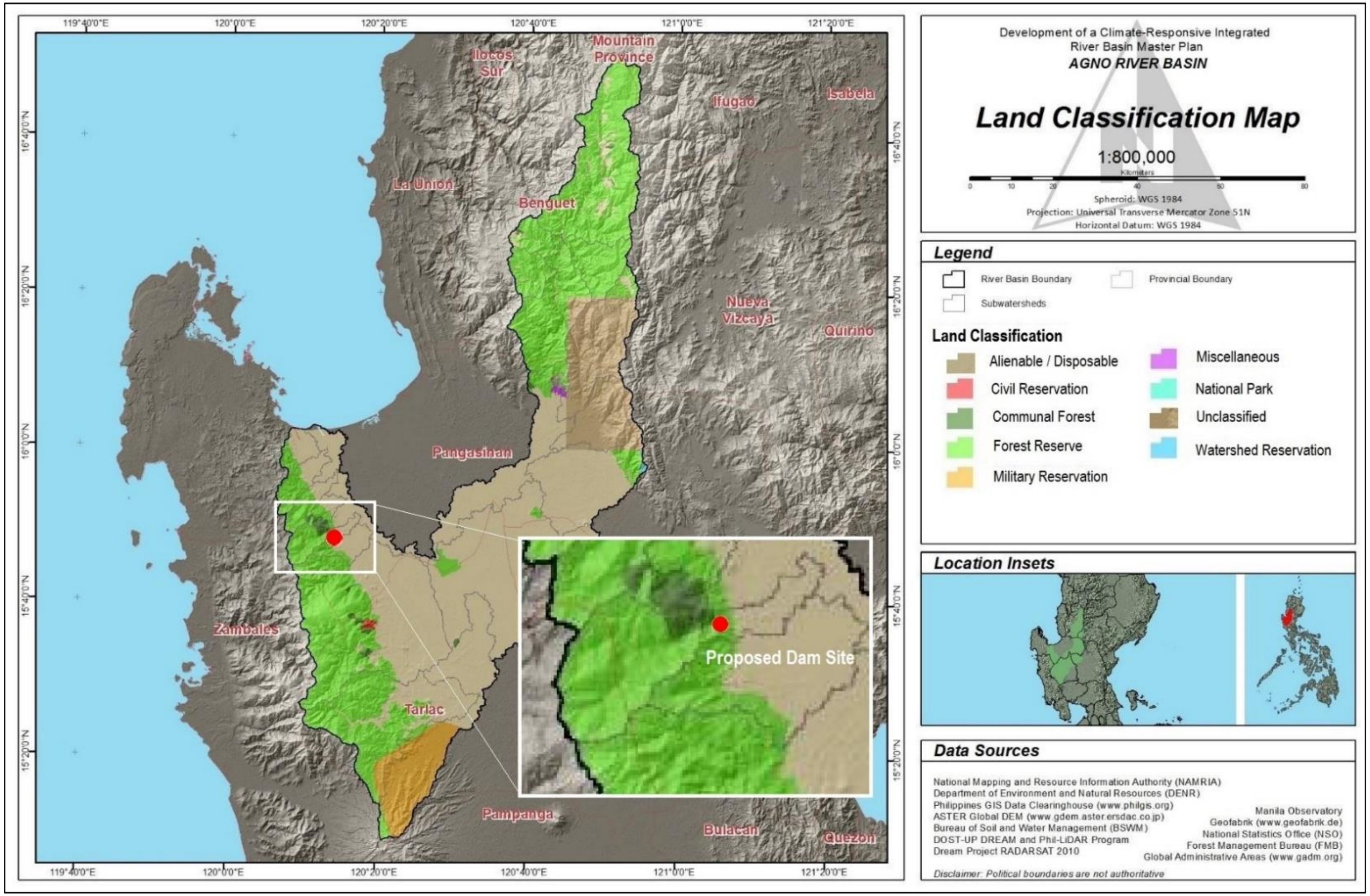


Figure 2.1.1-1. Land Use Classification Map of the Agno River Basin (Source: DENR, 2017b)

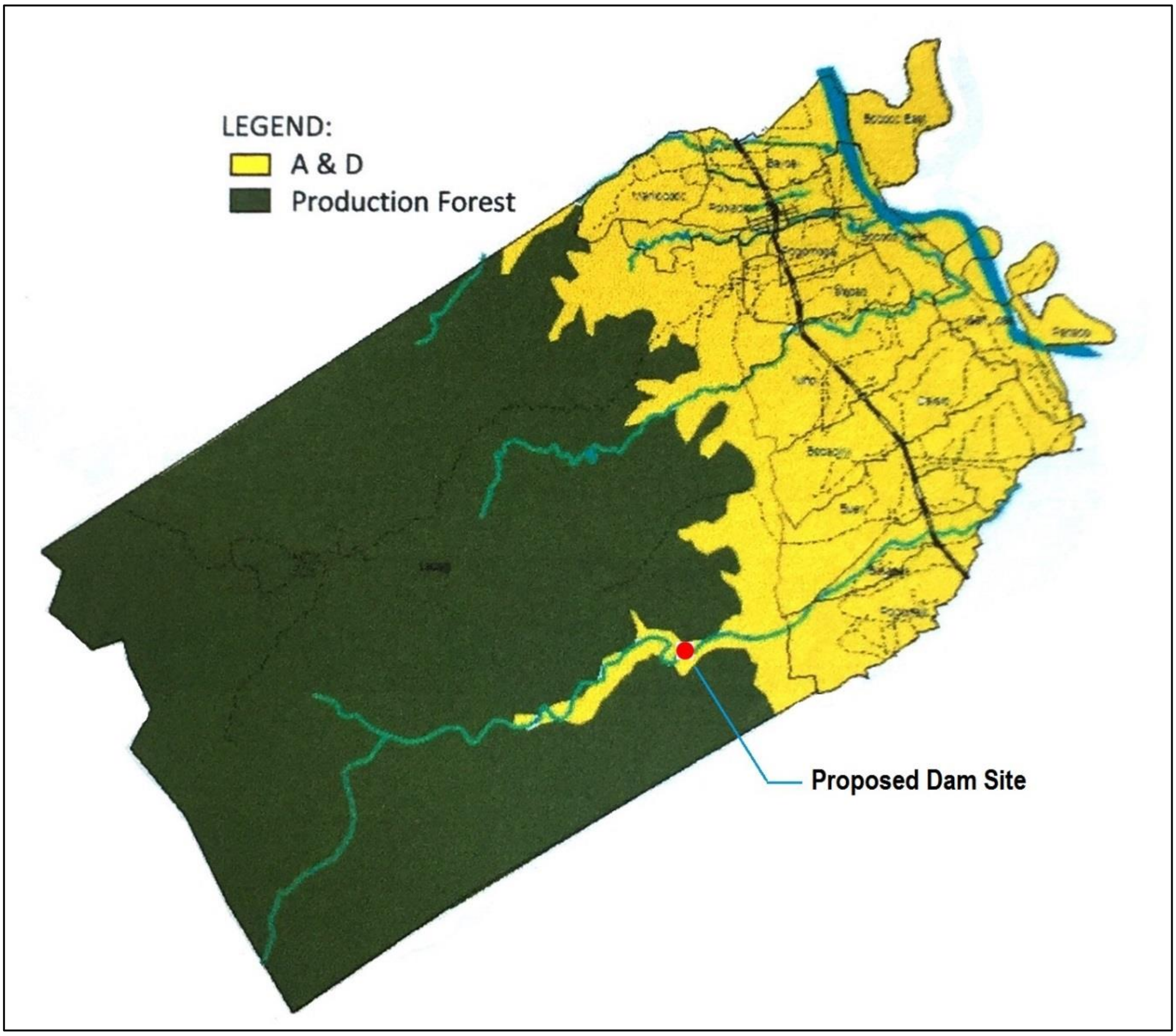


Figure 2.1.1-2. Land Use Map of Aguilar, Pangasinan (Source: CLUP, Aguilar Municipality, 2013)

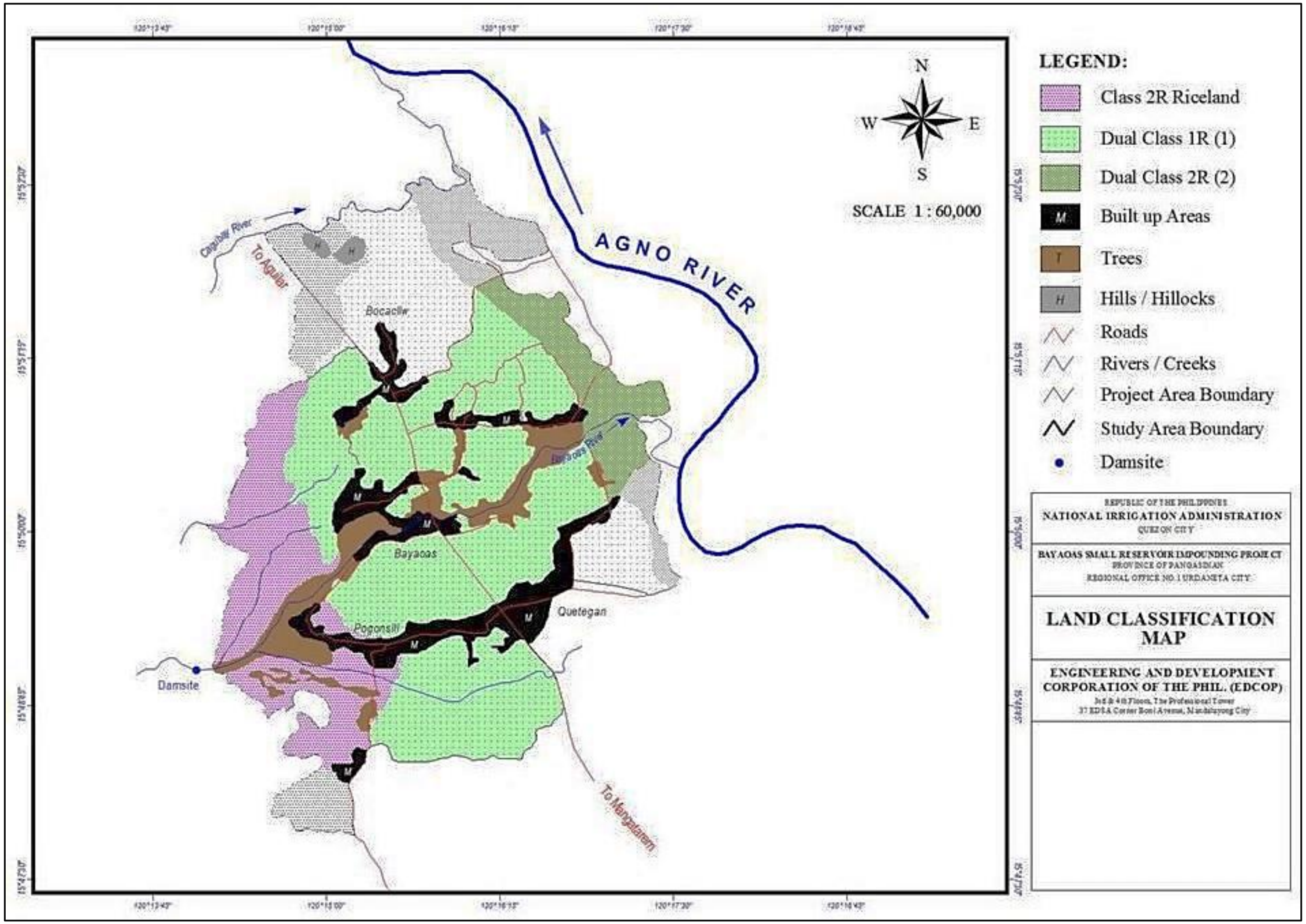


Figure 2.1.1-3. Land Classification Map of the Lowland Areas of the Proposed BSRIP (Source: NIA, 2015)

The data were obtained from the land classification survey in the project area in October 2014 following the USBR Land Classification Procedure and Specification with some minor adjustment to suit local project condition. The study includes feasibility grade land classification specification for gravity irrigation and the use of NAMRIA Topographic maps with scale of 1:50,000 and satellite imagery printouts. The analysis covered the each individual soil mapping unit in the frame of soil classification. Land classes and subclasses were determined and delineated to reflect the productive potential of the soil in accordance with the limitations on soil, surface configuration and drainage condition. The study covered six (6) master pits dug by hand and several auger boreholes for the final appraisal and correlation of the soil between land classes and subclasses. The areas were defined as follows:

Arable Lands. These are the lands, which when provided with the essential improvement on leveling, drainage and irrigation facilities, would have a productive capacity under sustained irrigation, sufficient to meet all production costs, give a reasonable return on the farm investment and provide satisfactory level of living for farm families. The arable area comprises all lands delineated in the land classification map which have sufficient potential net farm income to warrant consideration for irrigation development.

Riceland Classes. The rice land classes are characterized by moderately deep to deep solum, fine to medium textured soils with good to fair drainage and shallow water table. Topography is level, nearly level, and slightly sloping and undulating with slopes ranging from 0.0 to 5.0%. The soils can be easily saturated without excessive deep percolation losses. The area had long been developed to paddies for the production of rain-fed and pumped irrigated rice crops. An aggregate area of 1400.0 hectares or 70.0% of the total land area was classified suitable for irrigated rice production.

Class 2R Rice land: A total of 475.0 hectares or 34.0% of the total arable area was classified as Class 2R. The lands under this class is moderately suitable for the production of irrigated paddy rice in all respect during wet and dry seasons due to slight deficiency on topography. This class is capable of producing sustained moderate yields at medium cost with the application of proper farm management practices. The soils of Class 2R lands are mainly fine to medium textures, grayish brown, light brown, brown and dark brown, fair to good externally and poor internal drainage. With the provision of irrigation and drainage, the lands are capable of producing two promising rice crops during the wet and dry seasons

Dual Class**:** The lands under this class are suitable for lowland rice and diversified crop production. The soils are medium textured moderately deep with good external and internal drainage. Land under this class has low level of farm inputs for the production of rice and other diversified crops. Most dual class lands are formed on level to nearly level topography occupying the middle and downstream portion of the service area. Dual Class lands are primarily devoted to the production of low land rice and diversified crops. The land s could be economically drained to produce irrigated diversified crops in the dry season and irrigated lowland rice during the wet season.

Dual Class IR (1): These are lands highly suitable for the production of irrigated paddy rice during the wet season, and with the provision of proper drainage system, the land is highly suitable for diversified crop production during the dry season. This land class covers a total of 730.0 hectares or 52.1 percent of the total arable area.

Dual Class 2R (2): The soil characteristics of this class are similar to Class 1R (1) but have lower productive potential. The limitation in the production of diversified crop is subsurface drainage which reduces the productive potential of crops. This class consists of productive and that is moderately suitable for rice production in the wet season with proper drainage system; it is likewise moderately suitable for diversified crops in the dry season due to poor subsurface drainage requirements. A total of 145.0 hectares or 10.4% of the total arable land was classified and mapped.

Dual Class 3R (2): The soil characteristics of this class are similar to class 1R (1) and 2R (2) but have marginal productive potential due to severe flooding. Two good crops with alternate growing of rice in the wet season and diversified crops in dry season can be produced, provided that adequate flood control measures and proper drainage system is constructed. A total of 50.0 hectares or 3.5 percent of the total arable land was classified.

Non-Arable Lands. These were identified and classified not suitable for irrigation development. Included are M-lands or built up areas, class 6 or river, creek, right-of-way (ROW) and Class 4 (Special land class, coconut, trees and orchards). A total of 600.0 hectares were delineated as non-arable lands.

Class 6: The lands in this class are those considered non-arable under the existing or proposed project plan because they do not meet the minimum requirements of the other land classes. It comprises areas with extremely coarse textures, steep, or complex topography, very severe flooding hazards, rivers, creeks, waterways, permanent waste areas or combinations of these limitations. Class 6 lands have a total of 30.0 hectares or 1.5 percent of the total project area.

M Lands: These are areas occupied by residential and commercial establishments, comprising a total area of 315.0 hectares. Right-of-Way: These are areas occupied by irrigation canals, structures and roads. It constitutes a total area of 25.0 hectares or 1.2 percent of the total project area.

2.1.1.5 Land Use

On land use, the location of the proposed Project was assessed as follows:

i. in wooded grassland for the dam site and annual to perennial crop for the lowland (**Figure 2.1.1-4);**
ii. not inside a protected area **(Figure 2.1.1-5**);
iii. not inside a Key Biodiversity Area **(Figure 2.1.1-6);**
iv. within the National Greening Program (NGP) of DENR for the dam site and reservoir **(Figure 2.1.1-7);**
v. not within Tenurial Instruments **(Figure 2.1.8),** but 1.3 km to the south is CBFM No. 013316 of Mangatarem Reforestation Association, Inc. ;
vi. not within CADT or CADTable land of the National Commission of Indigenous People **(Figure 2.1.1-9),** with a Certificate of Non-Overlap from NCIP Region 1 (**Annex 2.1.1**)
vii. not within mining tenement **(Figure 2.1.1-10).**
viii. within Petroleum Service Contract Area of Department of Energy (DOE) SC 70 (**Figure 2.1.1-11**).

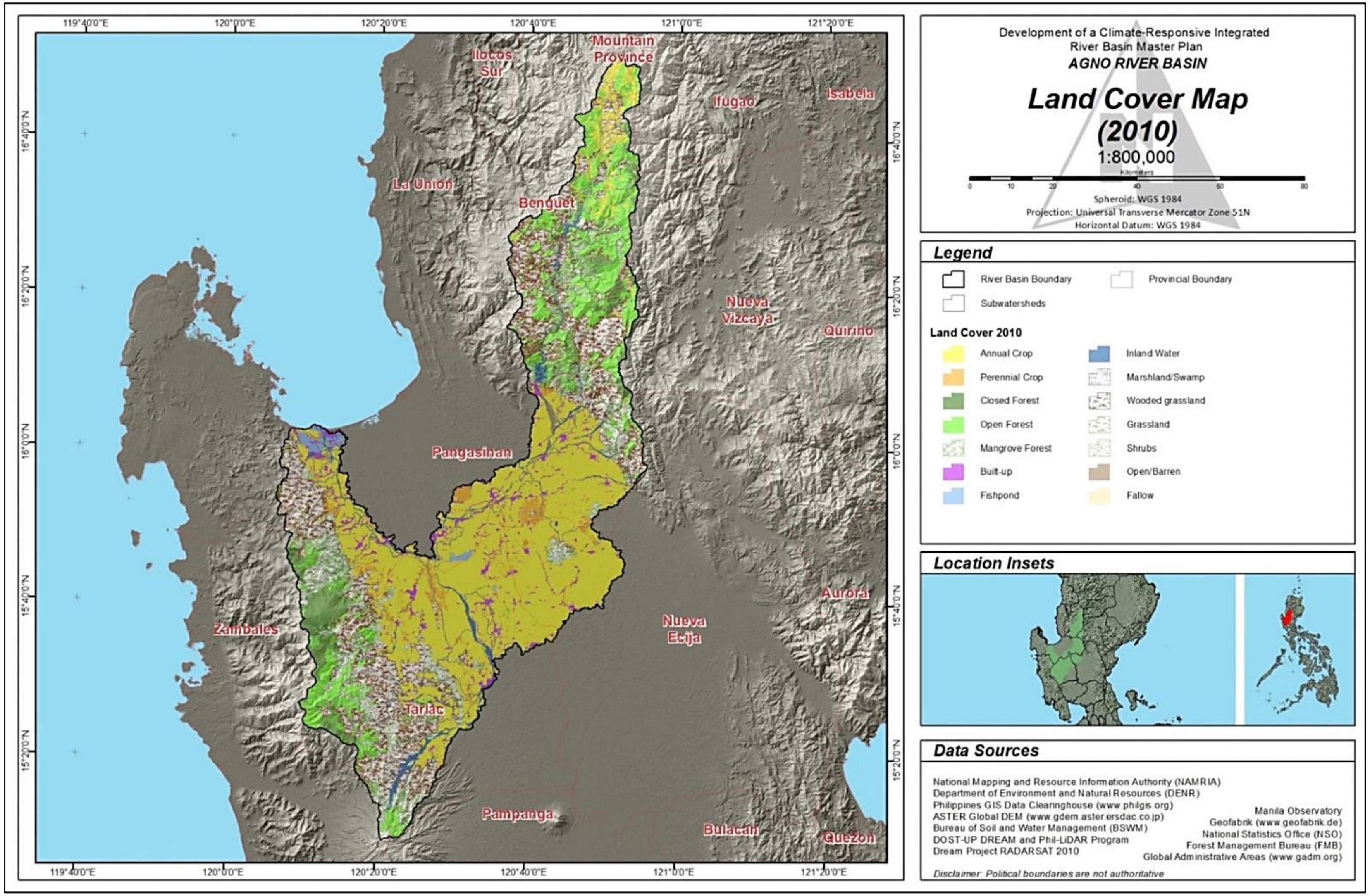


Figure 2.1.1-4. Land Cover Map in 2010 of the Agno River Basin (Source: DENR, 2017b)

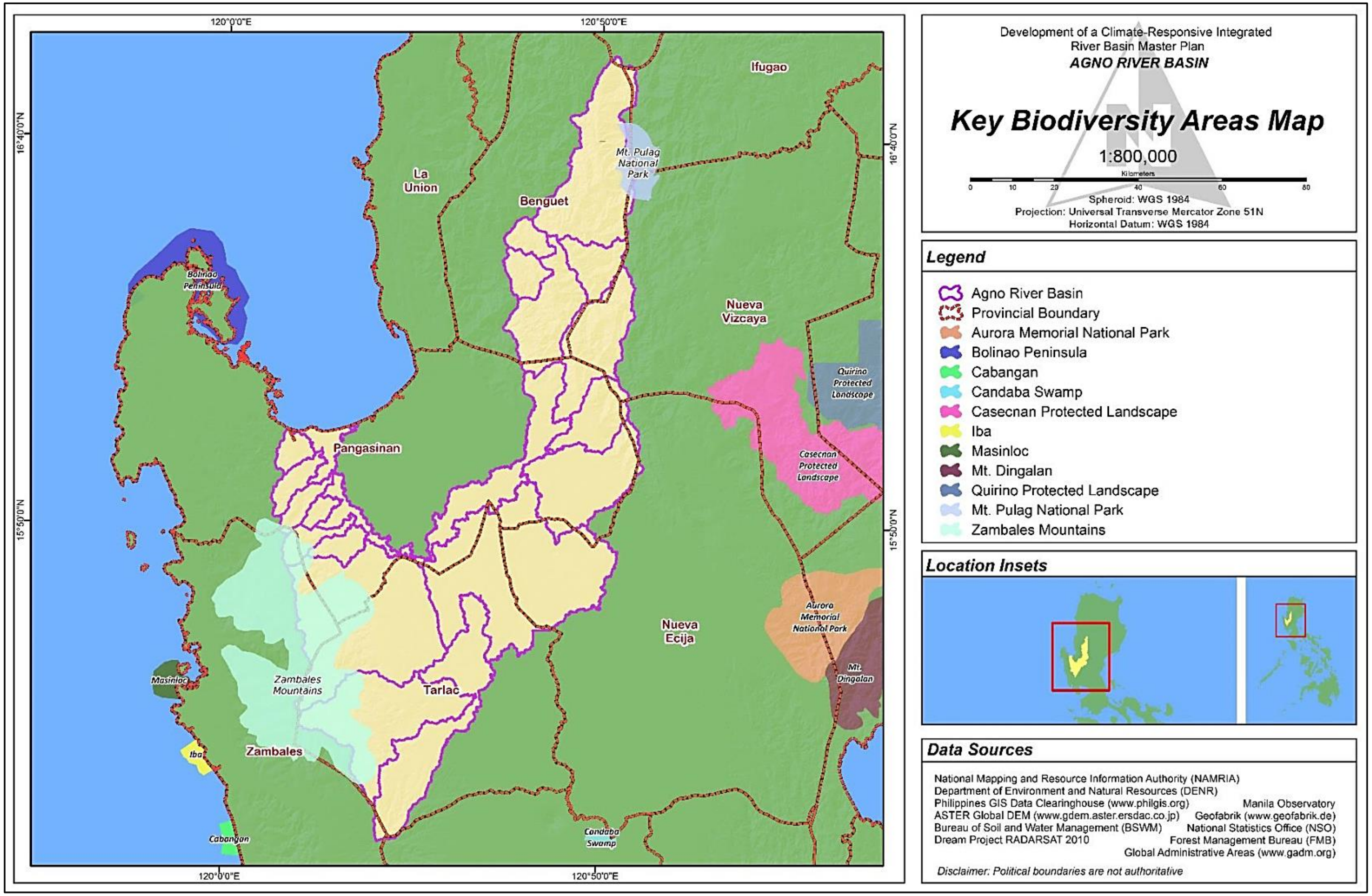
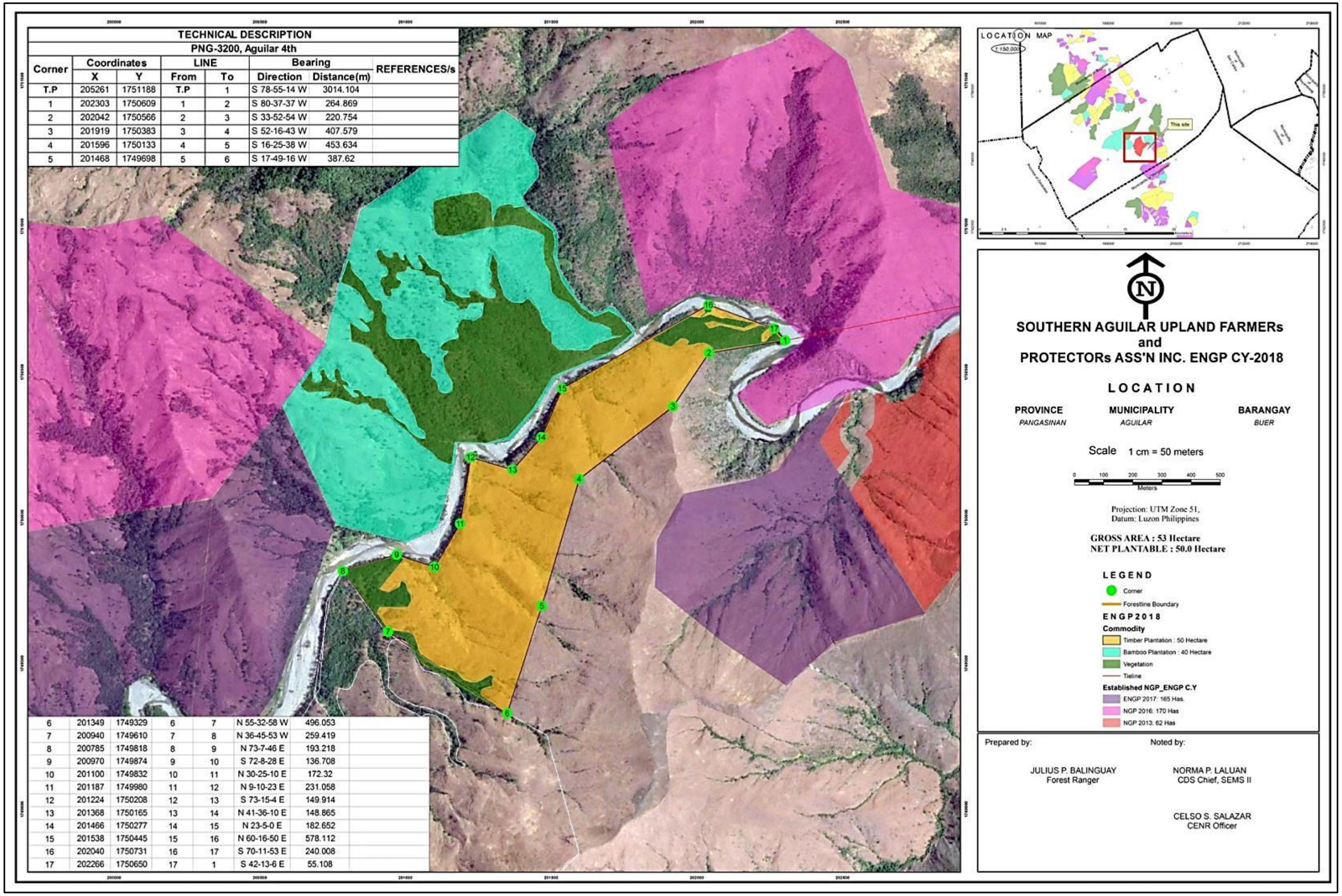
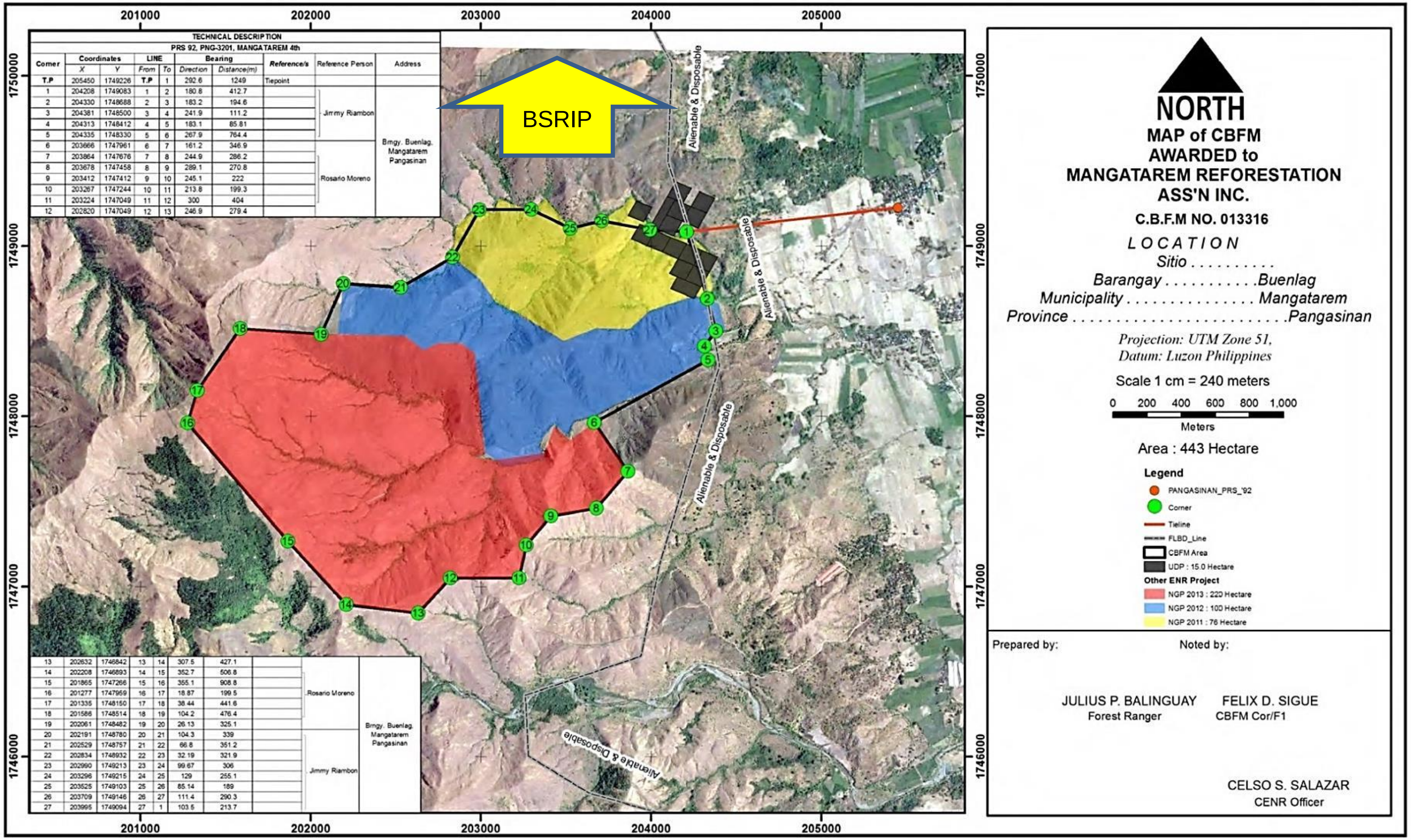


Figure 2.1.1-6. Key Biodiversity Areas Map of the Agno River Basin (Source: DENR, 2017b)



TECHNICAL DESCRIPTION							
PNG-3200, Aguilar 4th							
Corner	Coordinates		LINE		Bearing		REFERENCES/s
	X	Y	From	To	Direction	Distance(m)	
T.P	205261	1751188	T.P	1	S 78-55-14 W	3014.104	
1	202303	1750609	1	2	S 80-37-37 W	264.869	
2	202042	1750566	2	3	S 33-52-54 W	220.754	
3	201919	1750383	3	4	S 52-16-43 W	407.579	
4	201596	1750133	4	5	S 16-25-38 W	453.634	
5	201468	1749698	5	6	S 17-49-16 W	387.62	
6	201349	1749329	6	7	N 55-32-58 W	496.053	
7	200940	1749610	7	8	N 36-45-53 W	259.419	
8	200785	1749818	8	9	N 73-7-46 E	193.218	
9	200970	1749874	9	10	S 72-8-28 E	136.708	
10	201100	1749832	10	11	N 30-25-10 E	172.32	
11	201187	1749980	11	12	N 9-10-23 E	231.058	
12	201224	1750208	12	13	S 73-15-4 E	149.914	
13	201368	1750165	13	14	N 41-36-10 E	148.865	
14	201466	1750277	14	15	N 23-5-0 E	182.652	
15	201538	1750445	15	16	N 60-16-50 E	578.112	
16	202040	1750731	16	17	S 70-11-53 E	240.008	
17	202266	1750650	17	1	S 42-13-6 E	55.108	

Figure 2.1.1-7. Map of National Greening Areas at BSRIP (Source: DENR, 2017c)



TECHNICAL DESCRIPTION
PRS 92, PNG-3201, MANGATAREM 4th

Corner	Coordinates X	Coordinates Y	LINE From	LINE To	Bearing Direction	Bearing Distance(m)	Reference/s	Reference Person	Address
T.P	205450	1749226	T.P	1	292.6	1249	Tiepoint		
1	204208	1749083	1	2	180.8	412.7		Jimmy Riambon	Brngy. Buenlag, Mangatarem Pangasinan
2	204330	1748688	2	3	183.2	194.6			
3	204381	1748500	3	4	241.9	111.2			
4	204313	1748412	4	5	183.1	85.81			
5	204335	1748330	5	6	267.9	764.4			
6	203666	1747961	6	7	161.2	346.9		Rosario Moreno	
7	203864	1747676	7	8	244.9	286.2			
8	203678	1747458	8	9	289.1	270.8			
9	203412	1747412	9	10	245.1	222			
10	203267	1747244	10	11	213.8	199.3			
11	203224	1747049	11	12	300	404			
12	202820	1747049	12	13	246.9	279.4			
13	202632	1746842	13	14	307.5	427.1		Rosario Moreno	Brngy. Buenlag, Mangatarem Pangasinan
14	202208	1746893	14	15	352.7	506.8			
15	201865	1747266	15	16	355.1	908.8			
16	201277	1747959	16	17	18.87	199.5			
17	201335	1748150	17	18	38.44	441.6			
18	201586	1748514	18	19	104.2	476.4			
19	202061	1748482	19	20	26.13	325.1			
20	202191	1748780	20	21	104.3	339		Jimmy Riambon	
21	202529	1748757	21	22	66.8	351.2			
22	202834	1748932	22	23	32.19	321.9			
23	202990	1749213	23	24	99.67	306			
24	203296	1749215	24	25	129	255.1			
25	203525	1749103	25	26	85.14	189			
26	203709	1749146	26	27	111.4	290.3			
27	203995	1749094	27	1	103.5	213.7			

Figure 2.1.1-8. Location Map of Tenurial Instruments in Mangatarem, South of BSRIP (Source: DENR, 2017d)

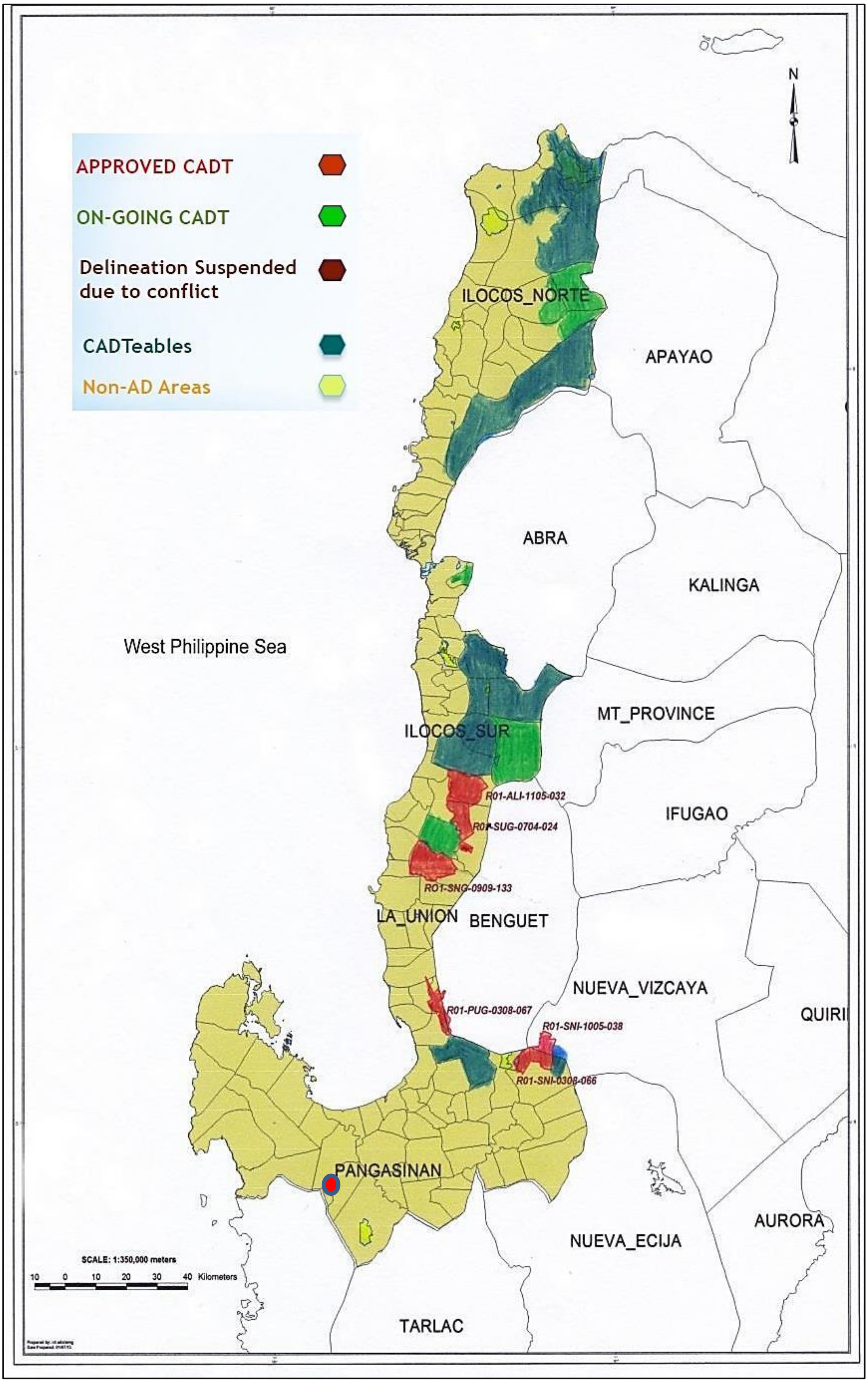


Figure 2.1.1-9. Location Map of Indigenous Peoples Areas in Region 1 (Source: NCIP, 2014)

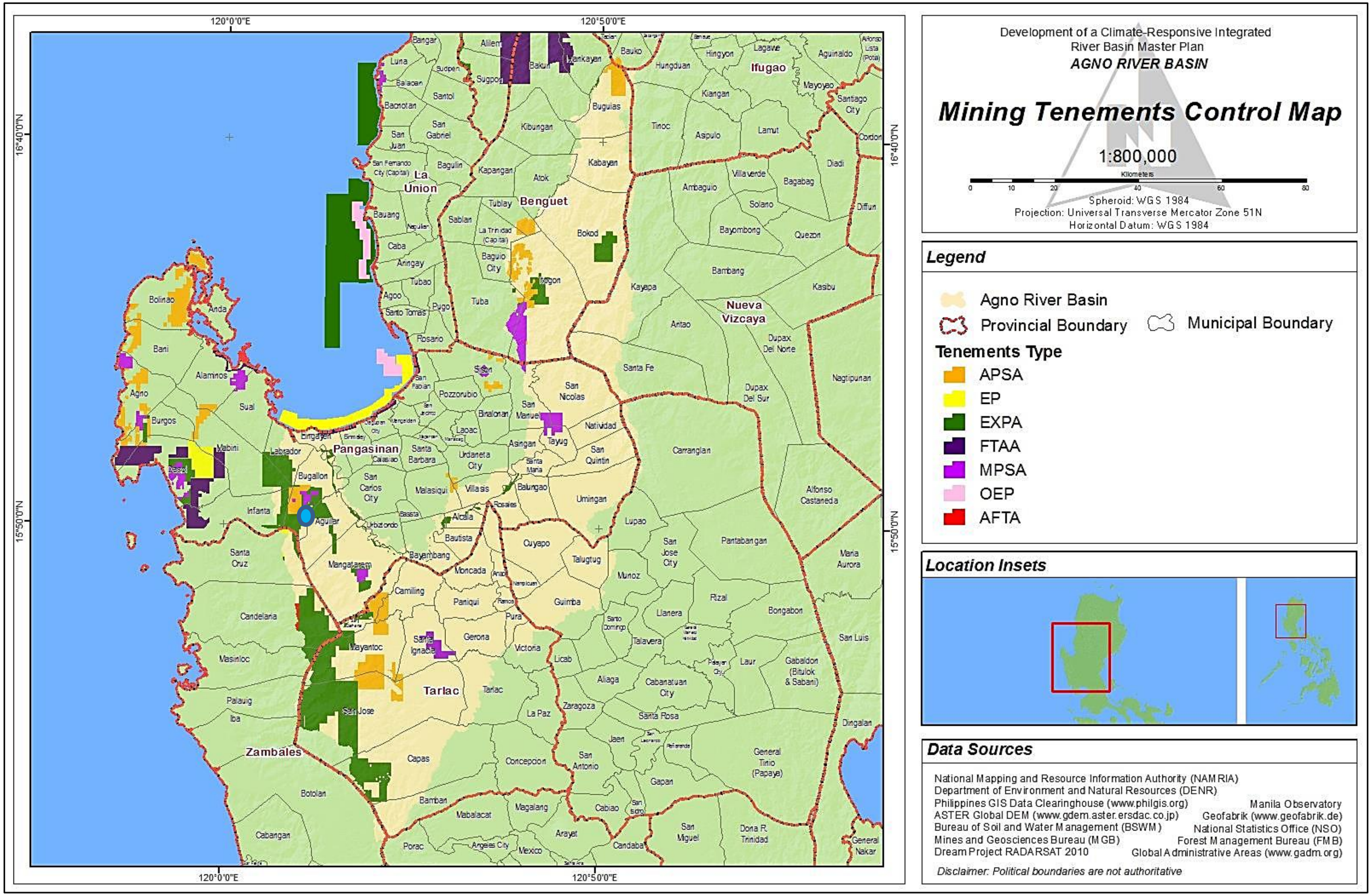


Figure 2.1.1-10. Location Map **of** Mining Tenements in Agno River Basin (Source: DENR, 2017b)

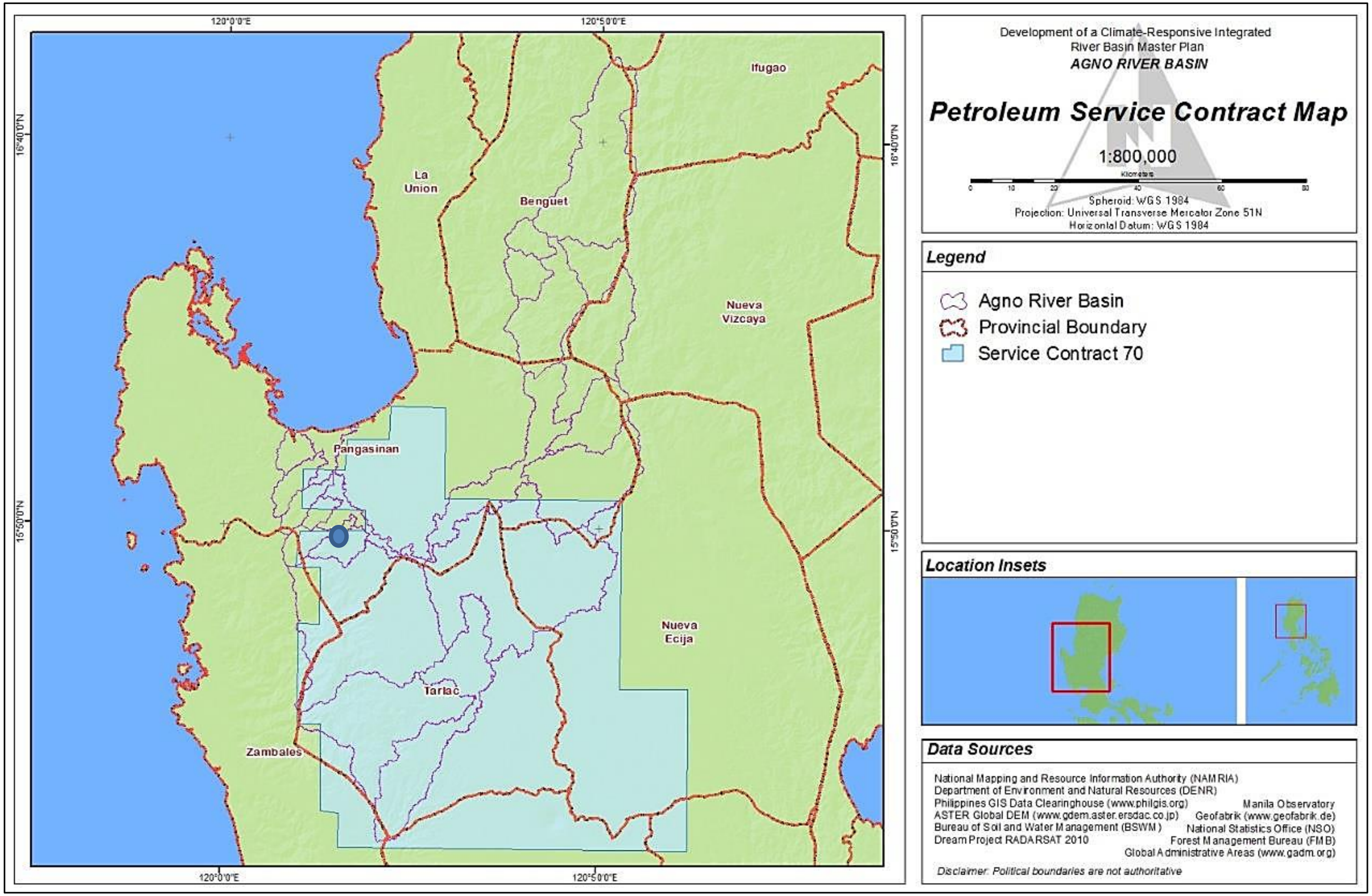


Figure 2.1.1-11. Petroleum Service Contract Map of the Agno River Basin (Source: DENR, 2017b)

2.1.1.6 Upland Dam Site Development and the National Greening Program

The National Greening Program (NGP) is by virtue of Presidential Executive Order (EO) No. 26 s. 2011 Declaring an Interdepartmental Convergence Initiative for a National Greening Program, and EO 193 s. 2015 Expanding the Coverage of the National Greening Program. Examples of the covered areas by DENR CENRO Dagupan are shown in **Table 2.1.1-2** for a total of 2,180 ha as of 2018. At the Project dam and reservoir sites the one local organizations involve Southern Aguilar Upland Farmers and Protectors Association, Inc., with the following information: ENGP 2017: 165 ha; NGP 2016: 170 ha; NGP 2013: 62 ha; timber plantation: 50 ha; bamboo plantation: 40 ha. Another local organization is the Buer Developer and Environmental Association, just north of the dam site[8]. Maps and geotagged photos for 2011-2018 are found in http://ngp.denr.gov.ph/index.php/maps.

2.1.1.7 Lowland Access Road, Supply Canals, and Service Areas

The proposed route access road and the right bank main supply canals will traverse titled private lands. Length of the proposed access road in private lots is about 1.1 km. Initial survey showed there are 16 lot owners to be affected, with a total 1.12 ha (48 – 2,354 m^2/lot). The actual route will be referred to the Cadastral Survey Map of the Land Management Bureau during the detailed design. Standing structures and irrigated farms will be avoided. The route will be cleared of patches oftrees and other vegetation providing the lot owners just compensation. (Initial funding for compensation for previously identified lots has already been secured).

On service areas, the set of agricultural land use area and productivity has been presented in the Project Rationale of this report. The arable land in study area was estimated to be 1,400 ha. Rice productivity is low during the dry season at 200 ha (14.3%), and 3.2 ton/ha.

http://ngp.denr.gov.ph/index.php/10-ngp-planting-sites/1579-cenro-dagupan-2016.

Table 2.1.1-2. Inventory of ENGP Production Areas (hectares) in Aguilar

ORGANIZATION	Bamboo	Fuelwood	Fuelwood, Timber, Fruit Trees	HVFT, Timber	Ilang-Ilang	Timber	Timber, HVFT	Brgy Forest	Grand Total
1. Buer Developer and Environmental Association						109.93			109.93
2. Crusader Environmental Developer and Management Ass.Inc.	33.33				149				
3. Enviro Save Association Incorporated		62.43							62.43
4. Highland Agroforest Growers Of Mapita Association Incorporated	99.22	211.18				49.99			360.39
5. Jungle Farmers Multipurpose Cooperative			214.46						214.46
6. LGU Aguilar								2.25	2.25
7. Mangatarem Aguilar Reforestation Association						20.03			20.03
8. Mapita Organic Producers and Traiders Ass'n Inc.						86.86			86.86
9. Mapita Spring of Life Inc.	55.71				154.58		118.71		329
10. Mountaineers Union of Laborers Association					81.81				81.81
11. NIñoy Upland Farmers Ass'n of Aguilar Pangasinan		88.94		0.37		12.82	120.52		222.72
12. Samahan ng Aguilarianong Makakalikasan		71.43							71.43
13. Southern Aguilar Upland Farmers and Protectors Ass. Inc.	60.83			15.04		20.03			95.83
14. Society of Aguilar Environmentalist in Pangasinan	30.12				198.64				347.6
Grand Total	279.20	433.98	214.36	15.41	584.84	411.51	239.23	2.25	2, 180.79

HVFT = high value fruit trees

2.1.1.8 Environmentally Critical Areas

Table 2.1.1-3 presents the various environmental critical areas (ECs) and their relevance to the proposed project site. These ECAs are grouped into special declared protection land areas, physical hazards or importance, and water environment. The proposed project is located in areas frequently visited and or hard hit by natural calamities (geologic hazards, frequently visited or hard-hit by typhoons), with critical slope, in prime agricultural lands, and in water body.

Table 2.1.1-3. List of Environmentally Critical Areas, Presence and Relevance at the Project Site

	ECA Category per EMC 2014-005	Presence in BSRIP	Relevance at the Proposed Project Site
1.	Areas declared by law as national parks, watershed reserves, wildlife preserves, and sanctuaries • Areas declared as such under Republic Act No. 7586 or the National Integrated Protected Areas System (NIPAS) Act. • Areas declared as such through other issuances from pertinent national and local government agencies such as presidential proclamations and executive orders, local ordinances and international commitments and declarations	No	The proposed project is not located in declared national parks, watershed reserves, wildlife preserves, or sanctuaries. Bayaoas Watershed is not listed in the protected areas of DENR R1. http://r1.denr.gov.ph/images/R1GISMAPS/PAs/r-1-pa.pdf
2.	Areas set aside as aesthetics, potential tourist spots • Aesthetic potential tourist spots declared and reserved by the LGU, DOT or other appropriate authorities for tourism development • Class 1 and 2 caves as cited in EMB MC 2014-004 and defined under DENR MC 2013-03 and significant caves as may be determined by BMB and EMB	No	The propose project is not located in aesthetics or potential tourist spot
3.	Areas which constitute the habitat for any endangered or threatened species of Indigenous Philippine wildlife (Flora and Fauna) • Areas identified as key biodiversity areas (KBAs) by BMB, • Areas declared as Local Conservation Areas (LCA) through issuances from pertinent national and local government agencies such as presidential proclamations and executive orders, local ordinances and international commitments and declarations.	No	The proposed project is not located in declared key biodiversity area or local conservation area by the local government. However, the headwaters upstream in part of the unprotected Zambales Key Biodiversity area.
4.	Areas of unique historic, archaeological, geological, or scientific interests • All areas declared as historic site under RA 10066 by the NHCP • The whole barangay or municipality, where archeological, paleontological and	No	The proposed project is not located in areas of unique historic, archaeological, geological, or scientific interests.

	ECA Category per EMC 2014-005	Presence in BSRIP	Relevance at the Proposed Project Site
	anthropological sites/reservations are located as proclaimed by the National Museum • The whole barangay or municipality, as may be applicable, of cultural and scientific significance to the nation as recognized through national or local laws or ordinances (e.g. declared geological monuments and scientific research areas and areas with cultural heritage significance as declared by the LGUs or NCCA)		
5.	Areas which are traditionally occupied by cultural communities or tribes • Areas issued Certificate of Ancestral Domain Title (CADT) or Certificate of Ancestral Land Title (CALT) by National Commission or Indigenous Peoples (NCIP) • Areas issued Certificate of Ancestral Domain Claim (CADC) or Certificate of Ancestral Land Claim (CALC) by the DENR • Areas that are historically/traditionally occupied as ancestral lands or ancestral domains by indigenous communities as documented in reputable publications or certified by NCIP	No	The proposed project is not located in areas which are traditionally occupied by cultural communities or tribes. However, migrant IPs from Benguet has been residents at Sitio Mapita of Barangay Laoag, about 8.5 Km WNW of the proposed dam, at the boundary with the province of Zambales, but just outside the NW boundary of the Bayaoas Watershed.
6.	Areas frequently visited and or hard hit by natural calamities The area shall be so characterized if any of the following conditions exist:	Yes	[as indicated below]
6.1	Geologic hazard areas: • Areas classified by the MGB as susceptible to landslide • Areas identified as prone to land subsidence and ground settling; areas with sinkholes and sags as determined by the MGB or as certified by other competent authorities	Yes	The proposed dam site is highly susceptible to landslide A landslide map is presented in Geology Section
6.2	Flood-prone areas • Areas with identified or classified by MGB or PAGASA as susceptible or prone to flood	No	The proposed dam site at the mountainous area is not prone to flood A flood susceptibility map is presented in Hydrology Section
6.3	Areas frequently visited or hard-it by typhoons: • For purposes of coverage, depressions, storms and typhoons will be covered in the category • This shall refer to all **provinces** affected by tropical cyclone in the past	Yes	The province is high risk to typhoons according to Mapping Philippine Vulnerability to Environmental Disasters. Manila Observatory http://vm.observatory.ph/cw_maps.

	ECA Category per EMC 2014-005	Presence in BSRIP	Relevance at the Proposed Project Site
			html The Philippine Cyclone Map is presented in Climate and Meteorology Section
6.4	Areas prone to volcanic activities/earthquakes: • This refers to all areas around active volcanoes designated by Philippine Institute of Volcanology and seismology (PHIVOLS) as Permanent Danger Zone as well as areas delineated to be prone to pyroclastic flow hazard, lave flow hazard, lahar hazard and other volcanic hazard as found applicable per active volcano. • This refers to all areas identified by Philippine Institute of Volcanology and Seismology (PHIVOLCS) to be transected by active faults and their corresponding recommended buffer zones, as well as areas delineated to be prone to ground-shaking hazard, liquefaction hazard, earthquake-triggered landslide hazard and tsunami hazard.	No	The propose dam site in not located in Permanent Danger Zone or volcanic hazard and transected by active faults, and not prone to ground-shaking hazard, liquefaction hazard, earthquake-triggered landslide hazard and tsunami hazard. The East Zambales Fault is about 8.5 km from the dam site Geological hazard maps are presented in Geology Section
7.	Areas with critical slope: All lands with slope of 50% or more classified as geohazard by MGB. This shall refer to all lands with slope of 50% or more as determined from latest official topographic map from NAMRIA	Yes	The propose dam site is located in a mountainous area Slope map is presented in Geology Section
8.	Areas classified as prime agricultural lands Prime Agricultural lands shall refer to lands that can be used for various or specific agricultural activities and can provide optimum sustainable yield with a minimum of inputs and developments costs as determined by DA, NAI or concerned LGU through their zoning ordinance	Yes	The proposed dam and water reservoir will supply irrigation water to prime agricultural land in the plain downstream.
9.	Recharge areas of aquifers • Recharge areas of aquifers shall refer to sources of water replenishment where rainwater or seepage actually enters the aquifers • Areas under this classification shall be limited to all local or non-national watersheds and geothermal reservations	No	The proposed dam site is located in areas with rocks without any known significant groundwater, largely untested, down to the foot of the mountain. The lowland has limited potential, low to moderate productivity or further down with local and less productive aquifers. The Agno River basin groundwater map is presented in Hydrology Section
10.	Water bodies All natural water bodied (e.g., rivers, lake, bay) that	Yes	The proposed dam site is located in Bayaoas River

	ECA Category per EMC 2014-005	Presence in BSRIP	Relevance at the Proposed Project Site
	have been classified or not		
11.	Mangrove areas Mangrove areas as mapped or identified by DENR	No	This type of ECA is not relevant for the proposed BSRIP
12.	Coral reefs Coral reefs as mapped or identified by DENR and/or DA-BFAR.	No	This type of ECA is not relevant for the proposed BSRIP

2.1.1.9 Impact Assessment on Land Use

Key impacts on land use were identified as follows:

i. partial encroachment of NGP areas considered as change in land use at the dam site and reservoir;
ii. longer access route for operators of NGP areas (disappearance of river channel access) but compensated by the access road to dam site;
iii. conversion of private land to access road to dam site and main supply canal with a right-of-way acquisition; and
iv. opportunities for other upland use such as water source for NGP, local tourism (aesthetics), educational tour and fishery.

The proposed dam is not expected to cause significant impairment on visual aesthetics. Primarily, the area is wooded grassland, far and partly hidden from the nearby populated area. In addition, the proposed Project would not cause significant devaluation of the land value as a result of improper solid waste management and other related impacts because the Project would not generate significant volume of solid wastes during the operations phase.

2.1.2 Geology/Geomorphology

2.1.2.1 Summary

The proposed dam is located in the rugged topography in the northeastern part of Zambales Mountain consisting of Ophiolite Complex an east-dipping complete sequence of oceanic crust and mantle material, generally sound and massive rock, consisting of series of basic to ultrabasic or ultramafic rocks consisting largely of massive gabbro, peridotite, sheeted diabase dike complex overlain by pelagic sediments: (conglomerate) in distinct transitional relationships. It is a mineral district of chromium (Cr), nickel (Ni), platinum (Pt), copper(Cu), and gold (Au).

At the dam sites, the joint systems within the rocks are generally tight and are filled with secondary alteration such as quartz and calcite. The nature of the joints and a lack of through-going structures suggest no problem regarding water seepage. The quite deep weathering may require grouting until fresh bedrock. The river deposit (alluvium) is thick from the foundation rocks. The dam site hosts chromite and asbestos deposits and the implications of their presence will be part of future works. The dam site provided sufficient quantity and good quality construction materials.

The dam site has shear zones and two northwest trending vertical faults are located approximately 75.00 meters downstream and 500 meters upstream of the proposed dam. The nearest active fault is the East Zambales Fault which is about 3.7 km east of the dam site. The maximum credible earthquake (MCE) is 7.4 for East Zambales Fault, based on possible surface rupture length. In consideration of the East Zambales Fault, the estimated PGA for the dam design by deterministic approach is 0.21g which is equivalent to PEIS VII, and already considered in the conceptual design of the dam. The dam site is highly susceptible to landslide. A more detailed geotechnical investigation will be done for detailed engineering design of the proposed Project.

The service areas for the reservoir or the rice farms are located in alluvial plains with high susceptibility to liquefaction.

The dam would prevent the natural channel replenishment of earth materials downstream.

2.1.2.2 Methodology

The geological information for the proposed Project were derived from the BSRIP 2015 FS Report, and internet search at the webpages of Phivolcs, MGB, DENR, Manila Observatory and technical literatures.

2.1.2.3 Surface Landform / Geomorphology

The Province of Pangasinan is generally a valley exhibiting a broad central alluvial plain, where the BSRIP service area is located, flanked by mountainous regions on each side, on the west by Zambales Mountains, where the proposed dam is located, and on the east by Central Cordillera (**Figure 2.1.2-1**). From the northwest to the northeast, moderate topography to the expansive alluvial plain comprise the central part where Agno River meanders through. In that plain, rolling hills and raised masses easing to lowlands, make up the southeastern portion where Mount Balungao, Amorong, and Cabaruan Hills are situated. The highest elevations are in the south-southwest portion bounded by the towns of Infanta and Aguilar, which forms a part of a major north-south trending mountain range, the Zambales Range. This mountain range extends from Zambales to some portions of Bataan.

Figure 2.1.2-1. Elevation Map of the Proposed Project
Source: https://upload.wikimedia.org/wikipedia/commons/3/3c/Zambales_Mountains_topographic_map_en.svg

The proposed dam and maximum water level of reservoir are within elevations of 55-100 masl according to the NAMRIA topographic map **(Figure 2.1.2-2)**. About 1 km NNW of the dam is peak 421 m (42.1%) and 1 km south of the dam is Peak 329 (32.9%) . Visually down the banks channel of Bayaoas River are steep slopes. By Google Earth image, the river bed has very low slope 1.1% ((106-48)/5170), making it an access route A regional slope map is presented in **Figure 2.1.2-3**. The highest elevation of the Bayaoas Watershed is 945 m to the southwest boundary. A 3D view of the Bayaoas Watershed is presented in **Figure 2.1.2-4.**

By physiography, there are two major drainage systems situated in the province of Pangasinan, namely – the Agno and Bued Rivers. The Agno River traverses the provinces of Benguet and Pangasinan and discharges into Lingayen Gulf in Dagupan City. This river system drains the southeastern half of the central cordillera and eventually flows to the central plains of Pangasinan. The Bued River, originating from Baguio City, drains the southwestern half and discharges into Lingayen Gulf.

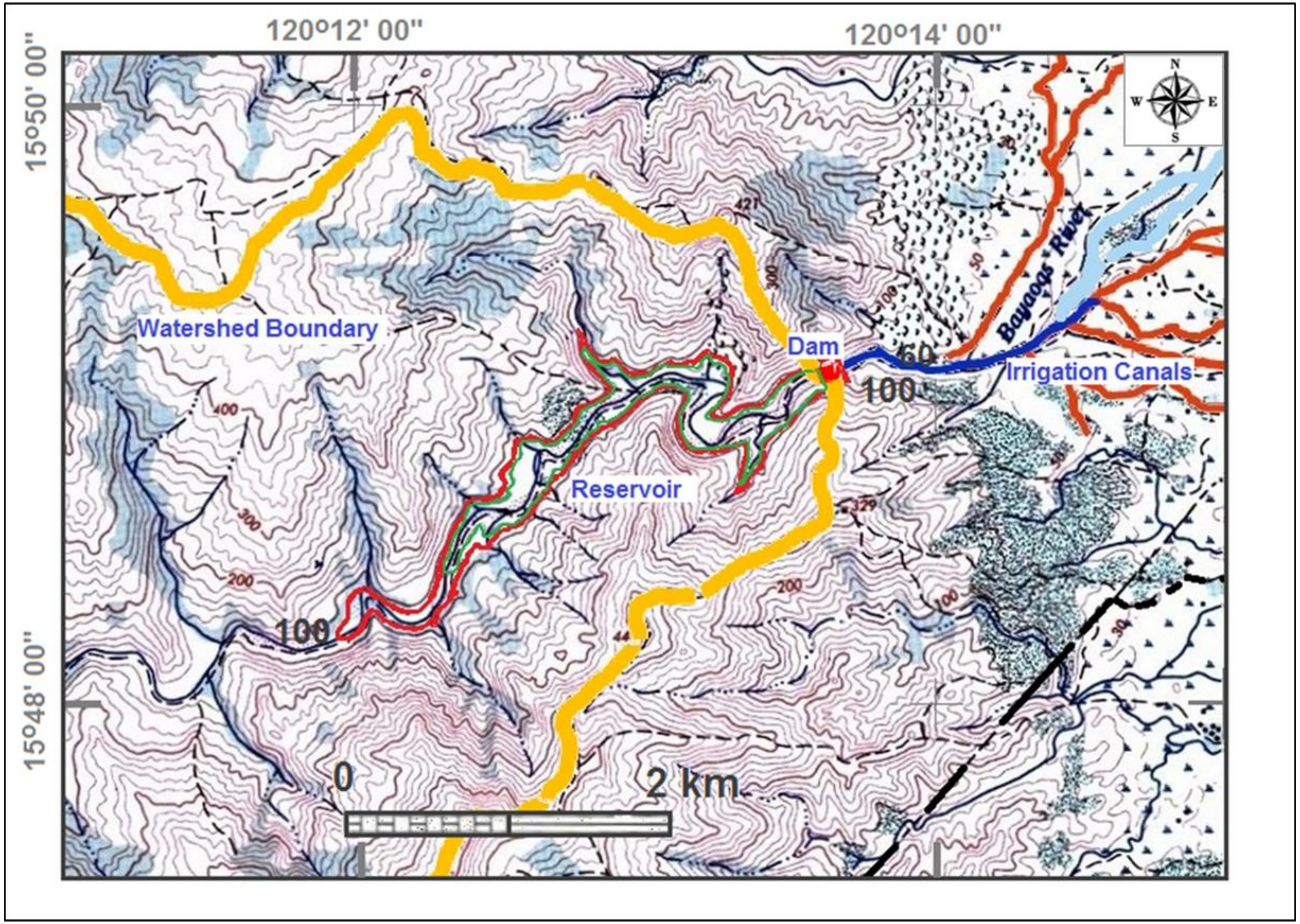


Figure 2.1.2-2. Project Site on NAMRIA Topographic Map Showing the Elevation Contour Lines in Meters Above Sea Level

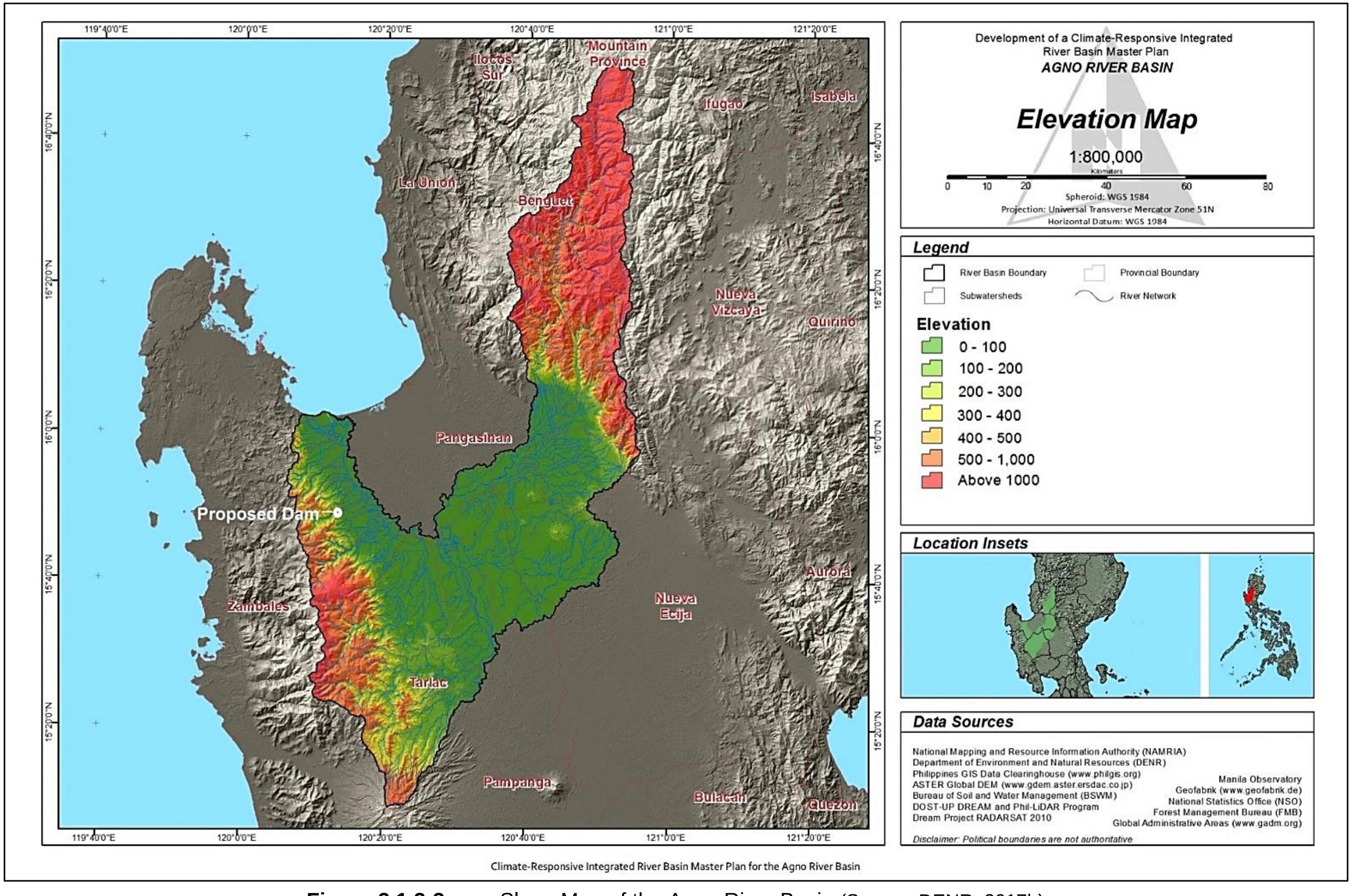


Figure 2.1.2-3. Slope Map of the Agno River Basin (Source: DENR, 2017b)

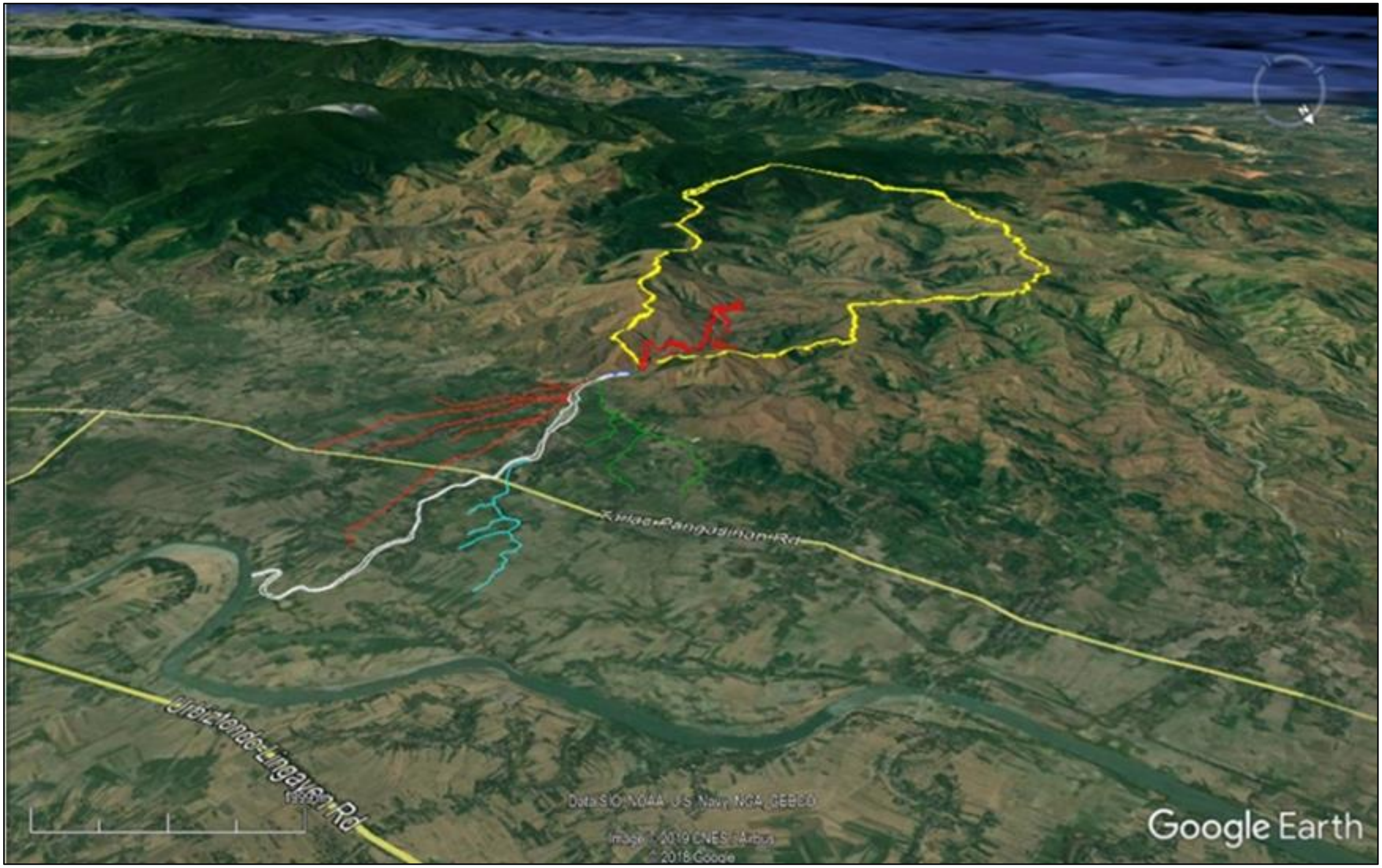


Figure 2.1.2-4. 3D Google Earth Map of the Bayaoas Watershed (looking southwest)

2.1.2.4 Sub-surface Geology / Regional Geology

The major geological components at the proposed Project area are Ophiolite Complex (for the dam) and Alluvium to the east (for the service area), based on the 2015 FS Report for BSRIP.

Ophiolite Complex. The proposed dam and reservoir is located in the the ophiolite sequence of western Luzon, known as the Zambales Ophiolite Complex in the Zambales Mountains (**Figure 2.1.2-5**). It is an east-dipping complete sequence of oceanic crust and mantle material. An ophiolite is a section of the Earth's oceanic crust and the underlying upper mantle that has been uplifted and exposed above sea level and often emplaced onto continental crustal rocks.

The complex forms the western portion of Central Luzon covering 160 km from north to south and spanning 40 km at its widest portion from east to west. The Zambales ophiolite exposes a typical succession of basalt flows, diabasic dikes, gabbro and tectonized harzburgite. The age established by limiting strata is late Eocene. Stratigraphic evidences point to its emergence during the Oligocene to Early Miocene (Scweller and others, 1983[9]).

Information on the Zambales Ophiolite Complex can be found in Yumol (2001)[10]. The complex is is made up of three massifs namely – Cabangan, Masinloc, and San Antonio, was generated in a subduction-related marginal basin separated by west-northwest trending faults. **(Figure 2.1.2-6)**. A massif is a section of a planet's crust that is demarcated by faults or flexures. In the movement of the crust, a massif tends to retain its internal structure while being displaced as a whole (https://www.definitions.net/definition/massif). By petrological and geochemical evidence, the Masinloc Massif is divided into Acoje Block (island arc) and Coto Block (transitional midoceanic ridge island) (e.g., Hawkins and Evans, 1983[11]; Yumul, 1989). They are believed to in contact by a fault, transitional, or intrusive boundary with the Acoje pluton intruded into the Coto block (e.g., Yumul, 1996). The Coto Block is geochemically similar to the Cabangan massif; while the Acoje Block with San Antonio massif the same can be said for both the San Antonio massif (Yumul, 1992[12]).

In addition, each block is made up of a complete ophiolite sequence of residual (upper mantle), transition zone, cumulate (base of crust), and volcanic (oceanic crust) rocks (Hawkins and Evans, 1983 ; Yumul, 1989, 1990)

The general domal nature of the lithological units indicates that the ophiolitic rocks are exposed by uplift, also suggested by a lack of evidence of thrust faulting. The Zambales ophiolite is considered one of the least disturbed ophiolitic masses known by emplacement where the exposed mass trends north and the upper surface drops at low angles to the north and south. The chemistry and composition of the rocks in the northwest part of the Zambales area (Acoje block) is distinct from that in the southeastern segment (Coto block).

[9] *Schweller, W.J., Karig, D.E., and Bachman, S.B., 1983, Original setting and emplacement history of the Zambales ophiolite, Luzon, Philippines, from stratigraphic evidence, in Hayes, D.E., ed., The tectonic and geologic evolution of Southeast Asian seas and islands, part 2: American Geophysical Union Monograph 27, p. 124-138. Reference cited in https://pubs.usgs.gov/pinatubo/newhall/*

[10] *Yumul, G.P. The Acoje Block Platiniferous Dunite Horizon, Zambales Ophiolite Complex, Philippines: Melt Type and Associated Geochemical Controls, Resource Geology, vol. 51, no. 2, 165–174, 2001.*

[11] *Hawkins, J.W., and Evans, C.A., 1983, Geology of the Zambales Range, Luzon, Philippine Islands: Ophiolite derived from an island arc-back arc basin pair, in Hayes, D.E., ed., The tectonic and geologic evolution of Southeast Asian seas and islands, part 2: American Geophysical Union Monograph 27, p. 95-123. Reference cited in https://pubs.usgs.gov/pinatubo/newhall/*

[12] *Yumul, G. P., Jr. (1992) Ophiolite-hosted chromite deposits as tectonic setting and melting degree indicators: Examples from the Zambales Ophiolite Complex, Luzon, Philippines. Mining Geol., 42, 5–17.*

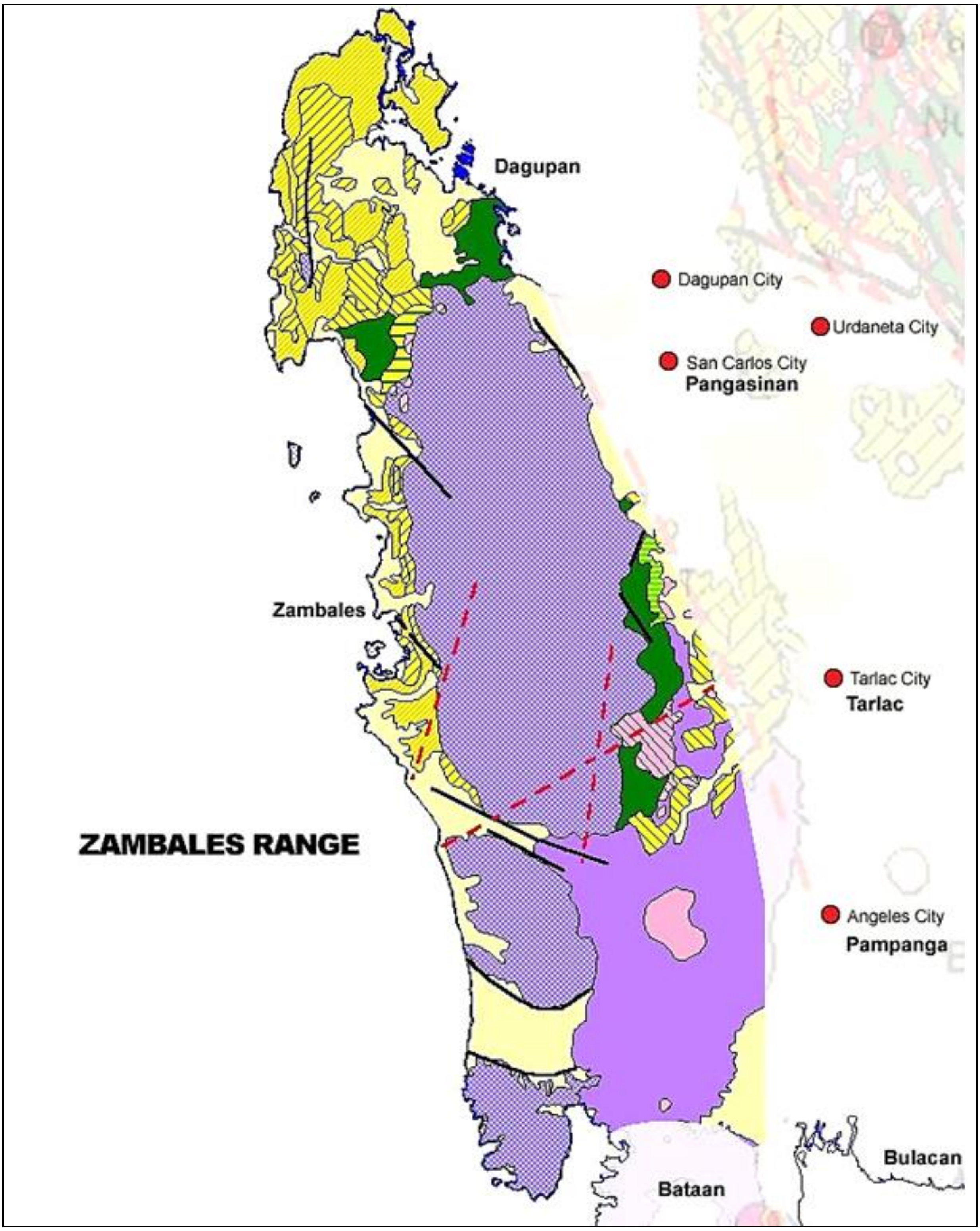


Figure 2.1.2-5. Ophiolite Complex of Zambales Range

Source: Geology Wiki. Accessed in https://geology.fandom.com/wiki/Zambales_Range

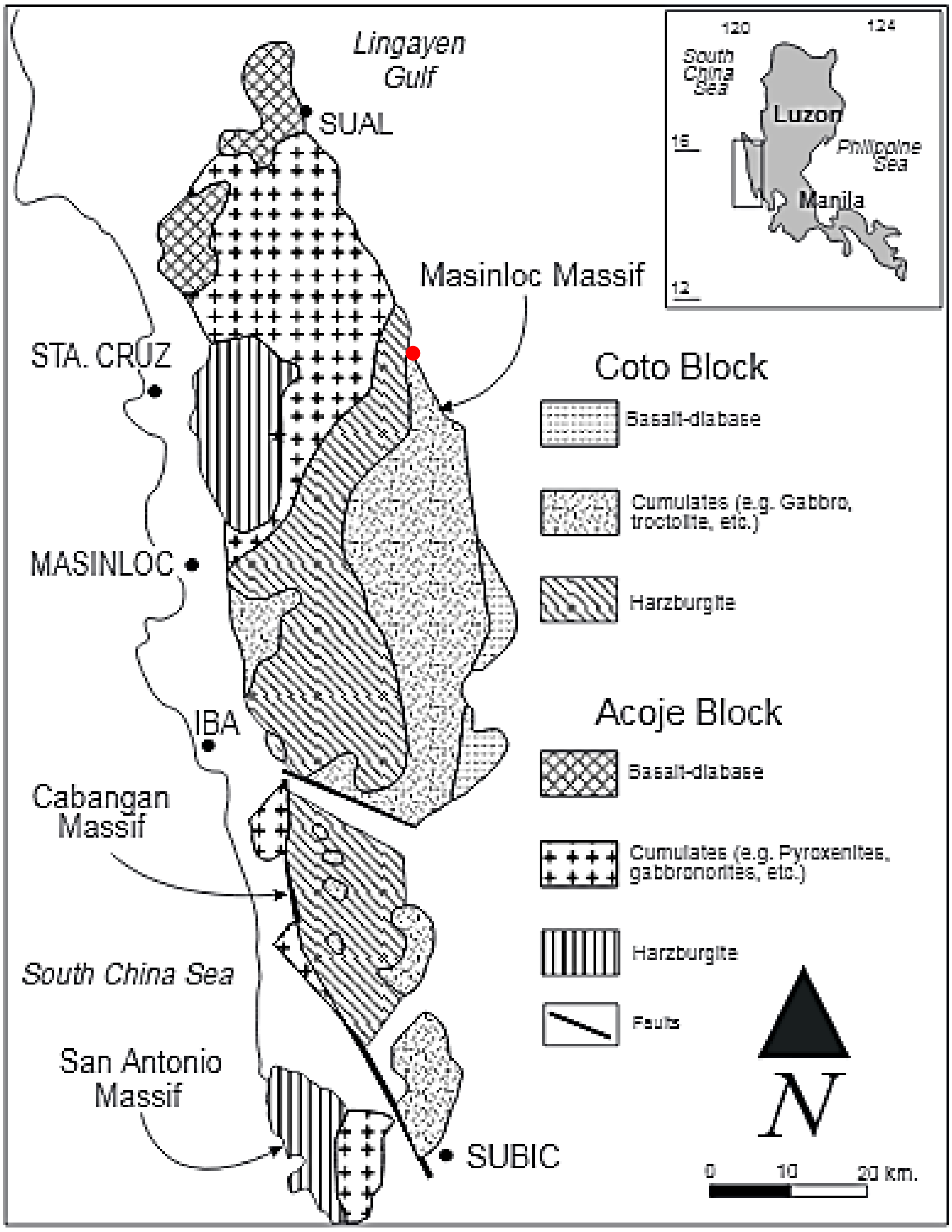


Figure 2.1.2-6. Coto and Acoje blocks of Zambales Ophiolite Complex
The red dot is the location of BSRIP damsite

Source: Yumul Jr. GP. 2001. The Acoje Block Platiniferous Dunite Horizon, Zambales Ophiolite Complex, Philippines: Melt Type and Associated Geochemical Controls. Resource Geology, vol. 51, no. 2, pp. 165–174. Accessed in https://onlinelibrary.wiley.com/doi/epdf/10.1111/j.1751-3928.2001.tb00089.x

Based on the figures above, the proposed Project is apparently located in southeast part of the Coto block comprising harzburgite which is an ultramafic, igneous rock, is a variety of peridotite consisting mostly of the two minerals, olivine and low-calcium pyroxene; it is named for occurrences in the Harz Mountains of Germany. It commonly contains a few percent chromium-rich spinel as an accessory mineral (Wikipedia)

"The Ophiolite Complex is a series of basic to ultrabasic or ultramafic rocks consisting largely of massive gabbro, peridotite, sheeted diabase dike complex overlain by pelagic sediments: (conglomerate) in distinct transitional relationships." **(Figure 2.1.2-7)** It is a mineral district of chromium (Cr), nickel (Ni), platinum (Pt), copper(Cu), and gold (Au).

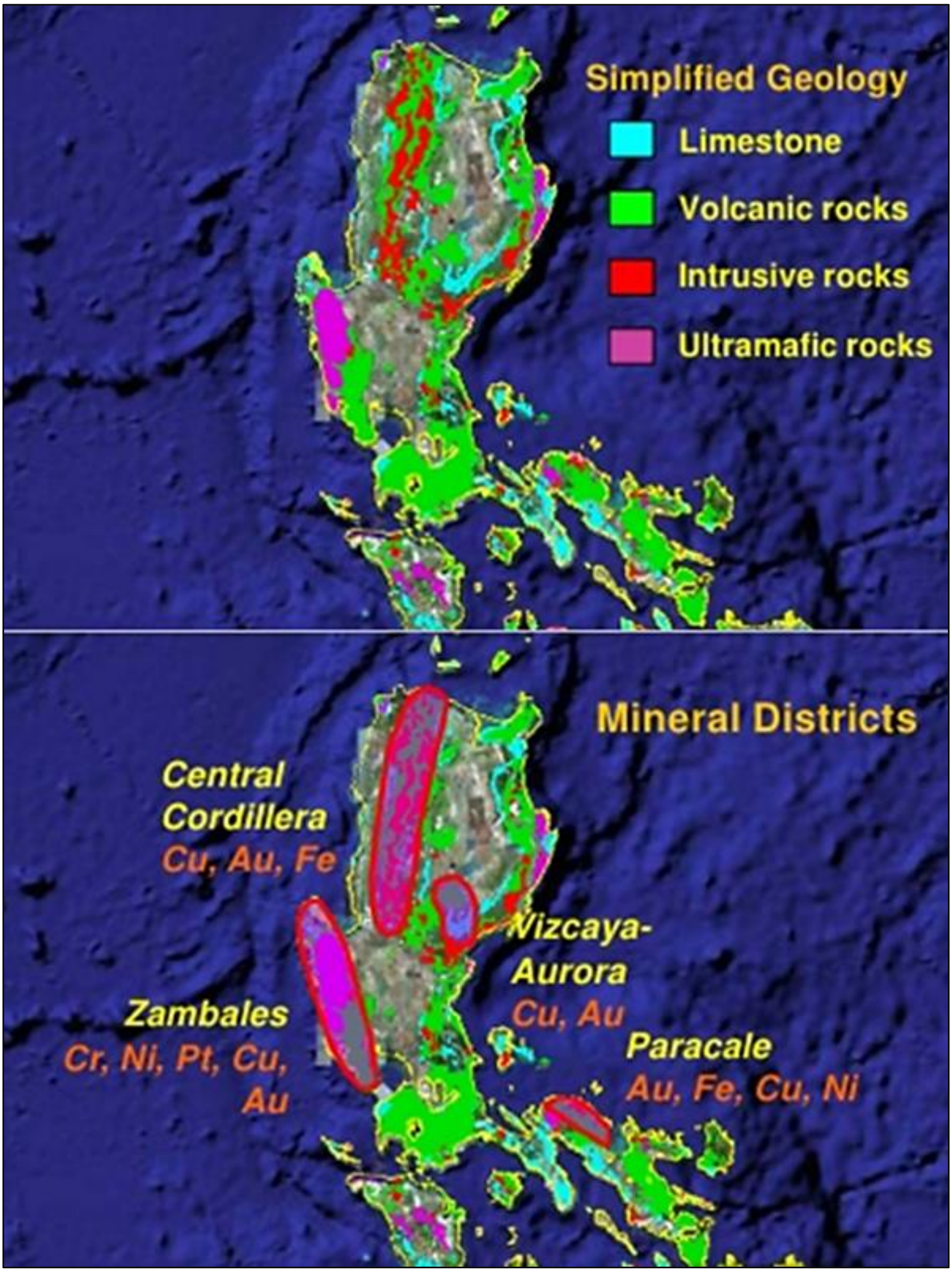


Figure 2.1.2-7. Simplified Geology and Mineral District of Luzon

Adapted from the tresentation for FG Sajona and E G Domingo in Mining Phils 2011 Conference and Exhibition . Sep 13-15 2011. Accessed in https://www.slideshare.net/no2mininginpalawan/philippine-mineral-exploration-perspective-sajonadomingo

Each rock type comprising the ophiolite complex along with their age (from oldest to youngest) is described in **Table 2.1.2-1**:

Table 2.1.2-1. Description of Rock Types at BSRIP

Rock Type	Description
Gabbro	Extensive and massive to layered norite, partly troctolite, normal gabbro and pegmatite anorthosite. Principal minerals are calcic plagioclase with dark minerals of augite, hypersthene and olivine. Usually subhedral or anhedral with granular texture and finer textured varieties near lithologic boundaries. Located mostly at the reservoir area and are very hard and stable.
Peridotite	Mainly consist of massive to layered peridotite and pyroxene peridotite. Generally dark colored, coarse-grained and composed predominantly of olivine and pyroxene minerals. These rocks are transected by numerous chrysotile (asbestos) veins and veinlets. Serpentinization (alteration of rocks) is common having an effect on the similarity and competency of the peridotite.
Conglomerate	Occurrences of small isolated patches within the peridotite; generally gravel-sized.
Residual Soil	Composed of weathered rock fragments with brown silt and clay. Usually thin along the slopes and about 1 to 4 meter thick.

The stratigraphic column of the Zambales Range is composed of the Zambales Ophiolite Complex, the Balog-Balog Diorite, the Aksitero Formation, the Cabaluan Formation, the Sta. Cruz Formation, the Bolinao Limestone, and the Bataan Volcanic Arc Complex (**Figure 2.1.2-8**). The chronology of the formations includes the establishment of the Zambales Ophiolite. It is shown that about Mid-Eocene was the intrusion of the Balog-Balog Diorite followed by the emplacement of the Aksitero Formation. The Cabaluan Formation within the Middle Miocene was conformably overlain by the Sta. Cruz Formation, which later was covered by the Pliocene-old Bolinao Limestone. The Bataan Volcanic Arc Complex dates back in Late Miocene. In addition, **Figure 2.1.2-9** shows a geologic map showing the ages of the rocks comprising the area within the Agno River Basin.

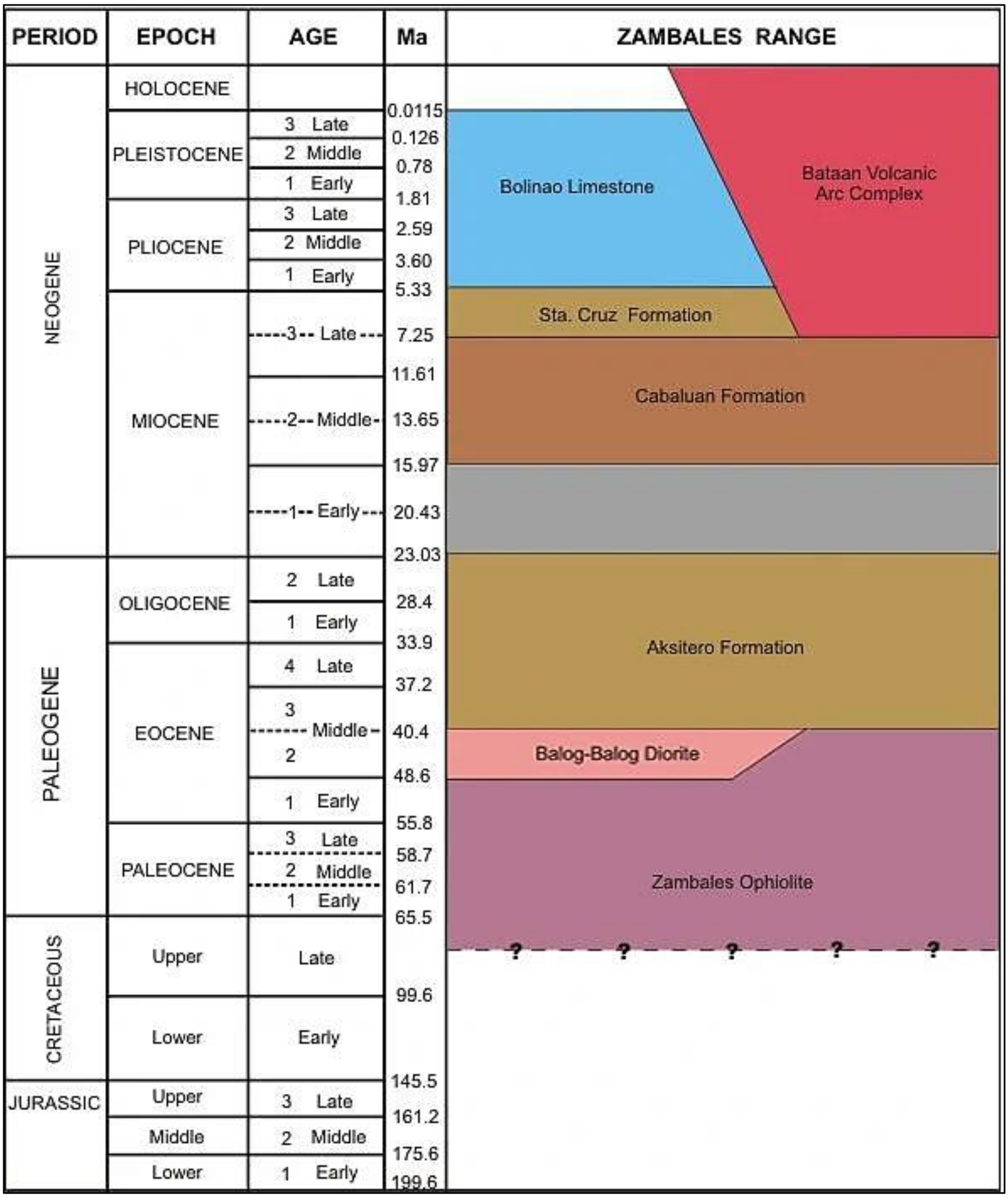
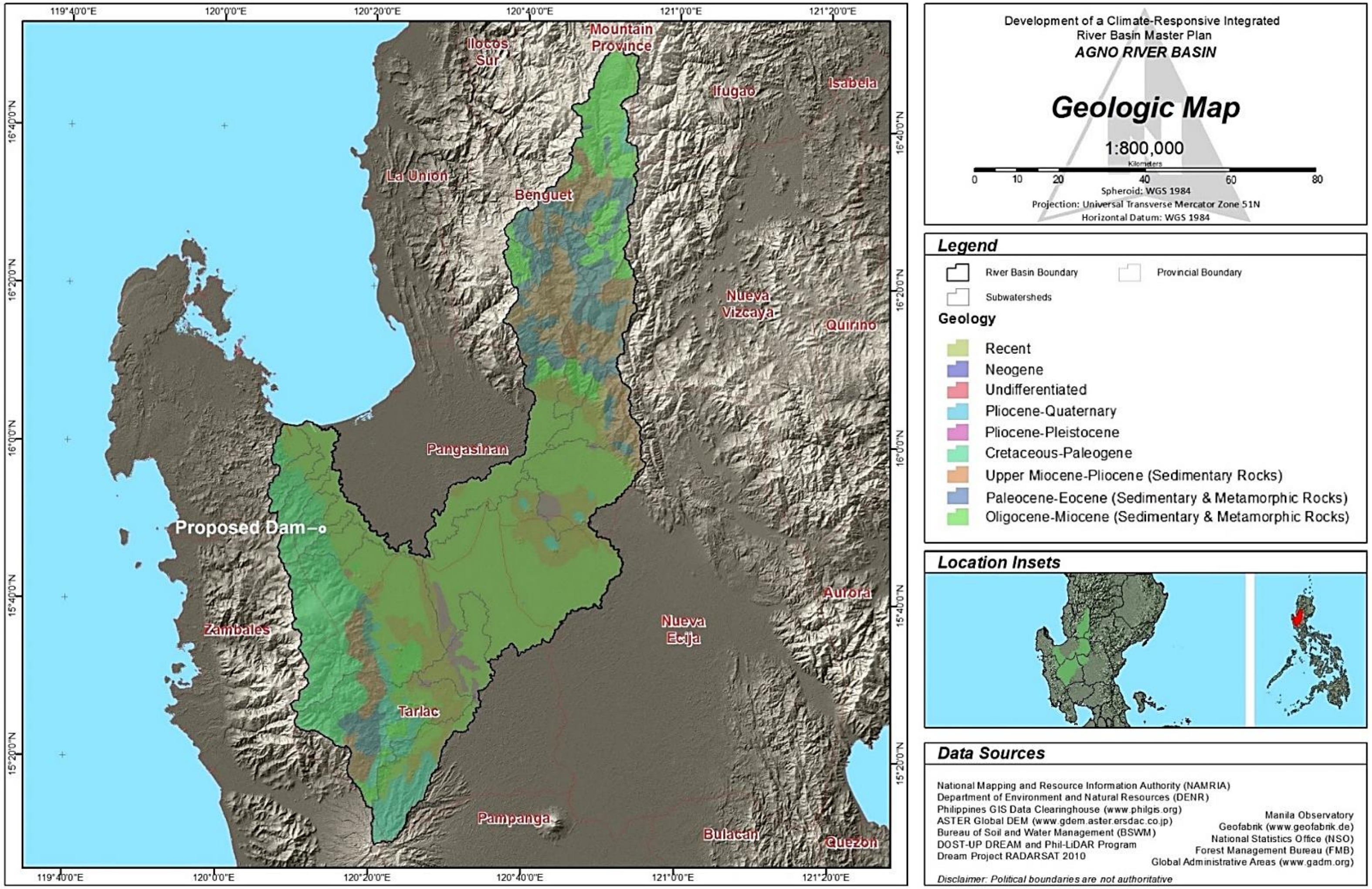


Figure 2.1.2-8. Stratigraphic Column of Zambales Range

Source: Geology Wiki. Accessed in https://geology.fandom.com/wiki/Zambales_Range



Climate-Responsive Integrated River Basin Master Plan for the Agno River Basin

Figure 2.1.2-9. Geologic Map of the Agno River Basin (Source: DENR, 2017b)

As supplementary information, the Province of Pangasinan is underlain by the eight rock units, showing the ultramafic complex in Aguilar, shown in **Table 2.1.2-2.**

Table 2.1.2-2. Rock Types by Age in the Province of Pangasinan

Age	Rocks
Cretaceous Paleogene	Ultramatic Complex- composed of gabbro, diabase complex, peridotite, pyroxenite, dunite and their serpentinized derivatives. Found at Labrador and infanta- Aguilar areas. Complex metavolcanics and meta sedimentary rocks exposed in Sual-Labrador area, near San Quinitin and Umingan. These rocks are intruded by diorite and other related intrusive.
Oligocene	Consists of wacke and shale generally associated with keratophyre and andesite flows. Noted in limited extent near Eguia at the western part
Middle to Lower Miocene	Sandstone, shale and conglomerate intercalated with Basalt. Found in the western and Eastern sections of the province.
Miocene	Numerous bodies of diorite and related rocks. Found near Dasol, Eguia and Infanta
Upper Miocene	Fine to medium grained clastic sediments made up mostly of mudstone and sandstone interbeds. Exposed in Sison-Pozorrubio area, extensive near Bani
Pliocene-Pleistocene	Limestone (coralline type) interbedded with tuffaceous shale. Exposed at the north-western portion and extending towards the Lingayen Gulf. Isolated patches of pebble to boulder sized clastics interbedded with consolidated sandstone at the southeastern boundary.
Quaternary	Volcanic plugs at Mt. Amorong . Alluvial deposits (unconsolidated fluvial sediments gravel and sand) extending from the southern fringe of Lingayen Gulf toward Tarlac-Pangasinan boundary. They are found mostly along the river beds, valleys and flood plains.

Alluvium. Alluvial deposits are confined mainly along Bayaoas River extending into the plain areas. This material reaches more than 10 meters thick in the dam site area but is limited. The predominant materials are fresh and hard gabbro and peridotite along with the other ultramafic rocks.

Figure 2.1.2-10 illustrates the subsurface relationships of these rocks (within the Central Luzon Basin setting) according to age along with the associated structures affecting these formations.

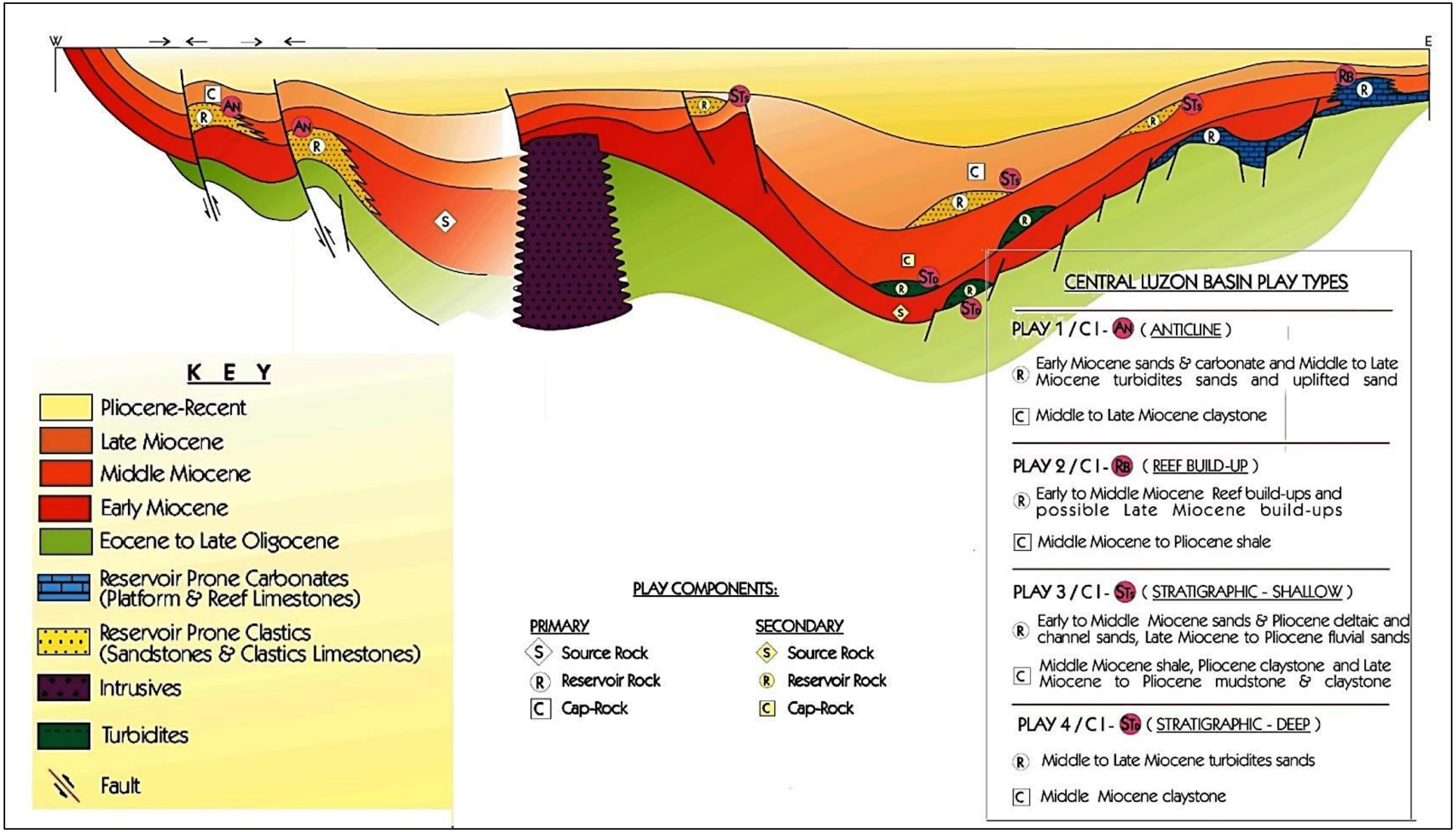


Figure 2.1-2-10. Cross Section Showing the Subsurface Geological Components and Associated Structures within the Central Luzon Basin.

Source: CCOP. 2002. Central Luzon Basin. Accessed in http://www.ccop.or.th/epf/philippines/philippines_petroleum.html http://www.ccop.or.th/epf/philippines/basin_pdf/centralluzon/CentralLuzon_Play.pdf

2.1.2.5 Project Site Morphology / Geology

Bayaoas Damsite. Site investigations with field testing were conducted at the project site as depicted in **Figure 2.1.2-11**.

Morphology. The proposed damsite is located in asymmetrical section of Bayaoas River. The left abutment is characterized by steep slopes of around 70 to 80-degree inclination, observed to be continuing downstream. Oppositely, the right abutment is gently sloping marked with old shallow slips and developing steeper downstream. Soil cover and weathered rock were generally observed along the slopes of the abutment

Lithology. The proposed dam site will be established primarily on the hard, coarse-grained pyroxene peridotite of the Ophiolite sequence. However, this unit exhibits some degree of serpentinization and where the degree of alteration is high, the rocks become unstable and would weather easily upon exposure. Weathering was measured to be 8m to 11m on the right side while reaching about 7m on the left. The alluvial deposits at Bayaoas River is almost 11m composed of sand, gravel, cobbles and few boulders with little amount of silt.

The joint systems within the rocks at the damsite are generally tight and are filled with secondary alteration such as quartz and calcite. The nature of the joints and a lack of through-going structures suggest no problem regarding water seepage. (Drawing BIP-V-5)

Two northwest trending vertical faults are located approximately 75.00 meters downstream and 500 meters upstream of the proposed dam. The geological disturbances appear to have controlled the orientation of several joints and localized faults which trend North East

The rocks at the damsite are generally disturbed. The average coefficient of permeability is 4.94×10^{-6} cm/sec, based on the results of the water pressure tests using single packer method at 3 m interval in four boreholes (**Table 2.1.2-3, Figure 2.1.2-12**),

Table 2.1.2-3 Location and Configuration of Geotechnical Boreholes Done at Damsite

Borehole No.	Location	Inclination	Depth
BH-2	Riverbed	Vertical	30.00
BH-2	Right Abutment	Vertical	40.10
BH-3	Intersection of spillway axis to right abutment	Vertical	40.45
BH-4	Left abutment	Vertical	-

Note: Drilled at the proposed damsite from June 7, 1987 to October 15, 1988

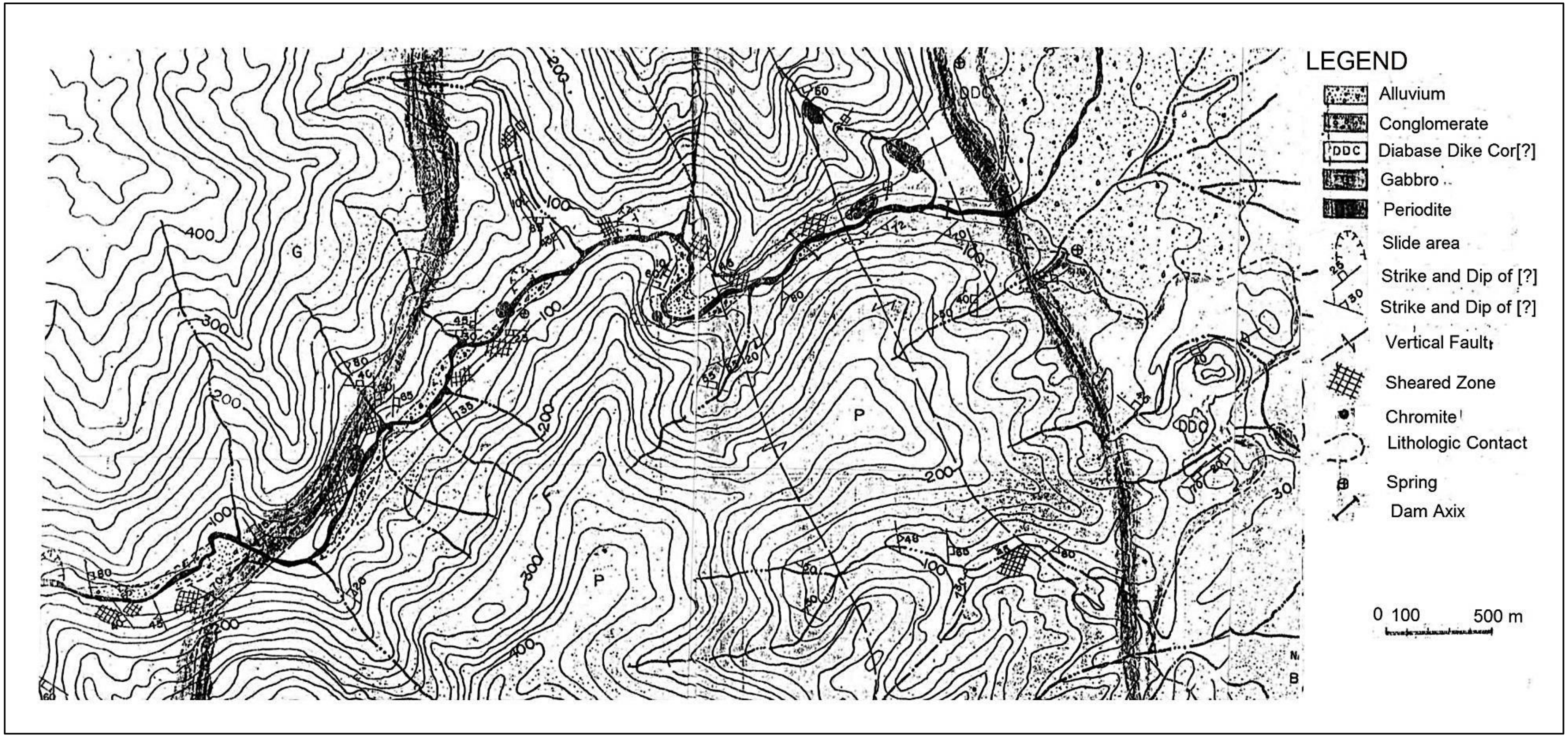


Figure 2.1-2-11. Field Testing Map at Bayaoas Damsite

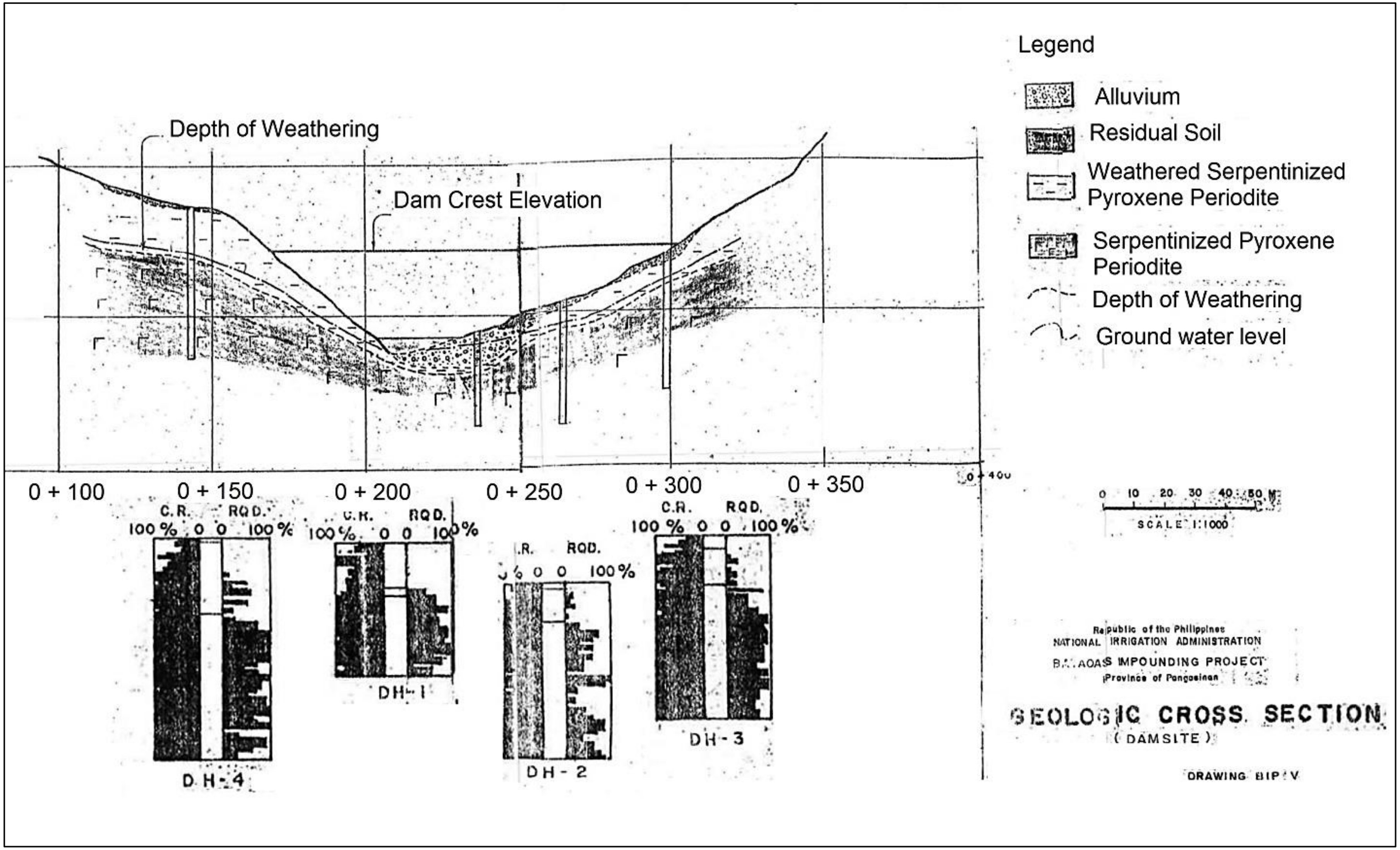


Figure 2.1.2-12. Damsite Boreholes Cross Section (looking downstream)

Spillway. The proposed location of the spillway is at the left abutment. The pyroxene peridotite rocks were mapped to be the underlying rocks in this area which are competent but are affected by well-defined joints. Minimal degree of stripping will be done to reach sound rock, given that the soil cover is generally thin extending at about 4 m. No core drilling work was done in this area.

Reservoir. The proposed dam at maximum flood condition may reach 5 km upstream. Moderate to high relief describes the area, which is sparsely vegetated but with limited forest growth lining up the creeks. The rocks in this area are pyroxene peridotite at the northeast and gabbro to the southwest. These rocks are hard, massive and stable particularly when fresh. Lithologic contact between these two types are transitional and with no suggestion of water leakages to be anticipated. A fault trending northeast runs parallel along the river governing the geological structures in the area. Several joints, fissures and shears are oriented perpendicular to this fault. These structures are tight and with secondary mineral infills making them impermeable. Rock slides in small magnitudes are widely scattered throughout. However, two (2) slide areas of considerable magnitude were identified within 500 meters upstream of the damsite.

Diversion Siphon Area. A siphon is proposed to cross Bayaoas River to the existing Don Quiron Intake structure. The area for this is made up of peridotite rocks at the right flank and fluviatile deposits at the left flank. The fluviatile deposits are characterized to be moderate to highly compacted comprised mostly of gravel with silt or clay materials. The alluvium in this area is about 15m to 20m thick.

2.1.2.6 Economic Deposits

Due to the presence of ultramafic rocks at the project area, it is common to find economically valued metallic and non-metallic deposits associated with these rocks.

Chromite. Outcrops of chromite bodies were delineated 500 meters upstream of Bayaoas Damsite. They are characterized by their black color and are very hard. Emplacement is believed to be controlled by the northwest trending fault within proximity of these bodies.

Asbestos. The asbestos deposits at the project area are more of the chrysotile type. They occur as cross-fiber veins and veinlets developed along fractures and minute fissures in the serpentinized periodite. Veins and veinlets have widths that range from hairline measurements to more than a centimeter.

2.1.2.7 Geotechnical Concerns

The relative thickness of the alluvium at the dam axis will pose some problems since a deep cut-off trench for the core will be necessary. The grain size of these materials is generally coarse, poorly classified and possess high permeability values.

The left abutment of the proposed damsite is dissected by a series of stress-relief joints striking NE-NW and dipping SE-SW towards the riverbank. Due to the steep inclination of this flank; rock sliding or creeping is bound to occur. This steep slope would require lowering to a more stable slope angle.

2.1.2.8 Sources of Construction Materials

Construction materials will consist of clay, gravel and sand, and riprap, according the 2015 BSRIP FS Report, discussed as follows:

Clay. The potential source of clay material or impervious material is at the foot of the mountain about 1 km downstream of the dam **(Figure 2.1.2-13).** Impervious materials were classified into two (2) types during the field investigations: residual and transported. The residual type, originates from the weathering of the parent rock materials in-situ. Color, plasticity and size of grains of the soil are directly influenced by these rocks. In the area where ultramafic rocks are predominant, the soil characteristics are dark brown to black color, highly plastic, with few coarse materials. With increasing depth, amount of coarse materials also increases due to the presence of unweathered rocks.

On the transported type, differences in soil composition are common. Soil near the present river course were observed to have moderate to low plasticity values, light brown to brown in color and high percentage of coarse materials. Other areas have the same characteristics except for the low percentages of coarse materials. These disparities are due to frequent changes in river flow where the heavier particles are deposited first than the finer ones.

Summarizing, Borrow area I is located 1.5 km, S 75 E of Bayaoas damsite with an approximate volume of 1,010,100 m3. (Drawing BIP V-1) Borrow area II, located 800 m N 65 E, has an approximate volume of 254,640 m3.

Auger borings were utilized on Borrow Areas I and II for the purposed of selecting good quality materials prior to the actual test pit excavations. Originally, twelve (12) test pits were excavated on the two (2) areas of which only seven (7) pits were logged and sampled. The remaining test pits were abandoned due to poor quality materials and flooding because of the high precipitation during the fieldwork. Composite samples weighing 30.00 kilograms were taken from each pit for the laboratory analysis. Six soil samples were tested for shear strength, permeability, workability, and cracking/piping.

Gravel and Sand. Sand and gravel for filter materials and concrete aggregates are found along Bayaoas River increasing in quantity downstream at the vicinities of Barrios Casagatan, Bayaoas and Buer. These materials are a mixture of particles comprising lithofacies found within the watershed areas from fine sand to boulders, the particle shape is sub-angular to sub-rounded with the coarse varieties exhibiting more rounded shapes. The individual grains are sound and hard with the exception of gabbro and periodite which contain minerals that are easily subjected to weathering. The predominant minerals are: Pyroxene, Olivene, Feldspars, Chrysotile (asbestos) and Magnetite/ Ilmenite. Deleterious materials are uncommon due to the low silica content of these rocks. Workable deposits covered by the survey are estimated at 864,000 cubic meters.

A dozer trench across Bayaoas River, excavated by the local contractor for their quarrying work, was used for the studies and designated as TR-1. Except for soil logging and sampling, no special field test were done. Particle size distribution was determined.

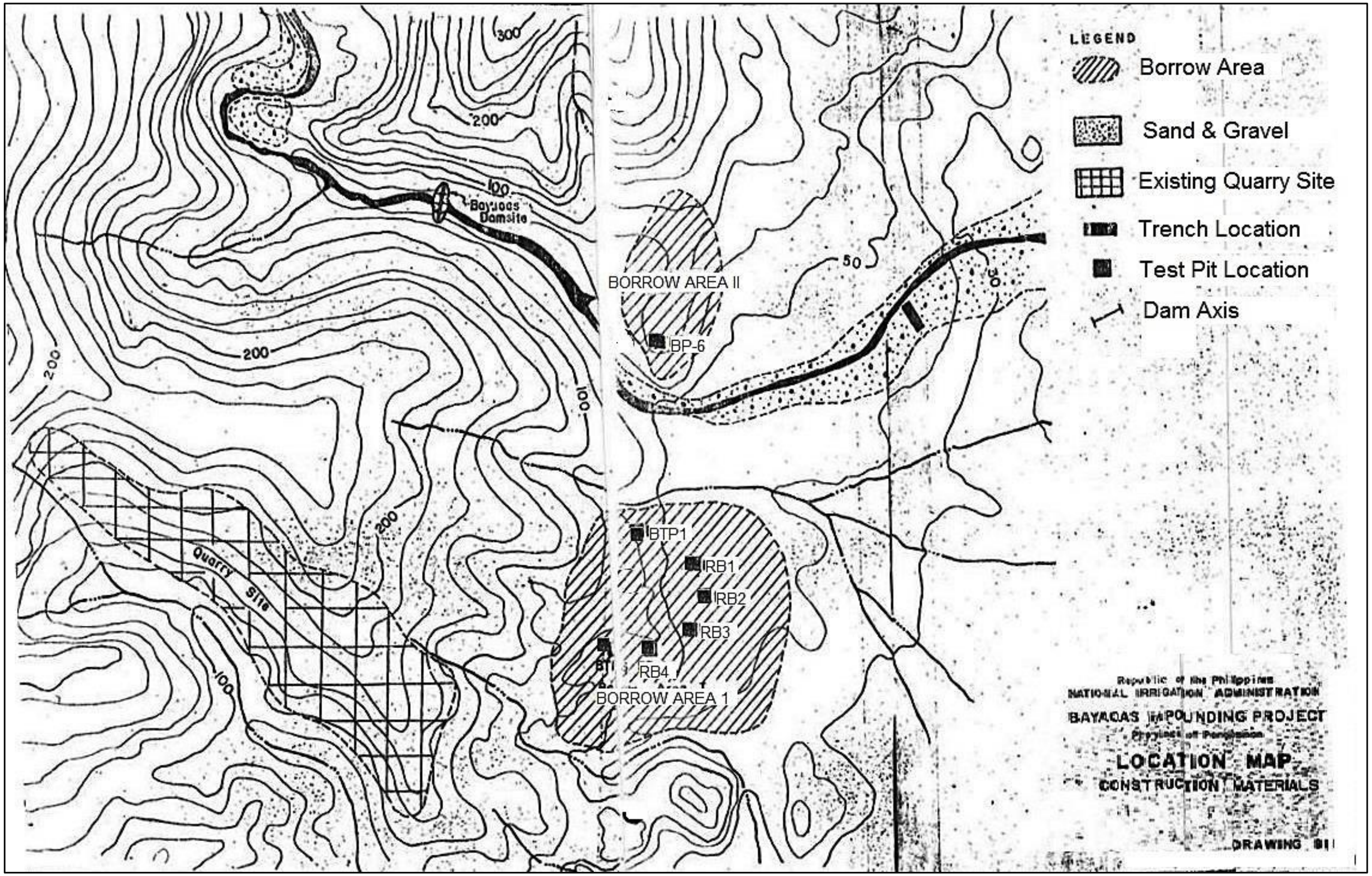


Figure 2.1.2-13. Location Map of Potential Construction Materials (Source: NIA, 2015)

2.1.2.9 Geological Hazards

The set of information of geological hazards was compiled as input to decisions on project location and design. These hazards are fault system, seismicity/earthquake, liquefaction, landslide, volcanic activity, and flood. These have been considered in the feasibility study.

Structural Features. The Pangasinan Province lies in the northwest extension of the Philippine Fault Zone. This major geological structure produces complimentary stresses, notably northwest trending structures, extending up to the Baguio Mineral District. Major fault elements are oriented parallel to the longitudinal section of the Cordillera and can be traced at its southern extension in Pangasinan. These structures are mainly splays of the Philippine Fault (**Figure 2.1.2-14**). Phivolcs has posted the fault system of Region 1 to include Pangasinan (**Figure 2.1.2-15**). Superimposing this to Google Earth indicates that the East Zambales Fault is about 3.8 km east of the proposed dam site (**Figure 2.1.2-16**). A morphostructural interpretation of 1:50,000 scale of the MGB Geologic Map of Bugallon shows that there is no active or potentially active fault cutting through the proposed dam site.

Seismicity and Earthquake. Seismically active areas of the archipelago that have influenced the Pangasinan Province are the northwestern extension of the Philippines Fault Zone and the so-called Manila Trench. Clusters of shallow to intermediate earthquakes were observed along this trench. The west-central Luzon Fault has a frequency earthquake distribution of only 0.86%. The site is located with 29-47 hits recorded (**Figure 2.1.2-17**), magnitude of 5.5 at 51-100 m deep (**Figure 2.1.2-18**), high danger zone (**Figure 2.1.2-19**). A ground shaking scenario at 7.3M along Zambales Fault is shown in **Figure 2.1.2-20**.

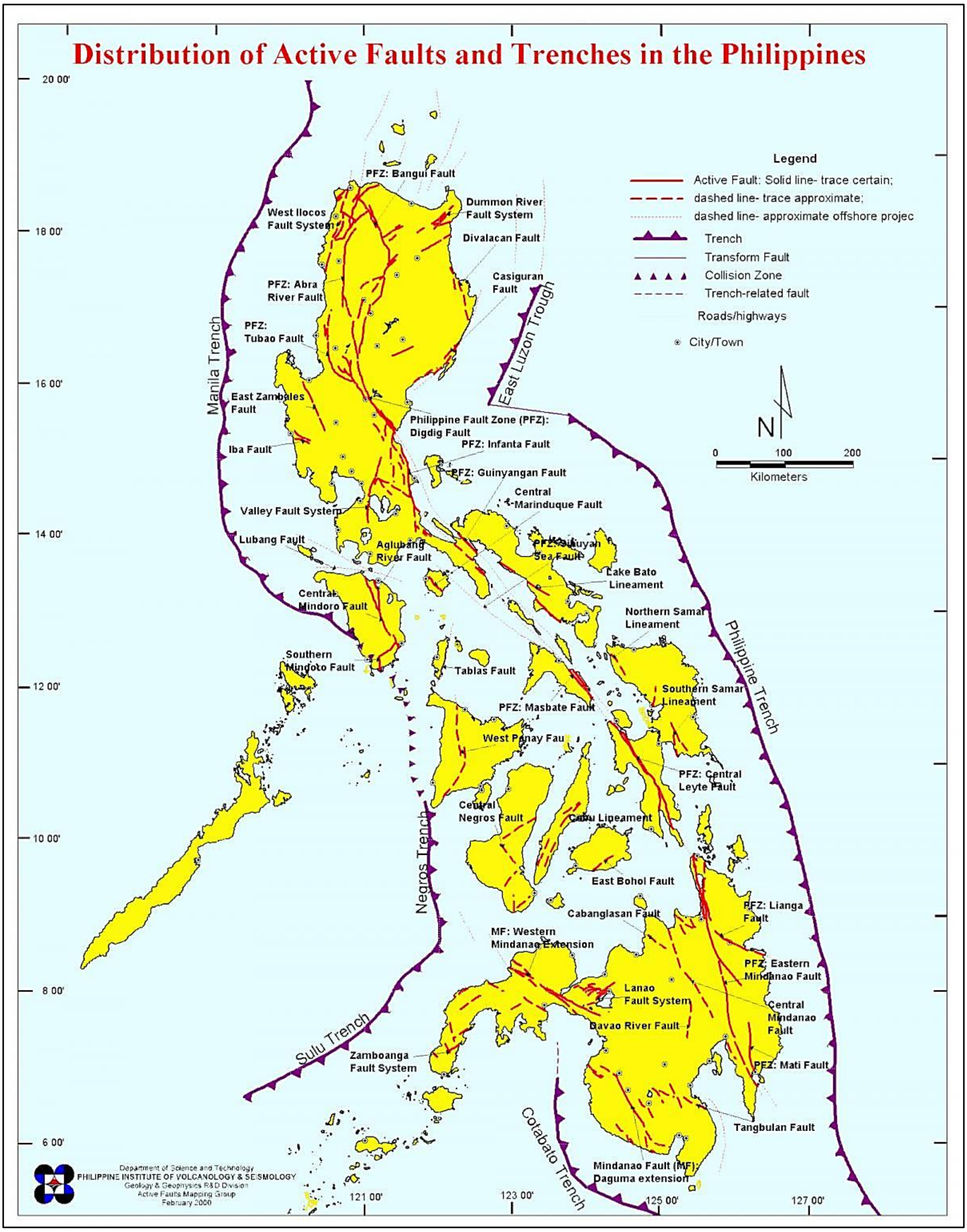


Figure 2.1.2-14. Distribution of Active Faults and Trenches in the Philippines (PHIVOLCS, February 2000).

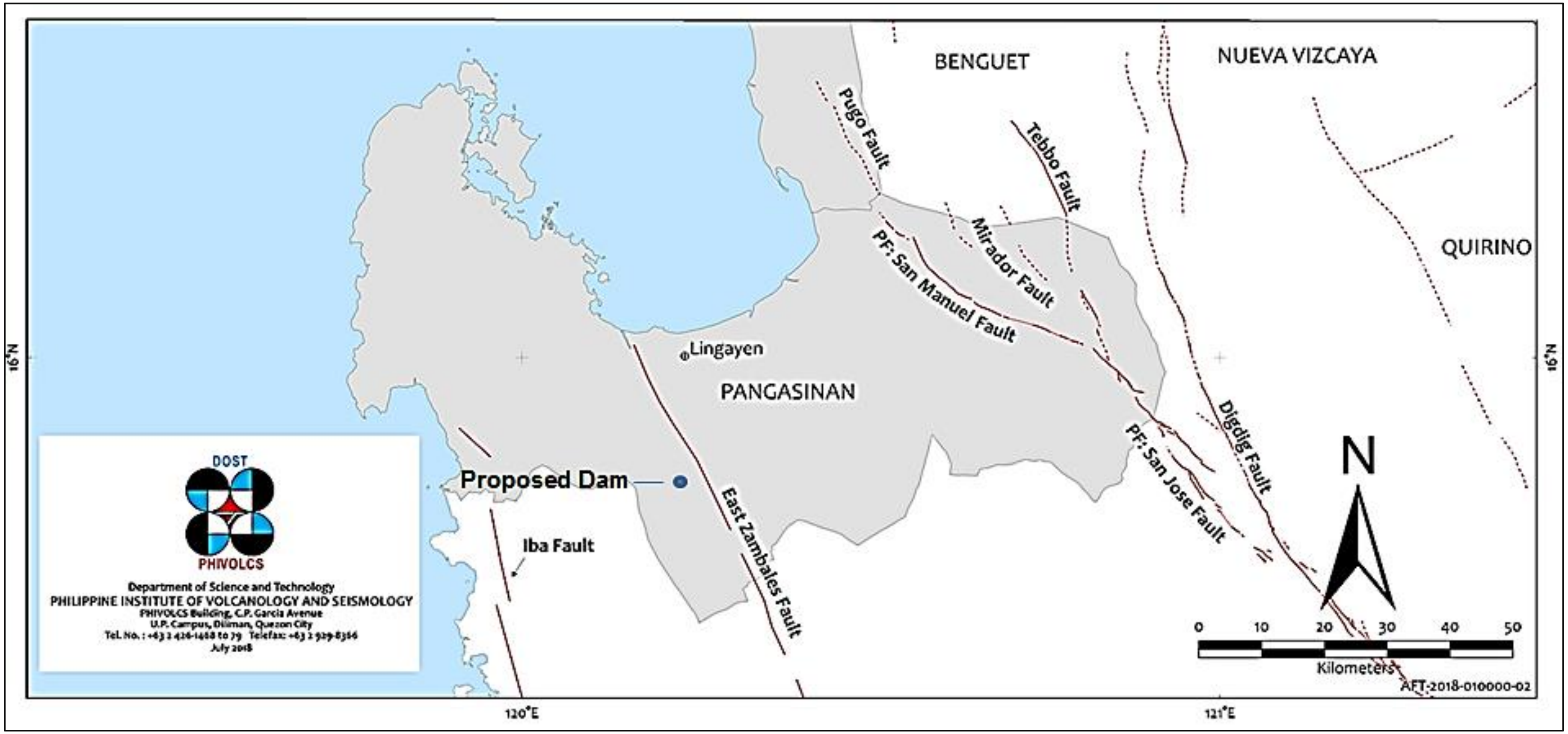


Figure 2.1.2-15. Location Map of East Zambales Fault (Extract from Distribution of Active Faults and Trenches in Region 1
(Source: Phivolcs, 2018)

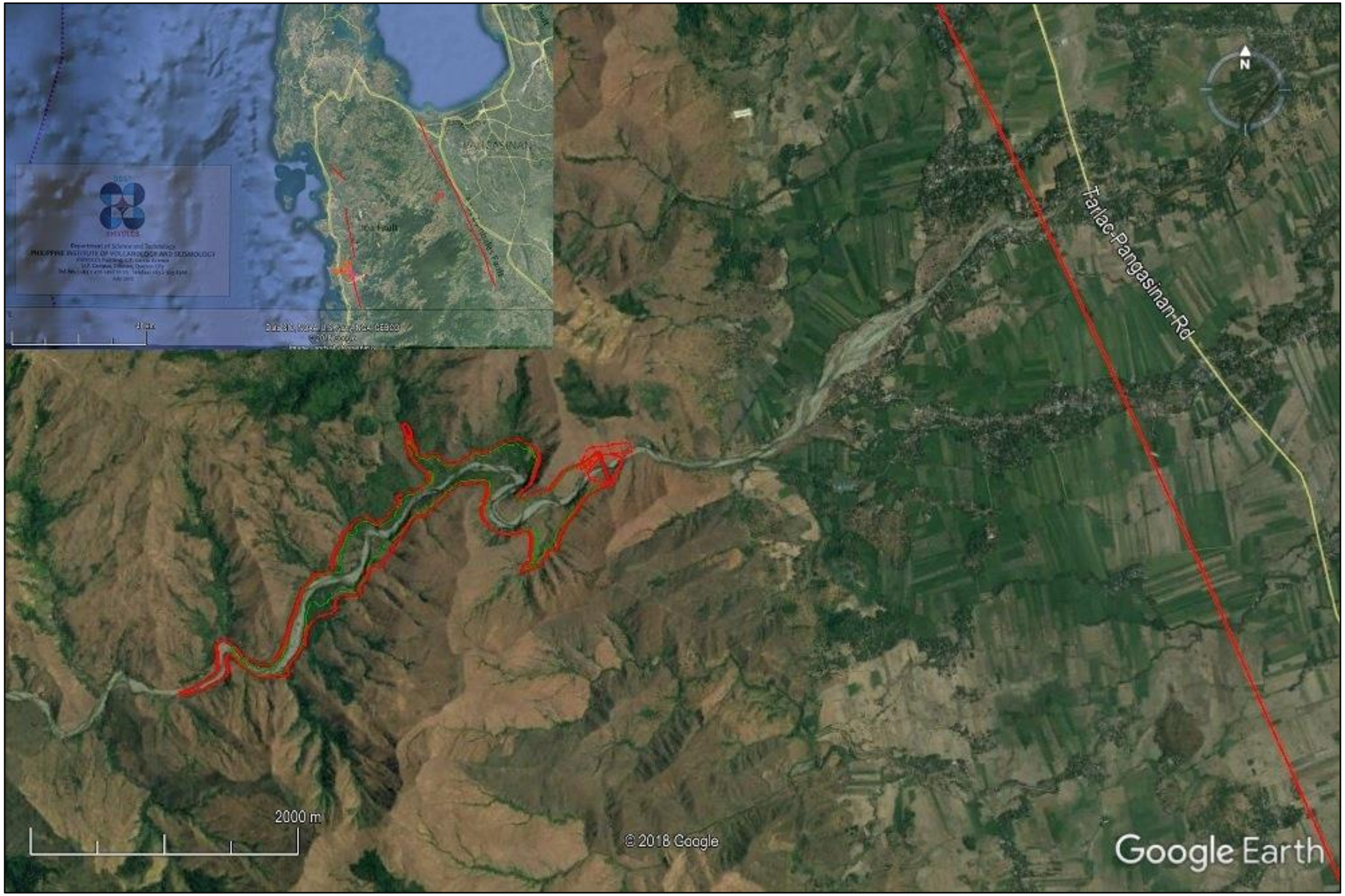


Figure 2.1.2-16. Plot of East Zambales Fault (red line) on Google Earth Satellite Image

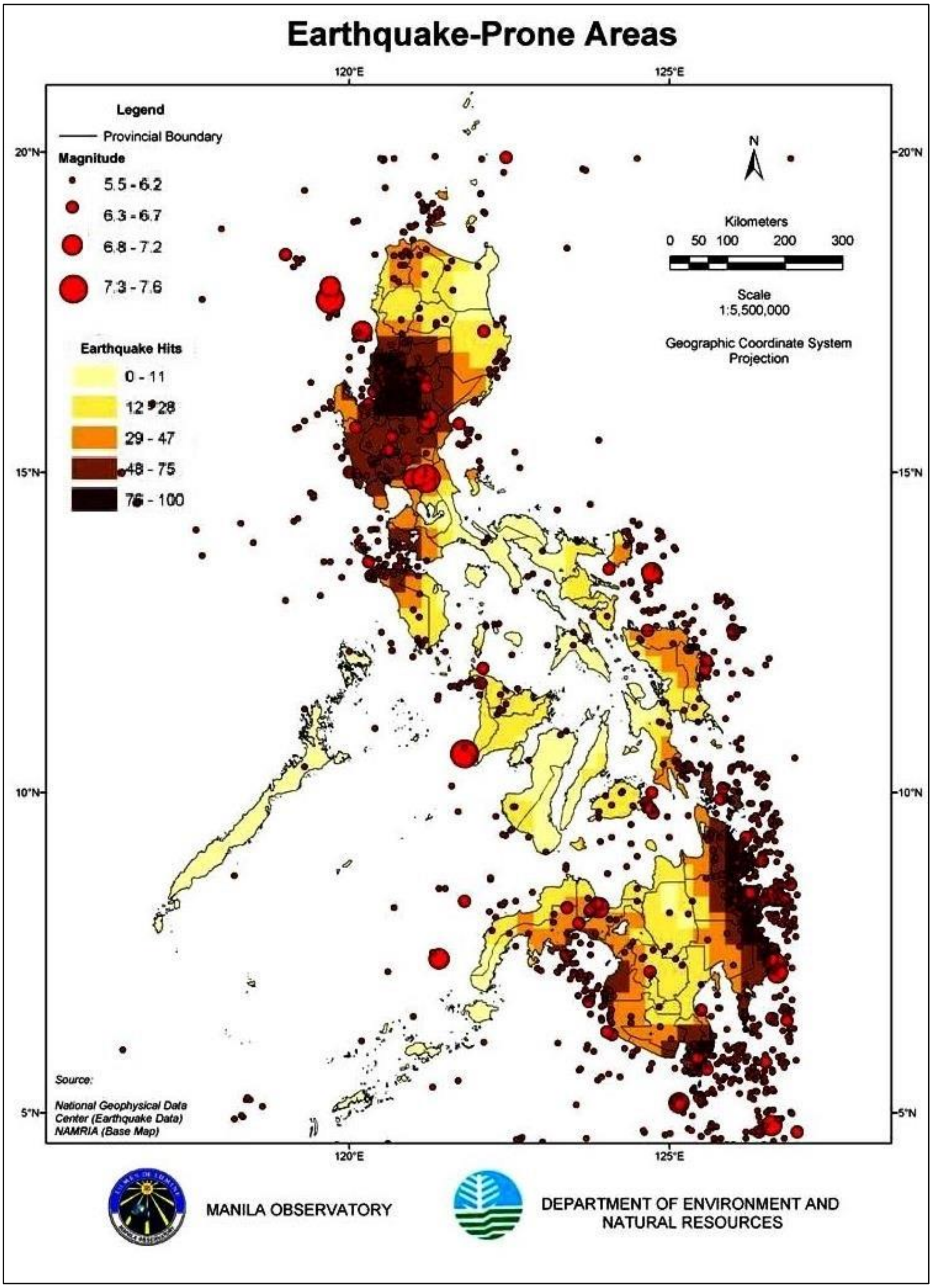


Figure 2.1.2-17. Earthquake-prone Areas Map of the Philippines

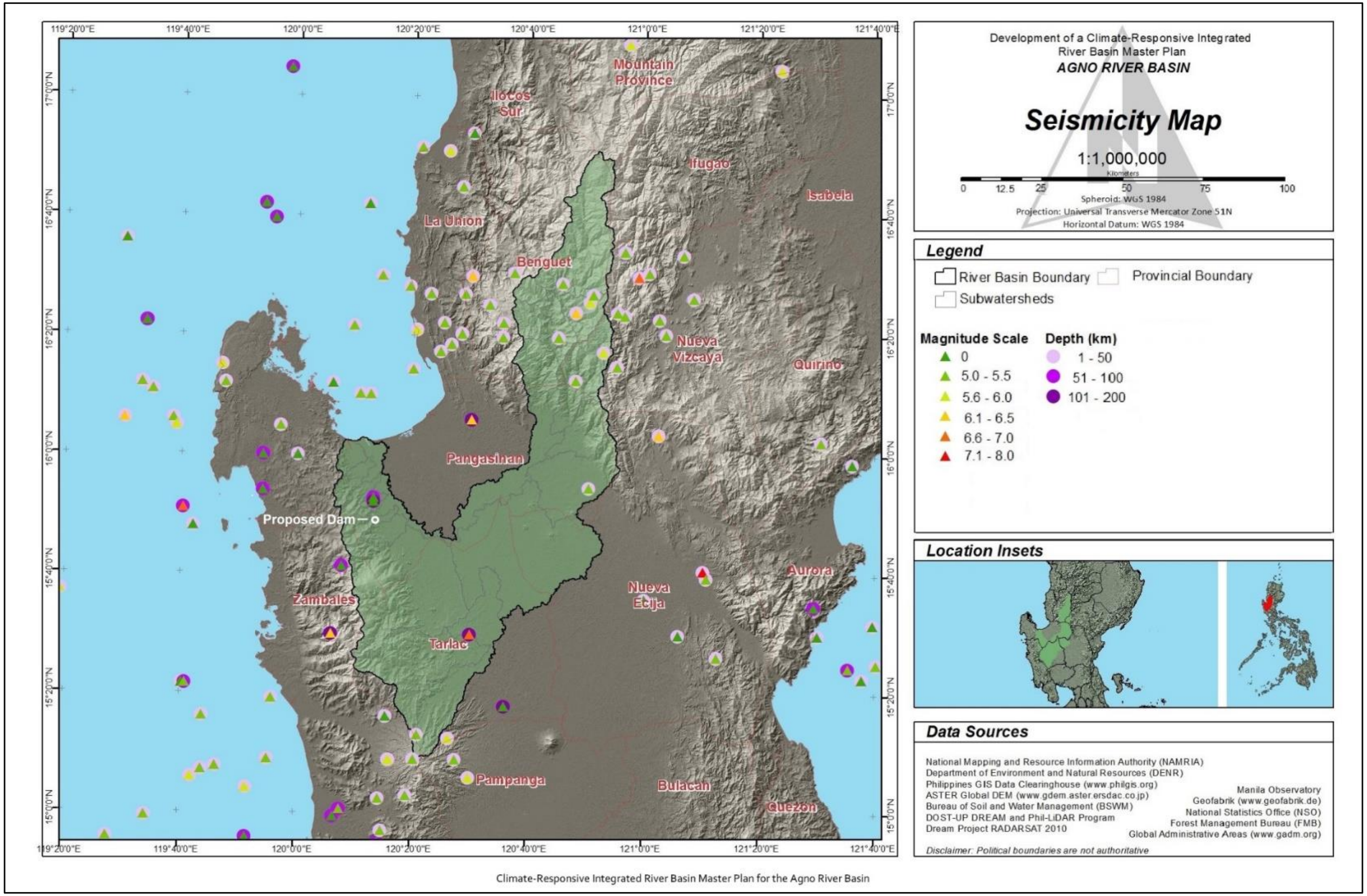


Figure 2.1.2-18. Seismicity Map of Agno River Basin

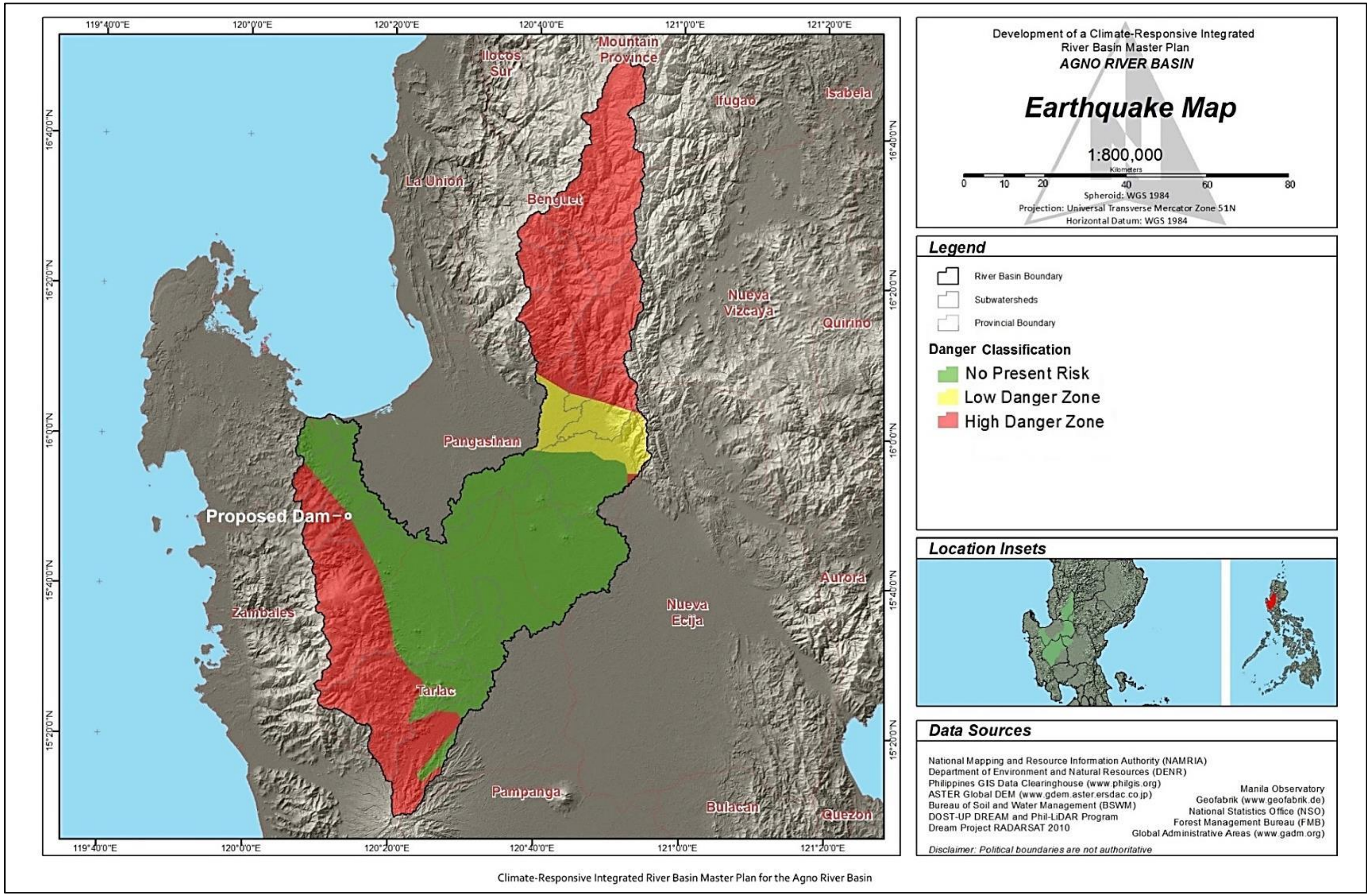


Figure 2.1.2-19. Earthquake Hazard and Risk Categorization within the Agno River Basin

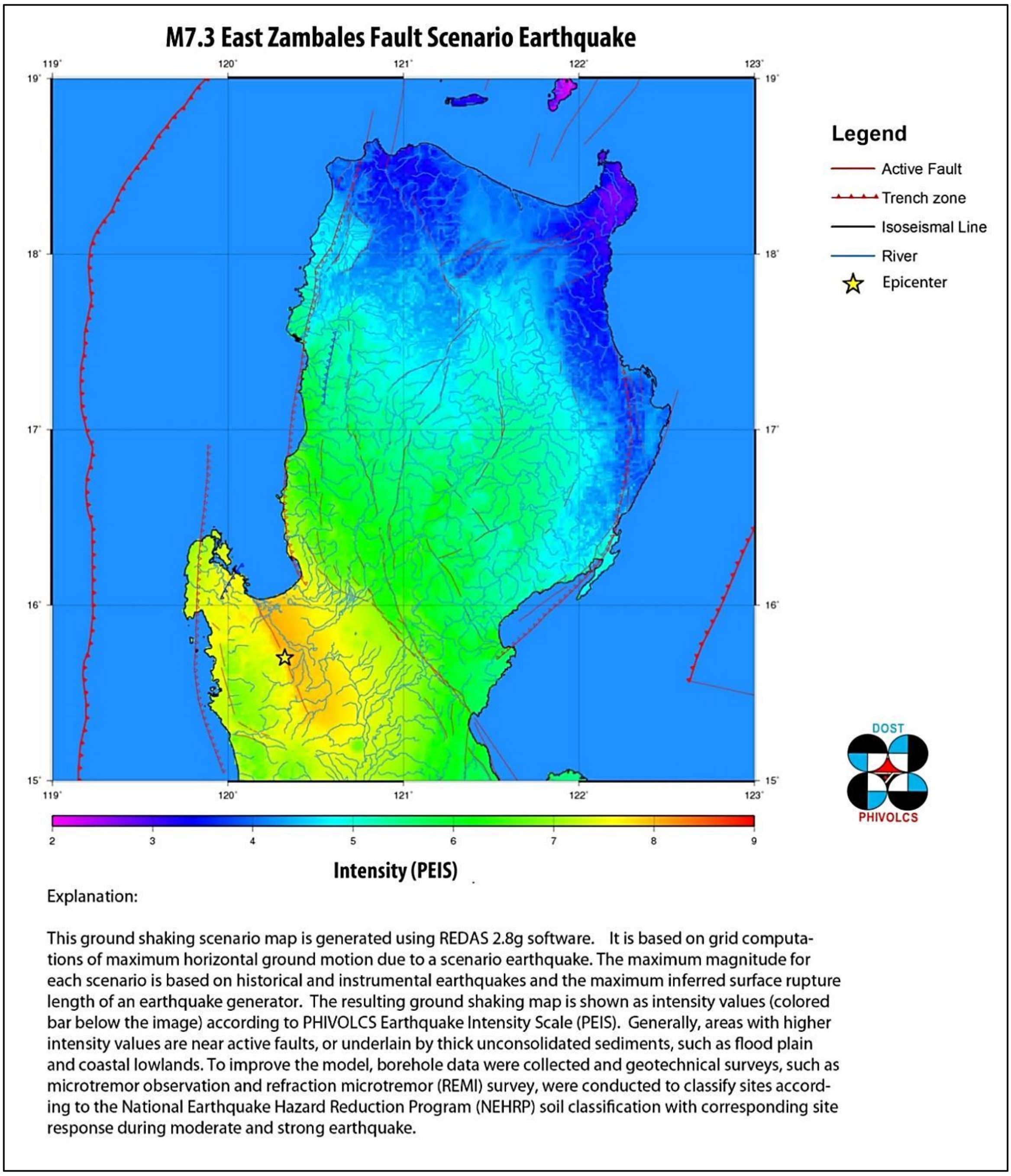


Figure 2.1.2-20. Earthquake Scenario from M7.3 along East Zambales Fault

The Manila Trench subduction zone appears as a symmetric feature at about 13 degrees north (Lewis and Hayes, 1983) at the western part of Luzon.

A series of earthquakes (earthquake distribution = 13.65%) are concentrated mostly along this zone with some areas whose epicenter are less than Magnitude 5 (M5). A few large events, however, are associated; March 3, 1968, M7.2; February 14, 1934, M7.6; April 8, 1942, M7.7; and April 25, 1971, M7.3 (2015 BSRIP FS Chapter 10. Table 5.2: Violent Earthquakes that have affected the Project Area in 1907-1988). The maximum credible earthquake (MCE) is 7.4 for East Zambales, based on possible surface rupture length, as shown **Table 2.1.2-4** for the various fault zones in the Philippines.

Ground rupture is an important effect of earthquakes offsetting the ground when the earthquake movement along a fault actually breaks the Earth's surface.

Table 2.1.2-4. Maximum Credible Earthquake (MCE) for Various Fault Zones

Source Zone	Based on Earthquake Data	Based on Possible Surface Rupture Length	References
Philippine Fault Zone (San Manuel segment)	6.0		Archarya,1980: Hirano et al.: 1986: Abe,1994: Bautista and Oike, 2000
Philippine Fault Zone (Digdig segment)	7.9		Archarya,1980: Hirano et al.: 1986: Abe,1994: Bautista and Oike, 2000
Philippine Fault Zone (Infanta segment)	7.6		
Philippine Fault Zone (Ragay Gulf segment)	7.4		Bautista and Oike, 2000
East Luzon Trough		7.8 - 8	Wells and Coppersmith, 1994
West Valley Fault	7		Nelson et.al 2000
East Valley Fault	6		Nelson et.al 2000
Laguna-Banahaw Fault	7.4		Abe. 1981
West Boundary Fault		7.5	Well and Coppersmith, 1994
Manila Trench		7.8 – 8	Archarya,1980: Hirano et al.: 1986: Abe,1994: Bautista and Oike, 2000
East Zambales Fault		7.4	Well and Coppersmith, 1994
Central Mindanao Fault		7.6	Well and Coppersmith, 1994

Source: Bautista. BC, 2001, "Ground Shaking Hazard Assessment of Metro Manila Phils, Paper presented in "Earthquake Tsunami Asia Pacific (EQTAP) Meeting, Phivolcs Auditorium" July 2001

A peak ground acceleration (PGA) was computed for the proposed Project. PGA Peak ground acceleration (PGA) is equal to the maximum ground acceleration that occurred during earthquake shaking at a location. PGA is equal to the amplitude of the largest absolute acceleration recorded on an accelerogram at a site during a particular earthquake.

A *probabilistic approach* was applied in previous studies in determining ground acceleration for the design of the dam. Based on statistical analysis of violent historical earthquakes within the project area, a recommended ground acceleration of **0.12g** was estimated for the design.

However, a *deterministic approach* was later applied to validate this value for ground acceleration that yielded 0.21g. The dam, its foundation and adjacent slopes will experience seismic loading in case of a major earthquake. An earthquake of certain magnitude is assumed to occur along an earthquake generator with epicenter along a point on the fault nearest to the site. The ground acceleration is then estimated by applying an attenuation model such as that of Fukushima and Tanaka (In Thenhaus et al, 1994), shown below:

log10 A = 0.41M - log 10 (R+0.032x10 0.041 M) – 0.0034R + 1.30

where:

A - the mean peak acceleration (in cm/sec^2)
R - the shortest distance between the site and the fault rupture (km)
M - surface-wave magnitude

Correction factors are applied to the computed peak acceleration depending on the type of foundation material. The correction factors are: rock - 0.6; hard soil - 0.87; medium soil - 1.07; and soft soil - 1.39.

This formula was applied for the proposed Project site considering the East Zambales Fault and and Digdig Fault as earthquake generators. The results are presented in **Table 2.1.2-5.**

The 0.21g corresponds to Instrumental Intensity of VII (**Table 2.1.2-5**) and magnitude (5.0-5.9)

Table 2.1.2-5. Results of PGA Determination Using Attenuation Model from Fukushima and Tanaka Considering the East Zambales Fault and Digdig Fault

	East Zambales Fault	San Jose-Digdig Fault
Magnitude	7.4	7.9
Distance	80	80
PGA	0.34g	0.14g
Corrected Values		
Hard Rock (0.60)	0.21g	0.08g
Hard Soil (0.87)	0.30g	0.12g
Medium Soil (1.07)	0.37g	0.15g
Soft Soil (1.39)	0.48g	0.19g

PGA = peak ground acceleration

Table 2.1.2-5. Correlation of Instrumental Intensity, Ground Acceleration, Velocity, Perceived Shaking and Potential by the United States Geological Survey

Instrumental Intensity	Ground Acceleration (g)	Velocity (cm/s)	Perceived Shaking	Potential Damage
I	< 0.0017	< 0.1	Not felt	None
II–III	0.0017 – 0.014	0.1 – 1.1	Weak	None
IV	0.014 – 0.039	1.1 – 3.4	Light	None
V	0.039 – 0.092	3.4 – 8.1	Moderate	Very light
VI	0.092 – 0.18	8.1 – 16	Strong	Light
VII	0.18 – 0.34	16 – 31	Very strong	Moderate
VIII	0.34 – 0.65	31 – 60	Severe	Moderate to heavy
IX	0.65 – 1.24	60 – 116	Violent	Heavy
X+	> 1.24	> 116	Extreme	Very heavy

Source: https://en.wikipedia.org/wiki/Peak_ground_acceleration

Liquefaction. The dam site area is not susceptible to liquefaction. The lowland is susceptible to liquefaction (**Figure 2.1.2-21).** Liquefaction takes place when loosely packed, water-saturated sediment temporarily loses strength and acts as a fluid in response to strong ground shaking. This effect can be caused by earthquake shaking. Liquefaction occurring beneath buildings and other structures can cause major damage during earthquake.

Subsidence. There is no record of subsidence at the project dam site (**Figure 2.1.2-22)**. Subsidence is defined as the sinking or settling of the ground surface in an abrupt or more commonly gradual manner. Ground subsidence can result from the settlement of naturally low density materials or soil, or the caving in of natural or man-made sub-surface voids. Subsidence may occur gradually over years when depressions form on the surface or the ground sags. Fewer incidents have occurred, but subsidence can occur abruptly or instantly as dangerous ground openings swallowing any structure located in the area.

Landslide. The proposed dam site is slightly susceptible to earthquake-induced landslide but highly susceptible to rain-induced landslide (**Figures 2.1.2-23, and 2.1.2-24).** Landslide is a type of mass wasting and defined as the movement of a mass of rock, debris, or earth down a slope. Landslide denotes any down-slope movement of soil and rock under the direct influence of gravity.

Volcanic Activity. The project site is not susceptible to volcanic activities.

2.1.2.10 Environmental Impact Assessment on Geology

The impact of the proposed Project will be limited to the local change in the surface landform and subsurface will be limited at the damsite, quarry area and spoil disposal area. The latter location is not yet identified but the criteria for site selection include stable areas and slopes and away from the reservoir but downstream. Some residents may ask for fill materials.

The main issue is about the geological hazards on dam stability. While a 0.21g for PGA has been estimated inconsideration of the East Zambales fault a more thorough geotechnical investigation will be done to address the presence of vertical fault, shear zone, alluvium characteristics of the dam axis (generally coarse, poorly classified and possess high permeability values), and the steep left bank for the spillway, with dissected by a series of stress-relief joints striking NE-NW and dipping SE-SW towards the riverbank, and rock sliding or creeping is bound to occur.

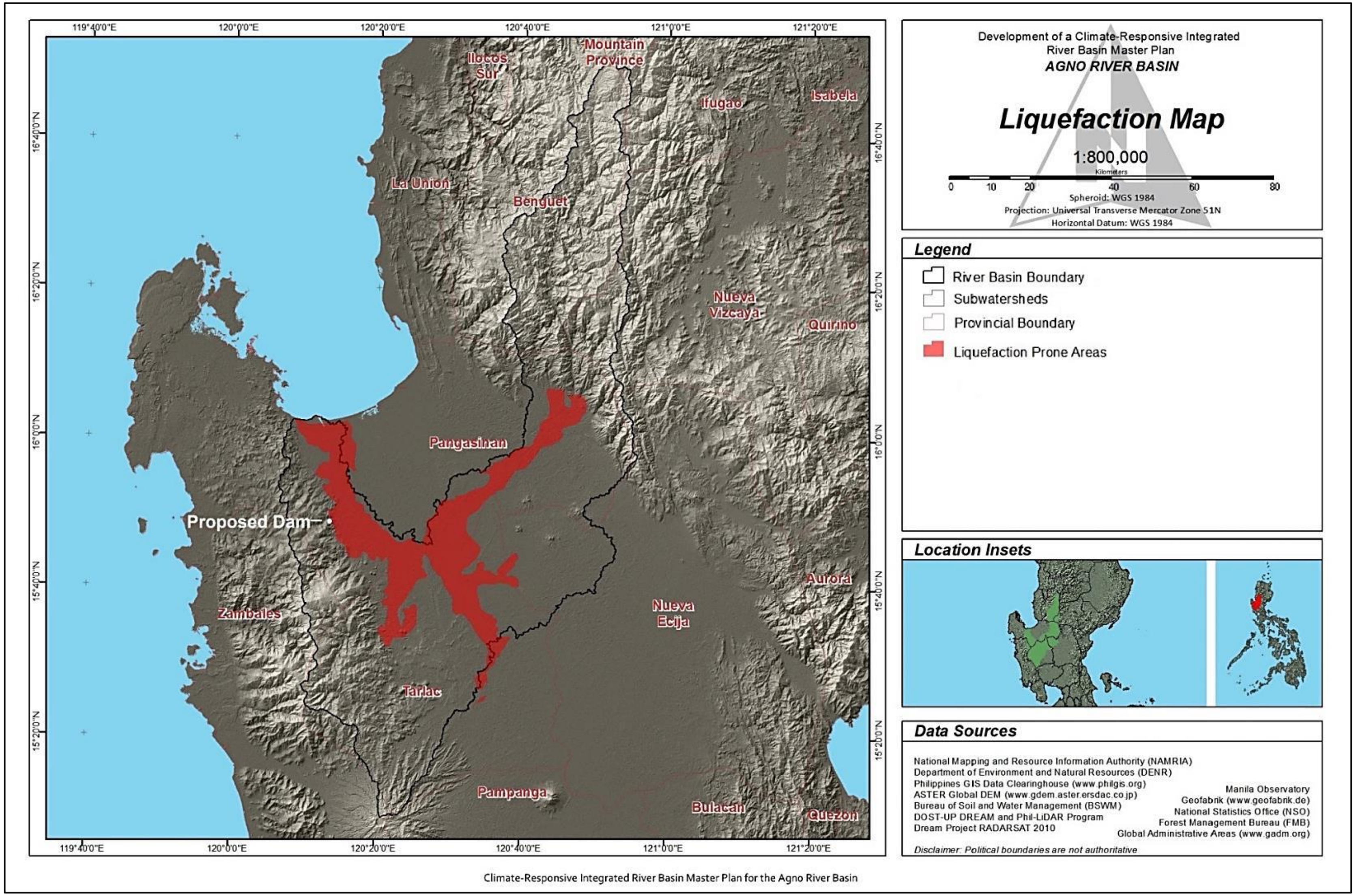


Figure 2.1.2-21. Liquefaction Susceptibility Map of Agno River Basin

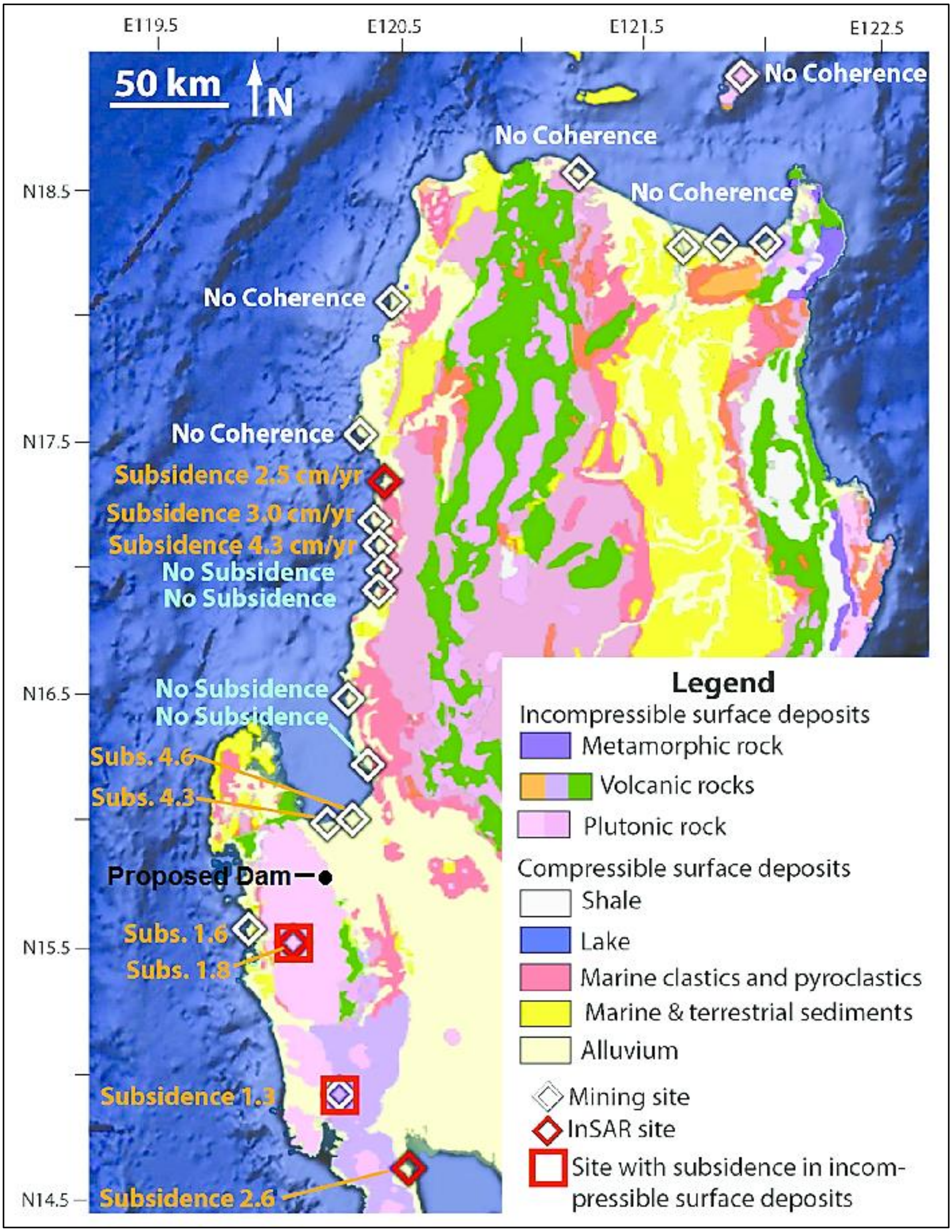


Figure 2.1.2-22. Subsidence Map

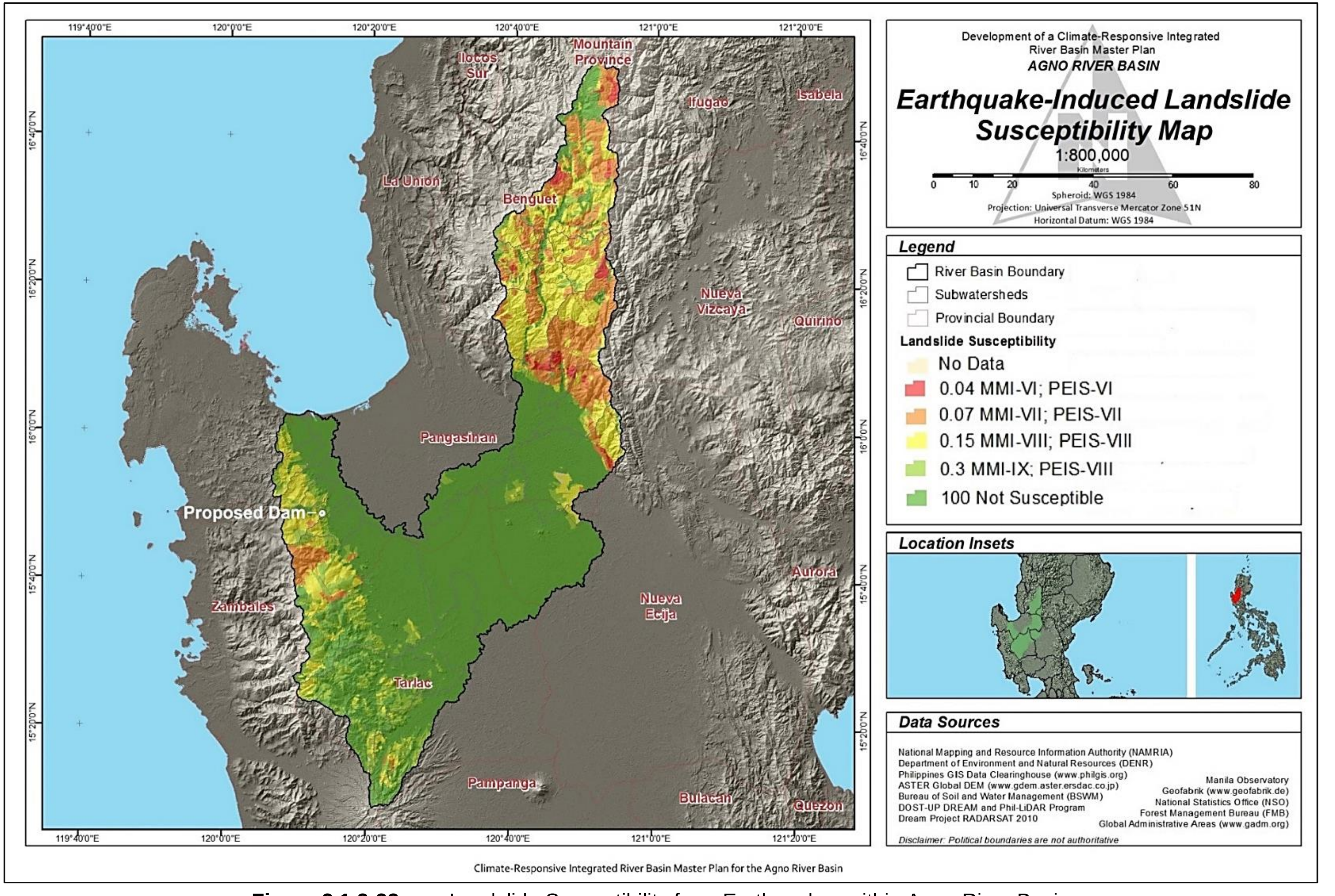


Figure 2.1.2-23. Landslide Susceptibility from Earthquakes within Agno River Basin

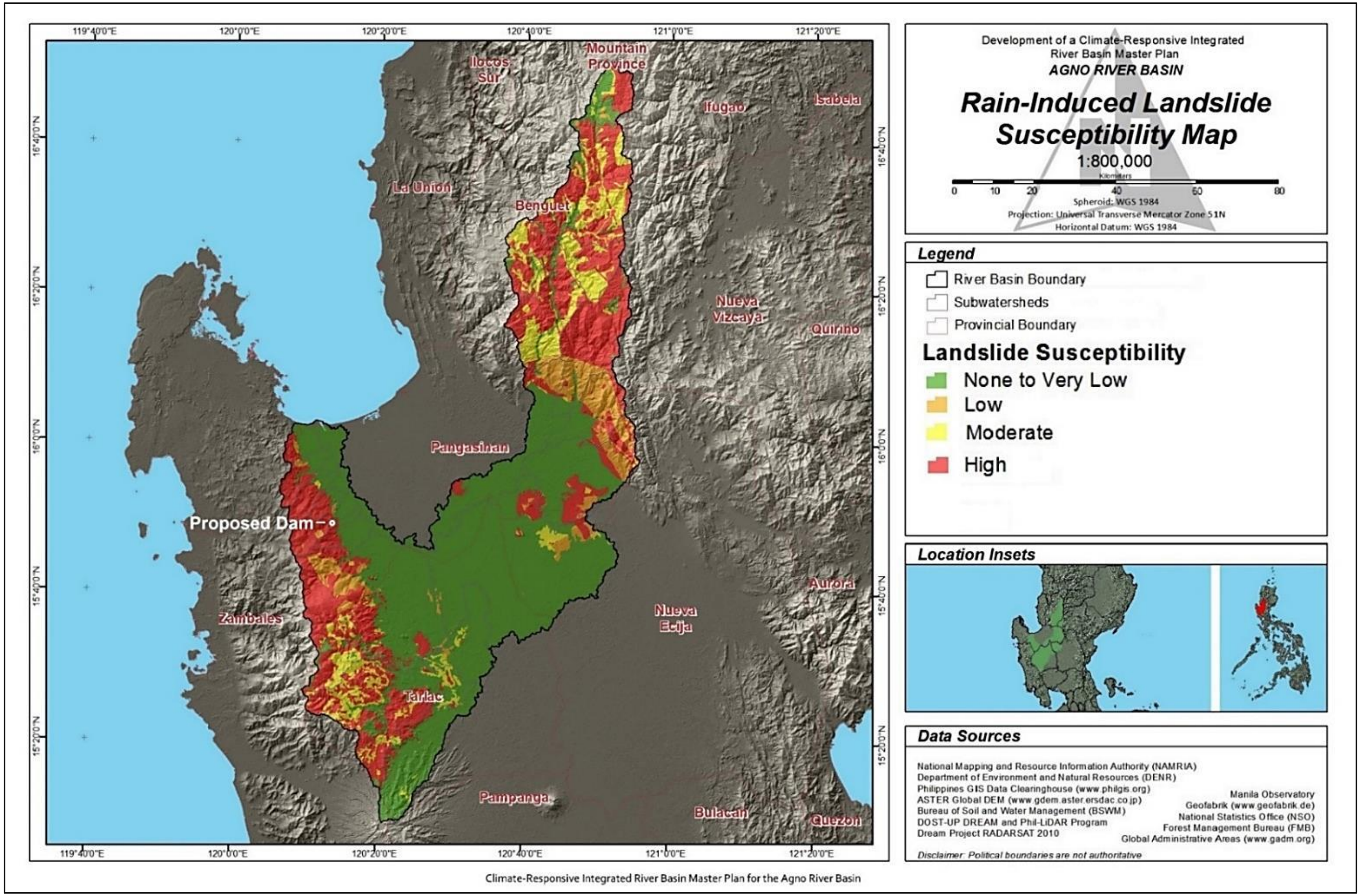


Figure 2.1.2-24. Landslide Susceptibility Caused by Rain within Agno River Basin

2.1.3 Pedology

2.1.3.1 Summary

The project site has an upland or mountainous Alaminos series soil, where the dam and reservoir are located, and the lowland San Manuel series soil where rice fields are located. In between them is the intermediate upland Alaminos Series, formed on moderately dissected residual fan terrace located near and along foot slopes of hills and mountain. They are characteristically fine loamy and fine clayey ranging from fine sandy loam to clay which is well suited to a wide range of climatically adopted agricultural crops. Majority of the soils have moderate depth to deep solum thus indicating a greater water holding capacity. The soils are moderately weak granular, sub-angular and angular blocky structures. The soils in the project area is considered medium fertility based on pH, cationic exchange capacity (CEC) and the content of organic matter (OM) or nitrogen source, phosphorus, and potassium. Addition of nutrients is recommended for an increase in crop production.

The upland soil is recorded as having severe soil erosion, although the banks of Bayaoas River at the damsite appear stable and the channel is dominated by sand, gravel, cobbles and boulders. Excavation of soil during the dam construction would cause severe soil erosion during the wet season. The physical nature of the proposed Project would not cause significant deterioration of soil quality, although measures to prevent oil and fuel spillages will be put in place during construction. Soil fertility in the rice field decreases with the increase in the frequency of planting to two seasons in most areas, and this would require the addition of fertilizers. The additional use of banned non-biodegradable pesticides would pose a risk of accumulation of pesticide residues on rice soils. Measures to monitor impact of fertilizers and pesticides shall be undertaken, including assessment of impact, mitigation, and monitoring, as deemed necessary. Action taken and their results shall be reported.

2.1.3.2 Methodology

Information on soils at the proposed Project was taken from the publication of PhilRice (Philippine Rice Research Institute), 2015 Feasibility Study Report for BSRIP and soil sampling at the dam axis. The PhilRice publication provides information on the upland and lowland soil, while the 2015 FS covered the lowland and intermediate upland. Soil sampling at the dam site was done to obtain supplementary information to obtain an idea on the chemical composition of soil to address the presence of nickel and chromite in the area. Soil erosion potential and land capability maps were obtained from the DERN study on Agno River basin in 2017.

2.1.3.3 Soils in Aguilar, Pangasinan

The town of Aguilar has two soil series: Alaminos series at the western and mountain area, and San Manuel eastern part or lowland (**Figure 2.1.3-1**). These soil series are described in **Table 2.1.3-1**.

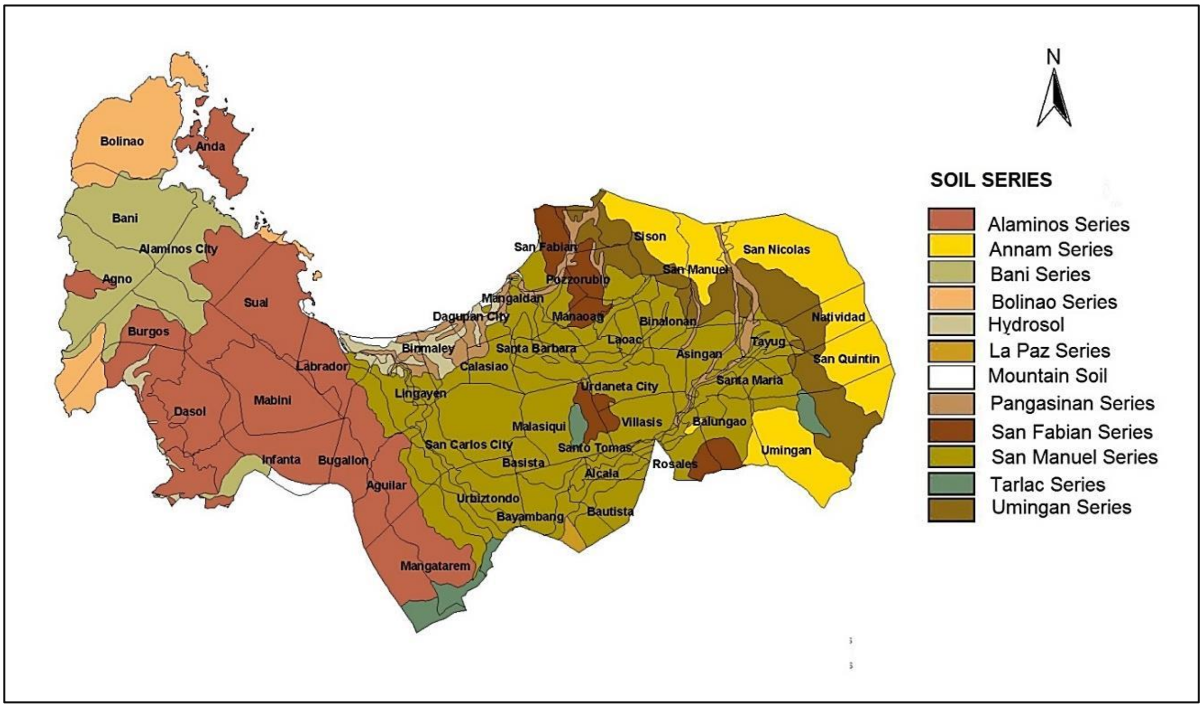


Figure 2.1.3-1. Soil Map of Pangasinan
(Source: PhilRice, 2013, https://dbmp.philrice.gov.ph/soils/province/Pangasinan/property)

Table 2.1.3-1. Description of Alaminos Series and San Manuel Series in the Study Area

Attribute	Alaminos Soil Series	San Manuel Soil Series
A. Surface Soil Type	loam/sandy loam	silt loam/silty clay loam/sandy loam/sand
B. Family Name	Fine-clayey, kaolinitic, isohyperthermic, Typic Kandiustox	Fine loamy, mixed, isohyperthermic, Typic Haplustalf
C. Area (ha)	9,018	4,255
D. Physical Soil Quality		
Relief	Slightly rolling to mountainous	Flat areas to gently sloping
Stoniness	Boulders of basalt, diorite, andesite, conglomerates and serpetine rocks are present; gravels and ir	None
Water Retention	Moderate	Moderate
Drainage	Good	Moderate
Permeability	Moderate to rapid	Moderate
Workability/Tilth	Moderate	Easy
Rooting Depth	Deep (>1m)	Deep
Flooding	None	Seasonal
Erosion	Moderate-Severe	None
E. Soil Fertility	Low	High
Soil pH	Acidic (4.5-5.5)	Slightly acid to neutral (5.5-7.2)

Attribute	Alaminos Soil Series	San Manuel Soil Series
Organic Matter	Moderate	Low
Phosphorus (P)	Low	High
Potassium (K)	Low	Moderate
Nutrient Retention	Low	High
Base Saturation	Low	High
Salinity Hazard	Low	Low
Properties limiting crop production	Acid soil; low fertility; excessive erosion	Excessively wet and annual flooding for short periods and excessive drought during dry season; low OM
F. Management Recommendation		
Rice	Upland rice farming; liming; application of fertilizers	Suited for paddy rice during wet season and with adequate irrigation during dry season; OM addition thru animal or green manuring
Diversified Crop	Contour farming and/or strip cropping; addition of organic matter and animal manure; application of phosphate fertilizers	Construction of adequate drainage, irrigation and flood control system due to seasonal flood hazard and high seasonal water table; use broad beds and ridges; suited for diversified crops such as corn, vegetables and watermelon in dry season irrigation
Root Crop	Suitable for root crops; practice contour cropping	Establishment of adequate drainage and irrigation system; regular addition of organic matter and animal manure to improve soil fertility

Source: PhilRice. https://dbmp.philrice.gov.ph/soils/province/Pangasinan/property; https://dbmp.philrice.gov.ph/soils/series/Pangasinan/Alaminos/property; https://dbmp.philrice.gov.ph/soils/series/Pangasinan/San-Manuel/property

Alaminos Series. This is soil loam to sandy loam of family fine-clayey, kaolinitic, isohyperthermic, typic Kandiustox, covering 9,018 ha of Aguilar Municipality in slightly rolling to mountainous areas. It has low base saturation, a typical representative of the great group Kandiustox. The soil fine textured with clay content of 35-60% and has an isohyperthermic temperature regime (>22°C). It is an Oxisol, which is an intensely weathered soil predominated by oxides from iron and aluminum due to repeated high precipitation and high temperature. Its stoniness is described as boulders of basalt, diorite, andesite, conglomerates and serpentine rocks are present; gravels and soil. The soil has moderate water retention, good drainage, moderate to rapid permeability, moderate workability, deep (>1 m) rooting depth, no flooding, and moderate to severe erosion. Soil fertility is low by acidic nature (4.5-5.5 pH units), moderate organic matter, and low in phosphorus, potassium, nutrient retention, base saturation, salinity hazard, and excessive soil erosion. Upland rice farming would require liming and fertilizers. Diversified crop farming would be contour farming, addition of organic matter, animal manure and phosphate fertilizers.

San Manuel Series. The soil type is silt loam, silty clay loam, sandy loam and sand, belonging to the family of fine loamy, mixed, isohyperthermic, typic Haplustalf, covering 4,255 ha of the flat to gently sloping areas of Aguilar. The series is an old soil which has undergone extensive weathering but has retained a high base status in its horizon, and exhibits minimum complexity in its horizonation. The mean annual soil temperature is higher than 22°C (isohyperthermic). The has no stoniness, moderate water retention, moderate drainage, moderate permeability, easy workability, deep rooting, seasonal flooding, and negligible soil erosion. Soil fertility is high given a slightly acid to neutral pH (5.5-72), low organic matter, high phosphorus, moderate potassium, high nutrient retention, high base saturation, and low salinity hazard. Limitations in crop production are due to excessively wet and annual flooding for short periods and excessive drought during dry season and low organic matter. Recommendations for crop production include addition of organic matter and provision of adequate drainage system.

2.1.3.4 Description of Soils in the 2015 Feasibility Study Report

In the 2015 Feasibility Study, the soils of the project area were classified into soil series, soil mapping units and miscellaneous land types, with the determination of the physical, chemical and biological properties of the soil. A soil series is a group of soils that has the same genetic horizon similar to important morphological characteristics and developed from similar parent material. A soil mapping unit is a subdivision of the soil series based on surface soil texture, slope and flooding hazard including erosion, if any, which are important in land use management. Miscellaneous land types are those lands that have no true soil covers such as rivers, creeks, drainage ways and other water bodies. The investigation

The survey consisted of using 1:50,000 topographic maps and satellite imagery printouts as working maps at soil series level. Auger boreholes were done to a number dependent of the homogeneity and heterogeneity of the area at depths down to 1.5 m or down to parent material for differentiating profile characteristics of the soil such as horizon, depth, texture, color, structure, consistency, drainability and parent material. Composite soil samples were collected and submitted to the Bureau of Soils and Water Management (BSWM) laboratory for specialized tests, determination of present levels of nitrogen (N), phosphorous (P) and potassium (K) and nutrient requirements for recommended crops. **Annex 2.1.3-1** presents the results of soil analysis.

By texture, the soils at the study area are fine sandy loam, silt loam, silty clay loam and clay loam to clay soil texture. Respectively, they were formed from residual materials and alluvial sediments brought and deposited by surface run-off and river flooding through the alternating process of erosion and sediment deposition in the lower slopes and in the closed valley floor.

By physiographic landform the soils at the study area were grouped into two categories: (i) soils of the lowland represented by San Manuel series; and (ii) soils of the intermediate fan terrace represented by Alaminos series. The miscellaneous land types are located in rivers, creeks and other non-arable lands. The identified soil mapping unit with soil series/type and area presented in **Table 2.1.3.2** and the soil map in **Figure 2.1.3-2**. The San Manuel Series (SnMA, SnMAFs, and SMAf3) covers 66% of the arable land at the eastern part of the study area. The Alaminos Series (AIB) covers only 34% and to the west or at the foot of the mountain

San Manuel Series*:* This series is found in level to nearly level relief subject to slight to moderate seasonal flooding hazard, and belong to the fine loamy family, moderately deep with fair to good external and good internal drainage. The surface soils measured 15-40 centimeters deep from the surface as grayish brown to pale brown, fine to medium granular structure, slightly sticky, slightly plastic when wet and friable, fine sandy loam to silty clay loam texture. The subsoil depth ranges from 50-100 centimeters from the surface, as brownish gray to light brown, fine granular structure with streak of yellowish brown mottles, with similar texture to the upper layer varying from fine sandy loam, silt loam and silty clay loam. Down the substratum is yellowish brown to light reddish brown, loose fine sandy loam texture.

SnMA, San Manuel silty clay loam, 0.0-3.0 percent slope: The soil of this mapping unit occupies the most extensive area, at the middle portion of the service area covering the barangay's of Bocacliw, Calsib, Buer, Bayaoas, Bunlalacao and Quetegan. The soil unit silty clay loam, silt loam and fine sandy loam surface texture occurring on a level topography subject to slight seasonal flooding which does affect the production of certain crops. The area is dominantly cultivated to rainfed and combination of gravity and pump-irrigated rice crop. With a full and sustainable irrigation and drainage system, the soil offers the production of dual crops.

SnMAf2, San Manuel fine sandy loam, 0.0-3.0 percent, moderately flooded: This series is near the Agno river covering barangay's of Limansangan and San Jose, with similar in soil characteristic to soil mapping unit SnMA but flooding deficiency that moderately affects the yield of crops, as the difference.

Table 2.1.3.2. Summary of Soil Series/ Types at the proposed Project

Soil Mapping Unit	Soil Series/ Type	Area (ha)	% of Total	% of Arable
A. Arable Land				
SnMA	San Manuel silty clay loam 0.0-3.0 percent slope	730.0	36.5	52.1
SnMAf2	San Manuel fine sandy loam 0.0-3.0 percent slope; moderately flooded	145.0	7.2	10.4
Sn MAf3	San Manuel fine sandy loam 0.0-3.0 percent slope; severely flooded	50.0	2.5	3.5
AlB	Alaminos clay loam 3.0.-5.0 percent slope	475.0	23.8	34.0
Subtotal		1,400.0	70.0	100.0
B. Non-Arable Land				
Class M	Residential/Built-up area	315.0	15.8	
Class 6	River/creek	30.0	1.5	
	Right of Way (ROW)	25.0	1.2	
Class 4	Special land use, Coconut, Trees & Orchard	230.0	11.5	
Subtotal		600.0	30.0	
Total		2,000.0	100.0	

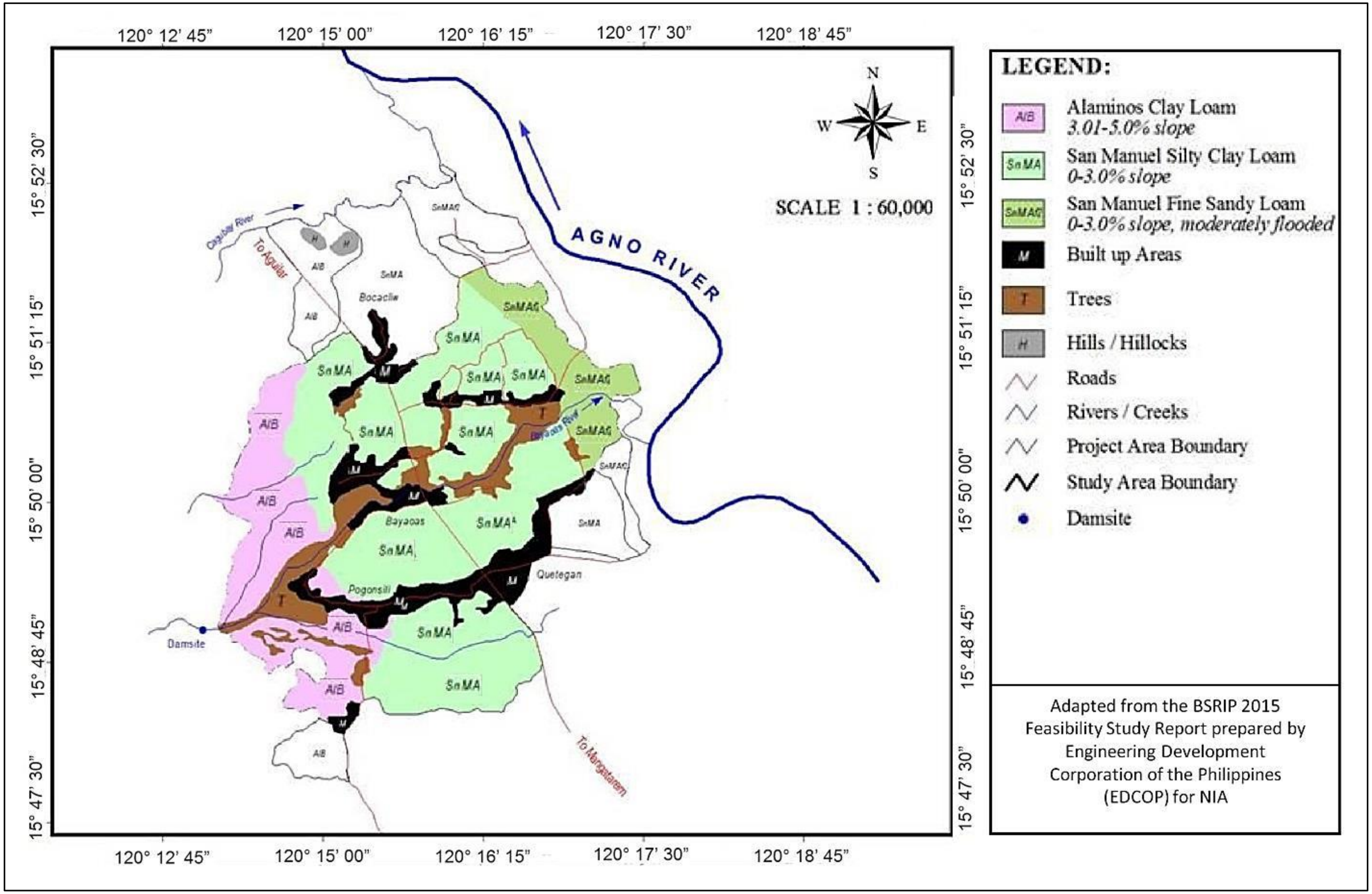


Figure 2.1.3-2. Plot of Soils in the Lowland and Intermediate Upland

Alaminos Series: The Alaminos series in the intermediate upland is formed on moderately dissected residual fan terrace located near and along foot slopes of hills and mountain on nearly level to slightly sloping to undulating topography with slopes ranging from 3.01 to 5.0 percent. The soils belong to the medium and fine clayey family moderately deep and poorly drained internally. The surface soil is 10 to 25 centimeters deep and are mainly brown, pale reddish brown to dark brown clay loam, weak medium sub angular blocky and granular structure, slightly sticky, slightly plastic and friable. The subsoil is about 40 to 100 centimeters deep and almost the same color as the surface soil, clay loam to clay, sub-angular blocky structure, sticky and plastic underlain by dark brown to brownish black clay loam substrata.

AlB, Alaminos clay loam, 3.01-5.0 percent slope: This is found in the western portion of the project covering the old alluvial deposits near the foot slope of Mt. Mangatarem. The soil characteristics are similar to that described for the series, and consists clay loam surface texture formed on nearly level to slightly sloping and undulating topography. The soil unit is moderately suitable to paddy rice production but to limited area irrigated by gravity or pump during the dry season.

Miscellaneous Land Types*:* The miscellaneous land types are areas with no true soil cover occupied by rivers, creeks and drainage ways, or with deficiency either on soil, topography and drainage, appearing singly or in combination which entail a very high cost of land development prohibitive to cultivation of agricultural crops. These lands may be used for recreational purpose and abundant source of gravels and stones for construction.

Summary of Soil Physical Properties. By texture, the soils of the project are characteristically fine loamy and fine clayey ranging from fine sandy loam to clay which is well suited to a wide range of climatically adopted agricultural crops. Majority of the soils identified have moderate depth to deep solum thus indicating a greater water holding capacity. The soils are moderately weak granular, sub-angular and angular blocky structures.

Summary of Soil Chemical Properties. The soils in the project area is considered medium fertility based on pH, cationic exchange capacity (CEC) and the content of organic matter (OM) or nitrogen source, phosphorus, and potassium. Addition of nutrients is recommended for an increase in crop production.

pH averaged at 6.5 which is slightly acidic but within the favorable limit for growing wide variety of crops. pH influences the availability of nutrients to plants and activity of microorganisms in the soil.

Cation exchange capacity CEC) averaged at 26.95 milliequivalent/100 g soils which is high, leading to increased crop yield because larger amount of fertilizer may be absorbed due to high buffering capacity thus reduces the danger of inducing nutritional imbalance.

Organic matter (OM) content of the soils averaged a low 0.4 percent, which implies an addition of 70 to 90 kilograms per hectare of nitrogen for wet season and 80 to 100 kg/ha N for dry season be applied to sustain the nitrogen requirements for rice. OM influences some physical condition of the soil by improving soil aggregation, soil structure, water holding capacity, permeability, aeration and root penetration and development.

Phosphorous averaged 16 ppm which is high which implies only a minimal amount of phosphorous is recommended in order to balance the essential macro elements needed by crops grown in the area. The element is a component of every living plant cell and tends to be concentrated in the seeds and in the growing joints of the plants.

Potassium content averaged a moderate 0.16 milliequivalent/100g of soil or 58.5 ppm, implying an additional amount of this element is necessary for crop production. Potassium is the third nutrient element that promotes plant growth, helping in maintaining the electrical neutrality in both the soil and plant by balancing the negative charges of nitrate, phosphate and other anions.

2.1.3.5 Soil Sampling at Dam Axis

Supplementary information on soil at the proposed Project was obtained from collected 2-kg hard surface soil on March 27, 2019, dry period at the south bank of the dam axis (**Figure 2.1.3-3**). The sample was sent to MachUnion Laboratory for analysis.

Figure 2.1.3-3. Location Map of Soil Sampling at Dam Axis, with Photo of Sampling Activity (looking southwest)

The results are presented in **Table 2.1.3-3** and **Annex 2.1.3-2** on the laboratory reports. The soil sample, with pH 6.6 was slightly acidic. By decreasing concentration, iron measured 88,979 mg/kg, followed by magnesium (13,157 mg/kg), calcium (927 mg/kg), manganese (710 mg/kg), nickel (395 mg/kg), potassium (172 mg/kg), chloride (2.48 mg/kg), and sulfate (<6 mg/kg). On the toxic elements, lead dominated at 4.46 mg/kg, followed by cadmium (0.76 mg/kg) and undetected arsenic, hexavalent chromium and mercury.

Table 2.1.3-3 pH and Chemical Composition of Dam Axis Soil Samples

Parameter	Unit	Value
1. pH		6.65
2. Iron	mg/kg	88,979
3. Magnesium	mg/kg	13,157
4. Calcium	mg/kg	927
5. Manganese	mg/kg	710
6. Nickel	mg/kg	395
7. Potassium	mg/kg	172
8. Chloride	mg/kg	2.48
9. Phosphorus, Total	mg/kg	0.919
10. Sulfate	mg/kg	<6
11. Lead	mg/kg	4.46
12. Cadmium	mg/kg	0.76
13. Arsenic	mg/kg	<0.4
14. Chromium Hexavalent	mg/kg	<0.2
15. Mercury	mg/kg	<0.05

2.1.3.6 Soil Erosion

The amount of soil loss and sedimentation into a stream channel is dependent on precipitation, nature of slopes, geology, soil types, land use and density of the channel system. These factors either operate independently or in conjunction to deter or advance the rate of erosion or sediment transport. An idea of the soil loss and sedimentation at the proposed Project may be gleaned from the study of De Vera for 18 watersheds in Luzon Island using the Universal Soil Loss Equation (USLE), as presented in **Table 2.1.3-4**. The estimated annual soil loss ranged from 223 to 1017 tons per km2 for an average of 448 tons/km^2. In addition, the estimated annual sediment yield ranged from 85 to 2213 tons per km^2 for an average of 685 tons/km^2. A plot of the soil loss versus the drainage area (**Figure 2.1.3-4**) does not provide a definite pattern.

A study of the Agno River Basin (DENR, 2017b) indicated that the Project site has severe soil erosion (**Figure 2.1.3-5**), although the banks at the dam site appear stable by ocular survey and by soil sampling, and the channel is dominated by sand, gravel, cobbles and boulders. Two areas of landslide in the reservoir area were reported in the 2015 FS. Bayaoas Watershed has an annual soil erosion potential of 131,591 tons (**Table 2.1.3-5** and **Figure 2.1.3-6).** The soil erosion study used Universal Soil Loss Equation (USLE) that factors in rainfall, erodibility, slope length and gradient.

The results of the soil erosion study were applied in preparing the land capability map for Agno River (**Figure 2.1.3-7),** described as the capacity of a land to provide multiple usage under bearable conditions, grouped into two major zones. One is the Protection Zone with subzones as (i) Strict Protection and (ii) Protection Buffer. The other is Production Zone with subzones (i) Agroforest Production (ii) Unlimited Production (iii) Limited Production and (iv) Production Buffer; Protection zone is composed of two subzones, (a) Strict Protection and (b) Protection Buffer. The areas of these zones in Bayaoas Watershed are presented in **Table 2.1.3-6.** Out of the 7,915 ha for the watershed, 56.77% is a protection zone and 43.23% for unlimited production. Strict Protection prohibits of activities that disrupts the development of forests such as logging and mining.

Table 2.1.3-4. Annual Soil Loss and Sediment Yield, Luzon Watersheds

Drainage Area km^2	Soil Loss ton/km^2	Sediment Yield ton/km^2
191	654	970
353	562	2049
274	665	1420
312	808	1262
258	296	209
285	1017	2213
347	291	195
1177	278	182
512	415	539
709	335	374
764	351	363
240	431	585
52	345	345
253	424	566
165	276	256
112	332	312
90	223	85
232	365	400
Mean	448	685

Source: De Vera, MR. 1981. Assessment of Sediment Yield Using the Universal Soil Loss Equation, Erosion and Sediment Transport in Pacific Rim, IAHS Publ. No. 132 (Christchurch, 1981)

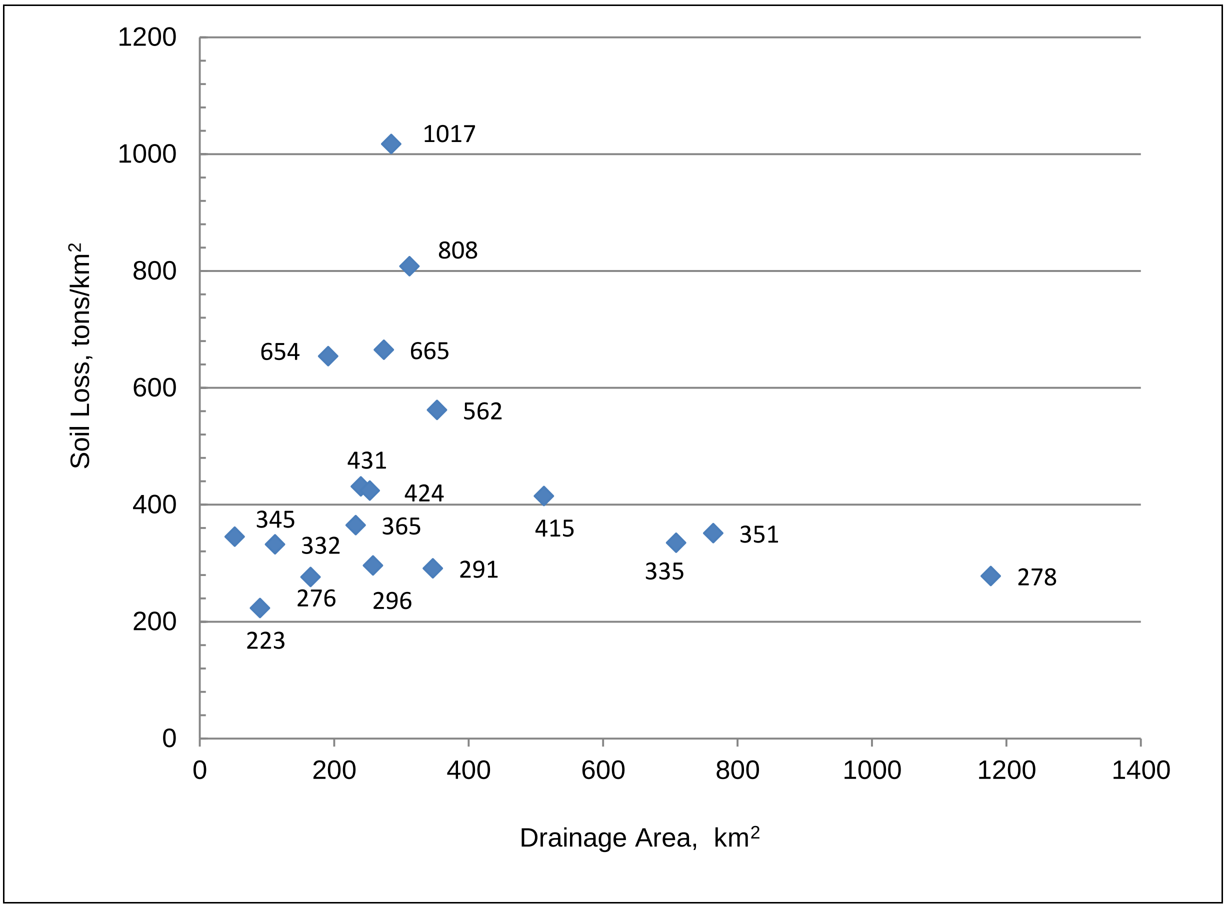


Figure 2.1.3-4. Annual Soil Loss Versus Drainage Area in Luzon Watersheds

Table 2.1.3-5. Annual Soil Erosion Potential of Bayaoas Watershed

Erosion Potential Range, tons/ha	Area, ha	Soil Quantity, tons
0-5	2,328.48	11,642.40
5-12	2,445.62	29,347.44
12-20	2,370.96	47,419.20
20-30	283.20	8,496.00
30-50	63.16	3,158.00
50-75	420.37	31,527.75
>75	-	-
Total	7,975.92	131,590.79

Note: The upper limit of the erosion potential range was used in computing soil quantity.

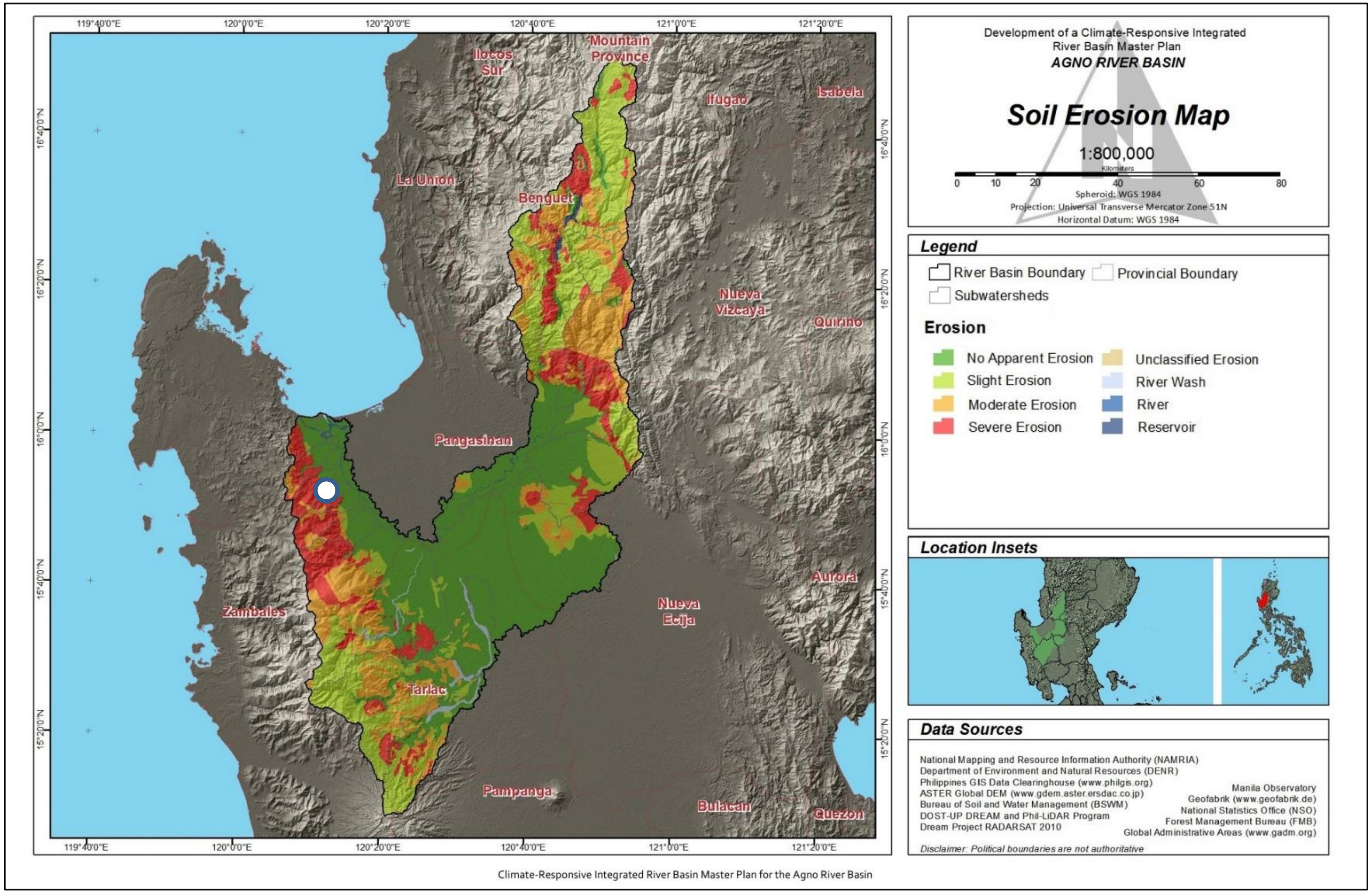


Figure 2.1.3-5. Soil Erosion Map of Agno River Basin (Source: DENR, 2017b)

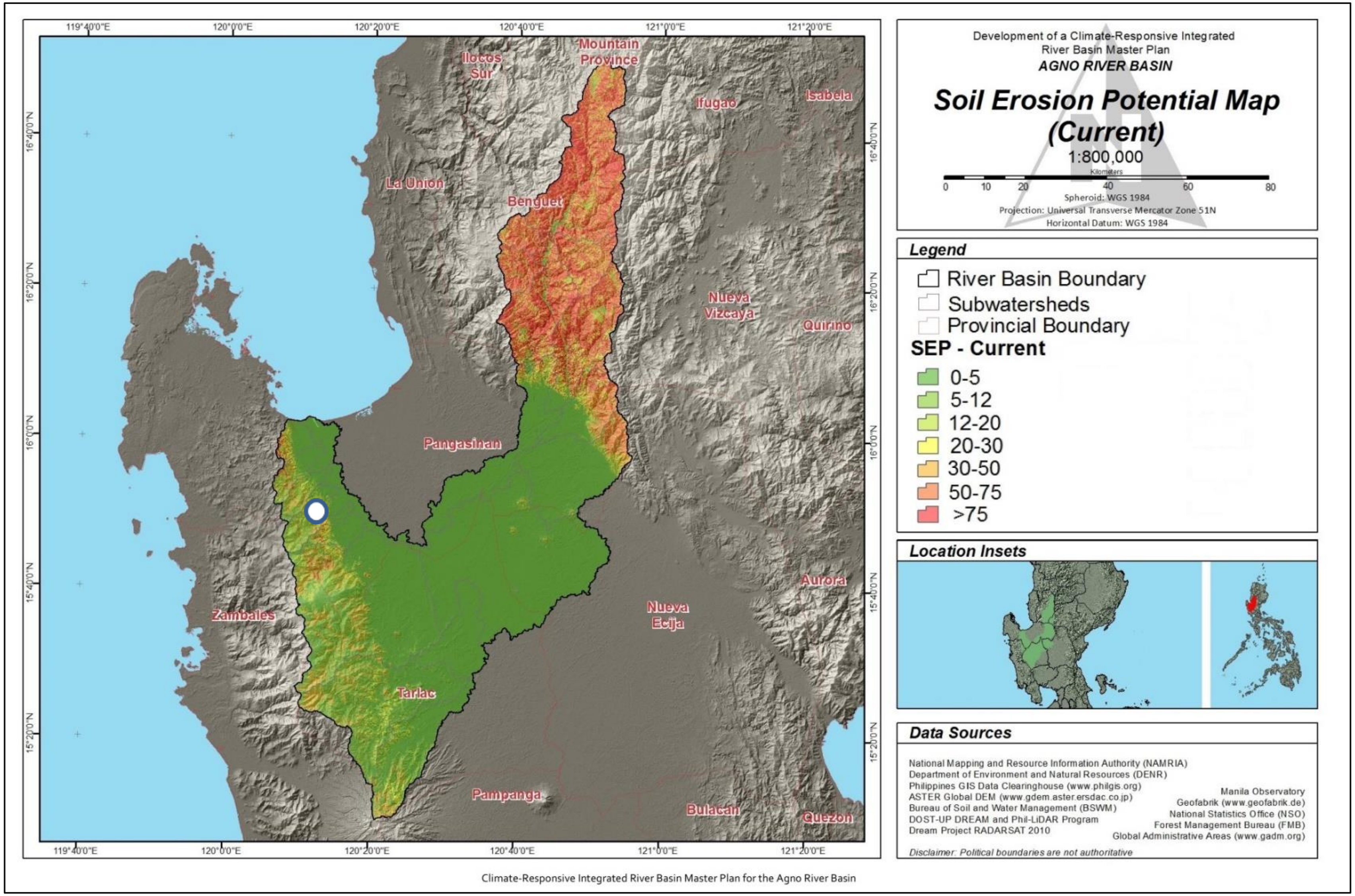


Figure 2.1.3-6. Soil Erosion Potential Map of Agno River Basin (Source: DENR, 2017b)

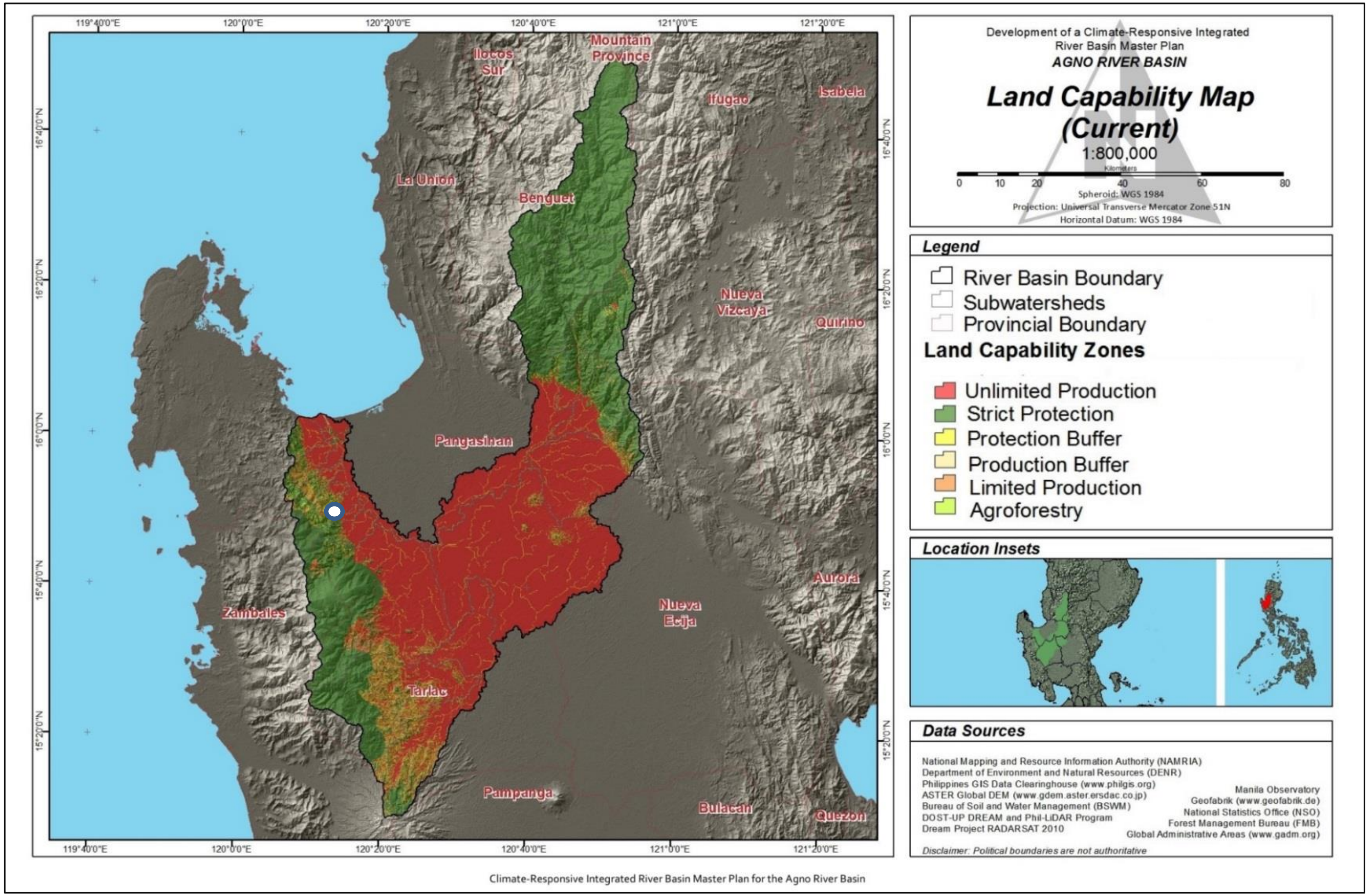


Figure 2.1.3-7. Land Capability Map of Agno River Basin (Source: DENR, 2017b)

Table 2.1.3-6. Land Areas of Land Capability Zones in Bayaoas Watershed

Land Capability Zone	Area, ha	% Area
A. Protection Zone		
Strict Protection	4,137.50	52.27
Protection Buffer	356.40	4.50
B. Production Zone		
Unlimited Production	2,291.90	28.96
Limited Production	257.70	3.26
Agro-forestry	840.40	10.62
Production Buffer	31.30	0.40
Total	7,915.20	100.00

2.1.3.7 Impact Assessment on Soil

During construction, soil excavations activities at the proposed access road and dam would cause significant soil erosion during the rainy season. Erosion will be minimized by the hauling of spoils and construction of cofferdam. For illustration, excavation of soil for 6-ha and 4-m deep to bedrock for the dam would mean 240,000 m^3 of spoil, and a spoil disposal site with run-off control features.

There would be a risk of localized spillages of hydrocarbons from vehicles and equipment, and this could be addressed by the implementation of protocols for change oil and equipment washing with provision of oil containment, collection, storage and disposal through DENR-accredited transporters and disposers. Used oil can be donated in the preservation of would. Fuel tanks and oil drums shall be installed on concrete to contained spillages.

Contractors shall be required to develop systems to comply with this requirement, including having available catchment containers, waste oil containers, system to orient staff (drivers, mechanics, attendants), documentation of oil changes, including proper disposal of rags towels and the like, filing of reports, or endorsement of wastes.

During the operation phase, the non-pollutive nature of water storage and distribution would not directly cause significant change soil quality in the area. However, soil fertility in the rice field decreases with the increase in the frequency of planting to two seasons in most areas, and this would require the addition of fertilizers. The additional use of banned non-biodegradable pesticides would pose a risk of accumulation of pesticide residues on rice soils.

NIA will undertake monitoring of impact of fertilizers, and pesticides to the environment, farm animals and to farmers, and shall endeavor to assess, mitigate these impacts, and to report on action taken, and the degree of success of the action.

2.1.4 Terrestrial Flora

2.1.4.1 Summary

The flora environment the project site was grouped by location, one is upland were the dam and reservoir are located and the lowland where the rice fields are located. The dam site and reservoir is located in wooded grassland northeast of the Key Biodiversity Area (KBA) of the Zambales mountain and site for the continuing implementation of the National Greening Program (NGP) with different kinds of trees are planted by 10 operators mostly based in the Municipality in Aguilar. The lowland flora within the proposed road route is sparse of economic trees.

A fieldwork was done on February 6-8, 2019 covering the canopy, understorey and groundcover layers of 27 plots, 20 in riparian areas from the dam site to the upstream most of the reservoir. The survey yielded 59 species, 29 families, and 19 genera. The family Lamiaceae is common in the area. On the conservation status, 17 from the 59-species identified are listed under the IUCN (2- Critically endangered (1- Endangered, 9-Least Concerned and 5-Vulnerable), while only three species are categorized under DAO-2017-11, two of which are other threatened species, and one is vulnerable).

The most abundant species by relative frequency were Molave and Talisai Gubat (15.79%) in the canopy layer, Molave (21.05%) in the understorey layer and Hagonoy (21.52%) in the groundcover layer. On the importance value, Agoho had the highest value in the canopy layer (66.50%) while Molave in the understorey layer (88.87%). On the relative density, Molave had the highest value in the canopy layer (26.61%) and in the understorey layer (35.85%), while Hagonoy in the groundcover layer (20.72%).

The vegetative layers exhibited low species richness based on Shannon-Wiener H' biodiversity index: 0.65 in the canopy, 0.43 in the understorey , and 0.72 in the groundcover. The Pielou's (J') Evenness Index measured 0.45 or moderate in the canopy, 0.38 or moderate in the understory, and 0.55 or high in the groundcover.

A thorough inventory of the trees will be done together with the NGP operators and DENR CENRO Dagupan. At the minimum, lost trees will be replaced according DENR Memorandum Order 2012-05 "Uniform Replacement Ratio for Cut or Relocated Trees. The overall impact mitigation and monitoring on the flora will be part of the Watershed Management Plan for the proposed Project, which will be prepared with the stakeholders.

Incidence of grassfire was noted in the area and will be considered in the project design, construction, and operations.

2.1.4.2 Methodology

Information on the description of the terrestrial flora for the proposed Project was obtained from primary data gathering, interviews, and literature.

Floral assessment was conducted on 06 – 08 February 2019 at Barangay Laoag Municipality of Aguilar Zambales with twenty-seven (27) identified sites (**Figure 2.1.4-1 and Table 2.1.4-1**) that were selected by purposive sampling covering both the sides of the streams from sites on the dam site and reservoir to upper streams of Bayaoas River. Most of the plots were along the riparian zone since it is the area that will be inundated and have higher vegetative cover as compared to the upland area.

Some plots are within the National Greening Program (NGP) plantation sites established by the Department of Environment and Natural Resources (DENR). NGP is a scheme headed by DENR to reforest the increasing vegetative degradation in the country. In the project area, there are ten (10) NGP sites identified encompassing the established sampling plots and all in production zone. Of which, seven (7) plantations will be inundated or subject to cutting of trees for road alignment. These affected NGP sites were established from year 2013 to 2018 (details on **Table 2.1.4-2**). All NGP sites are located within forest land as identified from NAMRIA map. About 82 hectared of the NGP area that would be affected by the dam construction and road alignment and in consideration with the 40- meter easement in forestland as stated in Presidential Decree No. 1067.

Prior to the actual field data collection, a community entry protocol coordination was done with the National Irrigation Administration (NIA), Department of Environment and Natural Resources (DENR), Barangay Local Government Units, Armed Forces of the Philippines (AFP) and Indigenous People (IPs).

Five (5) kilometers of transect was considered with a minimum of 100 meters for every sampling plots. Within the site, 20m x 20m sampling plots were established to assess the canopy layer taking the tree species with diameter at breast height (dbh) ≥ 10 cm. For the understorey layer, a 5m x 5m plot was established taking all saplings and small trees with dbh < 10 cm but dbh ≥ 5cm. For the groundcover layer, a 1m x 1m plot was established taking all seedlings, wildlings, grasses and other ground cover species. All species identified within the three plots were identified and recorded. Using a handheld Global Positioning System (GPS) the location of each plot was also determined and noted. Other species of trees, palms, shrubs, ferns and aerial plants that were observed outside the plots but along and up to 5 meters away from the transect were also identified and recorded. The species recorded were determined with its scientific name and family name is mainly based on Fernando (2007), Merill (1903) and Rojo (1999). Photographs were taken during sampling activities (**Photo 2.1.4-1).**

Table 2.1.4-1. Description of Locations of Terrestrial Flora Sampling Plots

Plot	Longitude	Latitude	Segment of River	River Side	Zone	Remarks
P01	120°11'06"	15°48'03"	Upstream	Left	riparian	
P02	120°11'27"	15°47'54"	Upstream	Right	riparian	within NGP plantation (Ilang-ilang)
P03	120°11'56"	15°47'56"	Upstream	Right	upland	within NGP plantation (Ilang-ilang)
P04	120°11'41"	15°48'08"	Upstream	Right	riparian	within NGP plantation (Ilang-ilang)
P05	120°11'43"	15°48'12"	Upstream	Left	riparian	within NGP plantation (Ilang-ilang)
P06	120°12'04"	15°48'24"	Upstream	Left	upland	within NGP plantation (Ilang-ilang)
P07	120°12'18"	15°48'14"	Upstream	Left	riparian	within NGP plantation (Bamboo)
P08	120°12'23"	15°48'11"	Upstream	Right	riparian	within inundation
P09	120°12'30"	15°48'14"	Upstream	Right	upland	near tributary
P10	120°12'29"	15°48'19"	Upstream	Right	riparian	near inundation
P11	120°12'30"	15°48'25"	Upstream	Right	riparian	within inundation
P12	120°12'34"	15°48'31"	Upstream	Right	riparian	within inundation
P13	120°12'31"	15°48'35"	Upstream	Left	riparian	near inundation
P14	120°12'50"	15°48'47"	Downstream	Left	riparian	within inundation
P15	120°12'28"	15°48'56"	Upstream	Left	upland	within NGP plantation (Agroforestry)
P16	120°12'54"	15°49'11"	Downstream	Left	upland	near inundation
P17	120°13'02"	15°48'58"	Downstream	Left	riparian	within inundation
P18	120°12'59"	15°48'53"	Downstream	Right	riparian	within inundation, within NGP plantation (Bamboo)
P19	120°13'12"	15°48'59"	Downstream	Right	riparian	within inundation, within NGP plantation (Bamboo)
P20	120°13'10"	15°48'55"	Downstream	Right	upland	within NGP plantation (Bamboo)
P21	120°13'15"	15°48'41"	Downstream	Right	upland	within NGP plantation (Bamboo)
P22	120°13'28"	15°48'50"	Downstream	Right	riparian	within inundation, within NGP plantation (Kakawate)
P23	120°13'38"	15°48'56"	Downstream	Right	riparian	within inundation, within NGP plantation (Kakawate)
P24	120°13'37"	15°49'00"	Downstream	Left	riparian	within inundation, within NGP plantation (Timber),
P25	120°13'43"	15°49'02"	Downstream	Left	riparian	Dam Area, within NGP plantation (Timber)
P26	120°13'44"	15°49'00"	Downstream	Right	riparian	Dam Area, within NGP plantation (Kakawate)
P27	120°13'47"	15°48'59"	Downstream	Right	riparian	Road Alignment, within NGP plantation (Kakawate)

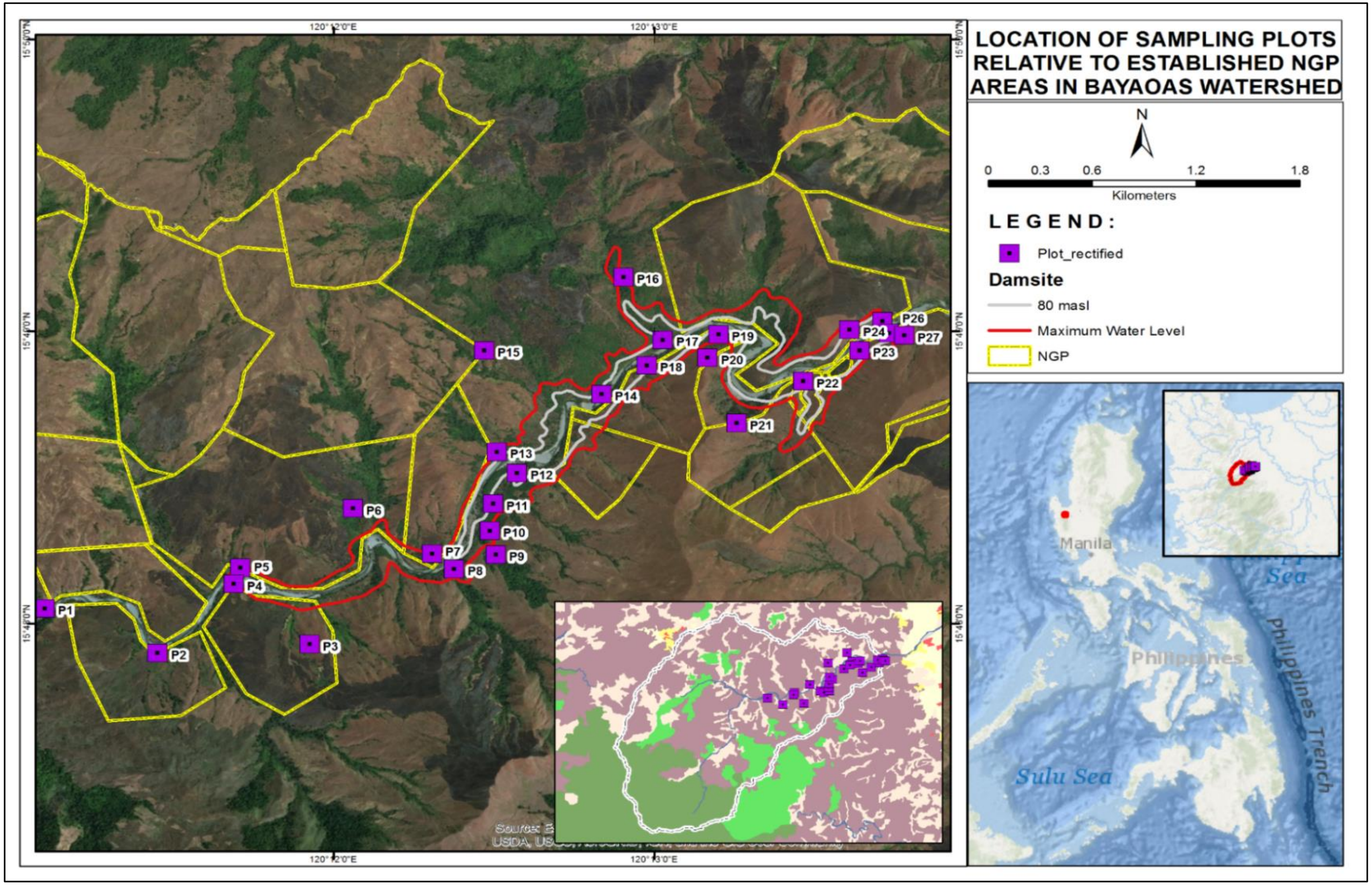


Figure 2.1.4-1. Location Map of Terrestrial Flora Sampling Plots

Table 2.1.4-2. List of NGP Sites in the Study Area

Location	Name of Organization	Component	Species Planted	Year Established	Area (ha)	Remarks
Buer, Aguilar	Buer Developer and Environmental Association			2016	70	Affected by Dam Construction and Road Alignment, with established sampling plots
Laoag, Aguilar	Ninyoy Upland Farmers Ass'n of Aguilar Pangasinan	Agroforestry		2016	100	With established sampling plot
Laoag, Aguilar	Sauthern Aguilar Upland Farmers and Protectors Ass. Inc.	Reforestation	Kawayang bayog, Kawayang Tinik	2017	30	Affected by Inundation, With established sampling plot
Laoag, Aguilar	Crusaders Environmental Developers and Management Ass. Inc.	Reforestation	Kawayang bayog, Kawayang Tinik	2017	30	Affected by Inundation, With established sampling plot
Laoag, Aguilar	Crusaders Green-Life Development Ass. Inc.	Reforestation	Ilang-Ilang	2017	100	Affected by Inundation, With established sampling plot
Laoag, Aguilar	Society of Aguilar Environmentalist in Pangasinan	Reforestation	Ilang-Ilang	2018	40	With established sampling plot
Laoag, Aguilar	Crusaders Environmental Developers and Management Ass. Inc.	Reforestation	Ilang-Ilang	2018	40	With established sampling plot
Pogonsili, Aguilar	Southern Aguilarian Upland Farmers Ass	Reforestation	Kawayang Tinik	2018	30	Affected by Inundation, With established sampling plot
Bayaoas, Aguilar	Southern Aguilarian Upland Farmers Ass	Reforestation	Manguim, Agoho	2018	20	Affected by Inundation, With established sampling plot
Buenlag, Mangatarem	Enviro Save Association Incorporated	Reforestation	Kakawate	2013	62	Affected by Dam Construction, with established sampling plot

** Source of Data: DENR-CENRO Dagupan

Photo 2.1.4-1. Photographs of the Terrestrial Flora Sampling Activities

(a) Establishment of 20mx20m plot

(b) Measurement of dbh

(c) Establishment of 1m x 1m plot

(d) Establishment of 5m x 5m plot

(e) Getting coordinates of plot

(f) Establishment of plot and simultaneously getting coordinates

	
(g) Grassland area but within NGP area	(h) Vegetation in riparian zone
	
(i) Molave trees planted along the riverbank	(j) Vegetation in the upland area
	
(k) Most of the vegetation in the riparian zone and upland area has planted seedlings.	(l) Acacia Plantation under NGP

Species Conservation Status and Endemicity. Recorded species were classified based on conservation status using the International Union for Conservation of Nature (IUCN) Red List of Threatened Species 2016 and DENR Administrative Order No 01 of 2007 "Establishing the National List of Threatened Philippine Plant and Their Categories. The following **Table 2.1.4-3**. provides a list of conservation categories and description of biodiversity:

Table 2.1.4-3. List of Conservation Categories and Description

Category		Description
Critically Endangered	CR	refers to species or subspecies facing an extremely high risk of extinction in the wild in the immediate future.
Endangered (EN)	EN	refers to species or subspecies that is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future.
Vulnerable	VU	refers to species or subspecies that is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future.
Near threatened	NT	refers to species or subspecies which do not qualify for Conservation Dependent, but which are close to qualifying for Vulnerable
Least Concern	LC	refers to species or subspecies which do not qualify for Conservation Dependent or Near Threatened
Other Threatened Species	OTS	refers to a species or subspecies that is not critically endangered, endangered nor vulnerable but is under threat from adverse factors, such as over collection, throughout its range and is likely to move to the vulnerable category in the near future
Not Evaluated	NE	refers to species or subspecies that has not yet been assessed against the criteria

Importance Value. Importance value (IV) is the measure of the dominance of a species in a given community. This is the percent sum of relative density, relative frequency and relative dominance that ranges from 0-100 percent each factor. As defined by Kimmerer (2014), the high importance value indicates that species is well represented in the stand because of some combination of i) a large number of individuals of species compared with other species in the stand, or ii) a smaller number of individuals of species, but the trees are larger compared with others in the stand.

The following formulas were used in the computations:

$$\text{BASAL AREA} = 0.7854\ (\text{dbh})^2\text{ , dbh is diameter at breast height in cm}$$

$$\text{FREQUENCY (f)} = \frac{\text{No. of occurrence among } n \text{ plots}}{n \text{ plots}}$$

$$\text{RELATIVE FREQUENCY (Rf)} = \frac{\text{frequency of a species}}{\Sigma \text{ frequency of all species}} \text{ x } 100$$

$$\text{DENSITY } (\rho) = \frac{\text{number of individuals of any species}}{\text{Area of the plot or quadrant (ha)}}$$

$$\text{RELATIVE DENSITY (R}\rho) = \frac{\text{density of a species}}{\Sigma \text{ density of all species}} \text{ x } 100$$

$$\text{DOMINANCE (f)} = \frac{\Sigma \text{ basal area of a species}}{\text{Area of the plot or quadrant (m)}^2}$$

$$\text{RELATIVE DOMINANCE (Rd)} = \frac{\text{dominance of a species}}{\Sigma \text{ dominance of all species}} \text{ x } 100$$

$$\text{IMPORTANCE VALUE (IV)} = \text{Rf} + \text{R}\rho + \text{Rd}$$

Diversity Index. The diversity index is a mathematical measure of species diversity in a community. Diversity indices provide information about species composition than just simply richness. This also takes the relative abundances of different species into account. Diversity indices computed for the layers of the sampling plots were Shannon- Wiener (H') diversity index and Pielou's evenness index:

SHANNON DIVERSITY INDEX determines the species diversity and dominance

$$H' = -\sum p_i ln p_i = -\sum \left[\left(\frac{n}{N}\right) \ln \left(\frac{n}{N}\right)\right]$$

where:

H' = Shannon-Wiener index
pi = fraction of the entire population made up of species i
n = total number of taxa of species i
N = total number of taxa in all species
ln = Natural logarithm of the number

PIELOU'S EVENNESS INDEX is a measure of how even the species in the plot. The higher the value of J, the more even the species is in their distribution within the plots *(Kent & Coker, 1992).* The evenness that is equal to one means all species are equally represented in the community.

$$J = sum \left(\frac{H\prime}{\ln S}\right)$$

where:

J = evenness index
H' = Shannon index of Species diversity
S = number of number of species
ln = Natural logarithm of the number

The computed values were assessed with the Fernando Biodiversity Scale (1998) shown in the **Table 2.1.4-4.**

Table 2.1.4-4. The Fernando Biodiversity Scale (1998)

Relative Values	Shannon –Wiener Biodiversity (H') Index	Pielou's (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

2.1.4.3 Inventory of Floral Species, Family, Genera

Recorded within the sampling sites were 59 species, 29 families, and 19 genera. (Refer to **Table 2.1.4-5, Figure 2.1.4-2,** and **Annex 2.1.4 Tables 1** and **2**). Lamiaceae is the dominating family with sixty five (65) total species count or 22.57 % of the total count followed by the Casuarinaceaae Family with thirty three (33) or 11.46% total species count. Meanwhile, there are seven (7) families that were only represented by only one (1) species having 0.35 %, among of which were Ochnaceae, Celastraceae, Pandanaceae, Phyllanthaceae, Rhizoporaceae, Rubiaceae and Sapindaceae, respectively.

Table 2.1.4-5. Top ten (10) Families with Highest Number of Species and Genera

Family Name	No. of Species	No. of Genera	Percentage of Species	Percentage of Genera
Lamiaceae	65	1	22.57	2.38
Casuarinaceae	33	1	11.46	2.38
Poaceae	28	2	9.72	4.76
Asteraceae	24	1	8.33	2.38
Combretaceae	19	1	6.60	2.38
Fabaceae	18	5	6.25	11.90
Anacardiaceae	13	4	4.51	9.52
Dipterocarpaceae	12	2	4.17	4.76
Memecylaceae	9	1	3.13	2.38
Myrtaceae	9	1	3.13	2.38

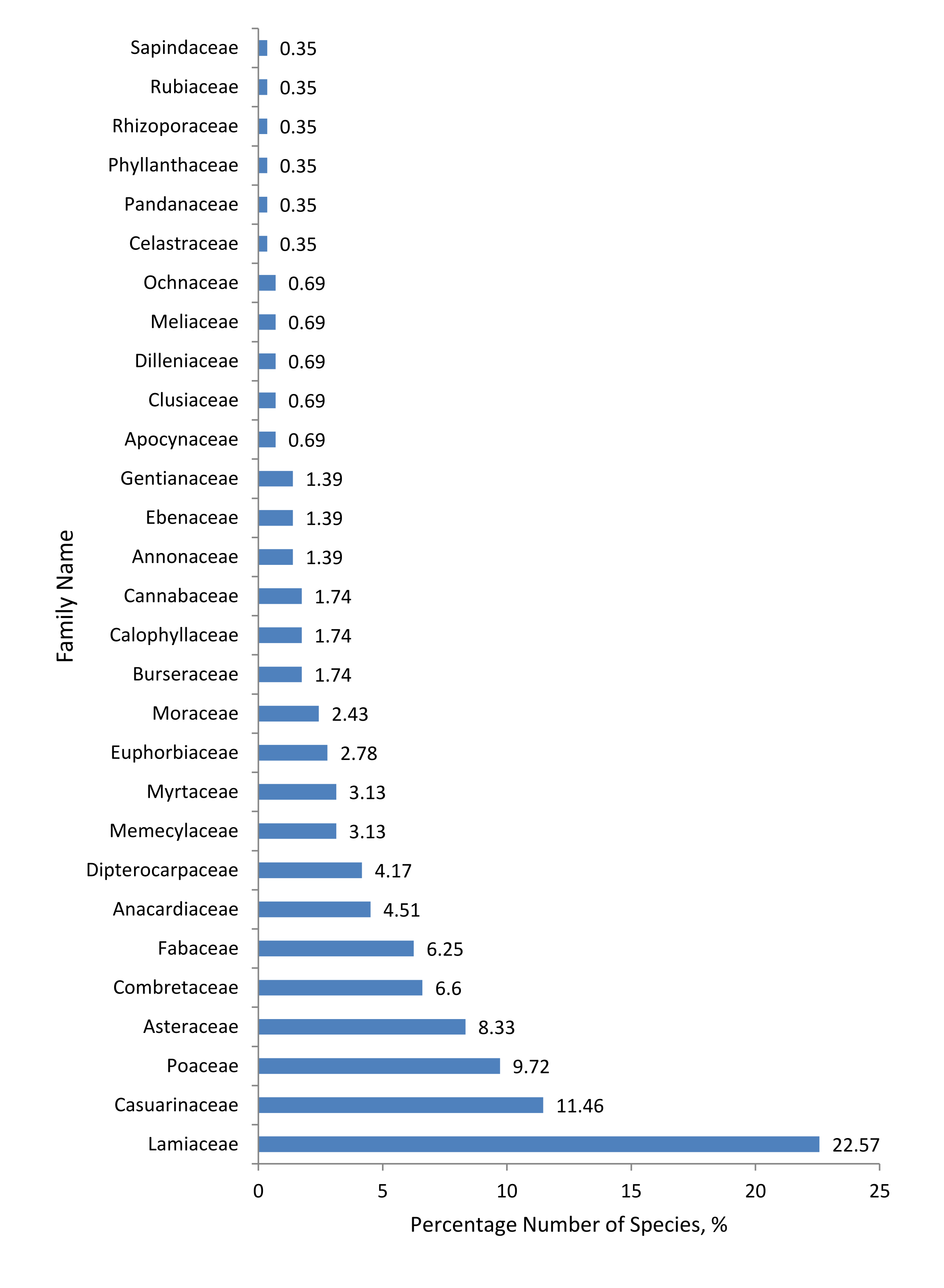


Figure 2.1.4-2. Graph of Floral Families with the % Number of Species

2.1.4.4 Conservation Status

The conservation status of the observed species within the project site **(Table 2.1.4-6**) was determined with the criteria of International Union for Conservation of Nature (IUCN),2016 and the DENR Administrative Order No. 2017-11 **(**DAO-2017-11) Re: Updated National List of Threatened Philippine Plants and their Categories. With the IUCN list, there were two (2) species, White Lauan and Malasangki listed as Critically Endangered (CR) species, one as Endangered (EN), five as Vulnerable (VU) and nine as Least Concerned (LC). With the list in DAO 2017-11, there were three (3) observed species with conservation status: two species (Bakawan gubat and Pili) belong to Other Threatened Species (OTS) and one species (Alupag) as vulnerable.

Table 2.1.4-6. Conservation Status of Observed Species

	Species	Scientific name	Family	IUCN	DAO 2017-11
1.	White Lauan	*Shorea contorta*	Dipterocarpaceae	CR	
2.	Malasangki	*Euonymus javanicus*	Celastraceae	CR	
3.	Nino	*Morinda citrifolia*	Rubiaceae	EN	
4.	Molave	*Vitex parviflora*	Lamiaceae	LC	
5.	Acacia	*Acacia auriculiformis*	Fabaceae	LC	
6.	Akleng parang	*Albizia procera*	Fabaceae	LC	
7.	Batino	*Alstonia macrophylla*	Apocynaceae	LC	
8.	Dao	*Buchanania nitida*	Anacardiaceae	LC	
9.	Kamagong	*Diospyros blancoi*	Ebenaceae	LC	
10.	Kawayan tinik	*Bambusa blumeana*	Poaceae	LC	
11.	Mangga	*Mangifera indica*	Anacardiaceae	LC	
12.	Pamitoyen	*Calophyllum cf pentapetalum*	Calophyllaceae	LC	
13.	Malakatmon	*Dillenia luzoniensis*	Dilleniaceae	VU	
14.	Narra	*Pterocarpus indicus*	Fabaceae	VU	
15.	Kulis	*Memecylon lanceolatum*	Memecylaceae	VU	
16.	Lasalia	*Wendlandia luzoniensis*	Rubiaceae	VU	
17.	Mangium	*Acacia mangium*	Fabaceae	VU	
18.	Bakawan gubat	*Carallia brachiata*	Rhizoporaceae		OTS
19.	Pili	*Canarium ovatum*	Burseraceae		OTS
20.	Alupag	*Litchi chinensis*	Sapindaceae		VU

* CR-Critically Endangered, EN- Endangered, VU-Vulnerable, LC- Least Concern, OTS-Other Threatened Species

2.1.4.5 Canopy Layer

Canopy layer is known as the primary layer of the forest that forms a roof over the two remaining layers. This refers to tree species with diameter at breast height (dbh) ≥ 10 cm. In the 27 sampling plots of 20m x 20m each, there were 26 tree species were identified. The detailed results of observations and computations are presented in **Annex 2.1.4 Table 3**.

Canopy Importance Value (IV). .Agoho (*Casuarina equisetifolia)* belonging to family Casuarinaceae had the highest importance value (IV) of 65.50% (**Figure 2.1.4-3**), followed by Molave *(Vitex parviflora)* of family Lamiaceae (57.23%), and Talisai gubat (Terminalia foetidissima) belonging to family Combretaceae (33.76%). There were five species identified that had the lowest importance value of just 2.74%. These species were Anolang *(Polyalthia lanceolata)*, Kulibangbang *(Bauhinia acuminata)*, Malasangki *(Euonymus javanicus)*, Pagsahingin (*Canarium asperum)* and Pamitoyen *(Calophyllum cf pentapetalum)*.

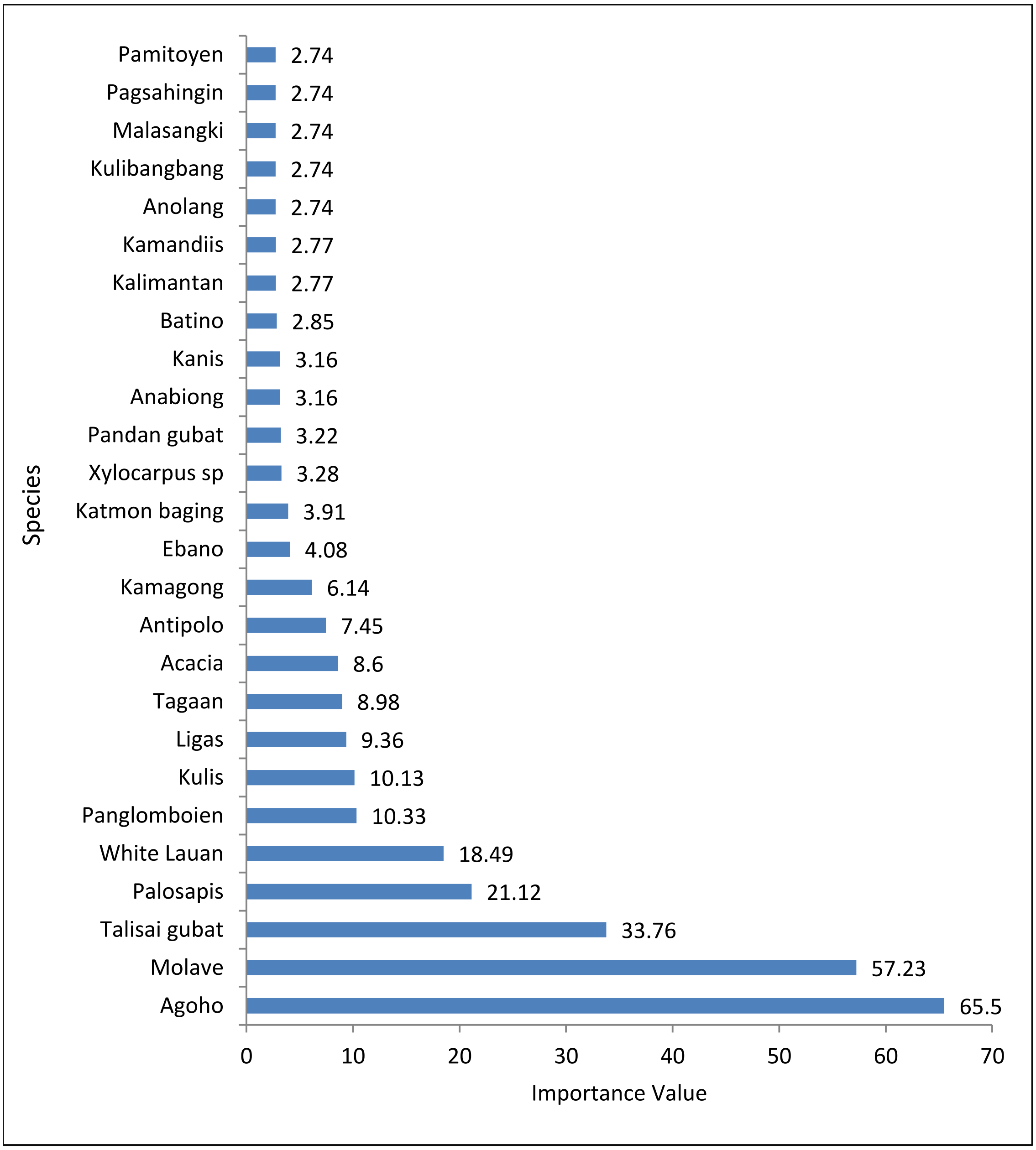


Figure 2.1.4-3. Importance Value of Canopy Cover

Canopy Relative Density (Rρ). Relative density refers to the ratio of the total number of a single species with the total area of sampling plots (derived from multiplying number of plots and area of sampling plot). Molave dominated the canopy layer with relative density of 26.61% followed by Agoho (20.97%) and the Talisai gubat (9.68%) (**Figure 2.1.4-4**). Thirteen (13) species had the least relative density of 0.81% each as follows: Anabiong *(Trema orientalis)*, Anolang *(Polyalthia lanceolata)*, Batino *(Alstonia macrophylla)*, Ebano *(Diospyros littorea)*, Kalimantan *(Utania philippinensis)*, Kamandiis (*Garcinia cf rubra)*, Kanis *(Gomphia serrata)*, Kulibangbang *(Bauhinia acuminata)*, Malasangki *(Euonymus javanicus)*, Pagsahingin *(Canarium asperum)*, Pamitoyen *(Calophyllum cf pentapetalum)*, Pandan gubat *(Pandanus tectorius)* and *Xylocarpus sp.*

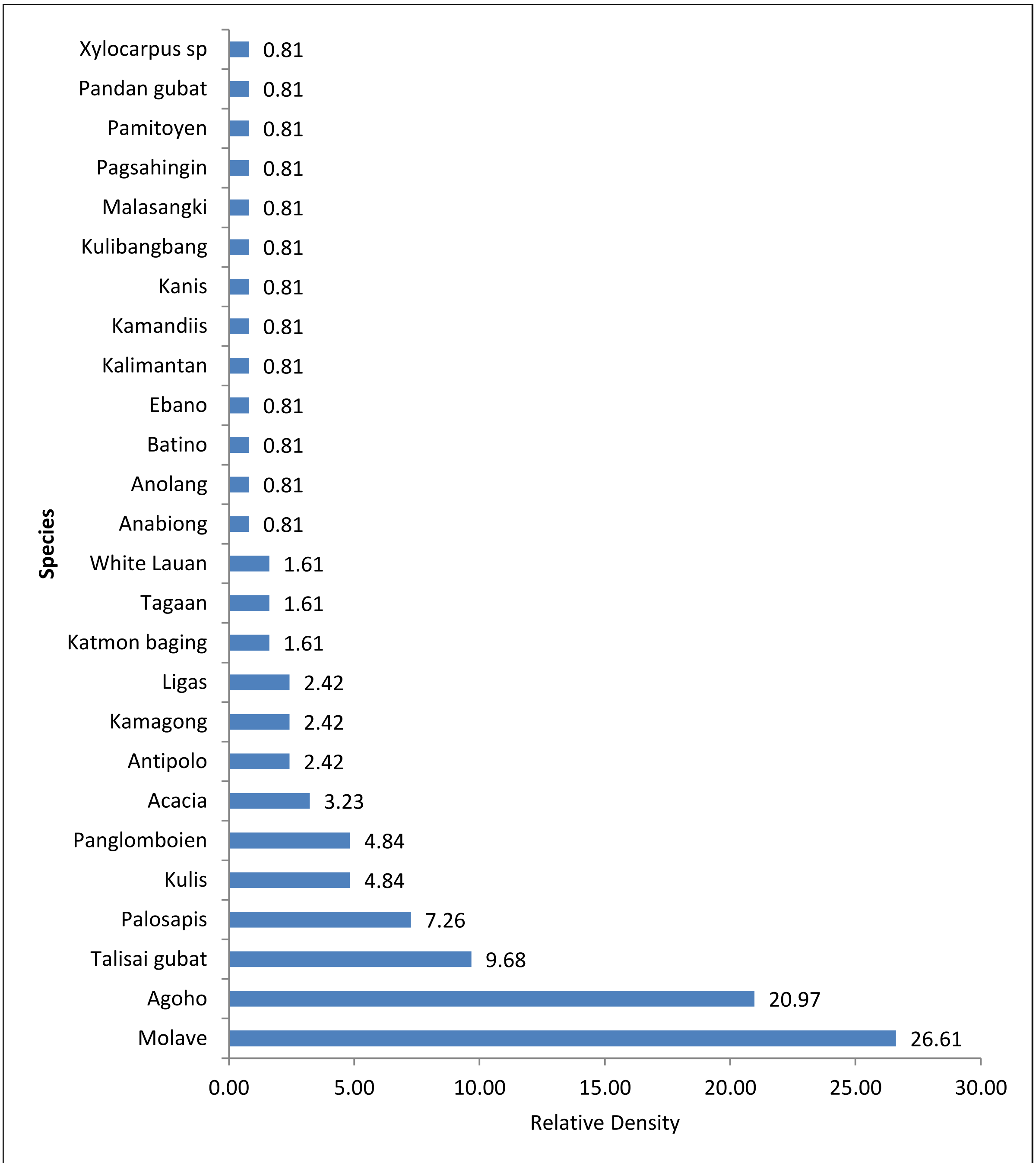


Figure 2.1.4-4. Relative Density of Canopy Cover

Canopy Relative Frequency (Rf). With relative frequency (Rf) of 15.79% each, Molave and Talisai gubat were the most abundant species, followed by Agoho with Rf value of 12.28% (**Figure 2.1.4-5**). There were 16 species found with relative frequency of 1.75% and considered the lowest abundance in the area; namely, Anabiong (*Trema orientalis*), Anolang (*Polyalthia lanceolata*), Batino (*Alstonia macrophylla*), Ebano (*Diospyros littorea*), Kalimantan (*Utania philippinensis)*, Kamagong *(Diospyros blancoi)*, Kamandiis *(Garcinia cf rubra)*, Kanis *(Gomphia serrata)*, Katmon baging *(Tetracera scandens)*, Kulibangbang *(Bauhinia acuminata)*, Malasangki *(Euonymus javanicus)*, Pagsahingin *(Canarium asperum)*, Pamitoyen *(Calophyllum cf pentapetalum)*, Pandan gubat *(Pandanus tectorius)*, White Lauan *(Shorea contorta)* and *Xylocarpus* sp.

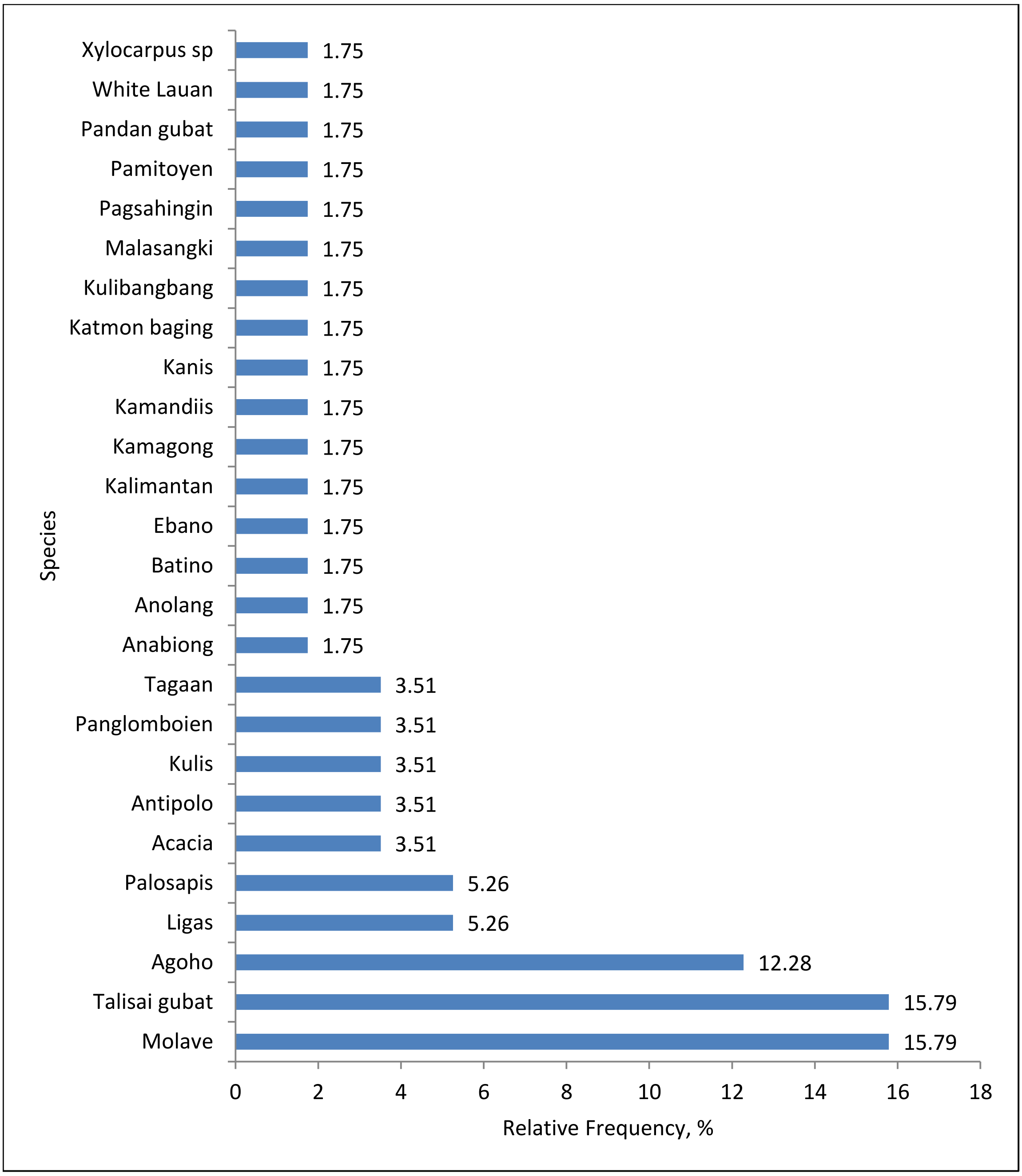


Figure 2.1.4-5. Relative Frequency of Canopy Cover

Basal Area. Basal area refers to the average amount of an area (square meter) occupied by tree stems computed as the total cross-sectional area of all stems in a stand measured at breast height, and expressed as per unit area (www.mdfp.com), **Figure 2.1.4-6** below shows the total basal area of all trees among the whole sampling plots. Agoho *(Casuarina equisetifolia)* had the highest basal area of 1.70 m^2, followed by White Lauan *(Shorea contorta)* (0.80 m^2), Molave *(Vitex parviflora)* (0.78 m^2), and Palosapis (0.45 m^2). Agoho and Molave were found widely distributed from upstream to downstream; while White Lauan and Palosapis were mostly found upstream. These tree species are viable for timber production.

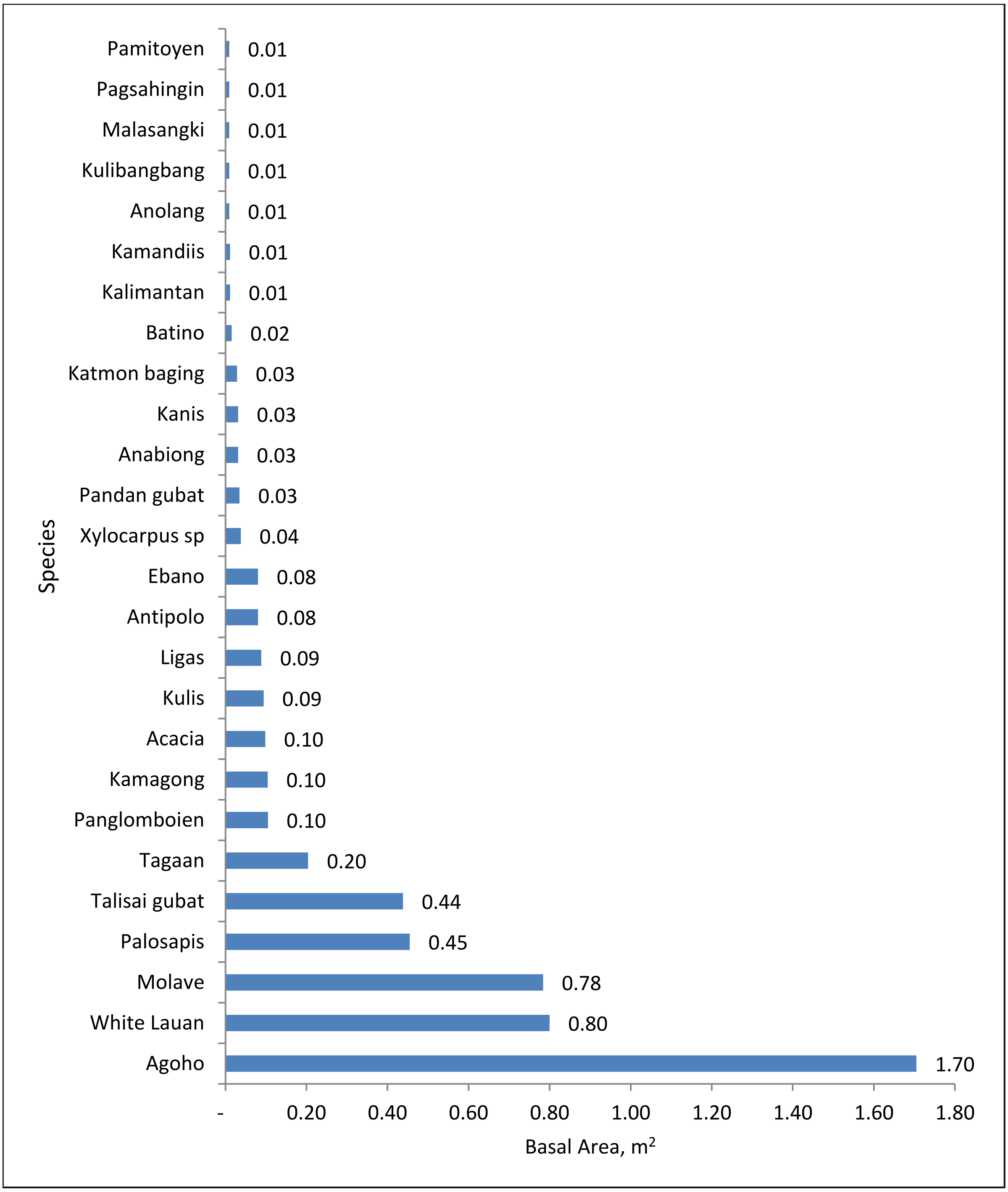


Figure 2.1.4-6. Basal Area Per Species in Canopy Layer

Tree Density. The tree density is the number of trees per unit area and is generally reported as the number of trees per hectare. In the 27 sampling plots, Molave *(Vitex parviflora)* had the highest tree density of 31 trees per hectare, followed by Agoho *(Casuarina equisetifolia)* (24 trees/hectare), and Talisai gubat *(Terminalia foetidissinma)* 11 trees/hectare **(Figure 2.1.4-7**). Estimates show that there will be 150 canopy trees per hectare in the dam site that may be affected, while about 138 canopy trees per hectare in the inundation area. The dominating species that will be affected in both the dam and inundation areas is Molave. Along the proposed access road, no canopy trees were found, but the seedlings planted in NGP areas.

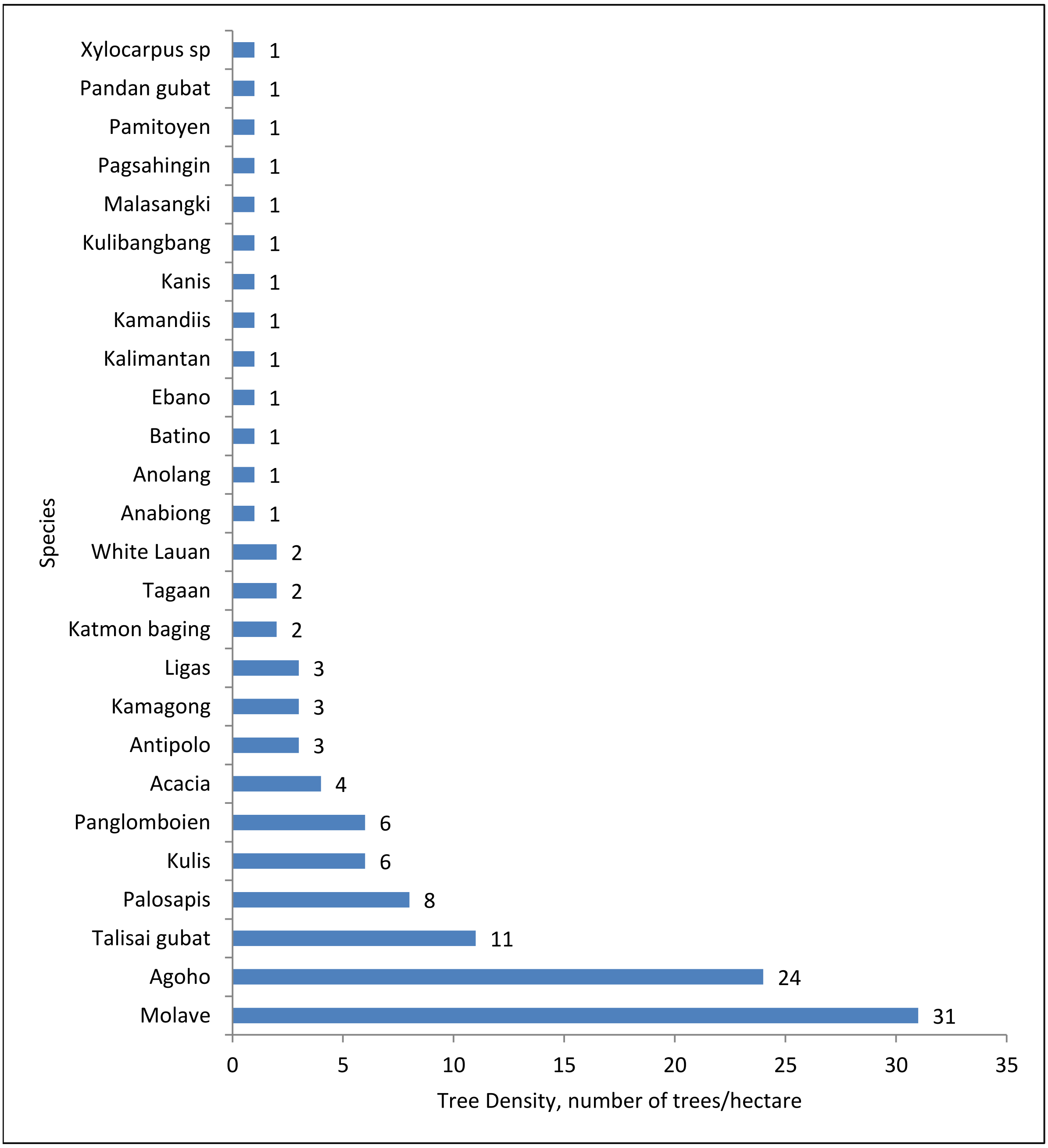


Figure 2.1.4-7. Tree Density in the Canopy Layer

2.1.4.6 Understorey Layer

Understorey layer refers to all of the vegetation growing under a forest overstory or canopy layer. Understorey layer are considered to be small trees and saplings having dbh < 10 cm but dbh ≥ 5cm. Twenty-five (25) species were identified the understorey layers of 27 sampling plots of 5m x 5m each. The results of sampling with computations are presented in **Annex 2.1.4 Table 4).**

Understorey Importance Value. Molave *(Vitex parviflora)* belonging to *Lamiaceae* family had the highest importance value (IV) of 88.87%, followed by Talisai gubat *(Terminalia foetidissima) of* family Combretaceae (19.19%), and Kulis *(Memecylon lanceolatum)* of family Memecylaceae (15.73%). Kanis *(Gomphia serrata)* together with Panglomboien *(Syzygium simile)* had the lowest importance value of just 5.54% each, among the 53 sapling species recorded (**Figure 2.1.4-8**).

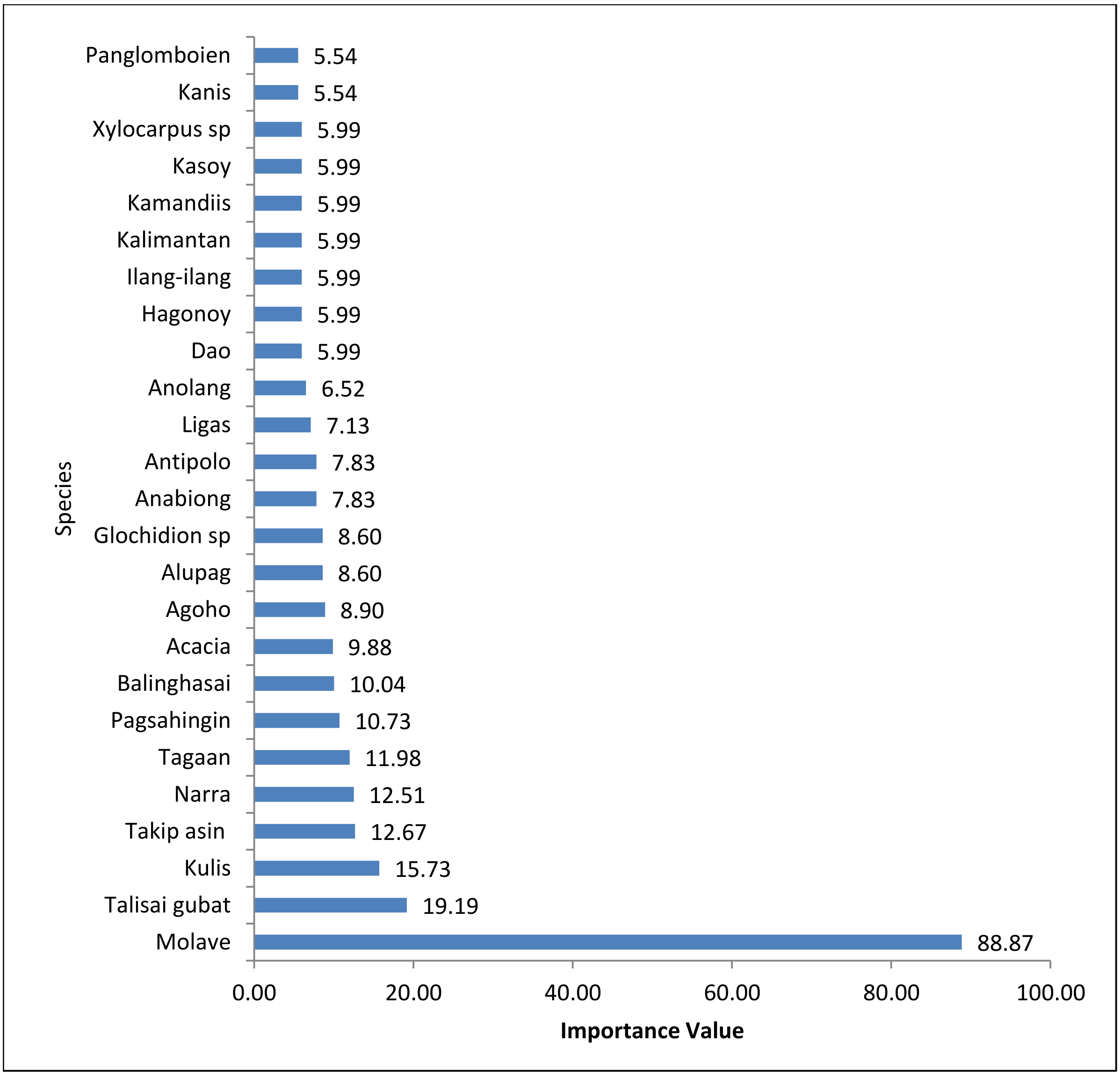


Figure 2.1.4-8. Percent Importance Value of Understorey Layer

Understorey Relative Density. Just like the canopy layer, Molave dominated the understorey layer with relative density of 35.85%, followed by Talisai gubat (5.66%) (**Figure 2.1.4-9**). Fifteen (15) species had only 1.89% relatively density, as follows: Alupag *(Litchi chinensis)*,Ilang-ilang *(Cananga odorata)*, Anabiong *(Trema orientalis)*,Kalimantan *(Utania philippinensis)*, Anolang *(Polyalthia lanceolata)*, Kamandiis (*Garcinia cf rubra)*, Antipolo *(Artocarpus blancoi)*, Kanis *(Gomphia serrata)*, Dao *(Buchanania nitida)*, Kasoy *(Anacardium occidentale)*, *Glochidion sp*, Ligas *(Semecarpus cf anacardium)*, Hagonoy *(Chromolaena odorata)*, Panglomboien *(Syzygium simile)* and *Xylocarpus sp.*

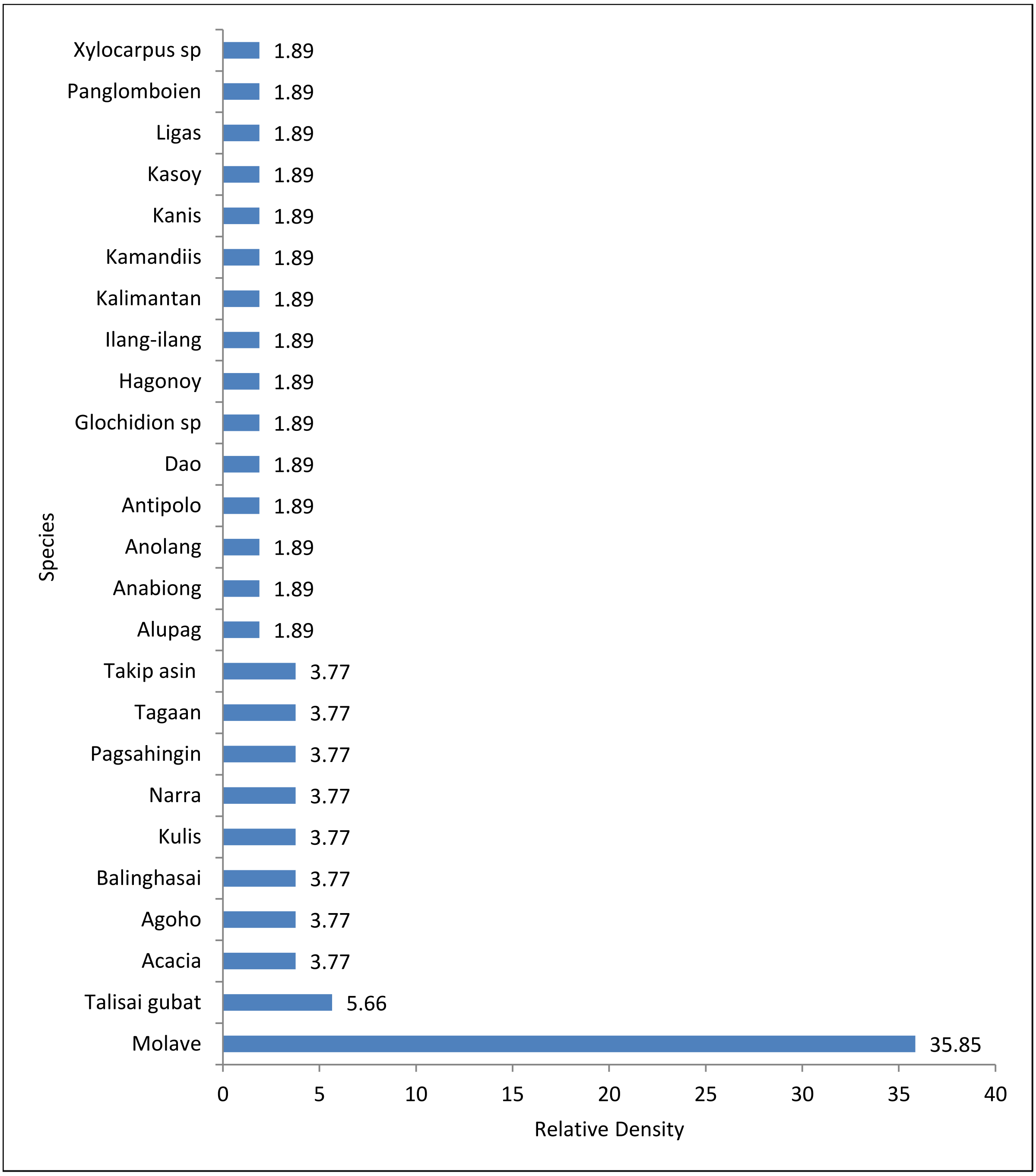


Figure 2.1.4-9. Relative Density of Understorey Layer

Understorey Relative Frequency. The most abundant species in the understorey layer was also Molave with relative frequency of 21.05%, followed by Talisai gubat (7.89%) (**Figure 2.1.4-10**). Eighteen (18) species had the lowest relative frequency of 2.63%, as follows: Acacia *(Acacia auriculiformis)*, Agoho *(Casuarina equisetifolia)*, Alupag *(Litchi chinensis)*, Anabiong *(Trema orientalis)*, Anolang *(Polyalthia lanceolata)*, Antipolo *(Artocarpus blancoi)*, Balinghasai *(Buchanania arborescens)*, Dao *(Buchanania nitida)*, *Glochidion sp,* Hagonoy *(Chromolaena odorata)*, Ilang-ilang *(Cananga odorata)*, Kalimantan *(Utania philippinensis)*, Kamandiis (*Garcinia cf rubra)*, Kanis *(Gomphia serrata)*, Kasoy *(Anacardium occidentale)*, Ligas *(Semecarpus cf anacardium)*, Pagsahingin *(Canarium asperum)*, Panglomboien *(Syzygium simile)* and *Xylocarpus sp.*

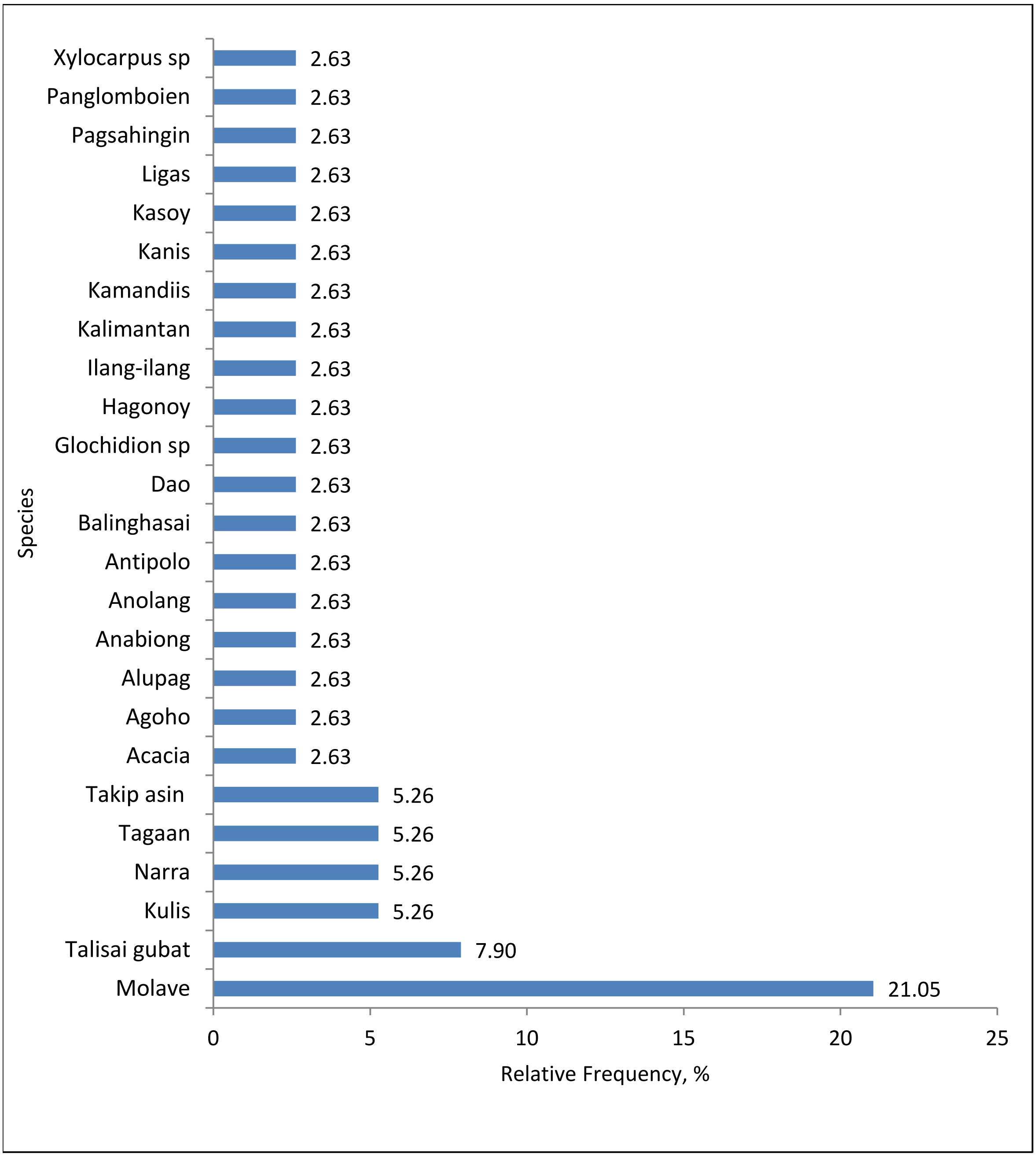


Figure 2.1.4-10. Relative Frequency of Understorey Layer

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2.1.4.7 Groundcover Layer

The groundcover layer comprises all seedlings, wildlings, grasses and shrubs species. A total of twenty-eight (28) species were recorded in the 27 1m x 1m sampling plots. The summary of inventory with results of computations is presented in **Annex 2.1.4 Table 5)**

Relative Density. Hagonoy (*Chromolaena odorata)* of family Asteraceae had the highest relative density of 20.72%, followed by a grass species *(Themed sp.)* of family Poaceae (17.12%) **(Figure 2.1.4-11).** Nine (9) species with low Rρ value of 0.90% were Akleng parang *(Albizia procera)*, Bakawan gubat *(Carallia brachiata)*, Batino *(Alstonia macrophylla)*, Ilang-ilang *(Cananga odorata)*, Kakauate *(Gliricidia sepium)*, Kulis *(Memecylon lanceolatum)*, Ligas *(Semecarpus cf anacardium)*, Palosapis *(Anisoptera thurifera)* and Santan *(Ixora philippinensis).*

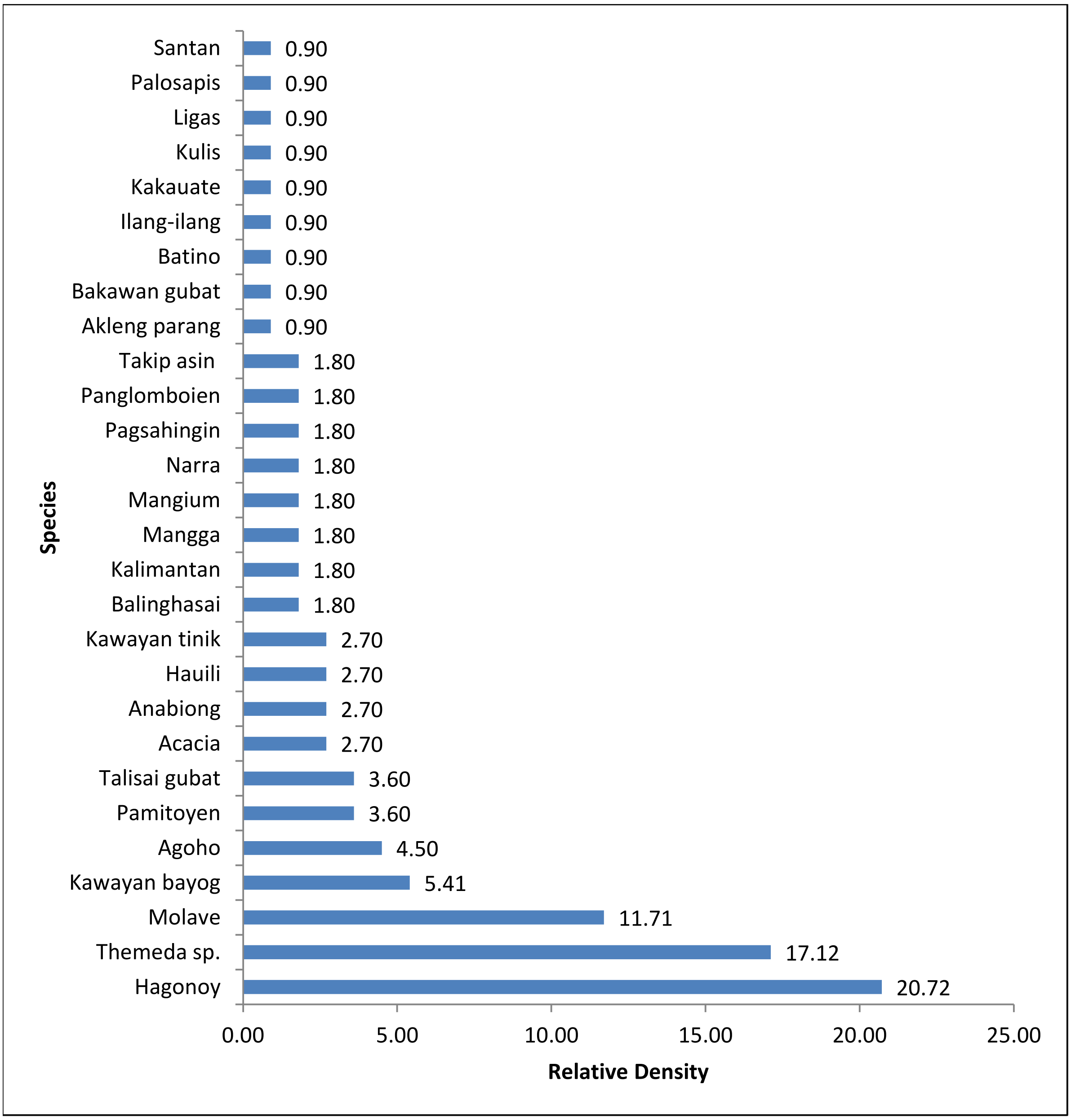

Figure 2.1.4-11. Relative Density of Ground Cover Layer

Relative Frequency. Just like the relative density, Hagonoy (*Chromolaena odorata)* of family Asteraceae has the highest relatively frequency of 21.52%, followed by a grass species *(Themed sp.)* of family Poaceae (13.92%) **(Figure 2.1.4-12).** Eleven (11) species had the least relative frequency of 1.27%, namely; Akleng parang *(Albizia procera)*, Bakawan gubat *(Carallia brachiata)*, Batino *(Alstonia macrophylla)*, Ilang-ilang *(Cananga odorata)*, Kakauate *(Gliricidia sepium)*, Kulis *(Memecylon lanceolatum)*, Ligas *(Semecarpus cf anacardium)*, Palosapis *(Anisoptera thurifera)*, Santan *(Ixora philippinensis),* Balinghasai *(Buchanania arborescens)*, Takip asin *(Macaranga grandifolia)* and Anabiong *(Trema orientalis).*

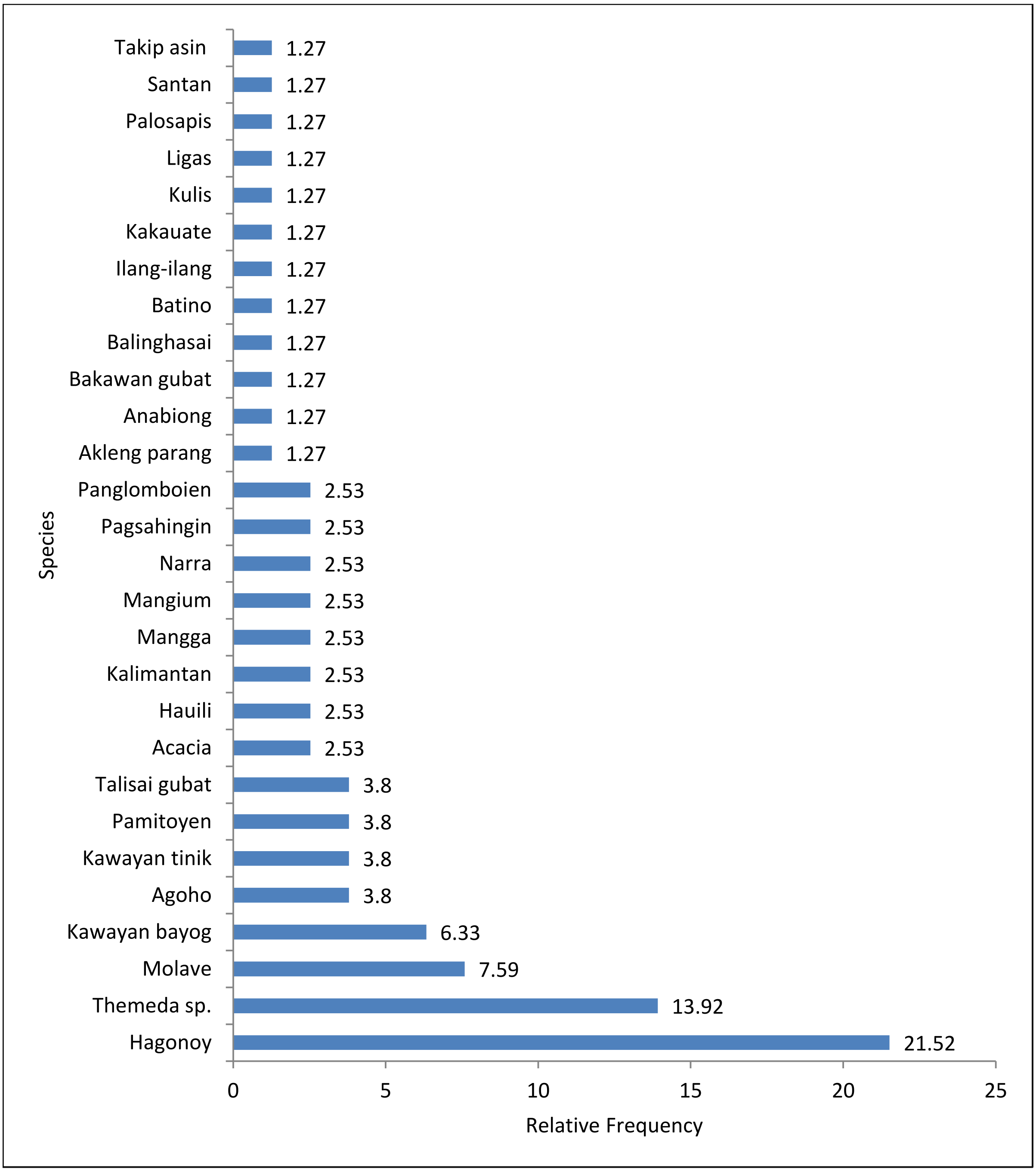

Figure 2.1.4-12. Relative Frequency of Ground Cover Layer

2.1.4.8 Diversity Index

The species richness measures the number of species per plot. This indicates that the more species present in a plot, the 'richer' the plot is. The average Shannon H' in all the 27 plots was 0.65 for the canopy 0.43 for the understorey and 0.72 for the groundcover layer (**Figure 2.1.4-13 and Annex 2.1.4 Table 7**). The values are lower than the 1.9 -- very low value in the Fernando Biodiversity Scale (1998), thus the study area is considered to have a low diversity.

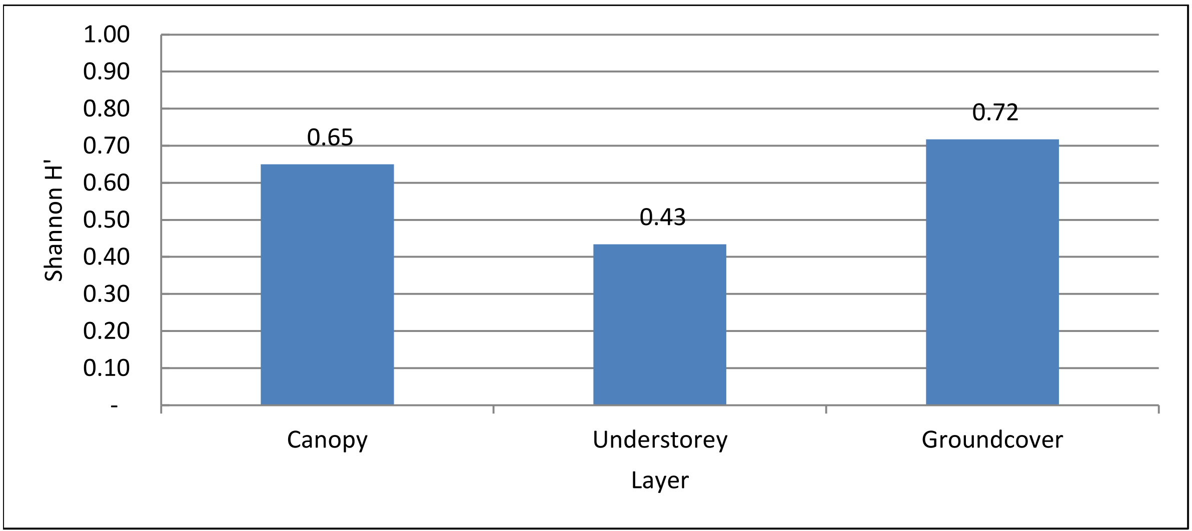

Figure 2.1.4-13. Average Shannon-Wiener Diversity H' of Canopy, Understorey and Ground Cover (very low)

In addition, the calculated average Pielou's (J') Evenness Index of 0.45 for the canopy is moderate, 0.38 for the understorey is moderate, and 0.55 for the groundcover layer is high when referred to the referring to the Fernando Biodiversity Scale (1998) (**Figure 2.1.4-14**). In other words, groundcover layer has more evenness than the canopy and understorey layers. Species evenness is a measure of the relative abundance of the different species making up the richness of an area.

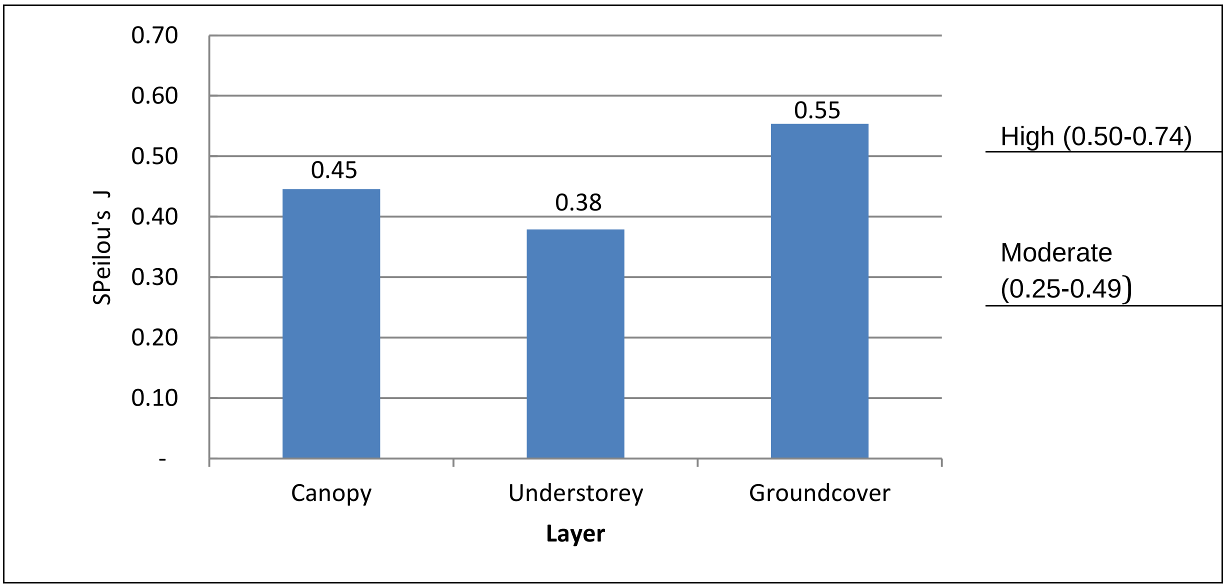

Figure 2.1.4-14. Average Pielou's (J') Evenness Index of the Canopy, Understorey and Ground Cover Layers in the 27 Plots

2.1.4.9 Environmental and Economic Significance

Vegetation is a general term for all the plant life within a region and this serves several critical functions in the biosphere at all spatial scales possible. Mainly, it regulates the flow of numerous biogeochemical cycle like the water, carbon and nitrogen. This also affects the soil characteristics and movements including soil productivity.

Different flora species also serves as wildlife habitat and source of food for animals as well as human. This is also critically important in the economy in the use of fossil fuels and source for wood, fuel, medicine and other materials.

As per the project site, the dominating species is Molave, a premium tree and economically important species, is known for its high-grade wood and highly suitable for construction materials. Agoho that is also abundant in the area is known for its good source of tannin or dye, construction, fuel-wood and medicine for cough, asthma and diabetes.

There are also Dipterocarp species just like Palosapis and White lauan that is observed in the area. These species are used for wood works such as veneer and plywood, furniture, mining timbers and general construction. These are also good shade trees for abaca and other tree shade loving species.

Another family that considers one of the most important in both ecological and economic terms is the Fabaceae that helps increase soil nitrogen fixation. Narra and Kamagong are also species that has high economic due to good wood that is usually used for furniture and sculptures due to its good color and aesthetically pleasing wood rings and grains.

There are also fruit bearing trees observed like the Manga and Pili which not only can be use as source of lumber and fuel wood but also produce fruits that can be harvested seasonally and sold in the market.

Lastly, bamboos observed in the area is very significant as it provides as natural soil erosion control measure at river banks and good source for building homes for the Indigenous People in the area.

2.1.4.10 Vegetation Along the Proposed Access Road to Dam Site

Only patches of vegetation (trees and crops) planted by the local residents were identified along the proposed access road from Barangay Bayaoas to dam site in Barangay Laoag (**Figure 2.1.4-15**)

2.1.4.11 Grass Fires

Incidence of grass fires were reported in the past years, affecting the NGP operations. The recent case was on February 28, 2019 (**Figure 2.1.4-16**), which was noticed during the March 2019 water program. The shape appeared as a broad leaf about 2 km x 2.5 km. Historical imageries of Google Earth of the nearby areas show indications grassfires in 2011, 2013, 2015, 2016, and 2017. Such incidence and preventive actions will be factored in the project design and operations. For instance, installation of temporary fuel and oil containers during the construction phase will be avoided in the area.

Figure 2.1.4-15. Indicative Access Road Showing Patches of Vegetation

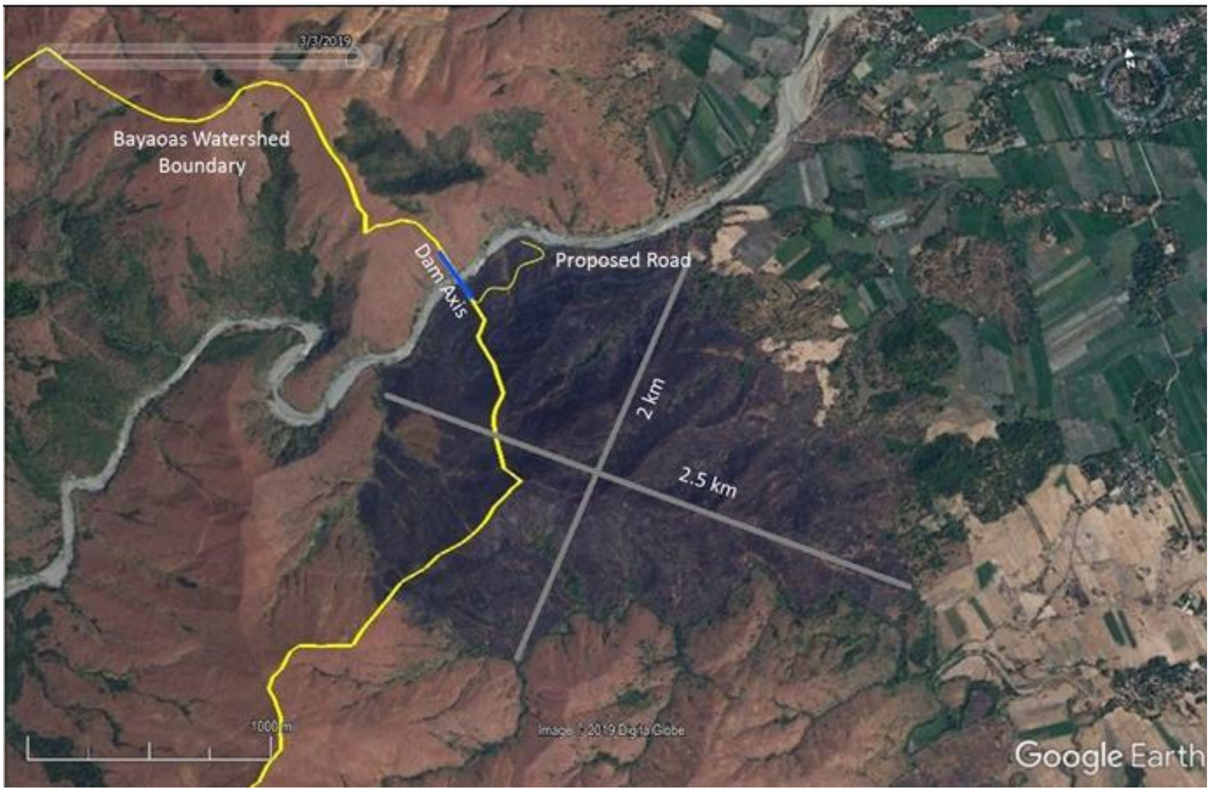

Figure 2.1.4-16. Extent of Grass Fire in the Proposed Project Area on February 28, 2019

2.1.4.12 Impact Assessment on Terrestrail Flora

Upon the implementation of project, it will require removal of vegetation that will result in the reduction of population of species emerging within the areas for inundation and road construction. During this clearing phase, regenerants will be of great threat due to hindering growth and natural dispersal of vegetation in the area.

Along the removal of vegetation along the river banks where most tree species were located, it will also affect habitat of wildlife existing in the area. Removal of a part of the remaining existing vegetation posts disturbance and reduction of home to wildlife as well as to other plant species.
Vegetation impacts soil erosion dynamics. Canopy reduces the impact of rain velocity and impact to soil surface. In addition, below ground biomass including roots will hold the soil and reduce erosion. Thus, the removal of vegetation cover will result in increased surface run-off with higher amount of sediments that will directly deposit into areas of lower slope and rivers, and in the long run will affect and change the topography of the area.

Also, erosion and siltation in the river may increase during occasional rains that may occur on soil stockpile and while constructing and passing over unpaved roads for the transport of materials and heavy equipment.

To compensate for the trees that will be cut on the construction of dam, the proponent will closely coordinate to the Department of Environment and Natural Resources (DENR) for clearance and issuance of needed tree cutting permit (PD 705). The proponent will replace the number of trees removed/cut thru planting of indigenous trees or endemic fruit bearing trees in the areas as advice by DENR. The number of seedlings for replacement should follow the DENR Memorandum Order 2012-05 “Uniform Replacement Ratio for Cut or Relocated Trees” item 2.2 “For planted trees in private and forest lands not covered under tree replacement will be 1:50 while naturally growing trees on the same area, including those affected by development projects will have 1:100 ratio in support of the National Greening Program (NGP) and Climate Change initiatives of the Government.”

All activities that will be conducted in the area will solely be based on the approved development plan of the project especially on the land clearing that will confined on designated sites only. There will be gradual land clearing and removal of vegetation to provide sufficient time for faunal species especially with the non-volant to transfer to nearby habitat.

All of the above activities and status of the floral environmental will form part of the environmental monitoring plan for the pre-construction (detailed inventory), construction, and operation.

The work of Paul Stamets has demonstrated the use of wood saw dust, combined with inoculated with mushrooms/ fungi. Experimental plots to prevent erosion shall be tested, using saw dust, and mushroom culture which envelope and decompose the sawdust. This will armour the exposed soil with wood carbon that will become bioavailable with nitrogen through decomposition.

2.1.5 Terrestrial Fauna

2.1.5.1 Summary

The terrestrial fauna covered in this study were amphibians, reptiles, birds and mammals, with field work on February 20-23, 2019, that recorded a total of 11 species of herpetofauna (amphibians, and reptiles) , 19 of avifauna (birds) and 7 of mammals (mouse, rat, bat, dee, pig). The survey covered three areas from the proposed access road, to dam site and further upstream of the maximum reservoir level, for about 10 km channel segment of Bayaoas River at elevations 330-150 masl. The species found or relayed through interviews are not classified as Threatened and/or Endangered, according to DAO 2004 15. There were endemic and native species ranging from Least Concern to Near Threatened in IUCN List and low in abundance and biodiversity.

An existing threat to wildlife is the recurrence of grass fire causing habitat destruction and limits the capacity forest to regenerate and grow despite efforts under the National Greening Project to nurture trees in the area. Illegal wildlife hunting for bushmeat, and livelihood also limits the increase in wildlife population.

Land occupancy, noise production and dust emission during construction would potentially but temporarily drive away terrestrial fauna from the works areas. The proposed dam and inundation area would potentially reduce the habitat areas and cause habitat fragmentation. However, the magnitude of impact on faunal population is potentially low due to thin vegetation, which is meant to house or provide nest for a large population. Loss of species is unlikely to occur since most of the recorded species are endemic and/or native, though of least concern as these are widespread within Zambales Mountain Range.

Mitigation measures would include replacement tree planting and continuing support to the National Greening Program in Bayaoas Watershed given the presence of the reservoir, as a source of water. Smaller tree species would also be planted to complement the larger tree species identified under the NGP, to rapidly provide cover for the soild and necessarily for wildlife. A wildlife monitoring and conservation program will be put in place, in coordination with the various stakeholders, alongside potential fire management measures.

2.1.5.2 Methodology

Sources of information about the terrestrial fauna at the proposed Project site included primary data gathering and interviews. Three areas or sites were established for the primary data gathering: one is below the proposed dam down to the proposed road route, the second is at the reservoir area, and the third is upstream of the reservoir. This covered a total length of 10 km at elevations 31-141 masl, with respect to the Bayaoas River channel. Each of the three sites covered strip transect line for the herpetofauna, transect line for the avifauna, 6 mist nets, and 20 cage traps. Mist nets and cage traps had prescribed bait. See **Table 2.1.5-1** for the coordinates of the sampling sites and **Figure 2.1.5-1** for the plot on a map.

Sampling was done on February 20-23, 2019 under sunny to partly cloudy sky, with a gratuitous permit secured from DENR Regional Office. Transect walks were done every 0600H to 0900H and 1600H to 1800H while Strip transect was done during 0600h -0900h and 1900H – 2100H. The nets and cage traps were checked every morning and watched every night during peak of activity of volant mammals and birds. Captured species were photographed, identified, characterized and released. Ethno biological survey was also done. Respondents were locals of the community, specifically the beneficiaries of the National Greening Program and those with prior experience, who have worked or who are working in the area.

Herpetofauna. Amphibians and reptiles (herpetofauna) were surveyed through strip transect sampling, opportunistic catching and ethno biological interviews with the locals. Sampling was conducted at least twice a day between 0600H -0900H and 1900H – 2100H. There were total of 36 person-hours overall for the whole project area, represented by three transect sites. Potential microhabitats, such as tree holes, underneath fallen logs and leaf litters, and burrows, were searched with the help of the local guides. Upon capture, descriptive and quantitative measurements were taken including pictures and were released afterwards. Identification of the species were based on Alcala (1986) and Alcala and Brown (1998). Identifiable species such as python, monitor lizards among others were identified through interviews with the locals.

Avi Fauna. A bird census was carried along a two-kilometer line transect in three different sites for 3 days, every 0600H to 0900H and 1600H to 1800H, for a total of 12 person-hours per site. Hence, a total of 36 person-hours for the project area was exerted. Six mist nets were placed per site thus for a total of 54 net days. Mist netting was done to supplement the aural and visual record completed through transect method. Moreover, this was done to record and identify the cryptic species. Mist nets were hoisted five feet above the ground using bamboo poles and operated from 0900H to 1800H and overnight for three days. Identification of species was based on Kennedy *et al*. (2000). All captured individuals were recorded and photographed before release.

Table 2.1.5-1. Coordinate of the Terrestrial Fauna Sampling Sites

Site	Northing	Easting	to	Northing	Easting
Strip Transect					
1	15°49’02”	120°14’12”		15°49’02”	120°14’11”
2	15°49’01”	120°13’14”		15°49’01”	120°13’13”
3	15°48’09”	120°11’41”		15°48’09”	120°11’42”
Transect Line					
1	15°49’22”	120°14’43”		15°49’04”	120°13’52”
2	15°49’59”	120°13’41”		15°48’48”	120°12’52”
3	15°48’17”	120°11’09”		15°48’17”	120°12’08”
Mist Nets					
1	15°49’06”	120°14’00”			
1	15°49’09”	120°14’00”			
1	15°49’17”	120°14’09”			
2	15°49’01”	120°13’18”			
2	15°49’00”	120°13’12”			
2	15°48’58”	120°13’19”			
3	15°48’30”	120°12’27”			
3	15°48’15”	120°12’27”			
3	15°48’35”	120°12’38”			
Cage Traps					
1	15°49”19”	120°14’40”		15°49’01”	120°13’55”
2	15°49’55”	120°13’46”		15°48’44”	120°12’55”
3	15°48’15”	120°11’12”		15°48’16”	120°12’16”

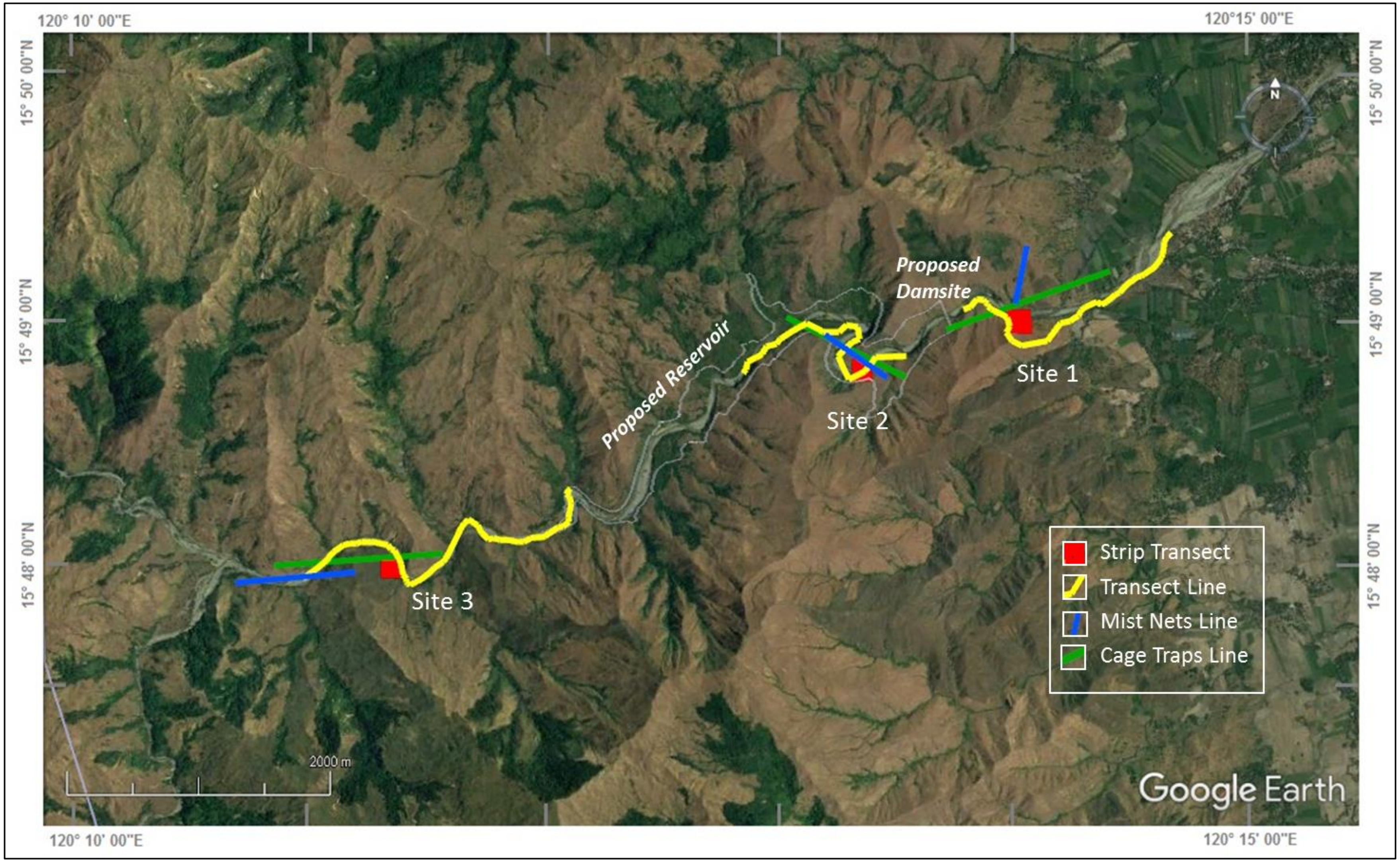

Figure 2.1.5-1. Terrestrial Fauna Sampling Sites

Mammals. Volant mammals (fruit and insect bats) were captured using the same mist nets used for birds, with a total of 54 net-days. The bats trapped in the net were carefully tended and untangled during the activity peaks of bats which were from early dusk (1700H), until night (2200H). Sex, age category and important body measurements were taken and were properly documented before release.

Small non-volant mammals were captured using cage traps that were properly baited for mouse and rats, and for shrews. Twenty cage traps were deployed for each site situated 5 to 10 meters apart on three different sites. A total of 180 trap-days were done to represent the whole project area. Ethno biological interviews with the locals were done to discern the surviving medium to large mammals in the area and to determine their perceived abundance.

2.1.5.3 Results of Herpetofauna (Reptiles) Survey

There were only 11 species of amphibians and reptiles recorded through strip transect method, opportunistic catching and ethno biological interviews. Abundance was low as well as the endemicity (**Table 2.1.5.3-1, Photo 2.1.5-1**).

Amphibians. Only three species of frog were recorded and none are listed as Threatened under DAO 2004-15 or under the Philippine Willdlife Act. Two live mainly on land as adult. *Limnonectes macrocephalus*, however, is classified under IUCN as near threatened species. This may be due to continuous habitat loss and disturbed habitat. The remaining two species, *Rhinella marina* and *Platymantis dorsalis* are terrestrial as adults and are listed as least concern. *Rhinella marina* are exotic species while *Platymantis dorsalis* are native to the Philippines. Both are of least concern under IUCN. The low abundance may be due to low abundance of grass in the area which can affect the population of insects that are the main diet composition of amphibians. In addition, there is observed overgrowth of algae in some areas allegedly due to excessive nutrients present. This may be from the poultry farm located upstream as mentioned by the locals.

Reptiles. Most of the reptiles recorded were determined from the ethno biological survey done by the team. Seven species of reptiles were recorded throughout the project area. One endemic species, *Naja naja* or the Philippine Cobra was recorded and is classified as Vulnerable. According to the residents, this species is generally rare and found in National Greening Project sites. Occasionally, they are hunted due to fear and/or as food. Moreover, due to frequently occurring grass fires, residents claim that they have observed this species itinerant at the residential areas located near the forests. Population may have been threatened due to habitat destruction and conversion of forest lands to residential, agricultural or logging operations.

Varanus marmoratus and *Parvocinus boyongi* are both Luzon endemic and are classified as Near Threatened. This may be due to illegal wildlife trade and illegal hunting, as mentioned from the interview with the locals.

Table 2.1.5-2. List of Recorded Herpetofauna at the Proposed Project Area

Family	Scientific Name	Common Name	Endemicity/ Conservation Status
A. Amphibians			
1. Ranidae	*Limnonectes macrocephalus*	Luzon Fanged Frog	Luzon Endemic/NT
2. Bufonidae	*Rhinella marina*	Cane Toad	LC
3. Ceratobatrachidae	*Platymantis dorsalis*	Dumeril's Wrinkled Ground Frog	Indigenous/LC
B. Reptiles			
4. Varanidae	*Varanus marmoratus*	Monitor Lizard	Luzon endemic/NT
5. Scincidae	*Parvocinus boyingi*	Boying's Zambales Mountain Skink	Luzon endemic/NE
6. Scincidae	*Eutropis multicarinata*	Philippine Mabuya	Indigenous/NE
7. Elapidae	*Elaphae erythrura*	Philippine Rat Snake	Indigenous/LC
8. Gekkonidae	*Hemidactylus sp.*		
9. Gekkonidae	*Gekko gecko*	Gecko	Indigenous/LC
10. Elapidae	*Naja naja*	Philippine cobra	Endemic/Vu

NE= nearly extinct; NT= nearly threatened; LC= least concern; Vu:= vulnerables

Photo 2.1.5-1. Photographs of Herpetofauna Captured

	
(a) Hemidactylus sp.	(b) Luzon Fanged Frog (*Limnonectes macrocephalus)*

2.1.5.4 Results of Avifauna (Birds) Survey

A total of 19 species of birds were identified (seen, heard or captured) which belong to 15 different Families (**Table 2.1.5-3, Photo 2.1.5-2**). Birds were observed perching on trees, soaring from the sky, flying from tree to tree and/or resting on the ground aside from those retrieved from the mist nets. Overall, the species observed were common and are of Least Concern (LC). Eight species were found to be endemic and all are resident species. They breed in the Philippines and are normally abundant in the country. In addition, no migratory birds were recorded.

The habitat type observed, which mainly were patches of shrubs and few trees, associates with the abundance of ground foraging birds. Flocks of *Anas luzonica* were mainly observed at Site 2 which was the most undisturbed area among the three sites. Site 1, which is nearer the residential area and access road, was dominated by *Corvus enca* habituating on branches of trees along the river bank, mostly wandering and partially sedentary. Prior to reaching Site 1 at night, a number of *Caprimulgus manillensis* were observed sedentary at rocky portions of the river bank. *Corvus enca* and *Caprimulgus manillensis* are both of least concern under IUCN classification. Some of the notable species observed were the Philippine Frogmouth, Philippine Nightjar and Philippine Duck which are all endemic to the Philippines.

Low species abundance was observed due to patchy forested areas and occurring habitat disturbances. Abundant species such as the *Corvus enca* among others are those gregarious species that perches on open areas. The solitary, cryptic species such as *Batrachomosus septimus* were less observed. Nonetheless, no species dominated as the vegetation composition, which mainly were patchy and with few trees, were consistent along the course of the river bank.

Table 2.1.5-3. List of Recorded Avifauna at the Proposed Project Area

	Family	Scientific name	Common name	Endemicity/ Conservation status
1.	Accipitridae	*Spilornis cheela*	Crested Serpent Eagle	Indigenous/LC
2.	Accipitridae	*Haliastur indus*	Brahminy Kite	Indigenous/LC
3.	Rallidae	*Hypotaenidia torquata*	Barred Rail	Indigenous/LC
4.	Columbidae	*Geopalia striata*	Zebra Dove	Indigenous/LC
5.	Strigidae	*Otus megalotis*	Philippine Scops Owl	Endemic/LC
6.	Podargidae	*Batrachomosus septimus*	Philippine Frogmouth	Endemic/LC
7.	Caprimulgidae	*Caprimulgus manillensis*	Philippine Nightjar	Endemic/LC
8.	Alcenidae	Ceyx cyanopectus	Northern Indigo-Banded Kingfisher	Endemic/LC
9.	Pycnonotidae	Pycnonotus goiavier	Yellow-vented Bulbul	Indigenous/LC
10.	Pycnonotidae	*Hypsipetes philippinus*	Philippine Bulbul	Endemic/LC
11.	Dicruridae	*Dicrurus balicassius*	Balicassiao	Indigenous/LC
12.	Muscicapidae	*Rhipidura cyaniceps*	Blue-headed fantail	Endemic/LC
13.	Laniidae	*Lanius schach*	Long-Tailed Shrike	Indigenous/LC
14.	Oriolidae	*Oriolus chinensis*	Black-Naped Oriole	Endemic/LC
15.	Muscicapidae	*Saxicola caprata*	Pied Bushchat	Indigenous/LC
16.	Columbidae	*Spilopelia chinensis*	Spotted Dove	Indigenous/LC
17.	Ardeidae	Egretta eulophotes	Chinese Egret	Indigenous/Vu
18.	Corvidae	Corvus enca	Slender Billed Crow	Indigenous/LC
19.	Anatidae	Anas luzonica	Philippine Duck	Endemic/LC

Photo 2.1.5-2. Photographs of Avi Fauna Captured

(a) Black-naped Oriole *(Oriolus chinensis)*

(b) Philippine Bulbul *(Hypsipetes philippinus)*

(c) Yellow vented Bulbul *(Pycnonotus goiavier)*

(d) Spotted Dove *(Streptopelia chinensis)*

(e) Philippine Nightjar *(Caprimulgus manillensis)*

(f) Long-Tailed Shrike *(Lanius scach)*

(g) Pied Bushchat *(Saxicola carpata)*

2.1.5.5 Results of Mammalia (Mammals) Survey

There were 7 species of mammals observed with only 1 volant mammal (**Table 2.1.5-4, Photo 2.1.5-3**). *Cynopterus brachyotis* are widespread species belonging to Pteropodidae. They are native to the Philippines, widespread and are of least concern. Volant mammals were not abundant in the area due to patchy vegetation and lack of fruit bearing trees, such as Figs, near the river bank. Four species of small non-volant mammals were observed, two of which are native and the remaining two are exotics. An exotic, *Rattus tanezumi*, is a known agricultural pest and most likely feeds from the surrounding rice fields irrigated by the river. These species are associated with diseases such as zoonotic parasites. *Apomys datae* was recorded along three different sites and is classified as least concern under IUCN. *Rattus everetti,* as identified by its half white half brown tail, is abundant in the area and is also classified as least concern.

Two large non-volant mammals, the Philippine warty pig and Philippine brown deer, were said to forage the project area, along the margins of the mountain upstream, near the riverbank. Philippine warty pig, *Sus philippinensis*, is classified as Vulnerable mainly due to illegal hunting for bush meat. According to the locals, their frequent encounter with the wild pig declined more over the years due to deforestation caused by illegal logging and grass fires and illegal poaching.

Moreover, hunters are commonly vigorous every after an occurrence of grass fire according to locals as they have observed that the deer is frequently seen feeding over patches of sprouting grass after a grass fire incident. *Rusa mariana*, the Philippine deer, is also an endemic species classified under Vulnerable as per IUCN. Overall, Muridae and Soricidae, rats, mouse and shrew, were the most commonly observed family along the area as they are not easily limited by fragmentation and are generally widespread.

Table 2.1.5-4. List of Recorded Mammals at the Proposed Project Area

Family	Scientific name	Common name	Endemicity/ Conservation status
1. Muridae	*Apomys datae*	Luzon montane Forest mouse	Indigenous/LC
2. Muridae	*Rattus tanezumi*	Oriental House Rat	Exotic/LC
3. Soricidae	*Suncus murinus*	Asian House Shrew	Exotic/LC
4. Muridae	*Rattus everetti*	Philippine Forest Rat	Indigenous/LC
5. Pteropodidae	*Cynopterus brachyotis*	Lesser Short-Nosed Fruit Bat	Indigenous/LC
6. Cervidae	*Rusa mariana*	Philippine Brown Deer	Endemic/Vu
7. Suidae	*Sus philippinensis*	Philippine Warty Pig	Endemic/Vu

Photo 2.1.5-3. Photographs of Mammals Captured

a) Luzon Montane Forest Mouse (*Apomys datae*)

(b) Oriental House Rat (*Rattus tanezumi*)

(c) Asian House Shrew (*Suncus murinus*)

(d) Philippine Forest Rat (*Rattus everetti*)

(e) Lesser Short-Nosed Fruit Bat (*Cynopterus brachyotis*)

2.1.5.6 Impact Assessment on Terrestrial Fauna

Generally, threat on wildlife is mainly due to frequent occurrence of grass fire in the area which is the main cause of habitat destruction and the inability of the forest to regenerate and grow despite the efforts of National Greening Project to nurture trees along the area. Illegal wildlife hunting for bushmeat and livelihood also affects the population. Pressure from hunting also increases immediately after a forest or grass fire, making animals more vulnerable.

During the construction phase, it is highly likely that the fauna will be disturbed especially those settling within the project site in the form of habitat removal, equipment, movements, dust emission and noise production.

The proposed inundation would likely cause habitat fragmentation between the left and right banks of Bayaoas River. However, the affected population of fauna, mainly on land dwelling animals, is expected to be lesser since the thin vegetation of the affected area is may be assumed inadequate to house a large population or provide nests.

Furthermore, loss of local species is unlikely since most of the recorded species are endemic and/or native, they are mostly of least concern and widespread within Zambales Mountain Range. Nevertheless, a wildlife conservation program will be put in place for the proposed Project, in coordination with various stakeholders. The program should pay close to the sources of population pressure namely: fire, hunting, hunting immediately after fire, construction noise, inundation, and the general paucity of forest cover.

Reasonable support for the National Greening Project will be given as part of the maintenance and management of the watershed for the Dam. This includes a no hunting operations within the area. The successful implementation of the project would be able to support a larger population and more diverse species. Alternative activities for game or livelihood should be developed so as to limit pressure on animal populations.

The forest cover will have to be developed rapidly if the water supply is to be stabilized, soil erosion managed, and forest cover improved. The use of technology such as the use of mulching, wood chips or other agricultural waste and animal waste to protect moisture, improve soil carbon, improve grass cover rapidly, and support succession of species. In the end, once the dam is in place, the development of the forest cover can be used as a site for tourist reforestation activity, and later for bird watching and wildlife observation, as part of the vision for the place.

2.2 The Water

2.2.1 Hydrology and Hydrogeology

2.2.1.1 Summary

The proposed Project is within Bayaoas River Catchment which is one of the subwatershed or tributaries out of 19 of the Agno River Basin in the central plain of Region 1. The river system is dendritic, 4th stream order, and has a drainage area of 79.15 km^2. The drainage area upstream of the proposed dam is 64 km^2. The river channel measures 25.9 km long from Agno River (at 3 masl), going southwest and south at the headwaters in Sta. Cruz Zambales (at maximum 840 masl). The longitudinal slope of the channel is low at the proposed reservoir. The river bed width varies and wide about 30 m at 180 masl upstream of the proposed reservoir to 250 m maximum at the lowland.

From the 2015 Feasibility Study (FS) Report for the proposed Project, the estimated mean monthly flow at the dam site is from the lowest 0.34 m^3/s in March to the highest 12.41 m^3/s in August. The observed peak flow ranged 18 to 258 m^3/s. In consideration of the climate projection for Pangasinan, the recommended design flood is 1,321.61 m^3/sec (100-year return period), while the check flood is 1,819.08 m^3/sec (1,000-year return period).

Uplands have rocks without any known significant groundwater, largely untested, while the lowland have rocks with limited potential, to moderate permeability. The dam site is not susceptible to flood, but the lowland have low to very high flood susceptibility. The area is susceptible to drought.

At flood condition for a 100-year return period and reaching the 36 m wide and 6 m high spillway, estimates showed a water depth of 48.8 m at the dam axis, 103.79 ha water surface area, and 18.03 million m^3 water stored. The dam site would serve as a flood control measures, provide significant irrigation water during dry season, and reduce pumping frequency of groundwater for irrigation.

2.2.1.2 Methodology

The basin characteristics were derived from the 2015 BSRIP FS, NAMRIA topographic map, Google Earth features, and DENR Report on Climate-Responsive Integrated Master Plan for Agno River Basin. Ocular surveys were done in March 2019, along with the water sampling program.

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2.2.1.3 Surface Water

Physiographic Characteristics. The proposed dam and reservoir will be within Bayaoas River which stretches from northeast part of Zambales Mountain Range to an easterly direction towards lowland to Agno River which has 19 tributaries and drains into Lingayen Gulf (**Figure 2.2.1-1**). The closer view of the drainage area is presented in **Figure 1-2** under Project Description Section. The drainage area at the proposed dam site is about 64 km^2 of the 79.15 km^2 of the Bayaoas Watershed. Bayaoas River is a dendritic and a 4th stream order river. The dam site is about 9.4 km channel length to Agno River main channel (3 masl); 5.2 km channel length to the maximum reservoir flood condition level; then 11.3 km toward the south watershed boundary at elevation of around 840 m (in Sta. Cruz Zambales), for a total 25.9 km channel length. The reservoir has an average slope of only 0.010 or 0.6 degree. The river bed is wide at the dam site about 30 m at 40 masl and even 4.4 km further upstream at 180 masl, with cases of 100 m along the reservoir. The river bed widens downhill 50 m at 40 masl, and with a case of 250 m at 25 masl the western part of Barangay Bayaoas, then constricts downstream at various widths to a minimum of 20 m.

Stream Flow. Bayaoas River has a stream gauging station of DPWH located in Barangay Bayaoas, Aguilar, Pangasinan, (**Figure 2.2.1-2**) which is approximately 1.2 km west from a concrete bridge near km post 183 of the national highway, at latitude 15^0 49' 24" North and longitude 120^0 15' 00" East, and with a drainage area at the station is 64 km^2. Decadal 910 days) mean daily discharges from 1983 to 2007 were made available, with some missing records (**Annex 2.2-1),** only 0.19 m^3/s in March and 0.94 m^3/s in August.

The gauging station is downstream of irrigation intakes and presumably indicated lower flow rate than that of the dam site further upstream. Mean monthly streamflow at the dam axis was estimated using the Crawford streamflow prediction model[13] developed for Southeast Asian watersheds. **Annex 2.2.1-2** shows a representation of the model which uses precipitation and potential evapotranspiration data. The calculations are based on the water balance equation for the watershed and make use of calibrated coefficients to represent watershed characteristics. The computations imitate the key hydrologic processes: infiltration of water into the soil profile; surface runoff; and flow along subsurface flow paths into the stream.

The simplified water balance equation is:

Runoff = Precipitation – Actual Evapotranspiration + Storage Change

The runoff or stream flow leaving out overland is calculated from the input volume flow from precipitation (rainfall), output volume rate from evaporation and transpiration, and the change rate (positive or negative) of the volume of water from storage in soil, groundwater aquifer and lakes. For the proposed Project, the decadal rainfall data and potential evapotranspiration (as presented under Climatology Section) were estimated and used in the model to generate decadal streamflow for Bayaoas River at the dam site, presented in **Annex 2.2.1-3**. The model was calibrated with the record of the gauging in Barangay Bayaoas, Aguilar, Pangasinan and in consideration of communal irrigation systems diverting river water between the station and proposed dam site.

Figure 2.2.1-3 shows the estimated monthly stream flow in correlation with the rainfall at the dam site, indicating lowest mean monthly flow is 0.34 m^3/s in March and highest mean monthly flow is 12.41 m^3/s in August. The average runoff coefficient is 0.64 and the average specific discharge is 0.056 $m^3/s/km^2$. The observed peak flow ranged 18 to 258 m^3/s (**Table 2.2.1-1**)

[13] Crawford, N.H. and Thurin, S.M. Hydrologic Estimates for Small Hydroelectric Projects, Hydrocomp, Inc. September 1981

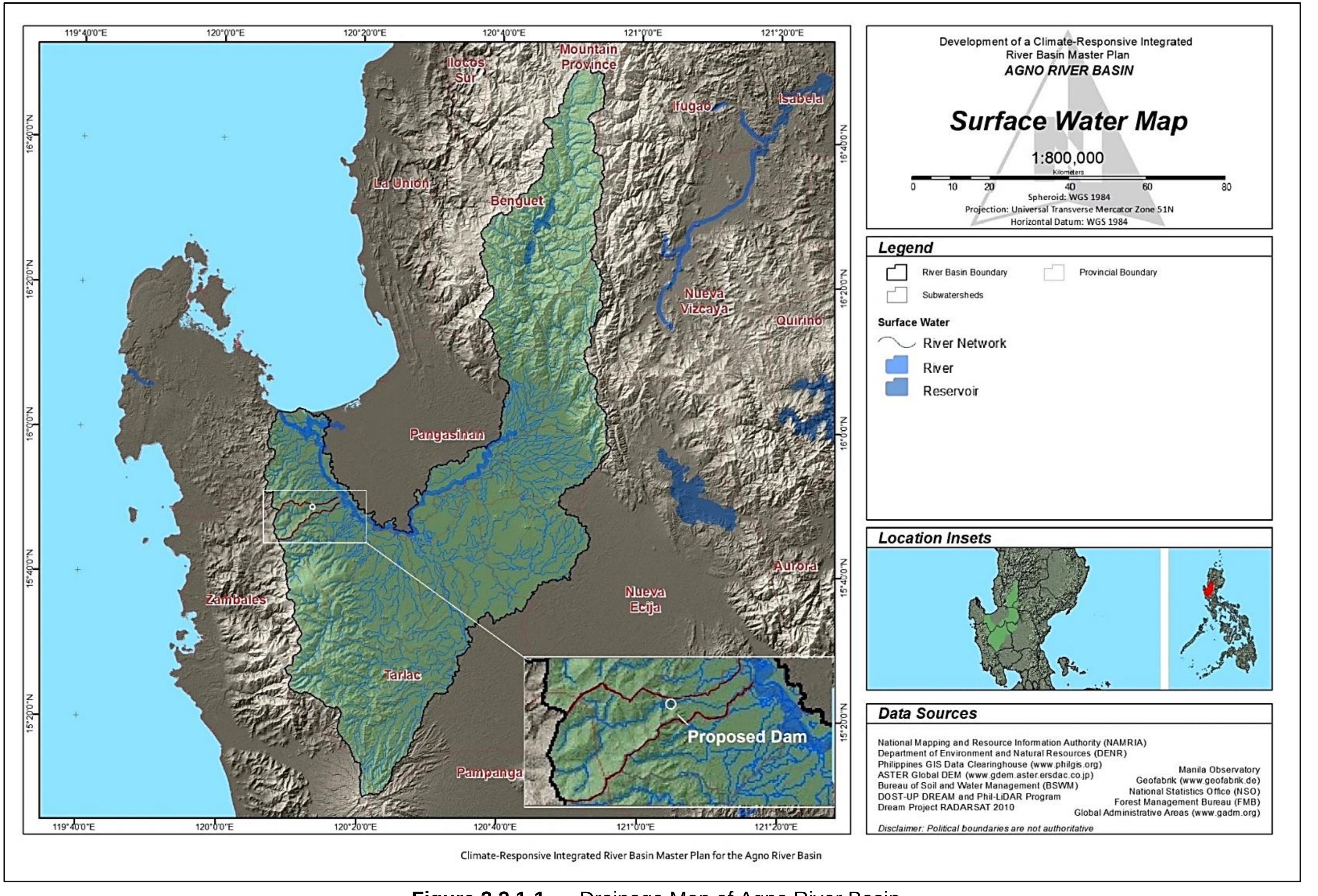


Figure 2.2.1-1. Drainage Map of Agno River Basin

Figure 2.2.1-2. Location of Bayaoas River Gauging Station and Dagupan Synoptic Station

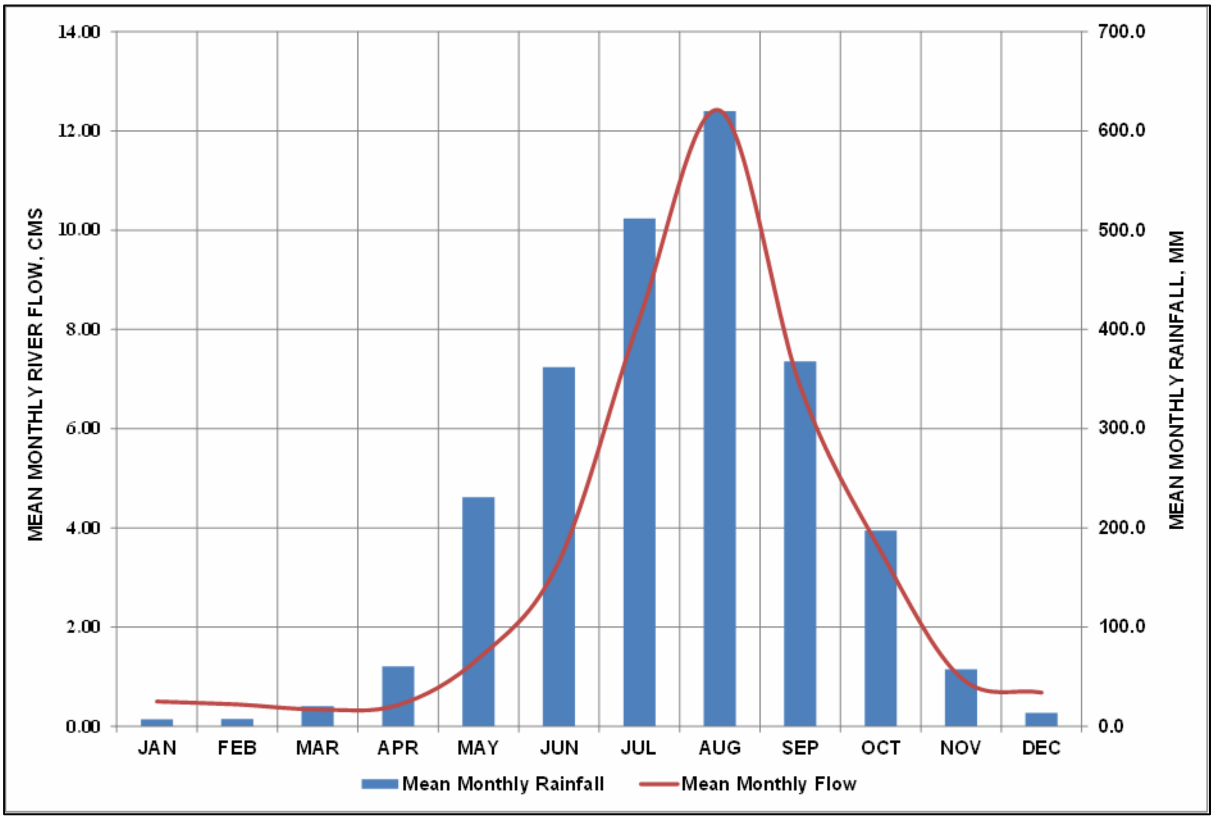


Figure 2.2.1-3. Generated Monthly Streamflow and Rainfall for Bayaoas River

Table 2.2.1-1. Observed Annual Peak Discharges, Bayaoas River, (m^3/s)

Year	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Peak Discharge	115.13	53.93	123.63	115.13	83.73	26.13	15.08	68.48	18.08	18.08	127.28
Year	1994	1995	1998	1999	2002	2003	2004	2005	2006	2007	
Peak Discharge	18.08	18.08	81.28	200.08	211.28	**258.08**	127.28	86.66	94.36	35.56	

Flood Study. For the dam and spillway design, the flood study[14] showed a specific discharge of 21.11 m^3/sec/km^2 for recommended design flood of 1,321.61 m^3/sec (100-year return period) while the check flood is 1,819.08 m^3/sec (1,000-year return period). The study considered the climate change projection for Pangasinan. The full length report is presented in **Annex 2.2.1-4** inasmuch as dam integrity is a major issue about the proposed Project.

The flood study report contains the major topics on the design storm, design flood for the dam, and flood routing for the spillway. The subtopics for the design flood include:

i. General Assumptions for Hydrograph Analysis,
ii. Flood Hydrograph derived from Unit Hydrograph of Gauged Stream,
iii. Soil Conservation Service (SCS) Unit Hydrograph,
iv. Statistical Method,
v. Probable Maximum Flood, and
vi. Selection of Design Flood.

The extensive data used and produced include the following:

i. Rainfall Intensity-Duration-Frequency Analysis Data for Dagupan City,
ii. Dagupan City 24-hour Maximum Rainfall,
iii. Updated Extreme Values of Precipitation for Dagupan City,
iv. Ordinates of Flood Hydrographs based on Derived Unit Hydrograph,
v. Graphical Presentation of Flood Hydrograph, and
vi. Flood Routing Result.

Results of the three methods of peak discharge estimation are presented in **Tables 2.2.1-2, 2.2.1-3 and 2.2.1-4.**

Table 2.2.1-2. Summary Peak Discharges Derived from Unit Hydrograph of Gauged River

Return Period (years)	5	10	25	100	200	500	1000	10000
Peak Discharge (cms)	650.01	811.82	1,016.27	1,318.48	1,468.49	1,666.38	1,815.95	2,312.53
Baseflow (cms)	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13
Total Discharge (cms)	653.14	814.95	1,019.40	1,321.61	1,471.62	1,669.51	1,819.08	2,315.66
Specific Discharge (m^3/sec/km^2)	10.43	13.02	16.28	21.11	23.51	26.67	29.06	36.99

Table 2.2.1-3. Peak Discharges by Soil Conservation Service (SCS) Method

Return Period (years)	5	10	25	100	200	500	1000	10000
Peak Discharge (cms)	518.59	647.69	810.80	1,051.92	1,171.59	1,329.48	1,448.81	1,844.99
Baseflow (cms)	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13
Total Discharge (cms)	521.72	650.82	813.93	1,055.05	1,174.72	1,332.61	1,451.94	1,848.12
Specific Discharge (m^3/sec/km^2)	8.33	10.40	13.00	16.85	18.77	21.29	23.19	29.52

[14] *Chapter 8. Feasibility Study Report, 2015.*

Table 2.2.1-4. Peak Discharges Using Statistical Method

Location / Statistical Method	Peak Diacharge (m^3/sec) by Return Period (year)											
	2	5	10	25	50	100	200	500	1000	2000	5000	10000
Bayaoas River												
Gumbel Extreme Value Type I	80	153	202	263	309	354	399	458	503	548	607	652
Log Pearson III	68	140	199	285	354	427	505	613	700	790	893	1011
Bayaoas River @ proposed Damsite												
Gumbel Extreme Value Type I	78	150	198	257	302	346	390	448	492	536	594	638
Log Pearson III	67	137	195	279	346	418	494	600	685	773	873	989

River Use. Upstream of the populated area Bayaoas River is mainly used for irrigation and recreational activities such as bathing and picnics. The extent of irrigation is presented under the Project Description. Irrigation intakes are found in the north (left) and south (right) banks. The riverbed is tapped for quarrying gravel, stones and sand.

2.2.1.4 Groundwater

By the regional hydrological map, the uplands where the dam and reservoir will be located have rocks without any known significant groundwater, largely untested. The lowlands have rocks with limited potential, to moderate permeability. (**Figure 2.2.1-4**). Springs are not known in the area. Tube and dug wells are popular in the lowland used for domestic purposes and source of irrigation water by pumping.

2.2.1.5 Flood Susceptibility

The upland has low susceptibility to flood. Areas of very high susceptibility to floods are those located near Bayaoas River that includes the western and southern part of Barangay Buer, and northern strip of Barangay Bayaoas, (**Figure 2.2.1-5**). Other others have low to high susceptibility to flood.

According to MGB, very high flood susceptibility areas are likely to experience flood height of greater than 2 meters and/or flood duration of more than 3 days. These areas are immediately flooded during heavy rains for several hours; include landforms to topographic lows such as active river channels, abandoned river channels and area along river banks; also prone to flash floods.

High flood susceptibility areas likely to experience flood heights of greater than 1 up to 2 meters and/or flood duration of more than 3 days. These areas are immediately flooded during heavy rains of several hours; include landforms to topographic lows such as active river channels, abandoned river channels and area along river banks; also prone to flash floods.

Moderate flood susceptibility areas likely to experience flood heights of greater than 0.5 meter up to 1 meter and/or flood duration of 1 to 3 days. These areas are subject to widespread inundation during prolonged and extensive heavy rainfall or extreme weather condition. Fluvial terraces, alluvial fans, and infilled valleys are areas moderately subjected to flooding.

Low flood susceptibility areas likely to experience flood heights of 0.5 meter or less and/or flood duration of less than 1 day. These areas include low hills and gentle slopes. They have sparse to moderate drainage density.

2.2.1.6 Drought

Majority (76%) of the Agno River basin is highly susceptible to drought brought about by El Niño events. These includes the provinces of Pangasinan, Pampanga, Zambales and Nueva Ecija (**Figure 2.2.1-6**). PAGASA defines drought a condition when the precipitation is less than 60% of the average normal rainfall condition for three consecutive months. Drought is a result of prolonged shortage in precipitation that leads to severe water scarcity relative to human and environmental needs (e.g. domestic water supply, irrigation).

Drought in the Philippines is significantly associated with the El Niño Southern Oscillation Phenomenon (ENSO), with extreme variations (i.e. reduction) of seasonal and annual precipitation, similar to most areas of the Western Pacific. From the historical records of PAGASA most major drought events in the country are associated with the occurrences of El Niño Phase (warm phase) of the ENSO in the Eastern and Central Pacific Ocean.

Drought has been occurring at two- to three-year cycles from earlier five-year cycles (Tejada et. at, 2012 in DENR 2017b). In addition, the strongest El Niño events occurred in 1997-1998 and 2015-2016, with an ONI score reaching 2.3. This is based on the Oceanic Niño Index (ONI) of the US National Oceanic Atmospheric Administration (NOAA) keeps records of to track the cycles of ENSO in the Pacific. ONI is a measure of the departure of the three-month average sea surface temperature from a 30-year average.

2.2.1.7 Impact Assessment on Hydrology

The significant impact of the proposed Project on hydrology will be the increase in the surface area and depth of the river channel upstream of the dam, as already presented under Project Description. At the dam axis, water depth will be 16.5 m at the minimum, then increases to 39.5 m at normal operation level, and then 46.8 m at maximum flood level. The respective surface area is 16.33, 77.68, and 103.79 ha, while the respective water volume stored are 1.28, 11.51 and 18.03 million m^3. The depth decreases upstream to natural level.

The dam serves as a flood control structure, with rising water level during the rainy season and decreasing during the dry season.

The presence of irrigation water supply will significantly reduce the frequency of pumping of shallow ground water during the dry season. This is a matter of groundwater conservation. Monitoring works will include water table depth in dug wells.

The continuous flow of water from the dam would ensure environmental flow along Bayaoas River and to the separate intake of the Buer-Calsib irrigation system. Future improvements may include the installation of wide diameter pipe (crossing Bayaoas River) from irrigation canal in Barangay Bayaoas to the Buer-Calsib intake.

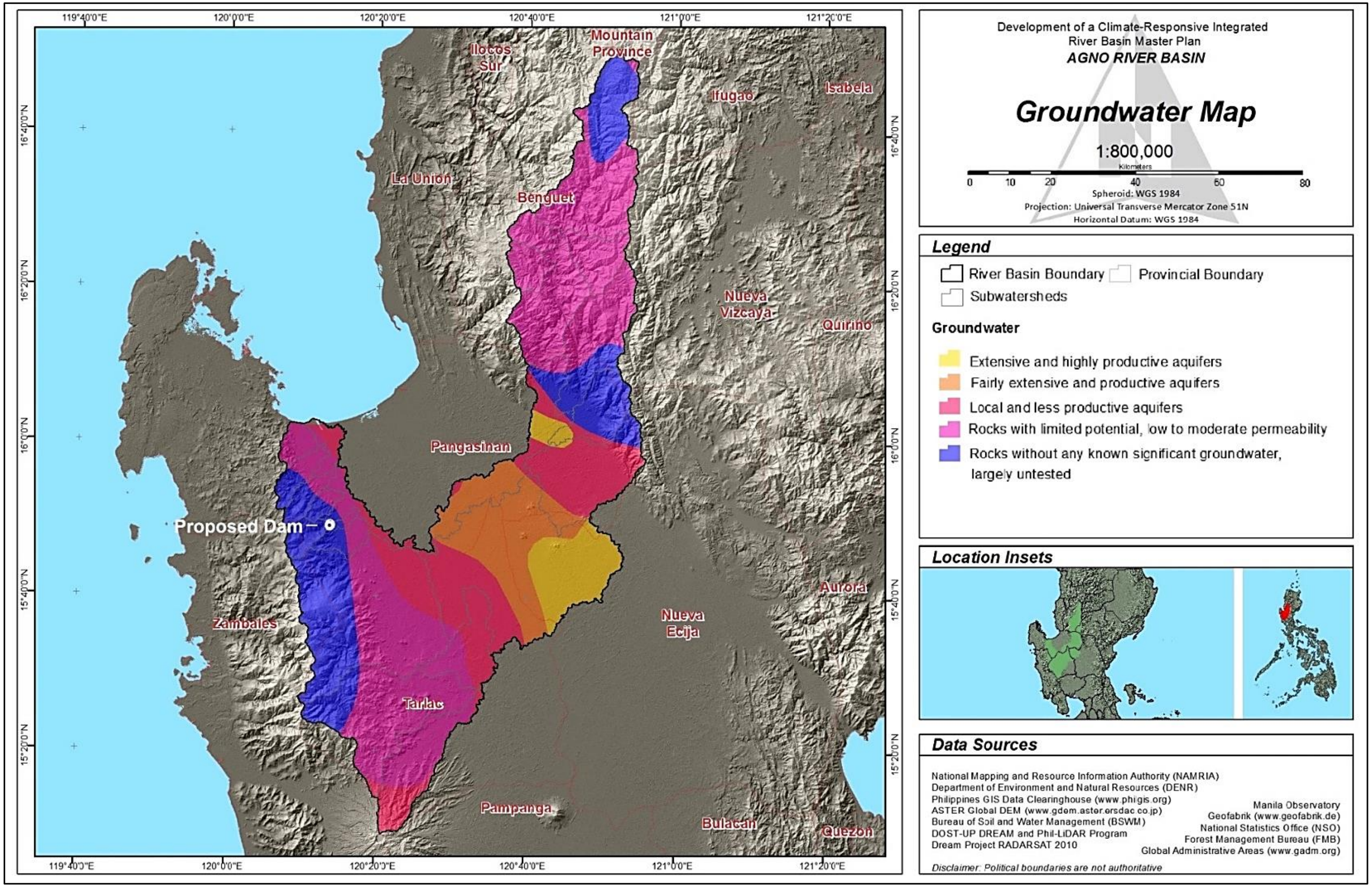


Figure 2.2.1-4. Groundwater Map of the Agno River Basin

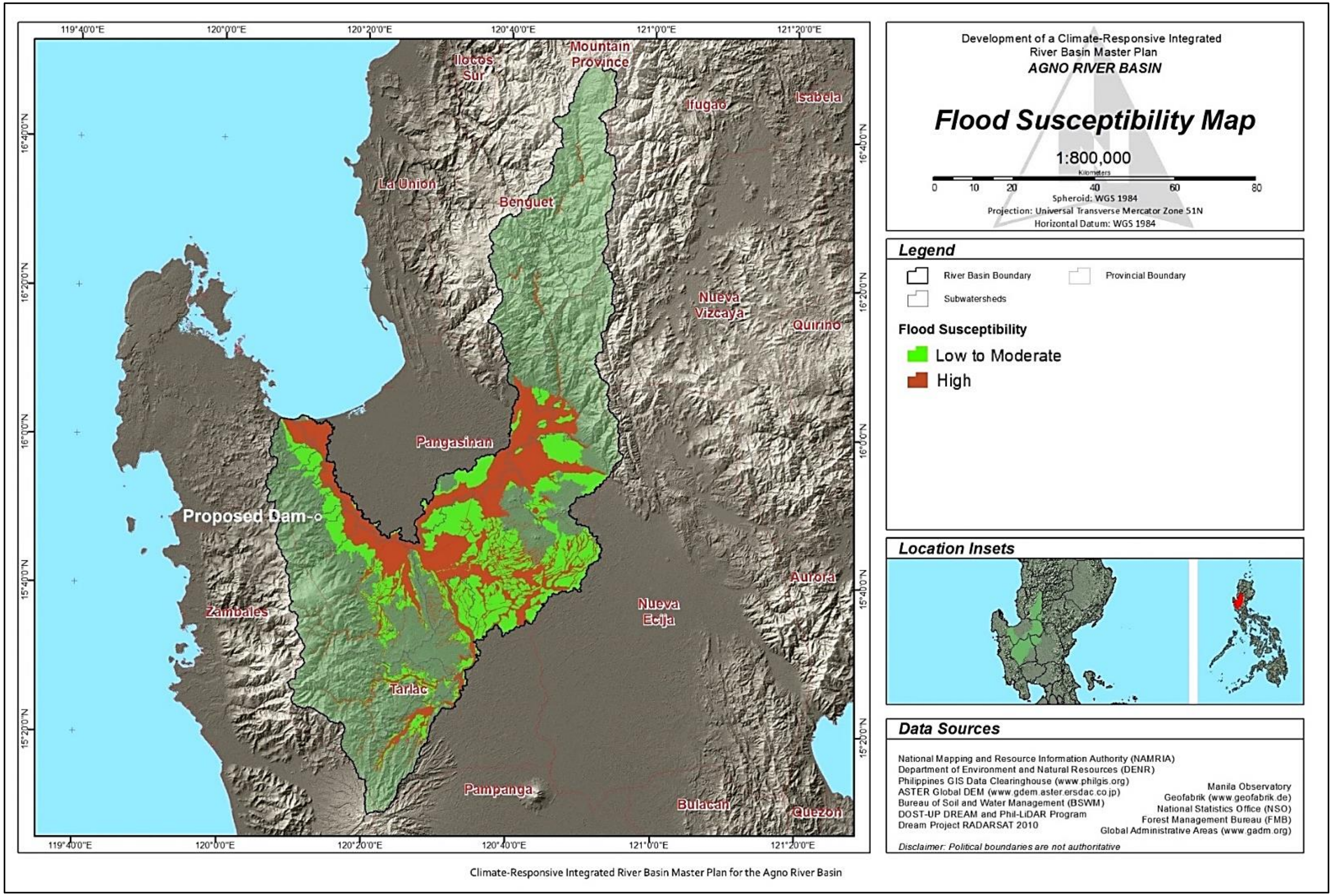


Figure 2.2.1-5. Flood Susceptibility Map of Agno River Basin

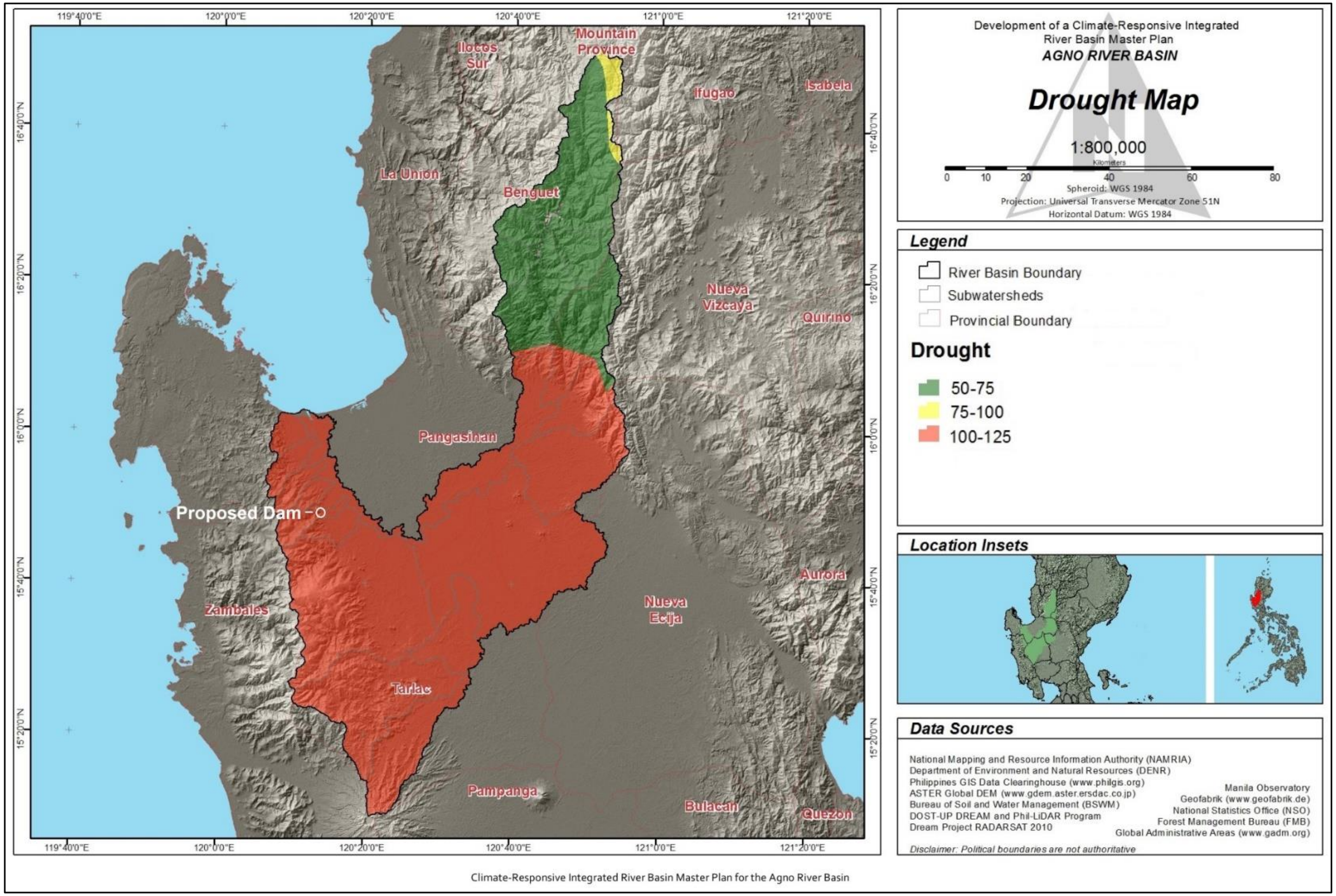


Figure 2.2.1-6. Drought Hazard Categories in Agno River Basin

2.2.2 Water Quality

2.2.2.1 Summary

The surface water Bayaoas River has good water quality at the uninhabited dam site area but with lower quality down the irrigated and populated area at the Calsib-Buer irrigation intake. This based on five (5) sampling sites and a total 30 water quality parameters measured in the dry months of April 2015 and Mar 2019. Concentrations of chloride, nitrate, phosphate, ammonia and sulfate appeared increased at the lowest elevation sampling site. The quarrying activities along the river did not show significant increase in the total suspended particulates due to low flow, ponding and absence of significant soil sediment fine components.

A groundwater sample from a shallow 3-year old tube well in a residential area in Barangay Bayaoas exhibited low quality manifested by objectionable odor and elevated concentrations of ammonia (4.21 mg/L), manganese (0.466 mg/L) and cadmium (0.009 mg/L) exceeded their respective water quality guidelines for Class C waters.

2.2.2.2 Methodology

Water quality assessment covered Bayaoas River which is the direct impact surface water of the proposed Project. Groundwater quality in a tube well was also covered as a supplementary baseline information for the associated impact on the increase frequency of rice farming to second and third cropping.

Sets of water quality data of Bayaoas River were compiled from the 2015 Feasibility Report of the proposed Project and for the results of water sampling program on March 27, 2019. Another set of water quality data is provided under the Freshwater Ecology module.

The water quality parameters in the data sets differed but covered those indicated in the Water Quality Guidelines under DENR Administrative Order (DAO) 2016-08. as follows:

- Primary Parameters — fecal coliform, pH, temperature, dissolved oxygen, biochemical oxygen demand, total suspended solids, chloride, nitrate as nitrogen, phosphate
- Secondary Parameters — Inorganics: sulfate, ammonia as N, boron
  Metals: arsenic, cadmium, chromium, lead, mercury, nickel
  Organics: oil and grease, surfactants
- Additional Parameters — turbidity, total dissolved solids, total solids, conductivity, calcium, magnesium, sodium, potassium, bicarbonate, and carbonate

The guideline values for these parameters differ according to the following classifications of water body.

Classification	Intended Beneficial Use
Class AA	Public Water Supply Class I. Intended primarily for waters having watershed, which are uninhabited and/or otherwise declared as protected areas, and which require only approved disinfection to meet the latest PNSDW
Class A	Public Water Supply Class II. Intended as sources of water supply requiring conventional treatment (coagulations, sedimentation, filtration and disinfection to meet the latest PNSDW)
Class B	Recreational Water Class I. Intended for primary contact recreation (bathing; swimming, etc.)
Class C	1. Fishery Water for the propagation and growth of fish and other aquatic resources 2. Recreational Water Class II – For bathing, fishing, or similar activities 3. For agriculture, irrigation, and livestock watering

The values for primary parameters are annual averages of at least 10 data sets except for coliform which is the geometric mean of at least data sets per quarter and twice WQG for maximum allowable limit; for secondary inorganic parameters, annual average of 4 data sets; for secondary metals and organics parameters, as maximum allowable limit; and for natural occurrence higher than WQG, as maximum 10% increase of the natural level.

Water sampling protocols were observed during the March 27, 2019 activities. Grab samples for laboratory analyses were collected into labeled sample bottles: (i) microbes into sterilized small glass bottles and wrapped with aluminum foil; (ii) oil and grease into wide mouth bottles; (iii) organics into amber glass bottle; and (iv) the rest of the parameters into polyethylene (PET) bottles. The samples were stored cooled with ice in an ice-chest and brought along with a Chain-of-Custody Form within 24 hours to chemical laboratories. Laboratory reports are presented in **Annex 2.2.1-1**.

The surface water sampling sites covered the dam site (uninhabited area) down to the intake of Buer-Calsib irrigation system (inhabited area). **Figure 2.2.2-1** shows the five sites for surface water and one site for the groundwater in a residential area. These sampling sites are described in **Table 2.2-1**. Pictures of the sampling sites are shown in **Photo 2.2.2-1.**

2.2.2.3 Bayaoas River Water Quality Data

The compilation of water quality data is shown in **Table 2.2.2-2**, consisting of 30 parameters for the five (5) sampling sites, with columns for the water quality guidelines for the different classes of water under DAO 2016-08 inasmuch as Bayaoas River is not yet classified. Agno River is classified as Class C water. Out of these parameters, 20 are provided with water quality guidelines.

In summary SW1, SW2, and SW3 are located at the uninhabited area at the dam site and exhibited clear and good water quality within Class AA. An apparent deterioration of water quality was down to the Buer-Calsib irrigation intake. The biochemical oxygen demand (BOD) for SW3, SW4 and SW5 ranged 8-16 mg/L exceeding the 7 mg/L for limit Class C water. Ammonia of 6.3 mg/L at SW5 exceeded the 0.05 mg/L limit for Class C. SW5 showed higher concentrations of chloride, nitrate, phosphate, ammonia and sulfate which are indicators of agricultural and domestic inputs. The quarrying activities along the river did not show significant increase in the total suspended particulates due to due to low flow, ponding and absence of significant soil sediment. Clear water was also observed during the IEC conducted on September 24, 2019 (wet season).

2.2.2.4 Groundwater Quality

There were 25 parameters analyzed (including pesticides) for a groundwater sample from a 3-year old, shallow (~6 m deep) tube well in a residential area in Barangay Bayaoas about 30 meters from the rice field. Seventeen (18) parameters are covered by the water quality guidelines. According to DAO 2016-08, groundwater shall be maintained at a quality consistent with its intended beneficial usage. For purposes of preserving and protecting groundwater quality, the WQG set forth in shall be maintained, as follows:

Intended Beneficial Use	Ground Water Quality Guidelines
Source of Potable Water and other Domestic Use	Adopt Class A WQG (except BOD) and dissolved oxygen)
Bathing and Other Primary Contact Recreation	Adopt Class B WQB (except BOD and dissolved oxygen)
Irrigation, fish culture, livestock watering	Adopt Class C WQG (except BOD. dissolved oxygen, and total suspended solids)

In summary, the groundwater sample did not exhibit good quality on a few parameters. The tube well is not used for drinking but for domestic activities. Objectionable odor was noticeable during the sampling activity. Results of laboratory analysis showed the concentrations of ammonia (4.21 mg/L), manganese (0.466 mg/L) and cadmium (0.009 mg/L) exceeded their respective water quality guidelines for Class C waters. Fecal coliform measured >8 MPN/100 ml which exceeds the <1.1 MPN/100 Class A guideline. The low quality can be attributed exposure of the unconfined aquifer layer to infiltration of water pollutants for domestic and agricultural activities.

Parameters within Class A guidelines include pH, total suspended solids, chloride, nitrate, phosphate, sulfate, arsenic, cadmium, hexavalent chromium, lead, mercury, iron, oil and grease. However, pesticides were not detected from the sample.

Additional baseline parameters were measured as part of groundwater studies. These are related to dissolved major ions, such as total dissolved solids, conductivity, calcium, magnesium, potassium and bicarbonate.

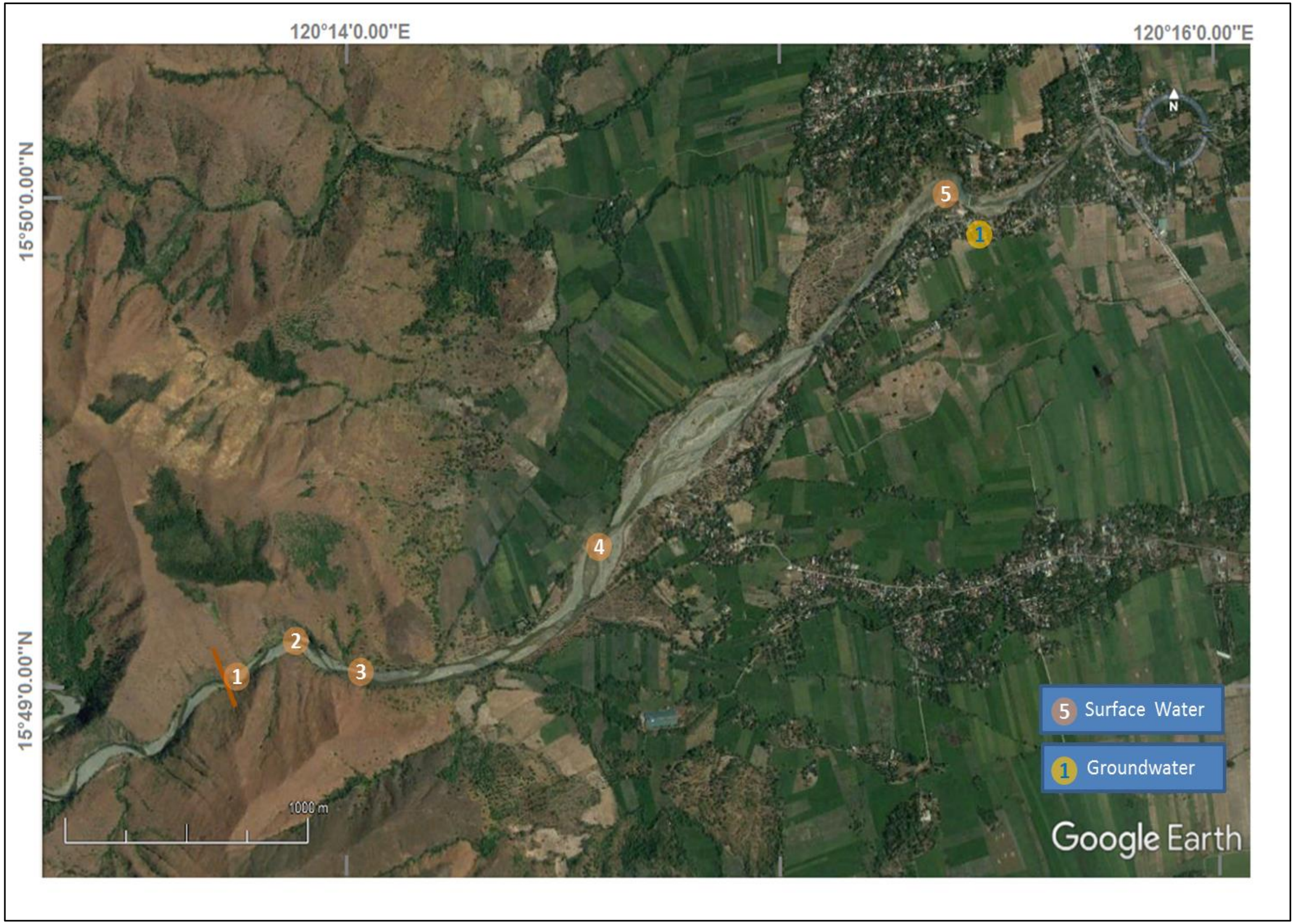


Figure 2.2.2-1. Location Map of Surface and Groundwater Water Sampling Sites in Bayaoas River for BSRIP

Table 2.2.2-1. Description of the Water Sampling Stations

Sampling Site Code	Longitude	Latitude	Elevation, masl	Channel Width, m	Wetted Width, m	Remarks
SW-1	120°13'44.40"E	15°49'0.50"N	48	35	7	within the dam axis
SW-2	120°13'53.20"E	15°49'5.30"N	47	55	16	about 300 m downstream of SW-1
SW-3	120°14'2.90"E	15°49'2.30"N	42	54	14	about 300 m downstream of SW-2, just upstream of the intake of Don Quiron irrigation system
SW-4	120°14'36.13"E	15°49'19.03"N	32	90	6	within the lowland but upstream of the populated area, impact of quarrying in the river bed
SW-5	120°15'23.03"E	15°50'0.84"N	16	90	4	Just about 80 m upstream of the Buer-Calsib irrigation intake
GW-1	120°15'26.66"E	15°49'55.78"N	18	-	-	objectionable odor, 20 ft, 3 years old, for laundry, cleaning, not for consumption

Photo 2.2.2-1. Water Sampling Locations on March 27, 2019

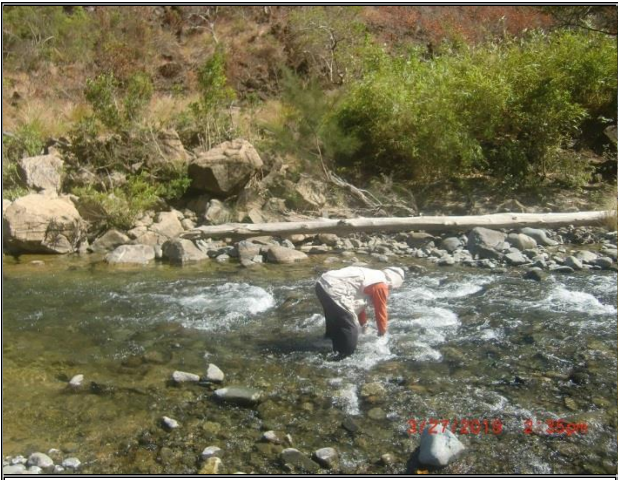
	
(a) SW-1	(b) SW-4
	
(c) SW-5	(d) GW-1

Table 2.2.2-2. Surface Water Quality of Bayaoas River in Comparison with the Water Quality Guidelines under DAO 2016-08

	Parameter	Unit	SW1 13-Apr-15 0952H	SW2 13-Apr-15 1007H	SW3 13-Apr-15 1026H	SW1 27-Mar-19 1400H	SW4 27-Mar-19 1600H	SW5 27-Mar-19 1640H	DAO 2016-08 Class AA	Class A	Class B	Class C
1.	Fecal coliform *	MPN/ 100 ml				2	790	79	<1.1	<1.1	100	200
2.	pH *		8.3	8.3	8.5	8.39	8.32	7.44	6.5-8.5	6.5-8.5	6.5-8.5	6.5-9.0
3.	Temperature *	ºC	29.2	30.6	29.2				26-30	26-30	26-30	25-31
4.	Dissolved Oxygen, DO *	mg/L	8	7.9	7.8				5	5	5	5
5.	Biochemical Oxygen Demand, BOD *	mg/L	1	2	6	**8**	**18**	**16**	1	3	5	7
6.	Total Suspended Solids, TSS *	mg/L	10	18	8	<2.5	<2.5	<2.5	25	50	65	80
7.	Chloride, Cl *	mg/L	3	3.5	3			25.3	250	250	250	250
8.	Nitrate as Nitrogen, NO_3-N *	mg/L	<0.02	<0.02	<0.02			0.0632	7	7	7	7
9.	Phosphate, PO_4^{-} *	mg/L	<0.006	<0.006	<0.006			0.193	<0.003	0.5	0.5	0.5
10.	Ammonia as N, NH_3-N	mg/L	<0.003	<0.003	<0.003			**6.3**	0.05	0.05	0.05	0.05
11.	Sulfate, SO_4^{-}	mg/L	<5.0	<5.0	<5.0			35.6	250	250	250	360
12.	Boron, B	mg/L	<0.2	<0.2	<0.2			-	0.5	0.5	0.5	0.75
13.	Arsenic, As	mg/L	<0.01	<0.01	<0.01			0.005	0.01	0.01	0.01	0.02
14.	Cadmium, Cd	mg/L	<0.006	<0.006	<0.006			<0..002	0.003	0.003	0.003	0.005
15.	Chromium, Cr^{+6}	mg/L	<0.02	<0.02	<0.02			<0.002	0.01	0.01	0.01	0.01
16.	Lead, Pb	mg/L	<0.05	<0.05	<0.05			<0.006	0.01	0.01	0.01	0.05
17.	Mercury, Hg	mg/L	<0.0001	<0.0001	<0.0001			<0.0001	0.001	0.001	0.001	0.002
18.	Nickel, Ni	mg/L						0.053	0.02	0.02	0.04	0.2
19.	Oil and grease, O&G	mg/L	0.4	0.4	0.4			<0.5	<1	1	1	2
20.	Surfactants (MBAS)	mg/L						<0.007	<0.025	0.2	0.3	1.5
21.	Turbidity	NTU	1	1	2							
22.	Total Dissolved Solids, TDS	mg/L	176	183	185	198	204	171				
23.	Total Solids, TS	mg/L	186	201	193	198	204	171				
24.	Conductivity	uS/cm	265	267	272			365				
25.	Calcium, Ca	mg/L	15	14	16							
26.	Magnesium, Mg	mg/L	15	17	17							
27.	Sodium, Na	mg/L	5.3	5.6	6.9							
28.	Potassium, K	mg/L	0.3	0.4	0.4							
29.	Bicarbonate, $HBO_3^{=}$	mg/L	108	106	110							
30.	Carbonate, $CO_3^{=}$ as $CaCO_3^{=}$	mg/L	9.6	9.6	12							

DAO 2016-18 guideline for DO is set at minimum, pH for a range and the rest are upper limits.

Table 2.2.2-3. Quality of Groundwater in Shallow Tube Well in Comparison with the Water Quality Guidelines under DAO 2016-08

	Parameter	Unit	GW1 27-Mar-19 1720H	DAO 2016-08 Class A	Class B	Class C
1.	Fecal coliform *	MPN/ 100 ml	>8	<1.1	100	200
2.	pH *		7.25	6.5-8.5	6.5-8.5	6.5-9.0
3.	Temperature *	ºC	-	26-30	26-30	25-31
4.	Total Suspended Solids, TSS *	mg/L	<2.5	50	65	80
5.	Chloride, Cl *	mg/L	99.3	250	250	250
6.	Nitrate as Nitrogen, NO3-N *	mg/L	0.095	7	7	7
7.	Phosphate, PO4 *	mg/L	0.44	0.5	0.5	0.5
8.	Ammonia as N, NH3-N	mg/L	4.21	0.05	0.05	0.05
9.	Sulfate, SO4	mg/L	37.5	250	250	360
10.	Arsenic, As	mg/L	<0.0009	0.01	0.01	0.02
11.	Cadmium, Cd	mg/L	0.009	0.003	0.003	0.005
12.	Chromium, Cr+6	mg/L	0.0028	0.01	0.01	0.01
13.	Lead, Pb	mg/L	<0.006	0.01	0.01	0.05
14.	Mercury, Hg	mg/L	<0.0001	0.001	0.001	0.002
15.	Iron, Fe	mg/L	0.323	1	1	1.5
16.	Manganese, Mn	mg/L	0.466	0.2	0.2	0.2
17.	Oil and grease, O&G	mg/L	<0.5	1	1	2
18.	Total Dissolved Solids, TDS	mg/L	332			
19.	Total Solids, TS	mg/L	332			
20.	Conductivity	uS/cm	686			
21.	Calcium, Ca	mg/L	50.7			
22.	Magnesium, Mg	mg/L	35.1			
23.	Potassium, K	mg/L	1.6			
24.	Bicarbonate, HBO3	mg/L	196			

Notes:
1. PNSDW = Philippine National Standards for Drinking Water
2. Pescticides were not detected or <0.0005 mg/L : azinphos-methyl, carbophenothion, chlopyrifos, demeton-O, demeton-S, diazinon, dichlorvos, dimethoate, diozathion, disulfoton, ethion, ethoptop, famphur, ponophos, malathion, ehtyl parathion, methyl parathion, phorate, phosmet, ronnel, terbufos, tetrachlorovinphos

2.2.2.5 Impact Assessment on Water Quality

The main impact of the construction works will be limited to the significant increase but temporary increases in the total suspended solids in Bayaoas River coming from soil excavations, especially during the rainy season. Mitigating measures would involve estimation of the volume of earthworks, provision of run-off control spoil disposal area, and immediate transport of excavated unusable earth material to disposal site.

Construction nuisance sources of impacts include those liquid wastes, oil spills, solid waste, food wastes, and washings and will be provided with appropriate containment and disposal facilities and procedures.

During the operation phase, the water reservoir would have a different water quality than the other segments of Bayaoas River. This may result in thermal stratification and nutrient enrichment along the water column of the reservoir. This will be part of the monitoring program.

The increase in frequency of irrigation water supply would lead to an increase frequency in the use of fertilizers and pesticides which may serve as pollutants into Bayaoas River and groundwater when applied in excessive quantities. To an extent, the irrigation water supply from Bayaoas River may have a diluting effect on pollutants compared with the use of groundwater through pumping. A continual IEC for the farmers will be implemented in the proper purchase, storage and use of fertilizers and pesticides, including the monitoring of groundwater.

2.2.3 Freshwater Ecology

2.2.3.1 Summary

The study on freshwater ecology of Bayaoas River involved the determination of the distribution and abundance of the organisms in the food chain such as the floating and drifting planktons (phytoplankton and zooplankton), bottom dwelling macrobenthos, and mobile fishes. Phytoplankton, a primary producer, serves as the base of the aquatic food web. Macrobenthos consists of organisms living at the bottom of a water column, which are visible to the naked eye. They are considered as bioindicators of the quality of Bayaoas River.

Five baseline sampling sites were established in the dry season of Feb and March, 2019 along a 4-km shallow channel length Bayaoas River from the proposed dam site (uninhabited) down to the intake area of the Buer-Calsib irrigation system (populated area). The four lowland sampling sites are highly disturbed by the presence of quarrying activities, maintenance of channel barriers to divert irrigation water, sustenance fishing, and inputs from agricultural and domestic activities. The phytoplankton community in the sampling sites consisted of at least fifteen (15) taxa representing four (4) groups, and dominated by *Chlorophyceae* (green algae). *Chlorella sp*. dominated in all sampling stations. Zooplankton community consisted of only one taxa *Branchionus sp of the Rotifera* group and in only two stations. The recorded benthos community includes *Arthropoda* and *Mollusca*, the latter as the dominant group. A total of four (4) families of fishes were recorded with *Gobiidae* as the dominant family.

The potential significant impact during the construction phase of the proposed Project on the freshwater ecology along Bayaoas River would be limited at the dam site and decreases downstream. During the project operations phase, a new ecology would develop in the reservoir. This will be part of the continual monitoring. A monitoring framework and plan shall be setup alongside introduction of species into the Bayaoas River System.

NIA in coordination with relevant LGUs, the Municipal Health Office shall address the need for sanitation services of households especially those that dispose in waterways that feed into the river system.

2.2.3.2 Methodology

A total of five (5) stations were established along the shallow Bayaoas River from the proposed dam reservoir going downstream to Calsib-Buer Irrigation Intake Area with a total channel length of 4 km. Four sampling sites are located at lowland and are highly disturbed by the presence of quarrying activities, maintenance of channel barriers to divert irrigation water, sustenance fishing, and inputs from agricultural and domestic activities. The coordinates of the sampling stations were determined using Garmin GPS Model Oregon 650 (**Table 2.2.3-1**). The Google Earth representation of the stations is shown in **Figure 2.2.3-1.**

The survey consisted of water quality testing and collection of biological samples (**Photo 2.2.3-1**) in the dry season last February 12 and March 5, 2019, respectively. On-site measurements of water quality parameters such as temperature, pH, dissolved oxygen, conductivity, turbidity and salinity were immediately gathered with (3) three trials using multi-parameter Horiba U50. Sampling test were done in the mid water column. Water samples in each site were also collected with (3) three replicates for further laboratory analysis to determine the levels of nutrients, chlorophyll-a and total suspended solids. Average river flow was measured using a simple float. Water samples were also collected from all stations for microbial analysis.

Table 2.2.3-1. Description of Freshwater Ecology Sampling Sites

Sampling Station	Coordinate	Sampling Station Description
FE1	15°49'00.7"N 120°13'43.4"E	About 37-meter wide river channel, but only about 30 meters was covered with clear water with about 15-cm depth, the riverbed composed mainly of cobbles and boulders and bedrock shorelines
FE2	15°49'21.5"N 120°14'39.7"E	About 68-meter wide river channel, but about 20 meters was covered with clear water with average depth of 90 cm, with cobbles and boulders river bed
FE3	15°49'59.7"N 120°15'25.9"E	About 40-meter wide river channel, and about 30 meters was covered with slightly turbid and 40-cm water depth, near bridge and ongoing construction of dike , sandy-muddy river bed
FE4	15°49'42.7"N 120°15'05.9"E	About 35-meter wide river channel, but only about 10 meters was covered with clear and about 11-cm water depth, with cobbles and boulders river bed, with river control dike
FE5	15°49'10.7"N 120°14'32.20"E	About 90-meter wide river channel , but only about 40 meters was covered with clear water with 20-cm depth, cobbles and boulders with sandy-muddy riverbed, near small irrigation canal

Plankton samples were obtained by passing water samples through plankton net with a mesh size of 64 microns and a mouth diameter of 0.38 meters. Three (3) tows per sample were collected each sampling location (Figure 5), placed in a properly labelled 500ml capacity plastic bottles, immediately fixed in a 10% formalin solution and brought in the laboratory for analysis. Density of phytoplankton and zooplankton were counted per milliliter of samples using a Sedgwick rafter counting chamber and identified to the lowest possible taxa using taxonomic keys acquired from Arsenia, Cagauan, Auburn University, USA. Species diversity was then determined by computing the mean and the relative mean density.

Macrobenthos sampling was done by laying a 1m x 1m metal frame, then handpicked the benthic organisms inside the frame and later collected the sediment. Each station was replicated three times. Sediments were brought to laboratory and processed by passing through 1mm mesh sieve then collected all organism and placed in a plastic container with 10 % formalin solution as preservative. Their abundance was recorded and expressed as individuals per square meter.

Fish distribution and diversity were carried out by visual estimation and recorded per square meters with 3 replicate zones at each site. Specimen were collected and placed in a plastic container with cover and preserved with 10% formalin solution for identification purposes.

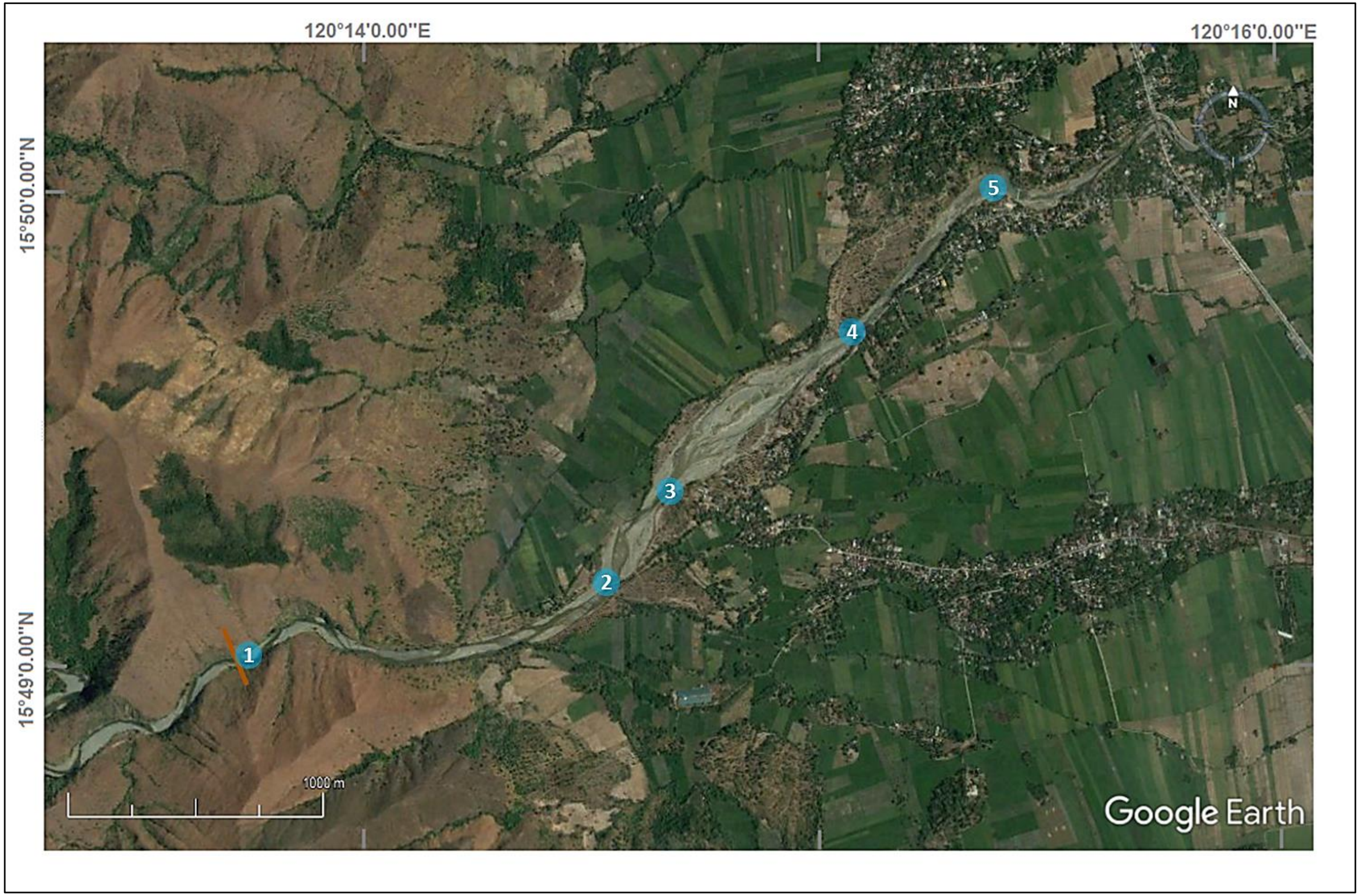


Figure 2.2.3-1. Location Map of Freshwater Ecology Sampling Sites

Photo 2.2.3-1. Freshwater Ecology Sampling Activities

(a) The Sampling Team

(b) On-site Measurement of Water Quality

(c) Water Flow Measurement Using Simple Float

(d) Plankton Collection

(e) Metal Frame Measuring 1 Meter by 1 Meter

	
(f) Organisms Retained After Sieving	**(g)** Preserved specimen Collected in Surveyed Stations

2.2.3.3 Supplementary Water Quality Data

The results of water quality of the five (5) stations are presented in **Table 2.2.3-2.** Temperature ranged 30.16-33.27°C, the highest at FE4; pH ranged 8.59 to 8.94, the highest at FE2. Conductivity ranged 270-310 µS/cm, the highest at FE4. Turbidity ranged 28.86-62.35 NTU, the highest at FE2. Dissolved oxygen concentration ranged 4.24-4.83 mg/L, the highest at FE5. Salinity values in all surveyed stations had the same reading of 0.10 ppt. Nitrite-nitrogen values ranged 0.003-0.005 mg/L, the upper value was at three (3) stations, FE2, FE4, and FE5. Orthophosphate ranged 0.003-0.013 mg/L, the highest at FE4. Ammonia-nitrogen concentration only ranged 0.02-0.03 mg/L, the highest was recorded at all stations except at FE5. Chlorophyll-a ranged 1.06 to 3.2 mg/L, the highest was at FE2. Total suspended solids ranged 2.22-40.01 mg/L, the highest at FE3. Water velocity values ranged 0.02-0.21 m/s, highest at FE1. Results of microbial analysis showed that only FE1 was free of coliform. Further analysis, however, showed that all stations were free of fecal coliform except at FE4 which had a very high reading of 2,300 MPN/100mL, suggesting the presence of untreated water containing human waste, though fecal coliform was no longer detected at the next sampling station some 650 meters downstream, suggesting the waste would have settled or has been degraded by then.

2.2.3.4 Plankton Community

The phytoplankton community at the surveyed stations were recorded, noting at least fifteen (15) taxa representing four (4) groups (**Table 2.2.3-3)**. The phytoplankton community was largely dominated by *Chlorophyceae* (green algae) comprising 87.28 % of the total count. Followed by *Bacillariophyceae* (diatoms) comprising 12.66 % of the total count. Comparatively lesser quantity were recorded for *Myxophyceae* (blue-green algae) and *Chrysophyceae* (golden-brown algae) comprising only 0.03% and 0.09%, respectively. Nine (9) green algae groups, four (4) diatom groups, and both one (1) taxa for blue-green and golden–brown algae were recorded. *Chlorella sp.* dominated in all the sampling stations, (249-32600 cells/L), followed by *Navicula sp.* (157-1,716 cells/L).

Table 2.2.3-2. Physical, Chemical and Microbial Characteristics of Water Samples

Parameter	Unit	FE1	FE2	FE3	FE4	FE5
1. Temperature	°C	30.16	32.99	32.01	33.27	32.50
2. pH		8.65	8.94	8.76	8.59	8.88
3. Conductivity	µS/cm	270	270	270	310	290
4. Turbidity	NTU	32	62	29	42	54
5. Dissolved Oxygen	mg/L	4.24	4.56	4.32	4.76	4.83
6. Salinity	ppt	0.10	0.10	0.10	0.10	0.10
7. Nitrite	mg/L	0.004	0.003	0.005	0.005	0.005
8. Phosphate	mg/L	0.010	0.004	0.003	0.013	0.011
9. Ammonia	mg/L	0.03	0.03	0.03	0.03	0.02
10. Chlorophyll-a	µg/m³	1.78	3.2	1.07	1.06	1.06
11. Total Suspended Solids	mg/L	2.3	9.7	40.	4.5	2.2
12. Total Coliform	MPN/100 ml	0	2,300	910	4,300	720
13. Fecal coliform	MPN/100 ml	0	0	0	2,300	0
14. Velocity	m/s	0.21	0.13	0.02	0.11	0.12

MPN = most probale number

Table 2.2.3-3 Phytoplankton Total Count (cells/L) and Relative Mean Density by Species per Sampling Site

Phytoplankton	FE1	FE2	FE3	FE4	FE5	Mean	Relative Mean Density (%)
1. *Nitszchia sp.*	71	425	-	-	-	99	0.90
2. *Navicula sp.*	1821	1716	157	708	234	927	8.41
3. *Melosira sp.*	472	-	-	-	-	94	0.86
4. *Closteriopsis sp.*	24	-	-	-	-	4.72	0.04
5. *Mougeotia sp.*	1415	410	7	1255	619	741	6.72
6. *Spirogyra sp.*	175	32	-	-	44	50	0.45
7. *Zygnema sp.*	85	-	-	611	244	188	1.71
8. *Fragilaria sp.*	-	241	193	585	350	274	2.48
9. *Pediastrum sp.*	-	4	-	6	-	1.99	0.02
10. *Cosmarium sp.*	-	7	-	-	5	2.48	0.02
11. *Microcystis sp.*	-	7	-	-	2	1.77	0.02
12. *Chrysamoeba sp.*	-	-	5	19	2	5.16	0.05
13. *Chlorella sp.*	5869	3468	249	32600	991	8635	78.32
14. *Chaetamorpha sp.*	-	-	2	-	-	0.47	0.00
15. *Ankistrodesmus sp.*	-	-	-	-	2	0.35	0.00
Total sp.	8	9	6	7	10		

2.2.3.5 Zooplankton Community

Zooplankton community was recorded only with one taxa in FE3 and FE4 with a total number of 23.6 individuals and 90.1 individuals per liter, respectively. The *Rotifera* group with a mean abundance of 22.73 individuals/liter was absent at FE1, FE2 and FE5 **(Table 2.2.3-4**).

Table 2.2.3-4. Zooplankton Count (cells/L) and Relative Mean Density per Sampling Site

Zooplankton	FE1	FE2	FE3	FE4	FE5	Mean	Relative Mean Density (%)
Branchionus sp.	0	0	23.6	90.1	0	22.73	100

2.2.3.6 Macrobenthos Community

Distributions and densities of macrobenthos are summarized in **Table 2.2.3-5.** A total of six (6) aquatic invertebrate taxa representing the groups of *Arthropoda* and *Mollusca* were recorded. *Mollusca* mainly dominated the macrobenthos community in most stations (FE1, FE3, FE4 and FE5). The highest density (115 ind/m²) was found in FE3. The molluscan community was not found in FE2. *Arthopoda*, representing (2) two Class (*Insecta* and *Malacostraca*) thrives in FE1 and FE4, wood shrimp (2 inds/m²) and crane fly larvae (1 ind/ m²) in FE1, and damsel fly nymph (2 inds/m²) in FE4.

Table 2.2.3-5 Macrobenthos Density (individual/m²) per Sampling Site

Taxa	Scientific Name	Local/ Common name	FE1	FE2	FE3	FE4	FE5
ARTHROPODA							
Malacostraca							
Atyidae	*Atyopsis sp.*	wood shrimp/ kinod	2	0	0	0	0
Insecta							
Coenagrionodae	*Zygoptera sp*.	damselfly nymph	0	0	0	2	0
Tipulidae	*Tipula sp.*	crane fly larvae	1	0	0	0	0
MOLLUSCA							
Thiaridae							
	Semisulcospira sp.		1	0	32	106	115
	Stenomelania sp.		0	0	0	0	5
Planorbidae							
	Gyraulus sp.		1	0	0	0	0

2.2.3.7 Icththyofauna

Distributions and identification of fishes are summarized in **Table 2.2.3-6**. A total of four (4) families were recorded in five (5) survey stations. Gobiidae (**Photo 2.2.3-8**) mostly dominated the ichthyofaunal community in all stations where FE3 (4 inds/ m²) had the highest number of individuals per square meter. The presence of Cichlidae (2 inds/ m²) (**Photo 2.2.3-9**), and Hemiramphidae (1 inds/ m²) (**Photo 2.2.3-10**) was recorded in FE3, while Cichlidae (2 inds/ m²) was recorded in FE2. The presence of *G. affinis* was recorded only in FE3. Bayaoas River is not known to have migratory fishes.

Table 2.2.3-6. Icththyofaunas Density (individual/m²) per Sampling Site

Family	Scientific Name	Local/Common Name	FE1	FE2	FE3	FE4	FE5
Gobiidae	*Glossogobius sp.*	goby/biya	2	4	3	1	3
Cichlidae	*Oreochromis sp.*	tilapia	0	2	0	0	1
Hemiramphidae	*Zenarchpterus buffonis*	needlefish/siwi-siwi	0	1	0	0	0
Poeciliidae	*Gambussia affinis*	mosquito fish/itar/tatampi	0	0	0	0	0

Photo 2.2.3-2. Fishes Caught in Bayaoas River

(a) Goby Specimen **(b)** Tilapia Specimen

(c) Needle Fish Specimen

2.2.3.8 Impact Assessment on Freshwater Ecology

The proposed construction works at the dam site would cause localized, intermittent, temporary physical impact on the distribution and abundance of aquatic organisms along Bayaoas River. Water will continue to flow during dam construction with the installation of cofferdam. The riverbed to be excavated 40-m wide and down to 10 meters is overlain by sand, gravel, stones, rocks which are of high density and will easily settle on site within the vicinity downstream, unlike soil particles. Excavation of soil at an average depth of 4 meter from the bank of the river up to dam crest and spill way would result in localized sedimentation along the river channel resulting in the burying the macrobenthos, clogging the fish gills, mortality of macroinvertebrates such as larval forms of aquatic insects, annelids (segmented worms) and molluscs (shelled animals), which serve as prey items for fishes and other aquatic animals. Such works will be provided with soil erosion control plan that will include avoidance of excessive earthworks during the rainy season or rain events, and provision of immediate hauling of spoils to run-off-controlled spoil disposal areas.

The proposed dam will be a natural barrier to fish passage and replenishment of earth materials downstream.

The reservoir would have a new aquatic ecology along Bayaoas River, from a shallow river channel segment to having deeper channel with stratification of temperature and dissolved oxygen, and emission of methane or greenhouse gas (GHG). There would be cases of introducing new fish species in the area for fish production. Water-borne diseases could be a risk. As such, new aquatic ecology and risk will be part of the regular monitoring and future studies. The project through NIA shall prepare a monitoring framework and shall undertake setting up of monitoring system leading to aforesaid regular monitoring.

In terms of disposal of human waste into the Bayaoas River, NIA in coordination with the LGU, the Municipal Health Office should consider undertaking an assessment of households without sanitation facilities and find means to address this situation, especially for households which can ill afford their own sanitary system.

2.3 THE AIR

2.3.1 Climate and Meteorology

This section covers the climate type, climatological normal values, climatological extremes, tropical cyclone, climate change, and greenhouse gas.

2.3.1.1 Summary

The proposed Project is located in an area with Type 1 climate characterized as having two pronounced seasons, with the dry season in November to April and wet season during the rest of the year, with August as the rainiest month, and the greatest rainfall was 722.6 on May 27, 2003. April is the hottest month with highest temperature of 39.9 ºC on April 12, 2015 while January is the coolest month, with lowest record of 14.3 ºC on January 8, 2007. Prevailing wind is south and southeast at an average of 2 m/s. The strongest was 56 m/s from WNW direction on October 11, 1974. The project area is high risk to typhoon, about 5 cyclones in 3 years.

Under a medium range scenario on climate change projection, Pangasinan would experience temperature increase, and rainfall decrease in March, April and May and increase in the rest of the year. Such rainfall projections were already incorporated in the dam design. Greenhouse gas (GHG) emissions would not appear to be significant from the temporary construction equipment. However, the GHG sequestration capacity of the dam and reservoir area would decrease due to submersion of vegetation. This calls for replacement tree planting as a mitigating measure. Emissions of methane from reservoir might happen but presently there is no standard estimation yet from the Nations Framework Convention on Climate Change (UNFCCC).

On the positive side, such adverse new emissions would be compensated by the avoided emissions in the decommissioning diesel fuel run pumps used for extracting groundwater for irrigation during the dry season. From another module/ component of this report, the effort to re-forest the watershed will likely contribute to carbon sequestration, which would also have co-benefits.

2.3.1.2 Methodology

The climate and local meteorology of the propose Project was obtained from the records of the Dagupan Synoptic Station of the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). The station is about 33 km NNE of the proposed Project dam site. Project site monthly rainfall estimated using the procedure of International Water Management Institute (IWMI). Information on climate change in the area was obtained from the publications of PAGASA.

2.3.1.3 Type of Climate

According to Modified Climate Classification of the Philippines, the proposed Project will be located in an area with Type I climate characterized as having two pronounced seasons, dry from November to April and wet during the rest of the year (**Figure 2.3.1-1**).

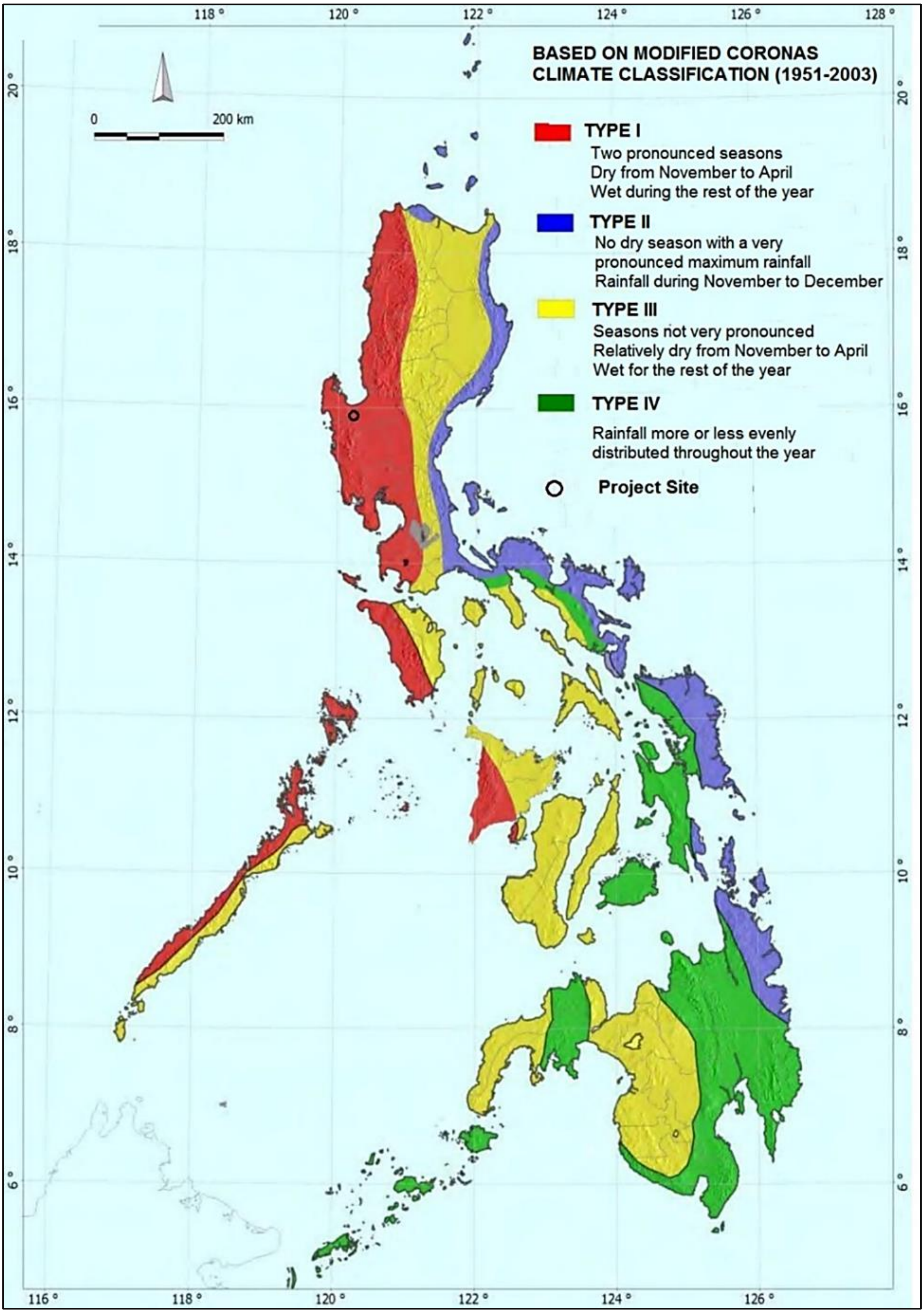


Figure 2.3.1-1. Climate Map of the Philippines (PAGASA)

2.3.1.4 Climatological Normal Values at Dagupan Synoptic Station

The climatological normal values for a 30-year period from 1981 to 2010 are presented in **Table 2.3.1-1**. For that period, the annual rainfall measured 2,381 mm for 119 days. August was the rainiest month with an average of 581 mm for 22 days. The mean annual temperature was 27.8 ºC, January appeared the coolest month (20.7 ºC) and April was the hottest month (34.7 ºC). The dry bulb temperature ranged 25.7 ºC in January to 29.1 ºC in April and May. The wet bulb temperature ranged 23.0 ºC in January to 26.2 ºC in May. Dew point ranged 21.9 ºC in January and 25.3 ºC in May to July. Vapor pressure ranged 26.2 mb in January to 32.2 mb in June. Relative humidity ranged 77% in March and April to 87% in August. Mean sea level pressure ranged 1007 mmHg in July to 1012 mmHg in January. Wind generally came from the south (in October to June) and southeast (in July to September) at average of 2 m/s. Cloud cover ranged from 3 octas in February and March to 7 octas in August. During the rainy months of May to October, the number of days with thunderstorm ranged 8-17 in May to October and the number of days with lightning ranged 9-17.

2.3.1.5 Climatological Extremes at Dagupan Synoptic Station

Table 2.3.1-2 shows the climatological extremes recorded at the Dagupan Synoptic Station. The greatest rainfall in 1903-2012 was 722.6 on May 27, 2003. The highest temperature recorded in 1903-2012 was 39.9 ºC on April 12, 2015, the lowest was 14.3 ºC on Jan 8, 2007. The strongest wind recorded in 1966-2012 was 56 m/s from WNW on October 11, 1974. The highest sea level pressure recorded in 1949 was 1022.2 mmHg on Jan 18, 1959, while the lowest was 978.3 mmHg on October 26, 1978.

2.3.1.6 Rainfall Estimate at Bayaoas Watershed

Rainfall in Bayaoas Watershed was estimated and reported in the 2015 Feasibility Study Report design of the proposed dam. The method estimated was adopted from the International Water Management Institute (IWMI). IWMI, with the assistance from the Government of Japan and the United States Agency for International Development (USAID) has prepared the “World Water and Climate Atlas”, having data compiled from weather stations around the world for the period 1961-1990. The Atlas provides monthly and annual summaries for precipitation, temperature, humidity, hours of sunshine, and Penman-Monteith reference evapotranspiration.

The results, as presented in **Figure 2.3.1-2,** provides similar trend as the Dagupan Synoptic Station. The ratios of Bayaoas over Dagupan values were then computed and used to translate the 1961-2013 Dagupan decadal (10-day) and monthly rainfall to Bayaoas decadal and monthly rainfall, as shown in **Annex 2.3.1**. These decadal rainfall data was then used in the projection of the streamflow of Bayaoas River using the Crawford Model, under the Hydrology Section.

Table 2.3.1-1. Climatological Normals Recorded in 1981-2010 at Dagupan Synoptic Station (16º 02' 36'' N, 120º 20' 00'' E.,2.4 masl)

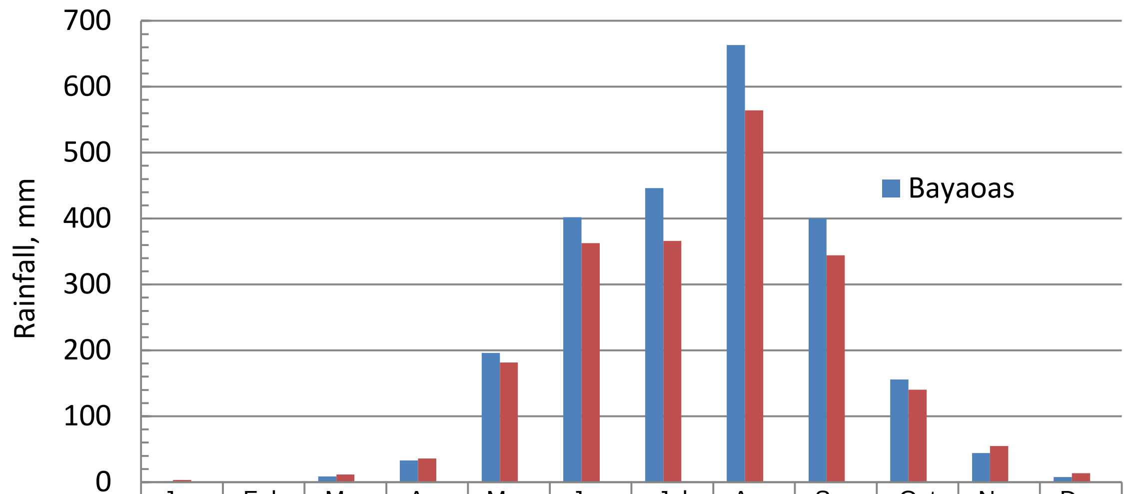
Month	Rainfall		Temperature, ºC						Vapor	Relative	Mean Sea	Wind		Cloud	No. of days	No. of days
	Amount, mm	Days	Min	Mean	Max	Dry Bulb	Wet Bulb	Dew Point	Pressure, mb	Humidity, %	Level Pressure, mm Hg	Direction	Speed m/s	Cover, Octa	with Thunderstorm	with Lightning
January	6.7	1	20.7	25.8	30.8	25.7	23.0	21.9	26.2	79	1012.4	S	2	4	0	0
February	10.7	1	21.2	26.5	31.8	26.4	23.5	22.4	26.9	78	1012.2	S	3	3	0	0
March	22.2	2	22.6	27.9	33.2	27.6	24.5	23.4	28.6	77	1011.3	S	3	3	1	1
April	60.4	5	24.4	29.5	34.7	29.1	25.8	24.7	30.9	77	1009.8	S	3	4	5	6
May	209.8	12	24.8	29.4	34.1	29.1	26.2	25.3	32.0	79	1008.2	S	3	5	14	17
June	337.9	17	24.7	28.9	33.1	28.4	26.1	25.3	32.2	83	1007.5	S	2	6	17	15
July	499.6	21	24.4	28.2	32.0	27.8	25.9	25.3	32.1	86	1007.0	SE	2	6	17	15
August	581.3	22	24.3	27.8	31.3	27.4	25.7	25.1	31.8	87	1006.6	SE	2	7	14	12
September	368.4	20	24.2	27.9	31.6	27.6	25.7	25.0	31.7	86	1007.6	SE	2	6	14	14
October	215.9	11	24.0	27.9	31.9	27.8	25.6	24.8	31.3	84	1008.6	S	2	5	8	9
November	53.9	5	23.0	27.4	31.8	27.3	24.9	24.1	29.8	82	1009.9	S	2	4	2	2
December	14.1	2	21.4	26.2	30.9	26.2	23.6	22.6	27.3	80	1011.6	S	2	4	1	1
Annual	2,380.9	119	23.3	27.8	32.3	27.5	25.1	24.2	30.1	82	1009.4	S	2	5	93	92

Source: PAGASA Open Data. https://data.gov.ph/dataset/climatological-normal-values; accessed on May 28, 2019

Table 2.3.1-2. Climatological Extremes Recorded at Dagupan Synoptic Station

	Greatest Rainfall, mm		Temperature, ºC				Strongest Wind, m/s			Sea Level Pressure, mm Hg			
Month	Amount	Date	High	Date	Low	Date	Speed	Direction	Date	High	Date	Low	Date
January	78.0	1/25/2006	36.0	1/14/1989	14.3	1/8/2007	18	S	1/24/2000	1022.2	1/18/1959	1001.3	1/1/1950
February	64.8	2/19/2009	37.0	2/25/2027	16.3	2/7/1971	18	NNW	2/11/1993	1022.0	2/1/1962	1003.2	2/7/2000
March	71.9	3/29/1938	38.7	3/24/2021	16.7	3/5/1971	19	NNW	3/20/1981	1020.8	3/30/1958	1002.0	3/13/1949
April	195	4/18/1998	39.9	4/12/2015	19.7	4/1/1973	23	SE	4/21/1979	1019.0	4/7/1968	999.4	4/21/1956
May	722.6	5/27/2003	39.6	5/12/2024	19.0	5/25/2004	35	E	5/17/2008	1015.5	5/12/1960	986.9	5/23/1976
June	306	6/21/1990	38.7	6/5/1987	20.2	6/30/1978	27	SE	6/22/2008	1016.0	6/6/1966	987.3	6/29/1964
July	376.8	7/8/1986	38.2	7/7/2015	20.4	7/14/2011	33	W	7/4/2001	1016.7	7/5/1951	984.6	7/22/2003
August	342	8/22/2003	36.4	8/10/2006	19.0	8/3/1999	35	SSE	8/24/1982	1016.0	8/18/1963	991.2	8/24/1982
September	316.7	9/3/2013	36.6	9/21/1983	20.5	9/6/1984	30	ESE	9/18/1998	1016.2	9/1/1971	985.7	9/14/1998
October	443.5	10/8/2009	37.2	10/22/1990	19.5	10/26/1990	56	WNW	10/11/1974	1017.7	10/27/1968	978.3	10/26/1978
November	229.1	11/17/1935	36.9	11/20/2000	17.2	11/13/2005	41	NNW	11/24/1981	1019.3	11/4/1958	983.4	11/24/1981
December	69.4	12/4/1936	36.9	12/30/1978	15.2	12/14/1988	27	N	12/2/2004	1021.0	12/8/1960	989.0	12/2/2004
Annual	722.6	5/27/2003	39.9	4/12/2015	14.3	1/8/2007	56	WNW	10/11/1974	1022.2	1/18/1959	978.3	10/26/1978
Period of Record	1903-2012		1903-2012				1966-2012			1949-2012			

Source: PAGASA Open Data: https://data.gov.ph/dataset/climatological-extremes , accessed on May 28, 2019



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bayaoas	1.54	0.66	8.54	32.91	195.95	402.06	446.12	663.2	400.04	155.84	44.28	7.69
Dagupan	3.31	0.9	11.87	35.73	181.79	362.49	366.1	564.19	344.06	140.37	54.99	13.47
Ratio	0.47	0.73	0.72	0.92	1.08	1.11	1.22	1.18	1.16	1.11	0.81	0.57

Figure 2.3.1-2. IWMI Dagupan and Bayaoas Monthly Rainfall

2.3.1.7 Tropical Cyclones

The proposed Project is located in Agno River basin where a total of 170 tropical cyclones have been recorded from 1900 to 2013, or about 1.50 typhoons a year (**Figure 2.3.1-3**). Typhoon frequency is about 80% from July to November. October has the highest frequency of 38 times for that period. This is consistent with the 5 cyclones in 3 years for the area based on tropical cyclone map (**Figure 2.3.1-4)** below.

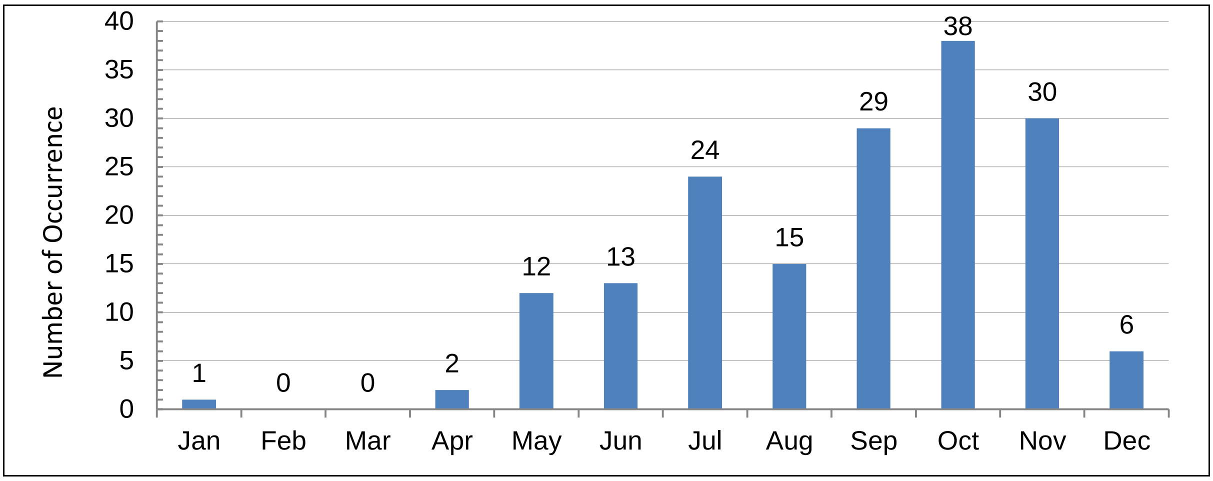


Figure 2.3.1-3. Monthly Frequency of Tropical Cyclones Whose Tracks Crossed the Agno River Basin from 1900-2013

(Source: PAGASA, as reported in DENR (2017) Development of Climate-Responsive Integrated Master Plan for Agno River Basin Comprehensive Report on the Studies Conducted (Volume II)

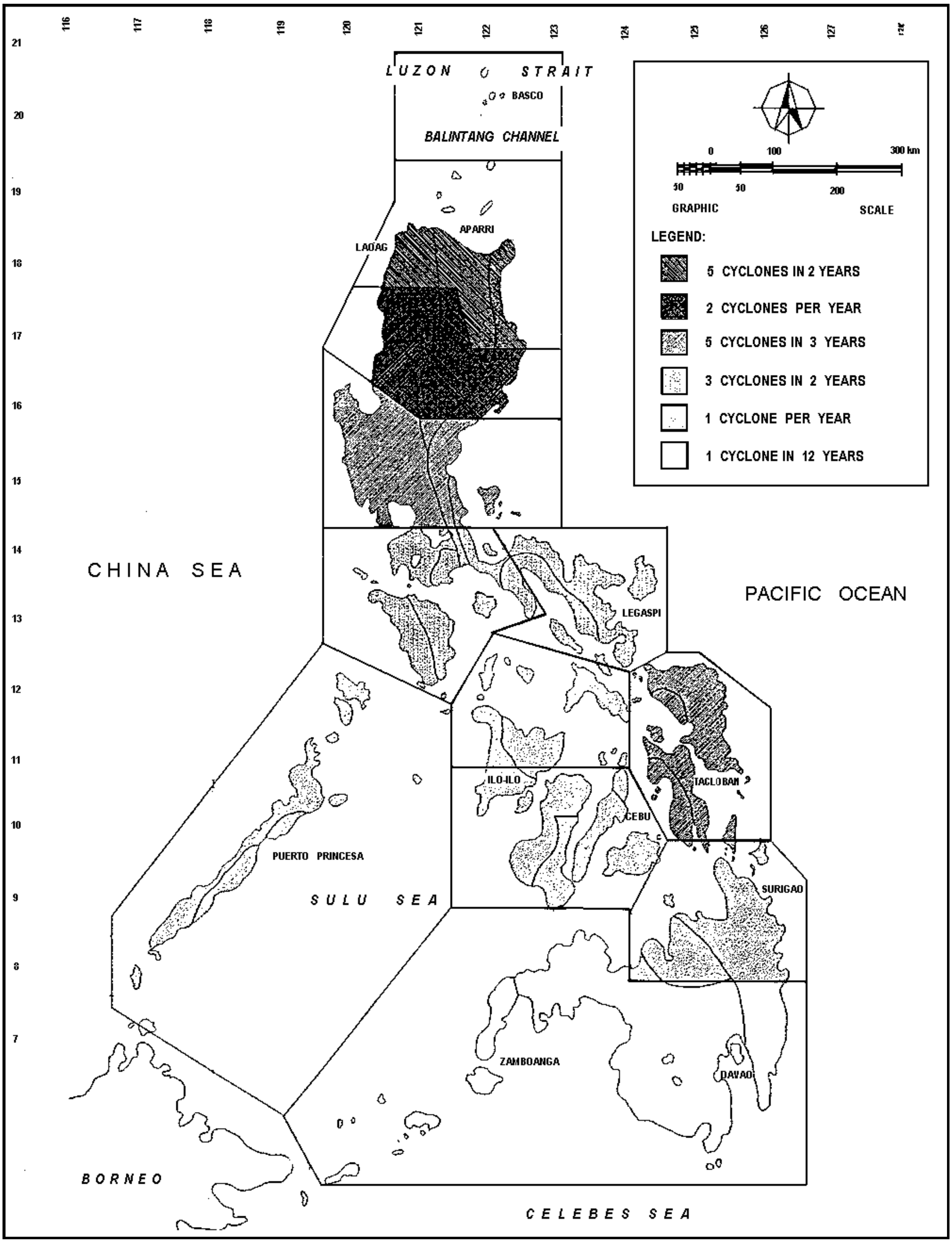


Figure 2.3.1-4. Tropical Cyclone Map (source: PAGASA)

2.3.1.8 Climate Change

According to PAGASA, climate projections in 2020 and 2050 indicate the following

i. *Seasonal Temperature Change: all areas of the Philippines will get warmer, more so in the relatively warmer summer months. 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. Likewise, all seasonal mean temperatures will also have increases in these time slices; and these increases during the four seasons are quite consistent in all parts of the country. Largest temperature increase is projected during the summer (MAM) season.*

ii. *Seasonal Rainfall Change: generally, there is reduction in rainfall in most parts of the country during the summer (MAM) season. However, rainfall increase is likely during the southwest monsoon (JJA) season until the transition (SON) season in most areas of Luzon and Visayas, and also, during the northeast monsoon (DJF) season, particularly, in provinces/areas characterized as Type II climate in 2020 and 2050. There is however, generally decreasing trend in rainfall in Mindanao, especially by 2050. There are varied trends in the magnitude and direction of the rainfall changes, both in 2020 and 2050. What the projections clearly indicate are the likely increase in the performance of the southwest and the northeast monsoons in the provinces exposed to these climate controls when they prevail over the country. Moreover, the usually wet seasons become wetter with the usually dry seasons becoming also drier; and these could lead to more occurrences of floods and dry spells/droughts, respectively.*

iii. *Extreme temperature events: hot temperatures will continue to become more frequent in the future.*

iv. *Extreme Rainfall Events: heavy daily rainfall will continue to become more frequent, extreme rainfall is projected to increase in Luzon and Visayas only, but number of dry days is expected to increase in all parts of the country in 2020 and 2050.*

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The incremental rainfall change, incremental temperature change, and extreme events under a medium range scenario for Pangasinan are shown in **Table 2.3.1-3, Table 2.3.1-4, and Table 2.3.1-5**. The mid-range emission scenario indicates a future world of very rapid economic growth, with the global population peaking in mid-century and declining thereafter and there is rapid introduction of new and more efficient technologies with energy generation balanced across all sources. In that scenario, Pangasinan would experience rainfall decrease in March, April and May by 6% in the 2020 period and 11.2% in the 2050 period. Rainfall increases are projected in the rest of the year by 5.9-54.3% in the 2020 period and 1.1-22.9% in the 2050 period. Increase in temperature would be consistent by 0.9-1.1 °C in the 2020 period and 1.8-2.2 °C in the 2050 period. The corresponding values and graphs of rainfall (at maximum 714 mm in August), and temperature (at maximum 38.0 °C in April) are presented in **Figures 2.3.1.8-1 and 2.3.1.8-2**, respectively.

The number of days with maximum temperature, >35 °C from a baseline of 1,280 days increases to 2,2,65 day in 2020 period and 3,728 days in 2050 period. The number of dry days decreases from the baseline 8,303 day to 6,443 days in 2020 period and 6,410 days in 2050 period. The number of days with rainfall >300 mm increases from 2 days to 13 days in 2020 period to 20 say in 2050 periods.

Table 2.3.1-3 SeasonalRrainfall Change (in %) in 2020 and 2050 Under Medium-range Emission Scenario in Pangasinan

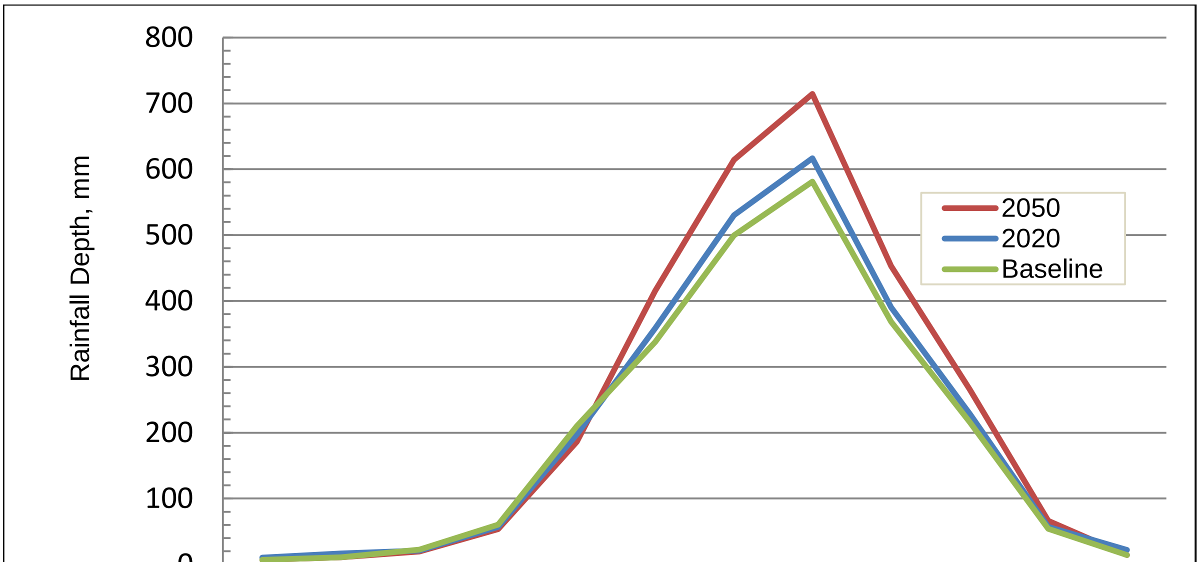
Month	Observed Baseline (1971-2000)	Change in 2020 (2006-2035)	Change in 2050 (2036-2065)
December, January, February	19.4	54.3	1.1
March, April, May	298.0	-6.0	-11.2
June, July, August	1608.9	6.1	22.9
September, October, November	707.8	5.9	11.9

Source: PAGASA. 2011, Feb. Climate Change in the Philippines

Table 2.3.1-4. Seasonal Temperature Iincrease (in °C) in 2020 and 2050 Under Medium-range Emission Scenario in Pangasinan

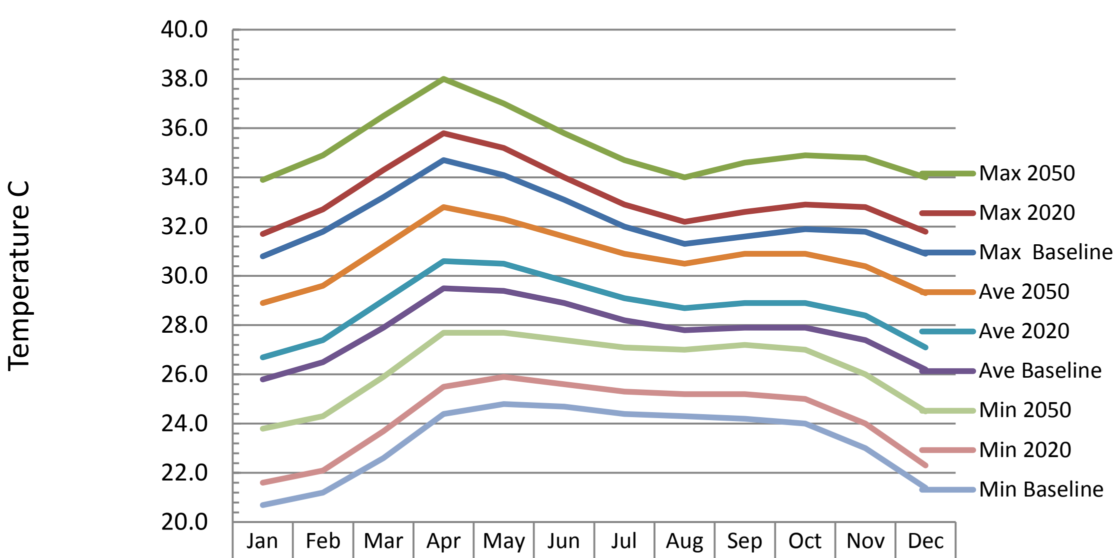
Period	Observed Baseline (1971-2000)	Change in 2020 (2006-2035)	Change in 2050 (2036-2065)
December, January, February	25.0	0.9	2.2
March, April, May	27.4	1.1	2.2
June, July, August	26.9	0.9	1.8
September, October, November	26.4	1.0	2.0

Source: PAGASA. 2011, Feb. Climate Change in the Philippines



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2050	6.8	10.8	19.7	53.6	186.3	415.3	614.0	714.4	452.8	265.3	66.2	14.3
2020	10.3	16.5	20.9	56.8	197.	358.	530.	616.	390.	228.	57.1	21.8
Baseline	6.7	10.7	22.2	60.4	209.8	337.9	499.6	581.3	368.4	215.9	53.9	14.1

Figure 2.3.1-5. Medium Range Projection of Rainfall for Pangasinan



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max 2050	33.9	34.9	36.5	38.0	37.0	35.8	34.7	34.0	34.6	34.9	34.8	34.0
Max 2020	31.7	32.7	34.3	35.8	35.2	34.0	32.9	32.2	32.6	32.9	32.8	31.8
Max Baseline	30.8	31.8	33.2	34.7	34.1	33.1	32.0	31.3	31.6	31.9	31.8	30.9
Ave 2050	28.9	29.6	31.2	32.8	32.3	31.6	30.9	30.5	30.9	30.9	30.4	29.3
Ave 2020	26.7	27.4	29.0	30.6	30.5	29.8	29.1	28.7	28.9	28.9	28.4	27.1
Ave Baseline	25.8	26.5	27.9	29.5	29.4	28.9	28.2	27.8	27.9	27.9	27.4	26.2
Min 2050	23.8	24.3	25.9	27.7	27.7	27.4	27.1	27.0	27.2	27.0	26.0	24.5
Min 2020	21.6	22.1	23.7	25.5	25.9	25.6	25.3	25.2	25.2	25.0	24.0	22.3
Min Baseline	20.7	21.2	22.6	24.4	24.8	24.7	24.4	24.3	24.2	24.0	23.0	21.4

Figure 2.3.1-6. Medium Range Projection of Temperature for Pangasinan

Table 2.3.1-5. Total Frequency of Extreme Events in 2020 and 2050 Under Medium-range Scenario in Dagupan Station, Pangasinan

	Observed Baseline (1971-2000)	Projected 2020	Projected 2050
No of Days w/ Tmax >35 °C	1,280	2,265	3,728
No. of Dry Days	8,303	6,443	6,419
No. of Days with Rainfall >300 mm	2	13	20

Source: PAGASA. 2011, Feb. Climate Change in the Philippines

2.3.1.9 Evaporation and Evapotranspiration

Evaporation and evapotranspiration data are used in the projection of the yield of a river and simulation study of reservoir utilization model. Evaporation is a function of temperature, humidity, sky cover, wind velocity, and barometric pressure, which is a function of altitude. In the absence of evaporation data in the project area, the open rim evaporation records observed at the agrometeorological station of the Central Luzon State University (CLSU) for 30 years (1977-2007) were used in this study. The lowest daily average evaporation is 3.82 mm in August while the highest is 7.10 mm in April.

The evapotranspiration rate from a reference surface is called the reference crop evapotranspiration or reference evapotranspiration and is denoted as ETo. The reference surface is a hypothetical grass reference crop that closely resembles an extensive surface of green, well-watered grass of uniform height, actively growing and completely shading the ground. ETo estimation requires weather parameters (i.e., radiation, air temperature, wind speed, humidity); crop characteristics (type, variety, development stage); management and environmental aspects; etc.

The following FAO Penman-Monteith equation was used in projecting the potential evapotranspiration:

$$ETo = \frac{0.408\,\Delta\,(R_n - G) + \gamma \frac{900}{T+273} U_2 \,(e_a - e_d)}{\Delta + \gamma\,(1 + 0.34\,U_2)}$$

where:

ET_o	-	reference crop evapotranspiration, mm/day
R_n	-	net radiation at crop surface, MJ/m2-day
G	-	soil heat flux, MJ/m2-day
T	-	average temperature, °C
U_2	-	wind speed measured at 2 m height, m/s
(e_a-e_d)	-	vapor pressure deficit, kPa
Δ	-	slope vapor pressure curve, kPa/°C
γ	-	psychrometric constant, kPa/°C
900	-	conversion factor

The lowest daily average potential evapotranspiration is 3.61 mm in December while the highest is 6.03 mm in April **(Table 2.3.1-6**).

Table 2.3.1-6. Evaporation and Potential Evapotranspiration (mm/day)

Month	*Ev (Dagupan)	*Eto	**Ev (CLSU)	***Ratio (Eto/Ev-CLSU)
Jan	3.83	3.87	5.41	0.72
Feb	4.68	4.75	6.02	0.79
Mar	5.33	5.42	6.53	0.83
Apr	5.83	6.01	7.10	0.85
May	5.59	5.46	6.18	0.88
Jun	4.92	4.57	4.89	0.93
Jul	4.52	4.31	4.35	0.99
Aug	4.24	3.89	3.82	1.02
Sep	4.18	4.00	3.98	1.00
Oct	4.00	3.99	4.15	0.96
Nov	3.77	3.85	4.51	0.85
Dec	3.34	3.61	4.92	0.73
Mean	4.52	4.48	5.16	0.87

*Estimated using FAO Penman-Monteith; **Source: PAG-ASA; ***Ratio of Eto and Ev (CLSU)

2.3.1.10 Impact Assessment on Climate

Change in Microclimate. The proposed Project may result in a change in microclimate. There are studies claiming humidity rates increases in close surrounding of especially large dams and annual temperature differences decreases; precipitation values did not vary significantly. The amount of change in the rate was found to become smaller with increase distance from dams. Kum G. (2016) studied the records of the 125-km long and 675 km² span Keban Dam Lake in Upper Euphrates Basin of Eastern Anatolia Region. He concluded that humidity values tend to increase and temperature average increases significantly especially during the hot season after construction of the dam. Humidity factor yielded more precise results than the other climate parameters. No trend in precipitation was noted. The reason for those changes was not stated in the report. The probable reason for this is the increase in the quantity of evaporated water resulting from increased exposed surface area of water that stagnates resulting from dam effect and higher heat capacity of the surrounding air environment, resulting from reduced forest cover associated with dam construction.

Greenhouse Gases. Emissions from the proposed project include greenhouse gases such as carbon dioxide (CO_2) and nitrous oxide (N_2O) from the combustion of fuels from the heavy equipment and service during the construction phase. The emissions are intermittent during the operating period and temporary for of the three years of construction.

During the dam and reservoir operation flooding vegetation would decrease the sequestration ability of the area, with potential emission of CO_2 and methane (CH_4) from the decomposition of plants by the bacteria. GHG emission estimation from dams is not yet adopted in the Nations Framework Convention on Climate Change (UNFCCC).

Such emissions may be compensated by the avoided emissions from the combustion of fuels in pumping groundwater for irrigation during the dry season. Mitigation for the submerged trees will be part of the replaced through tree planting activities in support to the National Greening Program, and the increased soil carbon capture from the development of grasses, bushes and small trees associated with the watershed management plans.

2.3.2 Air Quality

2.3.2.1 Summary

The proposed Project is located in a rural agricultural and woody grassland area with good air quality. The increase in the total suspended particulates (TSP) is the main air quality issue for the proposed project and only during earthmoving activities at the construction phase of the proposed access road near a low density populated area. TSP levels on March 27-28, 2019 in two sampling sites at the lowland in Barangay Bayaoas measured 211-26 ug/NCM for 1-hr sampling or less than the 300 ug/NCM ceiling of RA 8749, and 60 ug/NCM for 24-hour sampling or less than 300 ug/NCM limit. High dust emission will be mitigated by avoidance of earthmoving activities during high wind conditions, water sprinkling, and reduced speed of vehicles in unpaved roads in residential areas.

2.3.2.2 Methodology

The baseline air quality determination for the proposed Project is limited to the total suspended solids (TSP) as parameter for the dust emissions during the earthmoving activities within the populated area. Two sites (AQ-1 and AQ-2) were identified, as shown in **Figure 2.3.2**. Sampling site AQ-1 is within a residential area at the western most part of Barangay Bayaoas, about 2.3 km SW of the national road and 1.9 km NE of the proposed dam site. The area is the beginning of the indicative proposed access road to dam site. A 1-hour and 24-hr sampling were done in this site. Sampling site AQ-2 for another 1-hour sampling is located in a residential, just east of the Barangay Bayaoas Hall, about 150 m from the national road.

The service of the Unicorn Installation & Allied Services, Inc. was tapped to conduct TSP determination. The full report is presented in **Annex 2.3.2**, containing the results, methodology, raw data and photographs. The sampling was done on March 27-28, 2019, within the dry season.

The adopted sampling procedures and methods for laboratory were in accordance with the DENR standards for ambient air sampling and analysis which are prescribed in the Implementing Rules and Regulations (IRR) of the Philippine Clean Act of 1999.

Ambient air samples were drawn through a glass fiber filter for TSP in a glass fiber at a flow rate of 40 cubic feet per minute over a period of 1-hour. Calibrated high volume pumps were used to draw air sample into the sampling media to ensure collection of sufficient sample mass for analysis. The sampler flow rate and geometry of the shelter favor the collection of particles at aerodynamic diameter. Following sampling, filters were sent to Greentech Laboratory to analyzed gravimetrically for TSP. The concentrations of TSP in ambient air were computed as the mass of collected particles, measured gravimetrically and after moisture equilibrium divided by the total volume of air sampled, corrected to standard condition.

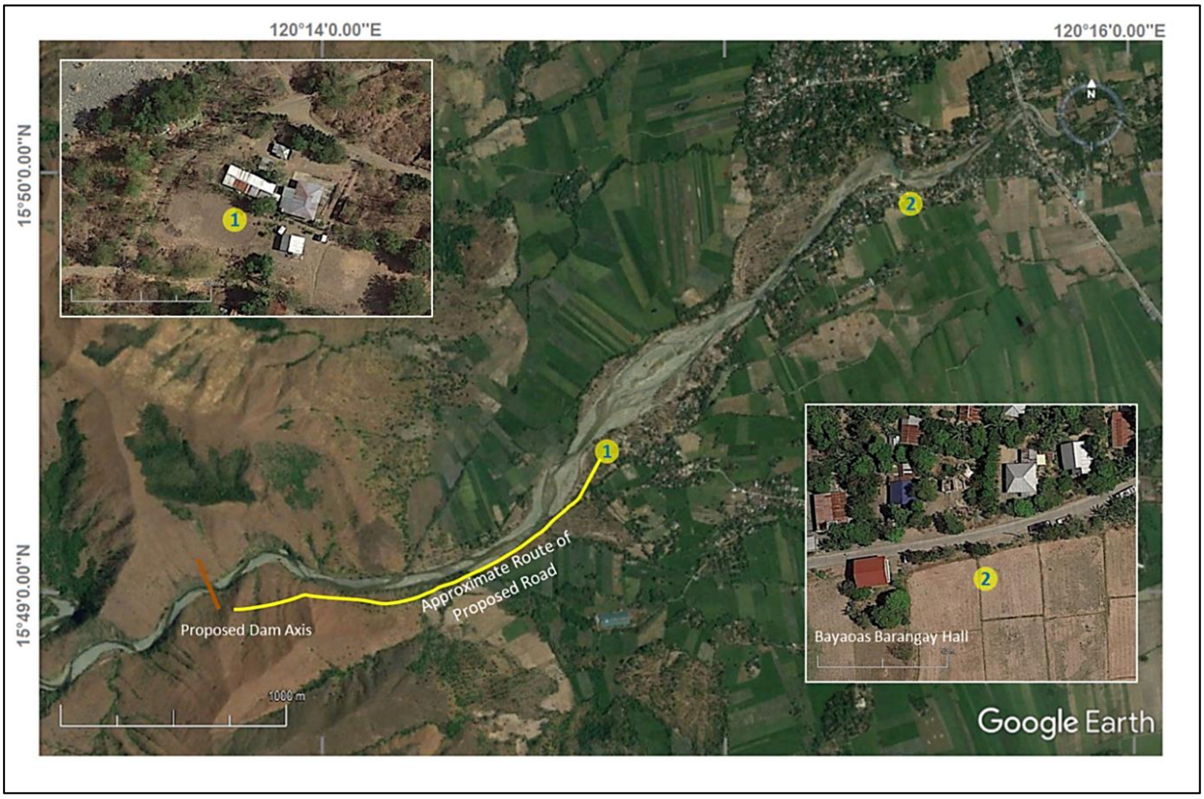


Figure 2.3.2. Location Map of TSP Sampling Sites, with close-up view of each site

2.3.2.3 Measured Total Suspended Particulates

Table 2.3.2-1 below presents the results of ambient air quality monitoring conducted on March 27-28, 2019. The TSP in the hourly averaging time in all stations and 24-hour averaging time in AQ-1 measured below the respective CAA limits of 300 µg/Ncm and 260 µg/Ncm. The highest concentration of TSP was 256 µg/Ncm recorded at AQ-2, while the lowest concentration was 211 µg/Ncm recorded at AQ-1. The concentration of TSP in AQ-1 for 24-hour sampling was 60 µg/Ncm. Sources of dust include the dry and dusty unpaved ground and vegetation. Dust emissions from heavy equipment the nearby river, north of AQ-1 is another source. Meteorological data (**Table 2.3.2-2**) were gathered using the sampling period as supplementary information. Temperature ranged 23.9-33.9 °C; dew point 18.9-21.1 °C; humidity, 41-73%; wind direction, variable; wind speed, 0.9-14 ms/s; and pressure, 29.76 inHg.

Table 2.3.2-1. Result of TSP Measurements at Two Sampling Sites

Sampling Site	From		To		Sampling Duration	Concentration	CAA Limit
	Date	Time	Date	Time	Hour	ug/NCM	ug/NCM
AQ-1	27-Mar-19	1340H	27-Mar-19	1440H	1	211	300
AQ-1	27-Mar-19	1340H	28-Mar-19	1340H	24	60	230
AQ-2	27-Mar-19	1540H	27-Mar-19	1640H	1	256	300

Table 2.3.2-2. Meteorological Data During the 24-hr s Air Sampling at AQ-1 on March 27-28, 2019

Year	Month	Day	Time	Temperature ºC	Dew Point ºC	Humidity %	Wind Direction Degree	Wind Speed m/s	Pressure inHg
2019	3	27	0	32.8	21.1	49	45	3.1	29.76
2019	3	27	1	32.8	20.0	46	45	7.2	29.76
2019	3	27	2	32.8	20.0	46	135	0.9	29.76
2019	3	27	3	31.1	18.9	49	135	14	29.76
2019	3	27	4	30.0	18.9	51	135	3.1	29.76
2019	3	27	5	27.8	18.9	58	158	2.2	29.76
2019	3	27	6	27.8	18.9	58	180	2.2	29.76
2019	3	27	7	27.2	18.9	61	225	2.2	29.76
2019	3	27	8	27.2	18.9	61	225	2.2	29.76
2019	3	28	9	26.1	18.9	65	225	2.2	29.76
2019	3	28	10	25.0	20.0	74	248	2.2	29.76
2019	3	28	11	25.0	18.9	69	270	2.2	29.76
2019	3	28	12	23.9	18.9	73	270	0.9	29.76
2019	3	28	13	23.9	18.9	73	270	0.9	29.76
2019	3	28	14	23.9	18.9	73	270	0.9	29.76
2019	3	28	15	23.9	18.9	73	270	0.9	29.76
2019	3	28	16	25.0	18.9	69	315	0.9	29.76
2019	3	28	17	27.8	20.0	62	0	2.2	29.76
2019	3	28	18	28.9	20.0	58	22	2.2	29.76
2019	3	28	19	31.1	20.0	52	180	0.9	29.76
2019	3	28	20	32.2	20.0	49	0	0.9	29.76
2019	3	28	21	33.9	18.9	41	135	7.2	29.76
2019	3	28	22	33.9	20.0	44	158	2.2	29.76
2019	3	28	23	32.8	20.0	46	180	4.0	29.76

Wind gust = 0 m/s; Precipitation = 0 mm

2.3.2.4 Impact Assessment on Air Quality

The main air quality issue for the proposed Project is the intermittent increase in TSP in the nearby residential area along the proposed access road to the dam site during the dry season or periods of the 3-year construction period. From the meteorological data there are 246 dry days a year. This may lead to increase number of cases in the upper tract respiratory illness of the nearby residents, increase in dust deposition in houses, and soiling of clothes.

Road construction includes earth materials excavation, transferring, leveling, grading, and paving. The passage of vehicles also generates TSP. PNOC-EDC (1993) measured a 200 ug/NCM concentration per dump truck at 3 m away from a road laden with 2.5 cm dust. A light vehicle may generate 29 ug/NCM. Prevailing wind generally comes from the south during the dry season and dust may generally flow away from the residential area near the proposed road. High dust emission from earthmoving activities at the dam site would not significantly increase the TSP in the far residential areas. Options to reduce the levels of TSP will include avoidance of earthmoving activities during high wind conditions, water sprinkling, and reduced speed of vehicles along residential areas. The access road will be eventually paved with concrete upon completion of construction works.

Nuisance emissions from heavy equipment include black smoke, but this will be prevented by good conditioning or maintenance of the units.

2.3.3 Noise

2.3.3.1 Summary

The baseline noise levels for the proposed Project were measured together TSP measurements on March 27-28, 2019 at located in the residential western and eastern part of Barangay Bayaoas, as south side of the barangay road. On the average, noise levels at N-1 (or AQ-1) located in low populated area measured 40-44 dBA or within respective standards in the morning, daytime, evening and nighttime. The daytime noise at N-2 (or AQ-2) measured 53 dBA which is within standard. Noise sources were people, vehicles and animals.

The increase in noise levels in populated areas would be felt only during the construction phase of the project due to an increase number of vehicles plying the barangay roads, and heavy equipment operations in the proposed accessed road. Nighttime operation and excessive use of vehicle horns, and vehicle accelerations will avoided near residential areas. Significant noise levels will occur at the dam site during construction driving away the wildlife which may return after construction.

2.3.3.2 Methodology

Noise measurements were conducted at the same stations for ambient TSP (AQ-1 and AQ-2), with respective change in the prefix for noise (N-1 and N-2). The Unicorn Installation & Allied Services, Inc. was tapped to conduct the measurements which were done on March 27-28, 2019, within the dry season. Noise level were measured using a precision type, digital sound pressure meter FLUS with a calibrator to check the instrument before and after the measurement. The difference between pre- and post-calibration is added or subtracted to the results. The sound pressure meter was set at low response “A” weighting, for the human ear.

Measurements at N-1 covered the four regulatory time periods for a day: morning (0500-0900H), daytime (0900-1800H), evening (1800-2200H) and night time (2200-0500H). N-1 is the nearest residential area at the proposed access road. Measurements at N-2 covered only the daytime period.

For an hour-period, 5 sets of readings, 10 readings per set for a total of 50 readings were recorded for each time period at each station. Noise sources were recorded. The readings were statistically processed for minimum, maximum, average, and median values for comparison with the existing noise standards under the 1978 Rules and Regulations of the National Pollution Commission (NPCC), as amended under NPCC Memorandum Circular 002 Series of 1980 (**Table 2.3.3-1**). Results were compared with the standards for Class A area (residential). The full report is presented in **Annex 2.3.2** of the Air Quality Section, containing the results, methodology, raw data, and photographs.

Table 2.3.3-1. Philippine Standards for Ambient Noise by Area Classification, in dB(A)

Classification	Morning 0500-0900H	Daytime 0900-1800H	Evening 1800-2200H	Night time 2200-0500H
Class AA	45	50	45	40
Class A	50	55	50	45
Class B	60	65	60	55
Class C	65	70	65	60
Class D	70	75	70	65

Class AA refers to a section or contiguous area which requires quietness, such as areas within 100 m from nurseries and school sites, hospitals and special homes for the aged

Class A refers to a section or contiguous area which is primarily used for residential purposes

Class B refers to a section or contiguous area which is used for heavy [sic, *commercial*] industries

Class C refers to a section or contiguous area which is used for light industries

Class D refers to section or contiguous area which is primarily reserved, zoned or used for heavy industries

Source: NPCC Memorandum Circular 002 Series of 1980.

Note: *For areas directly facing a public transportation route or an urban traffic artery, the foregoing standards plus a correction for equivalent to the following shall apply:*

i. areas directly fronting or facing a four-lane road : +5 dBA

ii areas directly fronting or facing a four-lane or wider road : + 10dBA

For impact assessment, the inverse square law was applied for the attenuation (reduction) by distance from noise from sources.

2.3.3.3 Noise Levels Measured

Noise sources at the measurement sites were people, vehicles and animals. On the average, noise levels at N-1 located in low populated area measured 40-44 dBA or within respective standards in the morning, daytime, evening and nighttime. The average daytime noise at N-2 measured 53 dBA which is within standard. (**Table 2.3.3-2**). Noise levels did not generally show large fluctuations due to very low human activities. Daytime passage of vehicles caused certain cases of peaks in the readings. Lower average noise levels (40 dBA) were measured in the evening and nighttime

Table 2.3.3-2. Summary of Noise Level Measurements

Station	Period	Date	Time	Min dBA	Max dBA	Ave dBA	Median dBA	Standard Limit dBA
N-1	Daytime	March 27, 2019	1345H-1445H	41	58	44	43	55
N-1	Daytime	March 27, 2019	1700H-1800H	41	47	43	43	55
N-1	Evening	March 27, 2019	2000H-2100H	39	43	40	40	50
N-1	Nighttime	March 28, 2019	0300H-0400H	39	47	40	40	45
N-1	Morning	March 28, 2019	0700H-0800H	40	52	43	43	50
N-2	Daytime	March 27, 2019	1550H-1650H	49	68	53	52	55

Notes:

1. A total of 50 readings per record (station, date, time)
2. Noise sources: people, vehicles, animals

2.3.3.4 Potential Impacts of Project Noise

The increase in noise levels in populated areas would be felt only during the construction phase of the project due to an increase in the number of vehicles plying the barangay roads, and heavy equipment operations in the proposed accessed road. Nighttime operation and excessive use of vehicle horns, and vehicle accelerations will be avoided near residential areas. Significant noise levels will occur at the dam site during construction driving away the wildlife which may return after construction.

Noise production from construction works would depend on the equipment in operation and type of activity. Noise emanates from the operating motors and engine exhaust silencers of equipment, pneumatic and mechanical operations of tools, material transfers and structures assembly works.

By regulation, there are no cases for proposed Project regarding the restrictions provided in NPCC Memorandum Circular 002 Series of 1980, as follows:

(1) The noise level, emitted from sound reproduction devices installed in a building, or an establishment within or abutting a public place such as a public road, street, thoroughfare, park, plaza or place requested by people or pedestrians, shall not exceed 75 dBA measured at 1 meter directly in front of the speaker, or the ambient standard when measured at the property line or doorway of the building or establishment wherein the point source is located, whichever is appropriate.

(2) These limits shall not apply to incidental sounds greater than 75 dBA emanating from a sport, entertainment or a public event for which a permit has been issued

The noise standards for construction activities are as follows:

The maximum noise level that shall be allowed from specific construction activities ... measured at a distance of 30 meters from the noise source shall be as follows:

Class 1 ...... 90 dBA
Class 2........ 85 dBA
Class 3 - 4..... 75 dBA

Class 1 – Work which requires pile drivers (excluding manual type), file extractors, riveting hammers or combination thereof. This classification does not include work in which pile drivers area used in combination with earth augers.
Class 2 – Work which requires rock drills or similar equipment like jack hammers or pavement breakers.
Class 3 – Work which requires air compressor (Limited to those compressors which use power other than electric motors with a rated output of 15 kw or more). Air compressors powering rock drills, jack hammers, pavement breakers are excluded.
Class 4 – Operation involving batching plant (limited to those with a mixer capacity of 0.5 or more cubic meters) and/or asphalt plants (limited to those with mixer capacity of 200 kg or more). Batching plants for the making of mortar are excluded.

Construction activities – no person shall engage in or permit any person to be engaged in construction activities in Class AA, A and B areas as indicated in Paragraph "2" above from 7 pm to 7 am for work activities classified as Class 1-2 and from 9 pm to 7 am from work activities classified as Class 3-4: Provided however that this prohibitions does not apply *during work in an emergency, disaster, or calamity or when there is a valid permit issued by a proper authority*.

Examples of noise level originating from heavy equipment are shown in **Table 2.3.3-3** arranged at decreasing level**,** roughly from 100 dBA down to 70 dBA, by order of magnitude, which are above the standard ceilings of ambient noise. A typical heavy duty bulldozer used in excavation works may generate about 91-107 dBA.

Table 2.3.3-3. 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,	94	3	90-98
Insulated cab	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	84	5	78-90
Insulated cab	74	9	59-87
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

TWA means time-weighted average
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)

Noise levels from the sources listed above, especially for the construction works would attenuate or reduce by distance The impact of noise by distance can be approximated by the following formula (referred to as the "inverse square law") :

$$L_2 = L_1 - 20\log [r_2/r_1]$$

where
L_2 = predicted noise level at distance r_2 from the source
L_1 = measured source noise at distance r_1, say approximately 1 meter
Figure 2.3.3.4-1 shows the attenuation of noise levels by distance from the source. For example, a 100 dB source noise over a flat area would attenuate to 60 dBA at distance of 100 m, and 46 dBA at 500 m. Such levels would be even lower in the presence of barriers such as vegetation and structures

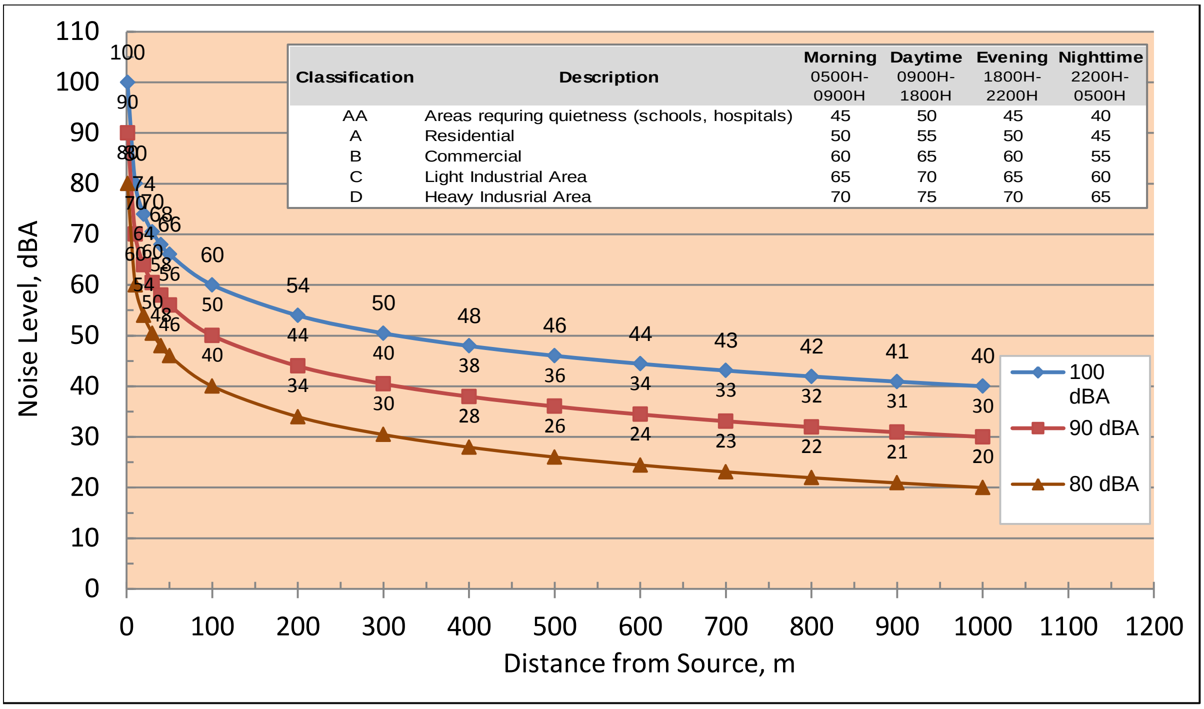


Figure 2.3.3-2. Unobstructed Attenuation by distance of different source noise levels (100, 90, 80 dBA)

Technical options to control noise emissions include:

i. Avoiding activities that generate high levels of noise such as pile driving during quiet morning and nighttime;
ii. Avoiding nighttime operations of excessive noise emitting equipment such as pile driver;
iii. Maintenance of exhaust silencers of heavy mobile equipment in good conditions;
iv. Enclosing major sources of noise emissions such as power generators and compressors, which may continuously operate during construction;
v. Requiring noise-generating equipment to be installed with effective noise control devices such as noise suppressors and mufflers to reduce noise;
vi. Proper maintenance of all equipment to ensure that no additional noise due to worn or improperly maintained parts would be generated;
vii. Requiring noise-generating equipment to be installed with effective noise control devices such as noise suppressors and mufflers to reduce noise;
viii. Use horns for collision avoidance only; and
ix. Avoidance of over speeding of vehicles excessive acceleration and unnecessary sudden braking

Supervisory controls include:

i. Contracts with the contractors to include prevention of unnecessary noise emissions;
ii. Orientation of workers and employees to ensure observance of the noise reduction measures;
iii. Coordination with the local community near the site, regarding the duration of activities that generate high noise levels and may cause nuisance to the neighborhood;
iv. Assigning the Community Relations (COMREL) Office to receive and attend to complaints.

2.4 THE PEOPLE

2.4.1 Covered LGUs

The barangays in Aguilar affected by the project are the following: Bayaoas, Bocacliw, Buer, Calsib, Niñoy, and Pogonsili. While the Mangatarem barangays are the following: Bunlalacao, Calomboyan Norte, Linmansangan, and Quetegan. The watershed area of the project is practically covered by Laoag. While practically all other barangays indicated are beneficiary barangays, in some instances they may be differentially affected.

2.4.2 Demographic Data of Impact Area

This section covers: population, number of households, and average household size.

2.4.2.1 Number of Households and Household Size

The indicative population of the relevant barangays (marked with asterisk in **Table 2.4-1**), is between about 2,100 to 3,469 individuals, with the number of household at about 400 to 620 households, correspondingly, with household sizes at about 6 persons.[15]

Table 2.4-1. Aguilar Barangays Population, Household Number and Household Size

Barangay	Population	# of Households	Ave Household Size
Urban			
1. Baybay	2,878	583	5
2. Poblacion	3,864	816	5
3. Pogomboa	1,762	361	5
4. Laoag *	3,049	570	6
Rural			
1. Bayaoas *	2,102	400	6
2. Bocacliw *	2,607	513	5
3. Bocboc East	2,636	482	6
4. Bocboc West	1,775	317	6
5. Buer *	3,137	607	6
6. Calsib *	2,351	476	5
7. Manlocboc	1,258	229	6
8. Niñoy *	3,349	620	6
9. Pañacol	1,672	351	5
10. Pogonsili *	2,439	466	6
11. San Jose	2,485	466	6
12. Tampac	2,269	476	5
Total	39,633	7,733	6

2.4.2.2 Land Area

Aguilar occupies a land area of 195.07 km2 or 75.32 sq mi, 3.58% of Pangasinan's total area. Loaoag has the largest share of this at about 14,130 hectares (72.4%), in large part because most of this area is uninhabited, and either barren or minimally forested. This is the

[15] *Most of the data available for Aguilar (2010), and from Mangatarem (2007) come from their respective CLUPs,unless otherwise indicated.*

same watershed serving the project. Bocacliw and Niñoy occupy some 3.2% and 3.1%, respectively. Other areas are smaller with Buer and Pogonsili, both at 2.6%, Calsib at 2.1%, and Bayaoas, 1.1% (**Table 2.4-2**)

Table 2.4-2. Land Area by Barangay of Aguilar, Pangasinan

Barangay	Land Area, ha	% of Aguilar
1. Bayoas	221.47	1.10
2. Baybay	391.16	2.00
3. Bocacliw	628.25	3.20
4. Bocboc East	380.19	1.90
5. Bocboc West	300.29	1.50
6. Buer	503.96	2.60
7. Calsib	402.25	2.10
8. Ninoy	607.35	3.10
9. Poblacion	264.78	1.40
10. Pogomboa	234.6	1.20
11. Pogonsili	507.3	2.60
12. San Jose	297	1.50
13. Tampac	167.63	0.90
14. Laoag	14,130.37	72.40
15. Manlocboc	309.99	1.60
16. Panacol	159.88	0.80
Total	19,506.47	100.00

In Mangatarem there are 82 barangays, and 222 sitios, of which 14 are poblacion and 68 are rural barangays (**Table 2.4-3**). The town's total land area is not consistently reported which is reported as 31,750 has. (DBM), 30,091 (LMB-DENR Cadastral Survey), and 31,011 (NAMRIA). The former is used by the LGU for planning purposes as it is important to have the same reference for computing for the Internal Revenue Allotment (IRA). The four beneficiary barangays from Mangatarem have small land holdings per barangay for beneficiary areas Bunlalacao, 0.67%, Calomboyan Norte, 0.40%, Linmansangan, 0.67%, and Quetegan, 0.60%. These four areas are correspondingly equivalent to: 203, 127, 213, and 191 hectares.

Table 2.4-3. Land Area by Barangay Mangatarem

Barangay	Land Area, ha	% of Mangatarem
Rural		
1. Andangin	244	0.77
2. Bantay	340	1.07
3. Bantocaling	403	1.27
4. Baracbac	213	0.67
5. Bedania	289	0.91
6. Bogtong Bolo	181	0.57
7. Bogtong Bunao	244	0.77
8. Bogtong Centro	64	0.20
9. Bogtong Niog	213	0.67
10. Bogtong Silag	321	1.01
11. Buaya	108	0.34
12. Buenlag	289	0.91
13. Bueno	140	0.44
14. Bunagan	198	0.64
15. Bunlalacao *	203	0.67

Barangay		Land Area, ha	% of Mangatarem
16.	Cabaluyan 1st	213	0.77
17.	Cabaluyan 2nd	416	1.31
18.	Cabarabuan	276	0.87
19.	Cabaruan	108	0.34
20.	Cabayaoasan	298	0.94
21.	Cabayugan	327	1.03
22.	CabisonBulaneyNiog	86	0.27
23.	Cacaoiten	257	0.81
24.	Calomboyan Norte *	127	0.40
25.	Calomboyan Sur	371	1.17
26.	Casilagan	321	1.01
27.	Catarataraan	244	0.77
28.	Caturay Norte	235	0.74
29.	Caturay Sur	191	0.60
30.	Caviernesan	340	1.07
31.	Dorongan Ketaket	267	0.84
32.	Dor. Linmansangan	191	0.60
33.	Dorongan Punta	267	0.84
34.	Dorongan Sawat	289	0.91
35.	Dorongan Valerio	289	0.91
36.	Historia	159	0.50
37.	Lawak Langka	425	1.34
38.	Linmansangan *	213	0.67
39.	Macarang	235	0.74
40.	Malabobo	800	2.52
41.	Malibong	140	0.44
42.	Malunec	159	0.50
43.	Muelang	267	0.84
44.	Naguilayan East	191	0.60
45.	Naguilayan West	140	0.44
46.	Nancasalan	416	1.31
47.	Olo Cacamposan	159	0.50
48.	Olo Cafabrosan	191	0.60
49.	Olo Cagarlitan	352	1.11
50.	Pacalat	810	2.55
51.	Pampano	352	1.11
52.	Parian	235	0.74
53.	Paul	191	0.60
54.	Pogon Aniat	159	0.50
55.	Ponglo Baleg	184	0.58
56.	Ponglo Muelag	197	0.62
57.	Quetegan *	191	0.60
58.	Salavante	235	0.74
59.	Sapang	321	1.01
60.	Sonson Ongkit	127	0.40
61.	Suaco	191	0.60
62.	Tagac	384	1.21
63.	Takipan	181	0.57
64.	Talogtog	127	0.40
65.	Tococ Barikir	222	0.70
66.	Torre 1st	86	0.27
67.	Torre 2nd	213	0.67
68.	Umangan	403	1.27
	Urban		
1.	Arellano	6.01	0.02
2.	Burgos	7.87	0.02
3.	Calvo	7.91	0.02
4.	Caoile Olegario	10.24	0.03

Barangay		Land Area, ha	% of Mangatarem
5.	General Luna	6.9	0.02
6.	Lopez	8.76	0.03
7.	Mabini	10.97	0.03
8.	Mar-Arellano Ext.	71.56	0.22
9.	Maravilla	24.28	0.08
10.	Osmeña	13.54	0.04
11.	Pogonlomboy	86.66	0.27
12.	Quezon	3.18	0.01
13.	Torres Bugallon	17.4	0.05
14.	Zamora	12.24	0.04
	Subtotal	*17,573	*32
	Other Land Uses	14,177	*44.7
	Total	31,750	100

Source: LMS-DENR

* Discrepancies in the sums

2.4.2.3 Population

Region 1 hit 5.03 million (PSA census reference date August, 2015)[16]. By then the population of Pangasinan was 2.956 million (**Table 2.4-4**). Of this 114,704 (3.88%) were from Aguilar and Mangatarem. The affected (both positive and negative) barangays' population is at about 20,616 for Aguilar, and for Mangatarem 4,808, equivalent to 0.70% and 0.16% of the province's population. Comparatively about 81% from Aguilar, and 19% from Mangatarem. This means that Aguilar, which accounts for 1.40% of the province's population, against Mangatarem's 2.48%, is preferentially treated by this project.

Table 2.4-4. Population of Aguilar and Mangatarem and Total Affected, 2015

Location	Count, #	Share, %
A. Population		
Pangasinan	2,956,726	
Aguilar + Mangatarem	114,704	3.88%
Aguilar	41,463	1.40%
Mangatarem	73,241	2.48%
B. Affected		
Aguilar + Mangatarem	25,424	0.86%
Aguilar (+/-)	20,616	0.70%
Mangatarem (+/-)	4,808	0.16%

Source: PSA, 2015[17]

Around half of the population Aguilar stand to be affected by the project, pre-dominantly as beneficiaries, with 18.5% coming from Niñoy (**Table2.4-5**). Laoag (16.6%) shall serve as the watershed of the project, and shall benefit from the project, indirectly through the National Greening Project, and its expanded version. Bayaoas, and Pogonsili which have largely benefitted from natural irrigation from the river, have fewer beneficiaries, given their population, so that the project can be viewed as a reallocation of water resource to benefit other communities which traditionally have not been able to do three or two times cropping in a year. Thus any view from the two barangays of irrigation channels breakage will also have to remember this.

[16] *http://rsso01.psa.gov.ph/content/region-i-population-hits-5-million*
[17] *https://www.psa.gov.ph/sites/default/files/attachments/hsd/pressrelease/R01.xlsx*

Table 2.4-5. Population of Aguilar and Affected Barangays, 2015

Location	Count, #	% of Total
AGUILAR Population	41,463	
Aguilar Affected (+/-)	20,616	49.7
Bayaoas	2,048	9.9
Bocacliw	2,951	14.3
Buer	3,245	15.7
Calsib	2,609	12.7
Niñoy	3,810	18.5
Pogonsili	2,540	12.3
Laoag	3,413	16.6

PSA, 2015[18]

Mangatarem farmers will account for about 19% of the population that will benefit from the project, translated to a distribution of majority coming from Quetegan (41.2%), and Bunlalacao (22.5%). The barangays with the least beneficiary populations will be from Dorongan Linmansangan (3.8%), and Malunec (7.0%) (**Table 2.4-**6).

Table 2.4-6. Population of Mangatarem and Affected Barangays, 2015

Location	Count, #	% of Total
Mangatarem Population	73,241	
Mangatarem Affected (+/-)	4,808	6.6%
Buenlag	642	13.4%
Bunlalacao	1,081	22.5%
Calumboyan Norte	585	12.2%
Dorongan Linmansangan	184	3.8%
Malunec	335	7.0%
Quetegan (Pogon-Baleg)	1,981	41.2%

PSA, 2015[19]

In 2010, the total population of Aguilar was at about 39,500, with the population by barangay shown in **Table 2.4-7**;and sex ratio of 104.4:100 in **Table 2.4-8**. The sex ratio of the population flips at the age range of 60-64 from 106.3:100 in the previous to 89.7:100, which is fairly consistent to the phenomenon that females outlive males.

[18] *loc. cit.*
[19] *loc. cit.*

Table 2.4-7. Aguilar Population of Barangays as of 2010

Barangay	Population
1. Bayaoas *	2,102
2. Baybay	2,878
3. Bocacliw *	2,607
4. Bocboc East	2,636
5. Bocboc West	1,775
6. Buer *	3,137
7. Calsib *	2,351
8. Manlocboc	1,258
9. Niñoy *	3,349
10. Panacol	1,672
11. Poblacion	3,864
12. Pogomboa	1,762
13. Pogonsili *	2,439
14. San Jose	2,485
15. Tampac	2,269
16. Laoag *	3,049
Total	39,633

* Potentially affected Barangay

Table 2.4-8. Aguilar Sex Population by Age Range, 2010

Age Range	Male	Female	Both Sexes
0-4	2,558	2,340	4,898
5-9	2,509	2,307	4,816
10-14	2,542	2,289	4,831
15-19	2,146	1,913	4,059
20-24	1,591	1,453	3,044
25-29	1,426	1,396	2,822
30-34	1,351	1,316	2,667
35-39	1,261	1,156	2,417
40-44	1,106	1,081	2,187
45-49	928	887	1,815
50-54	841	804	1,645
55-59	659	620	1,279
60-64	471	525	996
65-above	797	1,242	2,039
Total	20,186	19,329	39,515

Source: https://psa.gov.ph/sites/default/files/PANGASINAN_FINAL%20PDF.pdf

The Municipality of Mangatarem comprises 69,969 persons, or 3.2 percent of province's population (2,165,833). Mangatarem ranked 14th in terms of population, up from its rank as 16th and 14th, respectively, in the 1990 and 2000 population census. **Table 2.4-9** shows the population, land area and population density by barangay. **Table 2.4-10** shows the male and female population by age.

Buenlag has a population density of about 4 persons per hectare, while Quetegan has 10 persons per hectare, second or third highest. This latter figure is rather outstanding, suggesting it being a focus of economic activity among rural barangays in Mangatarem.

The population density difference between rural and urban barangays in Mangatarem is notable in that that highest urban population density is about 120, and the lowest at 6. In rural barangays, the highest is 12, while the lowest is at 2.

Details of data on 14 urban barangays of Mangatarem (2000) is excluded here, as none are affected by the project. (Their total population is 9,327, with a total land area of 287.52 hectares, at an average 32 persons/ hectare.)

Table 2.4-9. Mangatarem Population Density of Rural Barangays

ID #	Barangay	Population	Area, ha	Pop Density, #/ha
1	Andangin	819	244	4
2	Bantay	539	340	2
3	Bantocaling	1,343	403	4
4	Baracbac	1,210	213	6
5	Bedania	1,444	289	5
6	Bogtong Bolo	835	181	5
7	Bogtong Bunao	840	244	4
8	Bogtong Centro	417	64	7
9	Bogtong Niog	521	213	3
10	Bogtong Silag	1,762	321	6
11	Buaya	390	108	4
12	Buenlag	738	289	3
13	Bueno	766	140	6
14	Bunagan	490	203	3
15	Bunlalacao	1,051	213	5
16	Cabaluyan 1st	820	244	4
17	Cabaluyan 2nd	1,050	416	3
18	Cabarabuan	867	276	3
19	Cabaruan	528	108	5
20	Cabayaoasan	1,201	298	4
21	Cabayugan	670	327	2
22	CabisonBulaneyNiog	1,010	86	12
23	Cacaoiten	591	257	2
24	Calomboyan Norte	517	127	4
25	Calomboyan Sur	799	371	2
26	Casilagan	1,343	321	4
27	Catarataraan	356	244	1
28	Caturay Norte	717	235	3
29	Caturay Sur	855	191	5
30	Caviernesan	1,090	340	3
31	Dorongan Ketaket	949	267	4
32	Dor. Linmansangan	147	191	1
33	Dorongan Punta	1,802	267	7
34	Dorongan Sawat	1,760	289	6
35	Dorongan Valerio	1,860	289	7
36	Historia	468	159	3
37	Lawak Langka	985	425	2
38	Linmansangan	838	213	4
39	Macarang	1,365	235	6
40	Malabobo	1,619	800	2
41	Malibong	255	140	2
42	Malunec	351	159	2
43	Muelang	448	267	2

ID #	Barangay	Population	Area, ha	Pop Density, #/ha
44	Naguilayan East	493	191	3
45	Naguilayan West	551	140	4
46	Nancasalan	1,138	416	3
47	Olo Cacamposan	1,492	159	10
48	Olo Cafabrosan	1,034	191	6
49	Olo Cagarlitan	985	352	3
50	Pacalat	924	810	1
51	Pampano	2,161	352	6
52	Parian	1,064	235	5
53	Paul	433	191	2
54	Pogon Aniat	244	159	2
55	Ponglo Baleg	446	184	2
56	Ponglo Muelag	478	197	3
57	Quetegan	1,760	191	10
58	Salavante	708	235	3
59	Sapang	739	321	2
60	Sonson Ongkit	835	127	7
61	Suaco	511	191	3
62	Tagac	835	384	2
63	Takipan	664	181	4
64	Talogtog	589	127	5
65	Tococ Barikir	433	222	2
66	Torre 1st	539	86	6
67	Torre 2nd	864	213	4
68	Umangan	1,770	403	4
	Total	69,969	17,573	4

Source: Municipal Planning Development Office, 2010

Table 2.4-10. Mangatarem Sex Population by Age Range, 2010

Age Range	Male	Female	Both Sexes
0-4	4,232	3,882	8,114
5-9	4,161	3,701	7,862
10-14	4,097	3,807	7,904
15-19	3,730	3,349	7,079
20-24	2,954	2,844	5,798
25-29	2,645	2,467	5,112
30-34	2,456	2,395	4,851
35-39	2,255	2,151	4,406
40-44	2,194	1,956	4,150
45-49	1,808	1,635	3,443
50-54	1,450	1,396	2,846
55-59	1,181	1,184	2,365
60-64	967	1,054	2,021
65-above	1,590	2,412	4,002
Total	35,720	34,233	69,963

2.4.2.4 Population Density/Growth

From the years and populations shown above, we can see that from 1960 to 1995, the population growth rate was at about 2.23% that was consistently above 2% (**Table 2.4-11**). The following survey periods however showed upward movements suggesting disturbances in the population which is usually caused by extrinsic factors such as economic crisis, drought, storms, earth quake and the like.

Table 2.4-11. Aguilar Population and Growth Rate

Census Date	Population	Growth Rate
1960	14,125	-
1970	17,696	2.23%
1975	19,853	2.33%
1980	22,080	2.15%
1990	27,303	2.15%
1995	30,578	2.14%
2000	33,213	1.79%
2007	36,564	1.33%
2010	39,529	2.88%
2015	41,463	0.91%

For Aguilar, the Population Density (2015) is approximately 213 inhabitants/ km^2. The population density of this municipality is 2.058 persons per hectare, with a population of 65,366 in 2007 using the total land area of 31,750.00 hectares. However, the forest land in the municipality with a total land area of 14,177 hectares is separated from the 82 barangays of the Municipality. In this case, using the total alienable and disposable land of 17,573 hectares shows an average population density of 4 persons per hectare.

For Mangatarem, [20] referring to **Table 2.4-12**, the population growth rate has been hovering at about 1.40% to 1.63% from 1975 to 1990. In 1995, 2000, and 2010, the growth rate hit 2.20%, 2.79% and 2.5%, respectively. What is rather curious is the growth rate in 2007 at 0.97%, and in 2015 at 0.87% which may be worth investigating at a later time. It is highly likely that this particular years may have been associated to an upheaval, possibly economic so that it may have induced out migration, or a reduction in birth rate. It is also possible that this may have been driven by drought which resulted in a significantly reduced production output.

Table 2.4-12. Mangatarem Population and Growth Rate

Census Date	Population	Growth Rate
1960 Feb 15	28,931	–
1970 May 6	35,080	1.90
1975 May 1	37,604	1.40
1980 May 1	40,582	1.54
1990 May 1	47,714	1.63
1995 Sep 1	53,603	2.20
2000 May 1	60,943	2.79
2007 Aug 1	65,366	0.97
2010 May 1	69,969	2.51
2015 Aug 1	73,241	0.87

[20] https://www.philatlas.com/luzon/r01/pangasinan/mangatarem.html

2.4.2.5 Gender and Age Profile

Referring to **Table2.4-13**, the dependent population for Aguilar is 50.1% both male and 49.9% female. While there are younger male children aged 0-14 (51.6:48.4) than female, at the other end there are proportionately fewer men than women (40.1:59.9). A strong signal is the large dropout rate for males from grade school to high school which is about half, while the females just lose a few hundreds, and then only about a third of those males proceed to tertiary level, for females the number is about 20% higher (486 v. 565). Interestingly the number which goes to tertiary level appears to be slightly higher than the national average, following the cohort ratio of 10:6:1::primary (start), secondary (graduate), tertiary (graduate)).

Table 2.4-13. Aguilar Population Distribution (by School, Working, and Retired Age Groups), 2010

Age Group	Both Sexes	Male, #	Male, %	Female, #	Female, %
School Going Population	12,601	5,851	46.4	6,750	53.6
- Pre-school (3-6)	1,628	795	48.8	833	51.2
- Elementary (7-12)	5,739	2,997	52.2	2,742	47.8
- Secondary (13-16)	4,183	1,573	37.6	2,610	62.4
- Tertiary (17-21)	1,051	486	46.2	565	53.8
Working Age (15-64)	23,909	12,261	51.3	11,648	48.7
Labor Force (15+)	26,026	13,109	50.4	12,917	49.6
Dependent Population	15,724	7,872	50.1	7,851	49.9
- Young (0-14)	13,607	7,025	51.6	6,582	48.4
- Old (65+)	2,117	848	40.1	1,269	59.9

Referring to **Table 2.3-14**, the dependent population for Mangatarem is about 50% both male and 50% female. While there are younger male children aged 0-14 (52:48) than female, at the other end there are proportionately fewer men than women (40.8:59.2). The patterns for both towns are fairly similar, as the population archetypes are similar.

Table 2.4-14. Mangatarem Population by School, Working, and Retired Age Groups and Sex, 2007

Age Group	Both Sexes	Male		Female	
		Number	%	Number	%
School going population	27,885	14,572	52.26	13,313	47.74
- Pre-school (3-6)	6,424	3,340	51.99	3,084	48.01
- Elementary (7-12)	9,732	4,992	51.29	4,740	48.71
- Secondary (13-16)	5,908	3,102	52.51	2,806	47.49
- Tertiary (17-21)	5,821	3,138	53.91	2,683	46.09
Working age (15-64)	37,333	19,417	52.01	17,916	47.99
Labor Force (15 and over)	40,965	20,901	51.02	20,064	48.98
Dependent population	27,944	14,049	50.28	13,895	49.72
Young (0-14)	24,312	12,565	51.68	11,747	48.32
Old (65-over)	3,632	1,484	40.86	2,148	59.14

Source: Computed based on the latest NSO data on household population by age group.

Mangatarem appears to have better trends for education wherein the elementary cohort moves from about 5,000: 3,100: 3,138, for the males, while for the females it is: 4,740:2,800:2680. It suggests that participation of girls in education in Mangatarem shows a decreasing trend through the levels with losses higher for females.

(**Recommendation:** The LGUs should consider investigating the trend for this losses or trends for Mangatarem on the females, and for Aguilar, the males. There is definitely a need for targeting and nuancing the programs for Aguilar (males), and Mangatarem (females). There is available funding for financing livelihood programs and other gender-related programs and services from the GAD budget of the LGU. As for programs for males in Mangatarem, it may be interesting to check if male high school students are being marginalized in schools or if the school program or curriculum by design is not appropriate for those who drop out. It may also be important for DSWD to look into this such as under the Conditional Cash Transfer Program of government (also known as 4Ps).[21]

2.4.2.6 Literacy Rate, Profile of Educational Attainment

The literacy rate in both Aguilar (0.9886 : 0.9688 : 0,9888 :: males : females : total) and Mangatarem is relatively high (**Table 2.4-15** and **Table 2.4-16**), but still it indicates that there are individuals who are marginalized likely not just in terms of literacy, but also in terms of health and nutrition. These are also likely the same persons who might be affected by various shocks in the economy and catastrophic events in their lives such as debilitating illness, death or the like.

Table 2.4-15. Aguilar Literacy Rate, 2010

	Male	Female	Both Sexes
Population 5 yo +	17,820	17,625	35,085
Literate	17,617	17,075	34,692
Illiterate	203	190	393

Table 2.4-16. Mangatarem Literacy Rate, 2000

	Male	Female	Both Sexes
Population 10 yo +	23,122	22,166	45,288
Literate	21,815	20,695	42,510
Illiterate	1,307	1,471	2,778

[21] *4Ps has been institutionalized through a Republic Act signed into law April, 2019. The program started during the time of Former DSWD Secretary Corazon Juliano Soliman, during the term of former President Gloria Macapagal Arroyo, continued and expanded during the term of Benigno Simeon C. Aquino III, and almost got erased during the term. Through the advocacy by various groups and persons and availability of data, lobbying made it possible to become law.)*

As of 2010, in Aguilar, 956, of 34,617 have no formal schooling (**Table 2.4-17**). While in Mangatarem there are 1,739 of 61,839 persons without formal schooling (**Table 2.4-18**).

Table 2.4-17. Aguilar Highest Educational Attainment, 2010

Highest Educational Attainment	Male	Female	Both Sexes
No Grade Completed	504	452	956
Pre-School	632	581	1,213
Elementary	6,380	6,063	12,443
- 1st-4th Grade	3,070	2,695	5,765
- 5th-7th Grade	950	775	1,725
Graduate	2,360	2,593	4,953
- High School	7,249	6,816	14,065
- Undergrad	2,580	2,310	4,890
Graduate	4,669	4,506	9,175
- Post-Secondary	584	466	1,050
- Undergrad	49	38	87
Graduate	535	428	963
College Undergraduate	1,073	1,041	2,114
Academic Degree Holder	1,187	1,540	2,727
Post Baccalaureate	8	19	27
Not Stated	11	11	22
Total	17,628	16,989	34,617

Table 2.4-18. Mangatarem Highest Educational Attainment, 2010

Highest Educational Attainment	Male	Female	Both Sexes
No Grade Completed	948	791	1;739
Pre-School	1,118	946	2,064
Elementary	10,100	9,948	20,048
- 1st-4th Grade	4,934	4,257	9,191
- 5th-7th Grade	1,462	1,306	2,768
- Graduate	3,704	4,385	8,089
High School	13,588	12,743	26,331
- Undergrad	4,512	4,028	8,540
- Graduate	9,076	8,715	17,791
Post-Secondary	1,538	1,125	2,663
- Undergrad	65	46	111
- Graduate	1,473	1,079	2,552
College Undergraduate	2,084	2,044	4,128
Academic Degree Holder	2,078	2,682	4,760
Post Baccalaureate	26	55	81
Not Stated	8	17	25
Total	31,488	30,351	61,839

2.4.3 Settlements

Affected Settlements in Aguilar and Mangatarem for proximate to the dam are reported in a separate module with a Resettlement Action Plan.

2.4.4 In-Migration Pattern

In migration pattern is not considered relevant to the project, given that the project is not expected to being very attractive to provide significant profits to the beneficiary, but it is expected to be more of a poverty alleviation/ reduction and food security measure.

2.4.5 Indigenous Peoples

No indigenous peoples persons, families or communities were identified to be present in the area, and there was no overlap of any ancestral domain, community, as supported by a CADT or CALC or any declaration, with the project for both Aguilar and Mangatarem. Towards this end, NCIP-Regional Office-I issued a Certificate of Non Overlap to the project, given the project description provided by NIA to NCIP, as shown in **Annex 2.1.1**. Still the CNO provided a precautionary note wherein it directs NIA to undertake a proper FPIC should there be an overlap that will be noted along the way.

2.4.6 Historical and Cultural Heritage

Aguilar._On July 16, 1805, Governor General Rafael Maria de Aguilar issued a decree founding the municipality of Aguilar. Local folks believe that there is this eagle (*agila*) that flew around the place at night time, which would perch on a fence (*alar*) to take a break from flying[22].

Mangatarem._"Mangatarem derived its name from the combination of the Ilocano word "Manga ken Tirem" which means "mango and oyster". According to old tales, the name "Mangatarem" was attributed to woodcutters who happened to meet each other in a forested area which is now the present site of the town. One of them had a mango as his viand while the other one had oysters. When both of them saw this, they exclaimed "Manga ken Tirem", thus, the name Mangatirem or Mangatarem."[23]

2.4.7 Tourism

There are many Tourist Spots in Aguilar some of them are: St. Joseph The Patriarch Church and Mt. Nambersian. Hikers can climb to the summit of Mt. Nambersian in Barangay Niñoy, Aguilar, Pangasinan, one of the famous mountains in Aguilar. St. Joseph The Patriarch Church is also one of the famous sites in the town. It was built during 1810 by the help of friars to build the first church in Aguilar. It was named after the patron saint of the town and celebrated every March 18th for the town's fiesta.

Mangatarem has a forest protected area, defined as an Important Bird Area, designated in collaboration with the LGU and Haribon Foundation, Inc., using the standards and methodology of Bird Life International, Inc. As such, a possible tourism in Mangatarem is birdwatching, trekking and other non-consumptive outdoor activities associated with the forest. The town has also generated a management plan for the area, including mapping of some of the species of animals featured in their area.

[22] Municipality of Aguilar, 2010. Comprehensive Land Use Plan (CLUP).
[23] Verbatim from https://pangasinan.gov.ph/the-province/cities-and-municipalities/mangatarem/

2.4.8 Public Services

2.4.8.1 Water Supply

For both Aguilar and Mangatarem majority of water supply comes from tubed/ piped deep wells or shallow wells (**Table 2.4-19**). Level 1 or 2 water supply is not fully established. There are still households which source water from springs, lakes, river or rain, and other sources. The same pattern exists for water for laundry and bathing (**Table 2.4-20**). . This presents a significant health risk. Chances are, this would also be families with limited access to resources and schooling. About 1.11% of the town's total area of 218.04 hectares is covered with water. This is either rivers and/or creeks, the largest chunk of which is that of the Agno River.

Table 2.4-19. Main Source of Water Supply for Drinking and Cooking, 2000

Municipality	# of Households	Faucet, Community Water		Tubed/Piped Deep Well		Tube/ Pipe Shallow Well	Dug Well	Spring, Lake, River, Rain,	Peddler	Bottled Water	Other
		Own Use	Shared	Own Use	Shared						
Aguilar	6,131	450	410	1998	1977	1120	49	10	-	-	117
Mangatarem	11,704	466	412	4656	3041	2888	44	94	9	-	94

Table 2.4-20. Main Source of Water Supply for Laundry and/or Bathing, 2000

Municipality	# of Households	Faucet, Community Water		Tubed/Piped Deep Well		Tube/ Pipe Shallow Well	Dug Well	Spring, Lake, River, Rain,	Peddler	Other
		Own Use	Shared	Own Use	Shared					
Aguilar	6,131	257	381	2083	1909	1106	65	224	-	106
Mangatarem	11,704	366	201	4692	3144	2929	42	215	9	106

2.4.8.2 Power Supply

Power is supplied by the Central Pangasinan Electric Cooperative and is now servicing all barangays except some sitios in town which are now included in the priority programs of said entity through the National Electrification Administration and other national assistance fund such as PDAF. Approximately 2/3 of households in Aguilar, and three-fourths in Mangatarem access electricity (**Table 2.4-21**). This means that some households still cannot afford to pay for electricity. It is expected that in such cases, performance of students in school is affected.

Table 2.4-21. **L**ighting Power Source, 2000

Municipality	# of Households	Electricity	Gas	LPG	Oil
Aguilar	6,131	4431	1420	36	8
Mangatarem	11,704	8133	3284	51	12

2.4.8.3 Communications

Aguilar and Mangatarem:

Communication facilities such as cell sites from various service providers are strategically located within the LGU. Two-way radios are likewise used by barangay officials of the town. PLDT has presence in Mangatarem (and Aguilar?).

2.4.8.4 Transportation

Public utility vehicles (buses and jeepneys) are available in national and provincial roads, however, tricycles service farm to market roads or barangay roads, which can be costly for the communities. Farmers rent vehicles to transport their produce when they want to have this milled in the local rice mill.

2.4.8.5 Health Resources (Government and Private)

Aguilar. The rural health unit is the central health facility run by the government. It is situated in the heart of Poblacion. Birthing and other basic services are being catered there along with the health services delivered right at the various barangays in the respective health centers. There is a private hospital likewise in the Poblacion and another private medical clinic of general and pediatrics specialization in Poblacion.

Mangatarem. The municipality of Mangatarem has one (1) PhilHealth-accredited rural health units, one in Poblacion (RHU 2) ; the barangay health stations located strategically in various locations having thirteen (13) barangays Health Stations (BHS) manned by the RHU midwives with the help of 32 Barangay Health Workers and one (1) Barangay Nutrition Scholars. The local government of Mangatarem has four (4) ambulance to respond to the emergency and critical health needs of the populace.

Apart from these government facilities, there are also several private health institutions operating in the municipality. These include the Government Hospital located in Poblacion.
Health facilities in the municipality of Mangatarem has a total land area of 3.83 hectares distributed to various barangays, the multi-purpose hall are utilized as Health Care Unit. The nutrition rate of the Municipality is 6.6%.

2.4.8.7 Education Facilities

Aguilar: *Elementary Level.* There are 17 public elementary schools in town of which, two (2) have integrated up to 10th grade and two (2) privately-owned. The schools are strategically located in population districts.

Secondary Level: There are six (6) Secondary schools in the LGU. Four (4) of which are run by the government while the others are privately-owned

Mangatarem: *Primary School*: The Municipality of Mangatarem has forty seven (47) elementary school four (4) are privately owned. It has a total land area of 17.67 hectares or 0.0556% of the total land area of the Municipality.

The existing Elementary School has a total land area of 32.50 hectares. While the projected land requirement based on DECS Manual is averaging 12 classes per school site is 27.75 hectares based on the projected number of classes by year 2023. This means that the land area occupied by the existing elementary school sites could supply the required land demand for the elementary level.

Secondary. There are seven (7) secondary schools in the municipality, one (1) of which is a private school. It occupies an area of 10.37 hectares. Of the public secondary schools, the Mangatarem National High School and the Macarang National High School have the most number of high school enrollees with complete school facilities and utilities that are being required under the standards and guidelines of the Department of Education.

The size of the school site is largely determined by the level of education, the type of curriculum offered and the location of the school, i.e. urban or rural.
The ground areas occupied by the school building and other structures should not exceed 40% of the school site in order to provide adequate open spaces for assembly and co-curriculum activities as well as to conform with the national and local regulations and standards pertaining to setbacks and distances between buildings.
Using the standard administrative and instructional spaces the space requirements for secondary schools is 5.0 hectares. The total land occupied by the existing secondary sites is 8.45 hectares. This means that the land supply is 70.9 percent higher than the land requirements for calendar year 2023.

College. The Municipality of Mangatarem has one College School, the Mystical Rose Science and Technology, it occupies an area of 2.24 hectares located in Barangay Pogonlomboy.

Technical-vocational skills are strongly advocated by the local government of Mangatarem; the school offers Regular Programs such as: Cooking; Information Technology; Care-Giving; HRM and many others.

2.4.8.6 Recreational/Sports Facilities

Aguilar. There is one covered court available in Poblacion for sports and recreation purposes. Another covered court for the same purpose is available at the Bliss site in Barangay Laoag. Basketball courts with corresponding boards and rings are available in various points of the town. Multi-purpose pavements in various barangays are at times utilized for other sports such as volleyball.

Mangatarem. The lead agency officially tasked for the promotion of sports and recreation in the municipality is the Department of Education. Through the DepEd's schools and school officials, the sports and recreation sector gets promoted and improved. Among the concerned entities and the expected services that they render are the following:

- Mangatarem National High School with its teeming school population, wide playground and sports facilities and equipment;
- Mangatarem Central School with its sports facilities;
- Barangay secondary schools, like the Macarang National High School, also have sports facilities although very limited.

Complementing these sports organizations are the on-and-off youth sports organization in the 70 barangays of the municipality which exerts much effort in the promotion of sports and recreation. During competitions, they source their own funds through financial solicitation which has been proven to be effective and fruitful. Despite all the shortcomings, the activities being sponsored by these sports groups are highly rewarding and definitely educational.
For its part, the LGU Mangatarem through the Sangguniang Bayan always appropriates funds in the annual budget to be used in sports and recreational promotions, e.g. purchase of sports equipment and repair of existing sports facilities.

Some of the civic organizations and NGOs in the municipality—like the Rotary Club, Mangatarem Tennis Club, Mangatarem Bikers Association (MAMBA) and individuals who have inclination in sports, also assist in promotion and donate cash prizes, trophies and plaques during sports competitions.

2.4.9 Public Health

2.4.9.1 Morbidity and Mortality Rates (Infants and Adults – 5-year trend)

Table 2.4-22 shows the Mangatarem General Health Situation 2011-2013.

From the CLUP of Mangatarem:

> "From 2008 to 2012 Crude Death Rate (CDR) has been increasing. CDR is used as an estimator of mortality in the area. For 2012, it was 4.2 percent.

Infant Mortality Rate (IMR; deaths of children below one year old/ 1,000 live births), has been fluctuating.

- 2010, 2.6 percent,
- 2011, 0.0 percent, which could be a reporting error
- 2012, 4.0 percent

Similarly, Young Child Mortality Rate (YCMR) has been fluctuating

- 2010, 2.6 percent
- 2011, 1.8 percent, and
- 2012 to 5.0 percent.

Maternal Mortality Rate (MMR) in the municipality was shown to be at an even value, with no incidence of maternal deaths from 2009 to 2011 and a lone case of death in 2012. This favorable situation could be reflective on the effectiveness of maternal health and hospitalization services being adopted in the Municipality of Mangatarem."

Table 2.4-22. Mangatarem General Health Situation 2011-2013

Statistic	2013	2012	2011
Total Population	71,373	70,508	41,911
Total Birth	1,094	1,513	723
Total Death	321	359	194
Total Infant Death	2	6	7
Crude Birth Rate	44.47/1000	42.89/1000	17.25
Crude Death Rate	7.75/1000	3/1000	4.62
Total Households	--	21,229	--
Maternal Death	--	1	1
Neonatal Death	0	0	6

2.4.9.2 Common Diseases in the Area Including Endemic Diseases

Mangatarem. The top 3 most common causes of mortality are hypertension, pneumoniae, and ischemic heart, in other years this included cancer, cardiovascular disease, malignant hypertension, and diabetes mellitus (**Table 2.4-23**). Recent pioneering diet science suggests that most of these may be diet-related, except maybe for pneumoniae which in some part is related to diet, but more with nutrition, getting enough rest, and not having the resources to get timely medical attention.

Table 2.4-23. Mangatarem: Ten Leading Causes of Mortality (2013 – 2011)

2013	No.	2012	No.	2011	No.
1. Hypertension	37	1. Cardiovascular Disease	79	1. Malignant Hypertension	24
2. Pneumonia	37	2. Cancer (all kinds)	25	2. Ischemic Heart Disease	23
3. Ischemic Heart Disease	31	3. Diabetes Mellitus type 2	25	3. Cancer (all types)	15
4. Diabetes Mellitus	15	4. Pneumonia (severe)	21	4. Pneumonia	14
5. COPD	9	5. Pulmonary Tuberculosis	13	5. Hemorrhage	13
6. Cerebro Vascular Accident	7	6. COPD	9	6. Atherosclerosis	10
7. Liver Cirrhosis	7	7. Sepsis	8	7. COPD	9
8. Drowning	6	8. Renal Disease	6	8. Diabetes Mellitus type 2	8
9. Vehicular Accident	4	9. Bronchial Asthma	5	9. Pulmonary Tuberculosis	8
10. Colon Cancer	4	10. Traumatic Injuries	2	10. End Stage Renal Failure	7

Aguilar. The top 3 most common causes of mortality are upper respiratory infection, acute/ bronchitis, hypertension, and gastro enteritis, which often are considered illnesses of the poor. What is also glaring is that otitis media figured in the top 10, in 2011 (**Table 2.4-24**).

Table 2.4-24. Aguilar: Ten Leading Causes of Mortality (2013 – 2011)

2013	No.	2012	No.	2011	No.
1. Upper Respiratory Infection	1589	1. Upper Respiratory Infection	2241	1. Upper Respiratory Infection	222 8
2. Hypertension	1009	2. Bronchitis	588	2. Bronchitis	377
3. Acute Bronchitis	331	3. Acute Gastroenteritis	387	3. Hypertension	220
4. Urinary Tract Infection	165	4. Urinary Tract Infection	222	4. Age	195
5. Acute Gastroenteritis	144	5. Hypertension	222	5. Urinary Tract Infection	179
6. Arthritis	133	6. Wounds	145	6. Wounds (all kinds)	136
7. Wounds (all kinds)	110	7. Furuncle	102	7. Dengue	120
8. Vertigo	54	8. Bronchial Asthma	68	8. Anemia	100
9. Anemia	52	9. Conjunctivitis	38	9. Gastritis	71
10. Bronchial Asthma	41	10.Oral Thrush	35	10. Otitis Media	71

With regard to the leading cause of morbidity in the last three years, data from the Municipal Health Office during the period under study, the Upper Respiratory Infections leading the list. It has 1,589 cases in the year 2013 and hypertension with 1,009 cases listed as the second. Official records show that no epidemic has ever occurred in the municipality for the last 10 years.

2.4.9.3 Environmental Health Sanitation Profile

Aguilar. A Material Recovery Facility is located within the 2.5 hectare lot owned by the LGU; vermi-composting is utilized at the site. The temporary segregation site thereat is controlled via use of a meshed wire-fence, while re-segregation activity at the site is being undertaken.

Mangatarem. The Municipality operates a controlled dumpsite located at Barangay Sapang with an area of (6.5) hectares. Segregation of waste is highly encouraged and only residual waste is brought to the controlled dumpsite facility.

The daily collection of garbage in the Municipality is being taken care of by the Municipality Solid Waste Management Boards (MSWMB). The households are involved in solid waste management. Families and individuals are encouraged to do their composting in their backyards and do segregation of their solid wastes.

The Municipality of Mangatarem has an existing land area for solid waste management/ controlled dumpsite, the 6.5 hectares controlled dumpsite located in Barangay Sapang with Material Recovery Facility also developed within the barangay having an area of 7,614 square meters.

2.4.10 Socio-Economic Data

2.4.10.1 Main Sources of Income

The main sources of income in the province would be agriculture, mainly mangoes and hollow-blocks making. Mangatarem and Aguilar are mostly farming communities which produce rice. Mangatarem is known for making native charcoal-roasted native roll, called tupig.

2. 4.10.2 Employment Rate/Profile

Aguilar. In Aguilar, 14.88% of the males are employed, and half (50.8%) the male population is not employed (**Table 2.4-25**). While 12.13% of women are employed, and practically half (49.2%) of the female population is not employed. About 2,666 males and 3,073 females are not in the labor force, for a total of 5,739. With these numbers, it is not surprising that poverty is relatively high.

Table 2.4-25. Aguilar Labor and Employment Rate

Sex	Population 15&+	Employed	% Employed	Unemployed	% Total Unemployed	Not in Labor Force
Male	13,109	1,950	14.88	8,493	50.8	2,666
Female	12,917	1,567	12.13	8,227	49.2	3,073
Total	26,026	3,517	13.51	16,720	100.0	5,739

Mangatarem. In Mangatarem, two-thirds of the males are employed, and half that (a third) are not employed (**Table 2.4-26**). More than half of women are employed, while about 40% are not employed. About 15,000 males and 14,500 females are not in the labor force.

Table 2.4-26. Mangatarem Labor and Employment Rate, 2007

Gender	Population 15&+	Employed	% of PopuLtion	Unemployed	% of	Not in Labor Force
Male	20,639	13,778	66.75	6,861	33.24	15,045
Female	19,830	11,476	56.87	8,354	42.12	14,455
Total	40,469	25,056	61.81	15,215	37.68	29,500

From a national unemployment rate perspective a 37% unemployment rate is alarmingly high. However, it must be noted that in rural areas, mothers tend to be full time housewives, while at the same time providing some support to farmwork. What is also relevant is the relatively high unemployment rate among men which stands at 33%.

2.4.10.3 Sources of Livelihood

Aguilar. Because of the majority of vast farmlands in Aguilar, The major crops planted in the municipality are Rice, Corn, Vegetables, Mangoes, Luffas and other crops. Aguilar is also engages in Poultry and Livestock Raising including Cows, Pigs, Carabaos, Goats, Chickens and Domestic Ducks. Tourism is also a booming industry in the municipality due to the sudden growth of tourists visiting; due to this, various resorts has been established in various locations.

2.4.10.4 Poverty Incidence

In 2003, poverty incidence in Aguilar was reported to be 31.64, and 31.22 for Mangatarem (**Table 2.4-27**); they ranked 1000, and 1013 respectively among municipalities in the Philippines. In terms of number of persons, this meant 10,809 and 19,369 persons, respectively. This is a significant number[24,25]. Though apparently there has been a rapid decline in poverty incidence in both municipalities from 2003 to 2012. This decline in poverty is likely associated with the implementation of 4Ps, over these municipalities. In 2006 and 2009, Aguilare decline in Poverty Incidence was much better than Mangatarem. However, by 2012, Mangatarem closed the gap, and the score of both municipalities became quite near each other (0.62% difference). This may have been a result of implementation effectiveness either resulting from governance or participation of beneficiaries.

Table 2.4-27. Aguilar and Mangatarem Multi-Year Poverty Incidence Data

Municipality	2003	2006	2009	2012
Aguilar	31.64	26.0	15.0	9.98
Mangatarem	31.22	30.8	25.5	10.6

[24] *2003 City and Municipal Level Poverty Estimates https://psa.gov.ph/sites/default/files/2003%20SAE%20of%20poverty%20%28Full%20Report%29_1.pdf*
[25] *The 2012 Municipal and City Level Poverty Estimates. https://psa.gov.ph/sites/default/files/2012%20Municipal%20and%20City%20Level%20Poverty%20Estimates%20Publication%20%281%29.pdf*

2.4.10.5 Commercial Establishments and Activities

There are limited commercial establishments in Mangatarem and Aguilar. There is a sprinkling of restaurants and hotels, which are not classified as one-star, and these are usually owned by locals. These are usually located in the town proper, and not in the rural areas. Rural folk are not likely to buy from these establishments. The establishments serving the rural folk would be the rice mills, farming supply store (such as Angel House of Cockers), sari-sari store, gasoline station (Total, which is 1 km away from Magic Mall), and a wet market, which are there to serve the basic needs of rural folk. Other commercial establishments are there which mainly serve the urban population.

Mangatarem would have Puregold, Magic Mangatarem, CSI Mangatarem, Andok's, 7-11, fastfood stores (Mc Donald's, Jollibee, Mang Inasal, Andok's), bike shop, motorcycle shops (Yamaha 99 store, Motor Trade, SYM), coffee shop (Tribu), gift shop, bake shop (Mar Johann), mini-mart, appliance center, inn/ lodging house, upholstery store, funeral homes, seeds stores, medical clinics, trading stores (agriculture supply, food and beverage, dry goods), burger stands (Big Mak), drug stores (Mercury Drug, Raven, St. Joseph Drug). Petron Gasul delivers. PR Gaz has an outlet. There is also Magic Mall and CS Mall. In Magic Mall, one finds the Philhealth Office, Cindy's Bakery, Western Union, Magi Changer, and St. Joseph Drug. There are also small dining places, such as RNR Bulalohan and Eatery, and Tiny House). There is also a truck that delivers ice from Tarlac. There is a small electrical and radiator shop, beside a motorcycle supplies store. Royal Palm Plaza, which houses some offices, 7-11, and a separate building for Metro Bank. There is a hardware beside it (Top North). There is a multi-specialty clinic (Duque et al.), and beside a law firm (Soriano). There is a dress shop (Amy's), and an electronics shop beside it. There is a small LPG retailer, which sells mixed brands (Cuenta Gas). There is a wooden furniture store, which makes cabinets and aparadors, and sala sets, and across it, a furniture store, which makes bamboo sala sets, door frames, rocking chairs with wooden frame and wicker. Beside this is a motorcycle parts and electronics store, which doubles as a sari-sari store, with basic construction material such as cement, shovel and others. There is also a place which rents out plastic chairs. In the more interior areas (Zamora Street), there is a welding shop and hardware store which carries a good amount of cement bags. By the corner of the highway across Motortrade is a store that sells oils and lubricants; besides Motortrade is a photocopying and rush ID photograph store.

Establishments in Aguilar are found mostly along the highway. Its town center is around a fourth of Mangatarem's (1km x 2km) and it has not evolved yet. It does hold a few things like pawnshops, restaurants, dress maker shop, drug store, convenience store (7-11). In addition one finds the following types: rice mill (Evangelista, Servando Rice), drinking water (VSB Mineral Water Station, Calica Water Refilling Station, Biogreen Mineral Water), unmarked rice mills or warehouses, gasoline Station (Prime Energy, Petron, Centrum, Flying V) places for rest and recreation (Casa Minguillo, which is a local hotel), food and beverage (Abba's Tea , V. Limos Eatery, Pep's Resto Bar), produce trading (Aida's Bagoong, Aguilar Public Market, Bagsakan Wet and Dry Market), trading of goods (Nicko Gab's Store, Grace Mark Enterprise, Star Rock Hardware, Aguilar's Builder Enterprise, Abalos-De Leon Trading and Agri-Supply, JN/RM Agri Supply), pharmacy (The Generics Pharmacy, Abalos Pharmacy, All Star Pharmacy), sari-sari store (Bella's, Tuazon, Mary Jane, Cancino, close shop,) and education (Zaratan Educational Institute, public school). There are also some sheds for selling fruits in front of houses, along the highway.

Following is a listing of other establishments and types of establishments. Ang Dating Daan which hosts a motorcycle repair shop, a steel frames fabricator, and glass and aluminum supply. Lire Enterprise (motorcycle parts and supplies). Adessa Outlet (installment of appliances), softdrinks and snacks grocery store, a dental clinic, Dumlao Notarial Services, a grill house and videoke, a small t shirt printing and signages business. A small café and canteen (Star Lucks, and a small pizza vendor (King's). Evangelista Lao Bakery and Grocery Store. A medical clinic, money changer, clothes shop. Small shops including: motorcycle parts, feeds for chickens, smart shop and t-shirt printing, salon. Zaratan Jimenez Clinic and Hospital.

2.4.10.6 Banking and Financial Institutions

At the main highway, the entities include some multipurpose cooperative, pawnshops, rural or thrift banks (Rural Bank of Pangasinan, Producers Bank, BHF Bank, Rural Bank of Anda, Gulf Bank/ Rural Bank of Lingayen), and commercial banks, such as Metro Bank, HSBC. The situation in Aguilar is slightly different in that, it has less commercial banks, and more rural banks, by proportion. There are pawnshop (Cebuana Lhuillier, Villarica), and financial courier service (Western Union)

Aguilar has fewer banking and financial institutions (Rural Bank of Burgos Aguilar, St. Patrick Pawnshop, Bangko Mangaldan, Asenso Pangasinan Credit Corporation, St. Patrick Pawnshop, Jenica's, Western Union, Rural Bank of Anda, A+ Lending).

2.4.11 Gender Responsiveness

During the survey, there were no female headed farming household that were identified. Population data is generally gender disaggregated, and this is useful in schools, health and other social services delivery. For the irrigation project, irrigation does not differentiate if a farm is worked on by male or female. However, in cases wherein there are women farmers, NIA shall address this, and provide preferential treatment, especially if the male is deceased or diseased. NIA shall also refer the case to the MSWDO or DSWD's Conditional Cash Transfer Program, especially if there are children of schooling age.

2.4.12 Perception Survey

A Perception Survey was done in April 22-25, 2019 regarding the proposed Project using a Questionnaire Form (**Annex ES-5**). To determine the sample size, the 2010 population of Pangasinan was projected for 2019. The required sample size for the survey was determined using a 95% confidence interval, at 5% degree of certainty, which generated the number 145. This was allocated using barangay population as an estimate for allocation.

2.4.12.1 Respondent's Profile

Of the 145 respondents, majority were household heads (59%), or their wives (21%). In some cases the son (7%), daughter (6%), son-in-law (1%), daughter-in-law (1%), or grandfather/ mother (2% + 1%) were the respondents (**Table2.4-28**). Of the respondents, 88% were married, while 12% were single; 69% were male (**Table 2.4-29**). Almost 70% of the respondents were male (**Table 2.4-30**).

Interestingly, 23.4% are college graduates, about an equivalent half of this number are vocational course graduates (**Table 2.4-31**). Majority of the college graduates are either nurses or teachers, suggesting that the college degree of choice may be largely driven by economics, as these are the higher earning courses if the graduate goes abroad. Then there is the additional fifth who are college undergraduates, and twice that who are high school graduates, suggesting the level of importance education is given in the lives of the communities.

Table 2.4-28. Aguilar Highest Educational Attainment Population, 2010

Respondent	Percent of Respondents
Household Head	59
Spouse	21
Son	7
Daughter	6
Son-in-Law	1
Daughter-in-Law	2
Grandfather	2
Grandmother	1
Sister	1

Table 2.4-29. . Frequency Distribution of Respondents by Civil Status

Civil Status of Respondent	Percent of Respondents
Married	88
Single	12
Separated/ Annulled	0
Widowed	0
Total	100%

Table 2.4-30. Frequency Distribution of Respondents by Sex

Sex	Percent of Respondents
Male	69
Female	31
Total	100

Table 2.4-31. Frequency Distribution of Respondents by Highest Educational Level

Highest Level of Education	Percent of Respondents
Highschool Undergraduate	2
Highschool Graduate	41
College Undergraduate	20
College Graduate Unspecified	4
Teacher	8
Nurse	8
Engineer	1
Seafarer	1
Business Adm/ Commerce	2
Senior High School student	2
Vocational Graduate	12
Total	100

There were no reported PWDs or persons with special needs among the 145 household respondents.

In terms of employment situation,64% are gainfully employed working at least 40 hours weekly, a fifth are unemployed, a fifth are unemployed who maybe looking for work or have worked in the past, there are those too young or too old to work (14%). A small portion who can work, and who are in the employment age of the population consider themselves not in the (job) market (2%), and so are not classified as unemployed (**Table 2.4-32**)

Table 2.4-32. Frequency Distribution of Respondents by Employment Status

Employment Status	Percent of Respondents
Employed working at least 40 hours of work	64
Unemployed but looking for work or have worked in	20
No job and have not worked in the past or not	2
Too young/old to work	14

From the socio-economic survey, following are some of the key findings. In terms of work location, 7 are abroad, 16 work in other municipalities, 5 work in the city, 2 work in other barangays, and 22 indicated that the question is not applicable to them. The rest are work in their own barangays.

In terms of Job Payment Category, about two-fifths receive some form or wage/ salary, and nine-twentieth (45%) are self-employed. For the rest, the category does not apply, which means they are likely not employed (**Table 2.3-33**).

Table 2.4-33. Frequency Distribution of Respondents by Job Payment Category

Job Payment Category	Percent of Respondents
Wage/ Salary	39%
Self-employed	45%
n/a	16%

Of the households surveyed, respondents were usually farmers (41.4%), professionals (17.9%), or not working (17.9%), or working in government (13.1%) (Table 2.4-34). A few worked as clerks (1.4%), service workers (6.9%), trades and related workers (0.7%). This means t
Job by Industry Sector:

Responses to these question fall mainly under four categories, farmers mostly fall under agriculture (2/5), health and social work (1/5), none (1/5), and a few other items (1/5) (**Table 2.4-35) t**hat the poor who can work, do so in farms or in services and other blue collar jobs, those who are able to study become professionals or tend to work in government. There are no heavy or light industry workers in the area, which is consistent with the structure of the economy.

Table 2.4-34. Frequency Distribution of Respondents by Occupation Category

	Occupation Category	Count, #	%
1.	Officials of Government and Special Interest Orgs, Corporate Executives, Managers,	19	13.1
2.	Managing Proprietors and Supervisors	1	0.7
3.	Professionals	26	17.9
4.	Technicians and Associate Professionals	0	0.0
5.	Clerks	2	1.4
6.	Service Workers, Shop and Market Sales	10	6.9
7.	Farmers, Forestry Workers and Fishermen	60	41.4
8.	Trades and Related Workers	1	0.7
9.	Plant and Machine Operators /Assemblers	0	0.0
10.	Laborers /Unskilled Workers	0	0.0
11.	Special Occupations	0	0.0
12.	None	26	17.9

Table 2.4-35. Frequency Distribution of Respondents by Job Industry Sector

	Job Category by Industry Sector	Count, #	% of Total
1.	Agriculture, Hunting, Forestry and Fishing	59	40.7
2.	Mining and Quarrying	0	0.0
3.	Manufacturing(raw material to a product)	0	0.0
4.	Electricity, Gas and Water	0	0.0
5.	Construction	1	0.7
6.	Wholesale/ Retail Trade, Repair of Motor Vehicles,Motorcycles and Personal and Household Goods	7	4.8
7.	Hotels and Restaurants	0	0.0
8.	Transport, Storage and Communication	3	2.1
9.	Financial Intermediation	1	0.7
10.	Real Estate, Renting and Business Activities	0	0.0
11.	Public Administration & Defense,	9	6.2
12.	Compulsory Social Security	0	0.0
13.	Education	0	0.0
14.	Health and Social Work	31	21.4
15.	Other Community, Social & Personal Service Activities	1	0.7
16.	Private Households with Employed Persons	3	2.1
17.	Extra-Territorial Organizations & Bodies	0	0.0
18.	None	30	20.7
	Total	145	

2.4.12.2 Perception Survey Results

A good majority of the respondents knew about the project prior to the survey (85.5%) (**Table 2.4-36**).

Table 2.4-36. Frequency Distribution of Respondents by Prior Knowledge of Project

Prior Knowledge of Project	Percent of Respondents
Yes	85.5%
No	13.8%
n/a	0.7%

Majority believe that the project benefits would be good (97.2%). A small portion of the population declared that they do not know (2.1%), and a smaller portion shared no answer (0.7%) (**Table2.4-37**)

Table 2.4-37. Frequency Distribution of Respondents *by Would be Effects* of Project

Would be Effects of Project	Percent of Respondents
Good	97.2%
Bad	0.0%
I don't know	2.1%
No Answer	0.7%

The project is seen as a big help to farmers in the barangay (22.1%) or to livelihood (0.7%), the delivery of the irrigation system (27.6%), increased yield (44.1%), reduced fuel cost and increased yield (0.7%), and delivery of the irrigation system and increased yield (3.4%). There are respondents who said that the question does not apply to them (1.4%) (**Table 2.4-38**)

Table 2.4-38. Frequency Distribution of Respondents by Benefits of Project

Benefits of Project	Percent of Respondents
1. Big help to farmers in barangay	22.1
2. Big help to livelihood	0.7
3. Delivery of irrigation system	27.6
4. Increased yield	44.1
5. Less fuel cost & increased yield	0.7
6. Delivery of irrigation system & increased yield	3.4
7. n/a	1.4

While respondents believe in the benefit of the project to the communities, they are, in general concerned about possible dam breakage (22%) with flooding (14.5%), possible flooding (27%), and flooding (18%). A small portion of the population is settled with the thought that they are too far to be affected (3.4%), no effect (7%), I do not know (4%), and not applicable (4%) (**Table 2.4-39**)

Table 2.4-39. Frequency Distribution of Respondents to the Negative Effects of the Project

Possible Negative Effect of Project	Percent of Respondents
1. Possible dam breakage	22.1
2. Flooding, if dam breaks	14.5
3. Flooding, maybe	26.9
4. Flooding	17.9
5. Malayo na kami: guho, baha, pero imposible	3.4
6. Wala	6.9
7. hindi ko alam	4.1
8. n/a	4.1

The Information Education Campaign presented some information about the project at the municipal level and barangay levels. However, representation was limited, because of resource constraints. An Initial Perception Survey was conducted. There is evidence that there were representatives from communities concerned with how the watershed would be managed, the notion of dam failure and the problem of shift in water supply.

The learnings from FGDs were the following:

- Farmers commonly experience the following:
  - current water supply is not adequate for three croppings for all
  - during summer some farm lots across their barangay are not able to perform third cropping,
  - second cropping dependent on water pumps already
- Some farmers they know of were performing one cropping only but are rare.
- dependence on water pump removes a significant amount from their income.
- All FGD participant are dependent on farming except one, who is a ‘kagawad’.
- All agreed that water is continuous during wet season but is disrupted and barely enough during dry season. A water pump must be installed.
- Farming is a family practice, on their own respective farm lots, except for two who have less than ten years experience.
- None of the respondents could estimate their lots’ water consumption and cannot determine the number of beneficiaries.
- All of them were able to harvest more than forty cavans but below 100 cavans and earns not less than ten thousand and can increase up to Php 27,000 Net Income on one good harvest with relatively good gate price..
- None received free seedlings and/or fertilizer from their respective barangay/FA. It is not consistent and very rare according to them. The supply comes from the municipal office, one participant claimed, and that it will be distributed for 30 farmers only all over the barangays of the said municipality.
- All participant agreed that the dam will greatly help the water supply. Two of them said that they have been actually waiting for this project.
- All of them were interested on the involvement of FA/IA in the management of irrigation canals and the dam. They also expressed their gratitude for the project.

Participants are anticipating the completion of the project, some asked the timeline of the project. A bayanihan system for irrigation canals maintenance was suggested to ensure water supply is efficient and reliable.

From the FGD on dam breakage: the sources of information of the participants was mostly hearsay. In any case, since they have no other sources of information, it is their only source of information. They think that the dam might break, and that it might break in certain parts, such as the canals or diversion dams being chipped. Those living near the river are the most worried. There are suggestions about hiring a third party geologist to do assessments etc, which obviously they do not is part of the design processes (geologist with NIA, MGB, during FS, during EIA, geotechnical engineer during DED). There is a lack of understanding of the design of the dam and the whole irrigation system, and the rigor that goes with it. They also do not understand the standards that are being followed in undertake FS, EIA, DED, and EPC. They have no handle of how the dam looks like. No one among them has seen a dam such as what will be put up in the area. Most of the suggestions being made are already part of the project cycle methodology. This means that there is a lack of understanding also of the design processes, in addition to the system and its design. Thus an important task is not just to address the fear about dam breakage, but understanding the design, the system and the design standards, and processes, and the compliances which the project has to comply with.

From the FGD on watershed management, the findings are as follows:

- The forest is denuded and mainly composed of grass in some areas instead of trees.
- it is difficult to nourish trees to grow.
- Historically there was illegal logging in the past, which has made the soil barren, and forest fires frequent.
- There is an assertion that forest fires might be human-induced for hunting purposes.
- There are no forest guards or wardens or systems of monitoring the mountains to prevent forest fires.
- There is no adequate support from an NGP for these interventions except for the support for planting and planting material.
- There are transition issues and irregularities in the local NGP management.
- Government support at the moment is insufficient.

2.4.13 Impact Assessment and Options for Mitigation and Enhancement

2.4.13.1 Displacement of Settler/s

The proposed accessed road route would start from a one lane dirt road between Bayaoas River and residential areas in the last few houses at the western part of Barangay Bayaoas. The nearest structure with roofing is about 12 meter from the propose route, and the affected road segment is only about 10 m. Any road widening to effect an 8-m road can be towards the riverside, avoiding the existing fence. In other words, no houses would be traversed towards the damsite. As a result, no resident will be resettled to necessitate a Resettlement Action Plan

2.3.13.2 Displacement / Disturbance of Properties

The proposed road route would traverse vegetation such as trees in private lots to be addressed by the Just Compensation Package as required by Republic Act No. 8974, otherwise known as “An Act to Facilitate the Acquisition of Right-of-Way (ROW), Site, or Location for National Government Infrastructure Projects and for Other Purpose.

2.4.13.3 Change/Conflict in Land Ownership and Right-of-Way

Since the proposed access road will be located in private lots, a right-of-way under RA 8974 for the Just Compensation Package. NIA will endeavor to identify land ownership issues including change/ conflict in land ownership, which may burden families in fully benefitting from the NIA BSRIP. NIA acknowledges that such land ownership issues sometimes span generations and remain unresolved, or sometimes become properties under conflict of various claimants. In which case, NIA, as part of due diligence may undertake a survey on situation of lands, so that tenure issues may be resolved at the soonest possible time, so as to benefit the proper individuals/ families from the NIA project, through programs of other government agencies, such as the Department of Agriculture (DA).

2.4.13.4 Land Use Conflict at the Damsite

The land use conflict at the damsite and reservoir pertains to the National Greening Program areas of DENR. A Special Land Use Permit for will be obtained with a condition to compensate the efforts by negotiation the NGP Operators, not necessarily by pecuniary but in other forms such as provision of seedlings.

2.4.13.5 Impact on Public Access

In general, it is not expected that the project shall affect public access to their residence, livelihood, service facilities, schools, roads, markets, highways or communal or other common spaces, where necessary and feasible, the project shall address these issues, such as for example, providing ramps for farmers and animals so that they could cross to their farms, or access their orchards or fishing grounds, or their ports of destination. As part of post ECC requirements, NIA may undertake surveys, consultations, or key informant interviews, mapping or rapid assessments as may be deemed important, or needed, and as may be required by the EIA Review Committee.

2.4.13.6 In-migration /proliferation of informal settlers

The project is not expected to induce in-migration or proliferation of informal settlers, because 1) in-migration tends to be towards service areas and more urbanized areas, and the site is a highly rural area, with very much defined allocation of arable lands; 2) there is very limited access to the area, as well as limited resources that can be accessed by non-locals, compared to moving towards the more peri-urban area of the towns nearby whether of Aguilar, Mangatarem or other areas; 3) there is no openly accessible resource base that will serve as an attractor to in-migration, whether it be driven by the resource itself, political or economic interests.

2.4.13.7 Cultural/Lifestyle Change (especially on Indigenous People, if any)

NCIP has issued a Certificate of Non-Overlap (as cited in Section 4.0 under the People Module). It does provide a safeguard that, should there be findings that there are indigenous peoples, indigenous cultural communities, ancestral lands, ancestral domains, or ancestral domain titles over the area, NIA shall undertake necessary social assessment activities, including development of IP Development Framework, and plans, as the need arises, possibly in cooperation with relevant government agencies, such as NCIP, and DSWD.

2.4.13.8 Impacts on Physical Cultural Resources

This is not applicable to the project from the point of view of indigenous people or indigenous cultural communities as mentioned in Section 4.3 above. Should there be historical finds, NIA is required by various laws and issuances on cultural heritage to stop any construction or related activities, and contact the National Museum or possibly relevant institutions (as the national museum may allow or required, within the bounds or law, and constraint of resources) or persons who can do Preliminary or Detailed Archeological Site Assessment, pertinent to such archeological finds.

2.4.13.9 Threat to Delivery of Basic Services /Resource Competition

The project is not expected to threaten delivery of basic services; it is in fact a project for the delivery of basic services, which also complements the various social services being delivered to the poorer sector of society.

2.4.13.10 Threat to Public Health and Safety

The project is not expected to be a threat to public health and safety once it becomes operational except for minor risks which may be associated to truancy such as drunk swimming in the dam area or falling into the dam, in which case, as a part of the Operational System of NIA, such risks, among others, shall be considered. Associated risks that may arise such as the increased use of chemicals in agriculture, shall be monitored by way of technical studies, more than monthly monitoring, such as the potential increase in nitrates, and phosphates in the water column, or the increase in coliform associated with the more populous part of the beneficiary and non-beneficiary areas. These situations are, however, expected to be covered by the programs, such as DA's program on information, education program on the use of agriculture-related chemicals, and social services program of DSWD such as the conditional cash transfer program, Kapit-Bisig Laban sa Kahirapan – Community Integrated Delivery of Development Services (KALAHI-CIDDS), the zero open defacation program of the Department of Health, and the policy on Water Supply Safety Program to ensure that all potable water supply systems have water safety plans. NIA shall endeavor to share information such as these with the barangays, beneficiaries and the irrigators' associations.

2.4.13.11 Generation of Local Benefits from the project

Some local benefits from the project may be had through limited enhancement of employment and livelihood opportunities, increased business opportunities and associated economic activities, and some increased revenue of LGUs.

2.4.13.12 Enhancement of Employment and Livelihood Opportunities

For some areas, there will actually be a reduction in their farm outputs, owing to the reduction in water supply to support from instead of 3 to become 2 rice production cycles, while for some areas, the change shall be from 1 to 2 rice production cycles.

2.4.13.13 Increased business Opportunities and Associated Economic Activities

Related to the above, there may be those who provide inputs in terms of goods or services to rice-production who may experience some increase in income. Some farmers may experience some increased income from the fish cages in the dam which will be a replacement livelihood activity for those whose lands may particularly be affected by the project.

2.4.13.14 Increased Revenue of LGUs

The LGU may expect a slight increase in taxes from businesses that benefit from increased agricultural activities, such as the sale of inputs (chemicals, farm tools, fuel, rice cavans, seeds), sale of equipment (and spare parts) sale of rice outputs (rice).

2.4.13.14 Traffic congestion

The project is not expected to cause traffic congestion. However, it is expected that the project will double yield in some areas, but possibly reduced yield in some areas by one third, as a result of the shift of the water supply from excessive available water during the rainy season to having water available during the dryer months, and shifting from areas which may have had 3 cycles of rice-production per year to two cycles, and in some areas from one-cycle to 2-cycles of rice-production. So that during production seasons there may be minor adjustments in movement of vehicles which may be carrying farm inputs, farm equipment, farm wastes, and farm outputs in the course of the rice-production cycle.

2.4.13.15 Impact Assessment from the Community Point of View

From the Preliminary Perception Survey, and IEC, the key concerns that were raised were the following:

- the loss of water from those in (Bayaoas and Pogonsili) who are currently able to irrigate their fields three times a year, because of the availability of water to them;
- flooding in some areas due to excessive supply of rain water;
- the (risk perception of a) potential dam breakage, based on stories of dams in other places (though specific sites that were identified San Roque, did not really suffer from such);
- the LGU of Aguilar was concerned about the process because they felt the lead time for the the notice of meeting given to them as councilors was too short (later it was learned that the incumbent mayor was sick, and that it was the wife who was acting as mayor in behalf of the husband, and that there were other political concerns, including a barangay captain who had interest in illegal quarrying which had no permit, and was sourcing at the toe of the would be location of the dam, and they were using the would be top of the dam surface as the road for their quarry vehicles).

Subsequent IECs and FGDs were able to address these issues, as seen later in the Socio-Economic Survey, wherein the view about the project was positive that it will benefit the farmers. On the matter about the possible negative effects of the project the ideas put forward are discussed in the next paragraph. There was also word that the barangay captain who was expressing resistance to the project (because of the quarrying interest was discussed and resolved indicating that it was not necessary that the quarry business will close given the irrigation project; plus the fact that some parties intervened in behalf of the project). During IEC and the survey there were also some persons who said that a geologist had to be hired to make sure that the base of the dam was solid. (Of course this was already done as part of the previous study: Feasibility Study, and that during the EIA, specific concerns were also again evaluated by a geologist.)

The Socio-Economic/ Household Survey included a Perception Survey component which showed that, about 85% of the respondents (145) knew about the project, and have positive perception that the projects will have benefits (**Table 2.4-37** Would be Effects of the Project), and no one said that the project will have bad effects. They believed that these benefits will redound to farmers, livelihood, having and irrigation system, and increased production, as discussed above (**Table 2.4-38.**). Yet, when probed, they said that the dam might break, that it might result in flooding, that there might be flooding, that there will be flooding, that however, they are too far from the location. Further, when asked if they needed to relocate and what support they needed, not one of the respondents thought that they needed to relocate or that they would need anything. One respondent deviated from all by responding *depende* in both instances. In all instances it indicates, that while respondents appreciate the benefits of the project, initially declared that there won't be negative impacts, but when probed, identified perceptions of risks, and that there is no need to relocate or support to relocate, it is saying that there is a need for the community to understand the project better, and to participate in grasping the design of the project, their notions of risks, the actual technical risks, the design considerations, and the safeguards in place or to be put into place.

From the FGDs on water supply the resources available to them are generally not enough, there is practically no support coming from government in terms of seeds, fertilizers, pesticides, knowhow, irrigation, or access to market. As a result, the income derived from farming at 40 to 100 cavans output (equivalent to about 1.6 to 4.0mt/hectare), which translates to a net income of PhP10 to 27,000 for 4 months of work is very low to low. There is openness among them to participate in the management of the irrigation system. They are grateful for the project.

From the FGD on dam breakage: there should be a number of sessions with them to cover psychological and social concerns, as well as technical concerns. One part is mind shift, the other part is information sharing. For the mind shift, it is important to allay their fears by sharing initial information and processing their perceptions, without being dismissive, but to point errors in fact and perception. For the technical part undertake information sharing about the design, the system and design standards, design processes, and the compliances which the project has to meet. There is particular interest in a geological study, but it is not sufficient, as it should also link this to the design, construction, operations and maintenance and emergency procedures in the management of the irrigation system. It will benefit the process if the community is able to visualize the dam, not limited to a flat screen, but to tangible objects or 3D models, actual site visits, peer component review, process review, standards review, review of qualification standards used in procuring expertise, experts qualifications or CVs, operations and maintenance frameworks (management system shall be provided as part of training). This is the most sensitive part of the project, and proper attention should be given to it. If done properly, it could serve as a model and other NIA projects could benefit from it.

From the watershed concerns: prepare a long term watershed management plan, particularly monitor areas of slides, erosion, slumps, and the like, and use this as triggers for initiating action. Set up a watershed management team, and institutional arrangements around it. Link watershed management to other efforts, and activities, such as the National Greening Program, the protected area systems, forest activities, bird watching and the like. As part of the watershed management plan, an action plan has to be developed including an identification of watershed management issues and concerns, desired ideal state, action required, resources required, management and monitoring required. An indicative workplan and longer term time table has to be developed.

From the Socio-Economic Survey/ Household Survey, it is imperative that communities go through the process of understanding the design of the project, and the irrigation system, including the context on why the irrigation system is being put up, what problems or issues it is trying to address, the objectives, the approach and methodology, and what metrics will be used to monitor the success of the project. It is important that the IEC, group discussions be done, repeatedly, a number of times on the issues that are not clear, or for which they are not sharp. Focus especially on the problem of perception of risk, yet, they do not see any point in having to relocate. (A matter related to this is the need to address the long term concern of education particularly literacy, which should be part of the inclusion in the surveillance/ targeting by 4Ps as part of social services delivery. The challenge of educating beneficiaries about the project is as much a long term concern of education wherein communities rely on gossip more than facts in developing their notions about the project.)

3. ENVIRONMENTAL MANAGEMENT PLAN

A summary of impacts and options for mitigation by project activities and environment component is presented in **Table 3-1** which also includes the responsible entity, cost and guarantee of funding, in accordance with the format in in Annex 2-17 of RPM for DAO 2003-3. This is with reference to the discussion in the preceding sections which already incorporates the disaster risk reduction measures.

Overall, the potentials impacts of pre-construction and construction phases would the conversion of private lands to access road to damsite (a public benefit), encroachment in the National Greening Program areas at the damsite, removal of vegetation, temporary deterioration of Bayaoas River water with localized effect on aquatic ecology (due to excavations, accelerated soil erosion, siltation, sewage discharge, truck washings discharge, risk of oil or fuel oil spillage), intermittent increase in the local total suspended particulate matter, intermittent increase in the noise, increase in traffic along the Bayaoas or Pogonsili barangay road, increase in the local solid waste production. These impacts are all manageable with mitigation measures to be in place and recovery capacity of the environment.

The potential long-term impacts are: change in the land use from private lots to access road to damsite, from NGP areas to damsite and reservoir, loss of vegetation, emergence of new aquatic ecology at the reservoir area, and the benefits of long-term reliable water supply during the dry season for the increase in rice production.

The mitigating measures will be translated to different focused environmental management plans and inclusive of the environmental requirements for the contractors, as follows:

i. Right-of-Way Acquisition and Compensation Plan (to be developed and implemented by the proponent)
ii. Contractor environmental and social operations plan (to be prepared by the contractor, inclusive of mitigation measures identified and to be identified)
iii. Community Relations Plan
iv. IEC Plan
v. Social Development Plan (focused on capacity building for environment conservation)
vi. Equitable Irrigation Water Supply Plan
vii. Dam Watershed Management Plan (for the objectives of water collection, storage and conservation, and addressing the impacts of the reservoir and dam)

The plans will be flexible, updated and adaptive to prevailing site-specific conditions and in coordination with various stakeholders. A full-time Environmental Officer, with support staff will be employed.

Table 3.1 Summary of Environmental Management Plan

Project Phase / Environmental Aspect	Environment Component	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost (Preliminary Estimate)	Guarantee / Financial Arrangements
1.0 PRE-CONSTRUCTION PHASE						
1.1 Siting and negotiation of the Project Development Footprint and location of support facilities; access roads to damsite, access irrigation canals, staging area, basecamp, quarry site, spoil disposal site	The Land	The proposed Project would cause permanent and change in land use to built up area from agricultural area, and idle areas for the access road at the alienable disposable land, and from NGP areas for damsite and reservoir area in the forest land. Revision in the LGU landuse map [No local residents will be displaced, No IP claim in the area]	Detailed mapping and documentation of the areas physical characteristics, structures, land owners in the A&D areas (with cadastral survey), NGP Operators in the forest land, and other stakeholders, for detailed project footprint impact assessment Such change in land use is a consequence in development projects and requires proper coordination with the local government, national government agencies, residents and other stakeholders.	Proponent	P 2.0 million	For inclusion in the regular budget
			There will be acquisition of Right-of-Way, Special Land Use Permit, Tree-Cutting Permit, Water Permit, among others	Proponent	P1.0 million	For inclusion in the Project Budget
	The People	loss of private property, income at the proposed access road	Implementation of Just Compensation Package to affected landowners. This shall be guided by Republic Act No. 8974, otherwise known as "An Act to Facilitate the Acquisition of Right-of-Way (ROW), Site, or Location for National Government Infrastructure Projects and for Other Purposes"	Proponent	dependent on the valuation	For inclusion in the Project Budget
		Loss of planted trees and vegetation by NGP Operators	Implementation of Just Compensation Package to NGP Operators	Proponent	for negotiation	For inclusion in the Project Budget
		Change in the access route of NGP Operator, the reservoir as a barrier of access	Provision of walkway at the dam crest. Use of banca by NGP operators may be allowed subject to study and safety	Proponent	Part of Project Design	Part of Project Budget

Project Phase / Environmental Aspect	Environment Component	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost (Preliminary Estimate)	Guarantee / Financial Arrangements
			restrictions.			
		NIA as an added entity in the institutional jurisdiction of the area	NIA will be part of the Watershed Management Program of Bayaoas Watershed	Proponent	Part of regular work	For inclusion in the Project Budget
		Induced long-term proliferation of settlement at concrete road side without regard of setback or safe distance from the road	Increase the width of the right-of-way and early notice to residents on the regulatory set-back and safety considerations.	Proponent/ MMT	Part of Project design	
		Induced proliferation of informal settlers in the reservoir area	Settlement in the area will be prohibited	Proponent/ MMT	Part of regular work	
2.0 CONSTRUCTION PHASE						
2.1 Piloting, land clearing , earth excavations, at the proposed access road, staging area, basecamp, quarry site, spoil disposal site and dam, with the following associated civil works: • Disposal of excavated materials to spoil disposal area • Quarrying Works as source of rocks for the dam • Stockpiling of construction concreting materials (gravel and sand) • Filling of earth materials at dam	The Land	Removal of vegetation leading to wildlife habitat loss and fragmentation, reduction in the natural soil erosion control, acceleration of soil erosion, and decrease in carbon sequestration capacity of the area.	• Implementation of the conditions in the Special Land Use Permit and Tree-Cutting permit • Collection of cut wood for inventory, use, and disposition • Replacement planting. The proponent will replace the number of trees removed/cut thru planting of indigenous trees or endemic fruit bearing trees in the areas as advice by DENR. The number of seedlings for replacement will follow the DENR Memorandum Order 2012-05 “Uniform Replacement Ratio for Cut or Relocated Trees” item 2.2 “For planted trees in private and forest lands not covered under tree replacement will be 1:50 while naturally growing trees on the same area, including those affected by development projects will	Proponent/ Contractor	P5.0 million for the first year; P3.0 million in the succeeding year until full replacement	For inclusion in the Project budget

Project Phase / Environmental Aspect	Environment Component	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost (Preliminary Estimate)	Guarantee / Financial Arrangements
site This would cause localized vegetation removal; emission of dust, criteria pollutants and GHG; noise production; accelerated soil erosion; destruction of habitats; use of earth materials for the dam			have 1:100 ratio in support of the National Greening Program (NGP) and Climate Change initiatives of the Government."			
			• There will be gradual land clearing and removal of vegetation to provide sufficient time for faunal species especially with the non-volant to transfer on nearby habitat.	Proponent / Contractor	no cost involved	
			• Reasonable support for the National Greening Project will be given as part of the maintenance and management of the watershed for the Dam, with capacity building	Proponent	P2.0 million initially	For inclusion in the Project Budget
			• No hunting policy in the area			
		Addition of dam, quarrying, and spoil disposal area would cause localized change in topography	[Change in the land landform is part of development.]	not applicable	not applicable	not applicable
	The Water /People	Earthmoving activities will soil erosion potential at the construction sites and increase in siltation in TSS and browning of Bayaoas River especially during rainy season. Heavy siltation downstream of the	Option for mitigation includes the following • hauling of spoils to run-off controlled disposal site away from Bayaoas River • avoidance of excessive earthworks during rainy periods • construction of cofferdam with water diversion tunnel within Bayaoas River	Contractor	Part of Project Cost	Part of the bid requirements

Project Phase / Environmental Aspect	Environment Component	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost (Preliminary Estimate)	Guarantee / Financial Arrangements
		damsite along the river would discourage recreational activities (picnic and swimming)	to minimize soil and sediment transport			
		Excavation of soil depth at an average depth of 4 meter from the bank of the river up to dam crest and spill way would result in localized sedimentation along the river channel resulting in the burying the macrobenthos, clogging the fish gills, mortality of macroinvertebrates such as larval forms of aquatic insects, annelids (segmented worms) and molluscs (shelled animals), which serve as prey items for fishes and other aquatic animals	This is part of the residual impacts and can be compensated by the reservoir	not applicable	no cost involved	not applicable
	The Air / People	The main air quality issue for the proposed Project is the intermittent increase in dust emission and total suspended particulates (TSP) in the nearby residential area along the proposed access road to the dam site during the dry season or periods of the 3-year construction period. The critical segment of the access road near the residential area is about 200 m, and the nearest is about 15 meters from the proposed road. From the meteorological data there are 246 dry days a year. This may lead to temporary increase number of cases of upper tract respiratory	Excessive dust emissions will be prevented in the nearby residential areas by the following options: • avoidance of earthmoving activities during windy conditions and wind blowing towards the residential areas about south and east of the proposed access road. • scraping of thick dust along open road • water sprinkling of open road during windy conditions • immediate gravel lining of open • reduced speeds of vehicles in nearby residential areas	Contractor	P0.5 million for the sprinkler	For inclusion in the bid

Project Phase / Environmental Aspect	Environment Component	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost (Preliminary Estimate)	Guarantee / Financial Arrangements
		illness of the nearby residents, increase in dust deposition in houses, and soiling of clothes.				
		The operation of heavy equipment would cause emissions of criteria air pollutants at nuisance levels in in the proposed access road near the residential areas. the impact would just be about a month in the 200-m segment.	Heavy equipment will be well maintained to avoid emission of black smokes.	Contractor	Part of regular maintenance work	Part of contractor environmental commitment in the contract
		The operation of heavy equipment would also include greenhouse gases such as carbon dioxide (CO2) and nitrous oxide (N_2O).	[The GHG emissions would be addressed in tree planting activities and compensated by the discouraged use of diesel-run pumps to extract groundwater for irrigation, in the long term.	Proponent	Part of cost for tree planting	not applicable
		The operation of heavy equipment and passage of vehicles would cause intermittent increase noise levels the residential areas near the proposed access road. The impact would just be about a month in the 200-m road segment.	Options for mitigation include the following: • avoidance of activities that generate high levels of noise such as pile driving in the morning and nighttime. • avoidance of nighttime operations of excessive noise emitting equipment such as pile driver • maintenance of exhaust silencers of heavy mobile equipment in good conditions • enclosing major sources of noise emissions such as power generators and compressors, which may continuously operate during construction; • requiring noise-generating equipment to be installed with effective noise control devices such as noise suppressors and	Proponent/ Contractor	no cost involved, but part of good practices	Part of contractor environmental commitment in the contract

Project Phase / Environmental Aspect	Environment Component	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost (Preliminary Estimate)	Guarantee / Financial Arrangements
			mufflers to reduce noise; • proper maintenance of all equipment to ensure that no additional noise due to worn or improperly maintained parts would be generated; • requiring noise-generating equipment to be installed with effective noise control devices such as noise suppressors and mufflers to reduce noise • use horns only for collision avoidance • avoidance of over speeding of vehicles excessive acceleration and unnecessary sudden braking			
	The People	The construction phase will provide opportunity in hiring qualified residents	The local hiring will be coordinated with the contractor	Proponent	Part of regular work	Part of the provision in the contract
2.2 Repairs and improvements of existing irrigation canals, involving the following: • Quarrying works as source of gravel and sand from Bayaoas River. • Stockpiling of construction concreting materials (gravel and sand) • Concreting of Irrigation canal	The Land and People	The potential impacts of the repairs and improvements of existing canal on the natural environment will be within the work site. There may be cases of vegetation removal	Vegetation removal will be coordinated and negotiated with the farmer/owner of the vegetation. The design stage will identify the vegetation	Proponent / Contractor	highly dependent on the results of survey	Inclusion in the Project Budget
	The Water and People	There could be temporary disruption in the irrigation water supply	The activity will be coordinated with the farmers	Proponent/ Contractor	no cost involved	not applicable

Project Phase / Environmental Aspect	Environment Component	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost (Preliminary Estimate)	Guarantee / Financial Arrangements
2.3 Operations of Construction Support Facilities						
• Maintenance of Refueling Station for vehicles and heavy equipment, with risk of spillage	The Land/ Water	Fuel spillage on ground and into the groundwater to Bayaoas River is a risk during refueling and leaks	The fuel tank will be provided with spill catch basin	Contractor	Part of the contractor good practices	Part of contractor environmental commitment in the contract
		Risk of fire due to grass fire	The fuel tank will not be located at the damsite or grassy areas	Contractor	Part of the contractor good practices	Part of contractor environmental commitment in the contract
• Onsite maintenance of heavy equipment at dam site, as source of solid and liquid wastes	The Land	Replacement of parts of vehicles Increase in the local solid waste	Replaced parts will be collected into containers, temporarily housed for disposal by selling or DENR-accredited transported and disposer in accordance to RA 6969 and RA 9003	Contractor	Part of the contractor good practices	Part of contractor environmental commitment in the contract
	The Water	Maintenance of heavy generates waste oil and washings that may pose risk of contaminating the ground, groundwater and Bayaoas River	Waste oil will be collected in sturdy containers, temporarily housed and disposed thru DENR-accredited transporter and disposer, in compliance with RA 6969.	Contractor	Part of the contractor good practices	Part of contractor environmental commitment in the contract
• Operation of on-site Batching Plant, with stockpiling of erodible materials	The Land/Water	The operation of a batching plant generate stockpile of earth materials that may erode cause siltation in Bayaoas River	The batching plant will be located at a reasonable distance from Bayaoas River	Contractor	Part of the contractor good practices	Part of contractor environmental commitment in the contract
• Provision of package construction materials, generating solid wastes	The Land	Packaging materials would cause an increase in the local solid waste	Used packaging material would be segregated and put into container in a housing for be sold or donated or transported o municipal solid waste disposal site.	Contractor	Part of the contractor good practices	Part of contractor environmental commitment in the contract
• Use of basecamp at	The Land	Basecamp would be a source of food, solid waste, sanitary waste,	Food waste will be disposed through composting. Other solid wastes will be put	Contractor	Part of the contractor	Part of contractor environmental

Project Phase / Environmental Aspect	Environment Component	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost (Preliminary Estimate)	Guarantee / Financial Arrangements
dam site, generating solid and liquid wastes		and medical waste	into segregation containers for disposal to recyclers or municipal solid waste disposal site, in accordance with the requirements of RA 9003 and RA 6969.		good practices	commitment in the contract
	The Water	Basecamp would be a source of sewage, laundry washings, and insignificant increase in human sewage loading into Bayaoas River	The basecamp will be provided with required sized of septic tanks, basins for laundry, and separate basin for bathrooms, with concrete linings as primary treatment of the liquid waste. Secondary basin will be provided as backup for any necessary disinfection of final effluent. The basecamp will be located much farther away from Bayaoas River.	Contractor	Part of the contractor good practices	Part of contractor environmental commitment in the contract
• Demobilization Works. as source of solid waste and used oil	The Land	Demobilization after construction works would generate solid waste and increase the volume of municipal solid waste	Solid waste will be put in segregation containers for selling or donation. Biodegrable materials would be placed in a compost pit.	Contractor	Part of the contractor good practices	Part of contractor environmental commitment in the contract
	The Water	Stored used oils may pose risk of spillage when left at the site.	The demobilization will ensure all used oil will be sold or donated or disposed thru a DENR-accredited transporter and disposer.	Contractor	Part of the contractor good practices	Part of contractor environmental commitment in the contract
3.0 OPERATION PHASE						
3.1 Commissioning with initial filling of dam to operational level	The Land	Submersion of vegetation leading to wildlife loss and displacement. Submersion of would also reduce GHG sequestration capacity.	During the construction phase, vegetation at the reservoir area is supposed to have been inventoried on maps and then the actual affected vegetation validation during the commissioning period, as basis for the tree replacement program. A prior decision from DENR and other stakeholders will be sought if the trees to be submerged will be cut for use or not. The reduction of GHG sequestration	Proponent / MMT	[cost of tree planting is already covered in the tree planting cost above]	For inclusion in the Project Budget

Project Phase / Environmental Aspect	Environment Component	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost (Preliminary Estimate)	Guarantee / Financial Arrangements
			capacity will be addressed by tree planting activities in accordance with DENR Memorandum Order 2012-05. (An alternative technology to help accelerate grassland recovery, and improve carbon capture would be mulching of grasslands, to include monitoring of soil (surface) carbon.)			
			Sitings of wild life will be recorded	Proponent/ MMT	Part of monitoring cost	For inclusion in the Project Budget
			Wildlife capture will be prohibited unless for safety reasons and protection	Proponent/ MMT	Part of IEC activities	For inclusion in the Project Budget
	The Water	Increase in depth of Bayaoas River, as initial change in the aquatic characteristics	• The increase in water depth will be monitored. • Water sampling for comprehensive analysis will be done as baseline data. • Observed fishes will be recorded	Proponent/ MMT	Part of monitoring cost	For inclusion in the Project Budget
	The People	Safety risk	A wide dissemination to the public and NGP operators will be done on the increase in water level at the site. The dissemination will be through meetings, gatherings, radio, signboards and leaflets	Proponent/ MMT	Part of IEC activities	For inclusion in the Project Budget
3.2 Dam Operation and Maintenance	The Land	Emergence of new riparian area	The new riparian area will be monitored and documented as part of an ecological study	Proponent/ MMT	Part of monitoring cost	For inclusion in the Project Budget
	The Water	The dam serves as a flood control structure, with rising water level during the rainy season and decreasing during the dry season	Provision of continuous dam water level monitoring instrument.	Proponent	Part of Project Cost	Part of Project Budget
			Provision of continuous rainfall monitoring instrument, with other meteorological parameters	Proponent	P2.0 million with yearly maintenance budget	For inclusion in the Project Budget
		The continuous flow of water from	Future improvements may include the	Proponent/	not yet	

Project Phase / Environmental Aspect	Environment Component	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost (Preliminary Estimate)	Guarantee / Financial Arrangements
		the dam would ensure environmental flow along Bayaoas River and to the separate intake of the Buer-Calsib irrigation system.	installation of wide diameter pipe (crossing Bayaoas River) from irrigation canal in Barangay Bayaoas to the Buer-Calsib intake.	MMT	applicable	
		The water reservoir would have a different water quality and ecology than the other segments of Bayaoas River. This may thermal stratification and nutrient enrichment along the water column of the reservoir.	This will be part of the monitoring program, under an ecological study	Proponent/ MMT	Part of monitoring cost	For inclusion in the Project Budget
		The proposed dam will be a barrier to fish passage	This a residual impact	Proponent/ MMT	Part of monitoring cost	For inclusion in the Project Budget
		The proposed dam will be a barrier replenishment of earth materials downstream	This is a residual impact	Proponent/ MMT	Part of monitoring cost	For inclusion in the Project Budget
		There would be an opportunity for fish production, but there would be cases of introducing new fish species in the area for fish production. Water-borne diseases could be a risk.	A study will be conducted in coordination with BFAR As such, new aquatic ecology and risk will be part of the regular monitoring and future studies.	Proponent/ MMT/ BFAR	Part of monitoring cost	For inclusion in the Project Budget
		There would be an opportunity of available water supply for NGP operations	A study will be conducted on using the reservoir for NGP operations	Proponent/ MMT/ DENR/ NGP operators	Part of monitoring cost	For inclusion in the Project Budget
	The Air	The proposed Project may result in a change in microclimate. There are studies claiming humidity rates increases in close surrounding of especially large dams and annual temperature differences decreases; precipitation values did	No mitigation is applicable the microclimate monitoring on soil may be part of monitoring.	Proponent/ MMT	Part of monitoring cost	For inclusion in the Project Budget

Project Phase / Environmental Aspect	Environment Component	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost (Preliminary Estimate)	Guarantee / Financial Arrangements
		not vary significantly				
	The People	Opportunity for local tourism and educational tour	For inclusion in the study of opportunities	Proponent/ MMT	Part of monitoring cost	For inclusion in the Project Budget
3.3. Damsite office and workshop use with generation of solid and liquid wastes	The Land/ Water	Generation of solid and liquid waste from the damsite office and workshop would be environmentally insignificant	While the impact would be insignificant, good environmental practices would be implemented for the small volume generation fo solid and liquid wastes	Proponent	Part of office maintenance	Part of Project Budget
3.4 Supply of reservoir water to irrigation networks	The Land/ Water	The availability of irrigation water during the dry season would increase rice production by total area and tons/ha	The water supply distribution and production will be monitored and documented for continual evaluation	Proponent/ MMT/ IA	Part of monitoring cost	For inclusion in the Project Budget
		The increase in frequency irrigation water supply would lead to an increase frequency in the use of fertilizers and pesticides which may serve as pollutants into Bayaoas River and groundwater when applied in excessive quantities	A continual IEC for the farmers will be implemented in the proper purchase, storage and use of fertilizers and pesticides, including the monitoring of groundwater.	Proponent/ MMT/ IA	Part of IEC cost	For inclusion in the Project Budget
		The additional use of banned non-biodegradable pesticides would pose a risk of accumulation of pesticide residues on rice soils	Farmers will be continually advised to avoid using banned and non-biodegradable pesticides	Proponent/ MMT/ IA	Part of IEC cost	For inclusion in the Project Budget
	The Water	The separate intake of Buer-Calsib irrigation system in Bayaoas River may be deprived of water supply	Environmental flow towards to the separate intake will be monitored and maintained	Proponent/ MMT/ IA	Part of monitoring cost	For inclusion in the Project Budget
	The People	The supply of water would cause a chain of benefits from the opportunity to irrigate more ricefield, increase in farm labor, increase in rice production, to commercial activities to and increase taxes for the LGU.	Monitoring and evaluation will be done to quantitatively validate the chain of benefits	Proponent/ MMT/ IA	Part of monitoring cost	For inclusion in the Project Budget

Project Phase / Environmental Aspect	Environment Component	Potential Impact	Options for Prevention or Mitigation* or Enhancement	Responsible Entity	Cost (Preliminary Estimate)	Guarantee / Financial Arrangements
3.0 ABANDONMENT PHASE						
Removal of Dam and Appurtenances	The Land/ Water/ People	Removal of part or entire dam would cause complex impact as in the following: • generation earth materials to hauled to designated disposal area that may result in long term accelerated soil erosion • generation of solid wastes from dam instrumentation solid waste that would cause localized shot-term physical effects on the aquatic ecology, • release of accumulation sediments , settled logs and vegetation upstream as additional impact on the local aquatic ecology • long-term threat of landslide, • exposure of submerged areas with the emergence of another ecology, with long-recovery as wooded land • threat to public safety • cessation of dam functions as source of irrigation water supply, flood control, source of water for NGP operations.	The dam physical characteristics and condition will be continually recorded. A timely preparation and dissemination of Decommissioning, Abandonment and Site Rehabilitation Plan with environmental impact assessment will be prepared in consideration of the structural integrity of the dam, public safety, cost of maintenance, replacement and other decision factors. This will be done in coordination with experts and stakeholders in accordance with best international practices and regulatory requirements.	Proponent / MMT / IA	to be part of the Abandonment Plan	For future inclusion in the Project Budget

4. ENVIRONMENTAL RISK ASSESSMENT AND EMERGENCY RESPONSE POLICY AND GUIDELINES

4.1 Review of EIS Scoping and Screening Requirement

DAO 2003-30 defines Environmental Risk Assessment (ERA) as an assessment of risks associated with a project, focusing on determining the probability of occurrence of accidents and their magnitude (e.g. failure of containment or exposure to hazardous materials or situations), through the use of universally accepted and scientific methods,

The form for EIS Scoping and Screening of the proposed Project requires a section for the Environmental Risk Assessment and Emergency Response Policy and Guidelines. The form contains a checklist for the following

i. level of coverage (Level 2 requiring a quantitative risk assessment, Level 1 requiring an emergency plan based on hazard analysis, and risk screening level);
ii. safety risk types (fire, explosion, release of toxic substances), and
iii. physical risks (failure of structure which could endanger life, property and/or the environment).

The level of coverage and type of document are referred to the Revised Procedural Manual of DAO 2003-30 (EMC 2007-002) specifically Annex 2-7e, which is the Procedural Guidelines for Scoping of Environmental Risk Assessment (ERA), which has following outline:

- I. General Guidelines
- II. Levels of Coverage and Scoping Requirements
- III. Technical Guidelines
    - A. Determination of Risk Levels
        - 1. Levels of Coverage and Requirements
            - a. Risk Screening Level
        - 2. Levels 1 and Level 2 Threshold Inventory
    - B. Report Formats and Other Requirements
    - C. Risk Criteria for EIA Review

The general guidelines include the following provisions:

i. It should be noted that the ERA, within the context of Philippine EIS System, is concerned primarily with safety risks (characterized by low probability, high consequence, accidental nature and acute effects [human safety focus]). In contrast, geological risks are covered by the EGGAR requirement under the MGB while health risks (characterized by high probability, low consequence, ongoing or continuing exposure and chronic human health effects) are assessed in the environmental health impact assessment under the DOH mandate.

ii. An ERA is not an entirely separate assessment but deals with the further analysis of hazards identified in the EIA. It builds upon the EIA such that risks are impacts where the likelihood of occurrence and magnitude of consequences are uncertain.

iii. As defined by DAO 2003-30, ERA is the use of universally accepted and scientific methods to assess the risks associated with a project. It focuses on determining the probability of occurrence of accidents and their magnitude (e.g., failure of containment or exposure to hazardous materials or situations).

By analysis of Annex 2-7e, the technical procedures covers primarily the following substances: explosives (reactivity), flammable substances, oxidizing substances, toxic substances, and unclassified substances. The guidelines do not cover physical risks like the dam failure. The topics to cover include the following:

i. Description of conditions, events and circumstances which could be significant in bringing about identified safety risks
ii. Description & assessment of the possible accident scenarios posing risk to the environment
iii. Description of the hazards, both immediate (acute effects) and delayed (chronic effects) for man and the environment posed by the release of toxic substance, as applicable
iv. The safety policy and emergency preparedness guidelines consistent with the regulatory requirements. Emergency Preparedness should also consider natural hazards to the infrastructures and facilities.

4.2 Screening of Environmental Risk

Two sources of environmental risks were identified. One is the possible storage of diesel fuel for the refueling of heavy equipment and vehicles during the three-year construction period. Diesel fuel has a flash point of 52-96 °C which is within the 21-55 °C definition of flammable substances of ERA. The storage tank is only around 15,000 L capacity, much lower than 5,000 tons Level 1 threshold to be covered by ERA, with reference to **Table 4-1** below. The risks are spillages and fire. Locating the reservoir away from residential area, grass fire area, and Bayaoas River and provision of spill containment basin would not cause significant environmental risk. The Emergency Response Plan would be limited at the worksite and requiring only the application suppressant in case of fire, and soil clean up in case of spillage.

The other risk is dam failure that would cause flashflood and flooding in populated and agricultural areas. This is one of the issues raised in the IEC, Public Scoping and FGDs. There are topics provided in the Technical Scoping and Annex 2-7e, as guide for this case. The following sections provides an analysis of dam failures obtained from the literature, simulation of dam failure and flood, and issuance of NIA related to maintenance of dam and responding to emergencies.

Table 4-1. Levels 1 and 2 Thresholds Category of Substances Under ERA

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
Oxidising substances	50	200
Toxic substances (low)	50	200

CATEGORY	LEVEL 1 (tons)	LEVEL 2 (tons)
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

4.3 Dam Failure Analysis from the Literature

The literature provides cases and analysis of dam failures. One of these is Analysis of Earth Dam Failures: A database approach by Zhang, L.M, and Yuanhua Xu (2009). They compiled into a database more than 900 failure cases throughout the world over fifty countries including the US, India, and the UK, excluding China. About 70% covered the dams in US (**Table 4-2**). The numbers only reflect the number of failure cases reports, rather than the number of failure cases actually occurred out of the total. The known cases of dam failures covered earth dams (75.5%) , concrete dams (8,7%), masonry dams (7.7%), rockfill dams 2.9%) , and others (2.9%) (**Table 4-3**). The distribution of types of earthfill dams is presented in **Table 4-4**. Most of them are unknown (89.8%). For the known type, the homogeneous earthfill dam dominates at 62%. **Figure 4-1** shows the sketches of different earthfill dams.

Table 4-2. Distribution of Dam Failure by Country Covered in the Study

Country	Percent, %
1. US	70.1
2. India	4.2
3. UK	3.6
4. Australia	2.2
5. South Africa	1.9
6. Others	18.0
Total	100.0

Table 4-3. Distribution of Dam Failure by Dam Type

Dam Type	Percent of Total, %	Percent of Total of Known Dam Type, %
Earth	65.5	75.5
Concrete	7.5	8.7
Masonry	6.7	7.7
Rockfill	4.5	5.2
Others	2.5	2.9
Unknown	13.3	
Total	100	100.0

Table 4-4. Subdivision of Failed Earthfill Dams

Earth dam type	Number of Cases	Percentage of Total Cases, %	Percentage of Total Known Known type, %
Homogenous earthfill	38	6.4	62.3
Zoned earthfill	9	1.5	14.8
Earthfill with corewall	12	2.0	19.7
Faced earthfill	2	0.3	3.3
Unknown	532	89.8	
Total	593	100.0	100.0

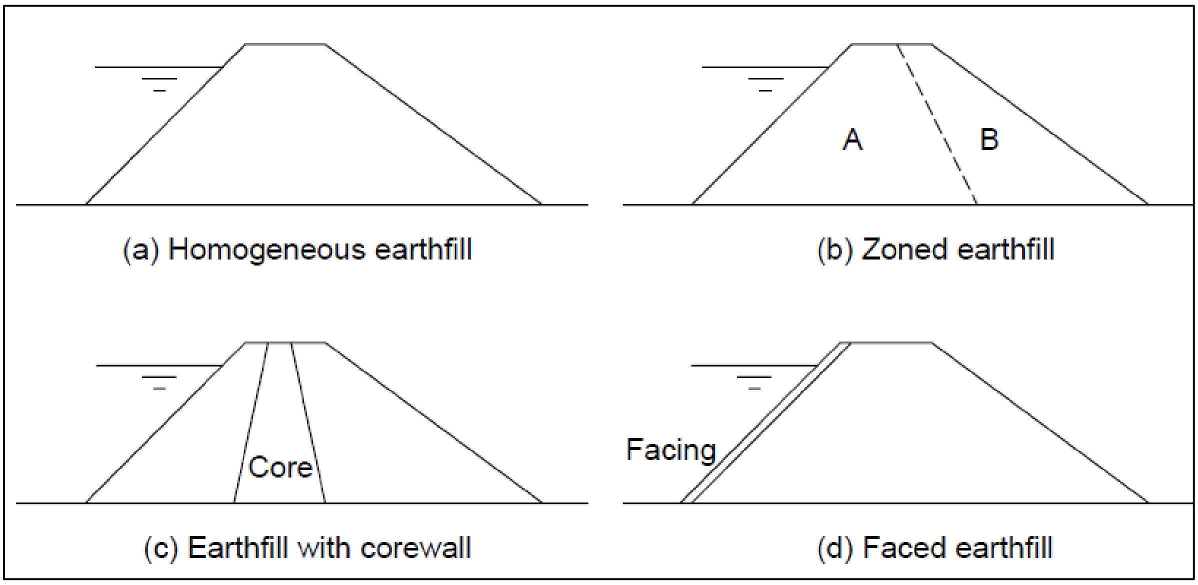


Figure 4-1. Sketches of Four Typical Types of Earth Dams

The collected data include the reservoir capacities (**Table 4-5**). About 25.1% of the failure cases, with respect to known dam height belong to dams with 10-100 million m^3 , or within the range of the proposed Project. About 8.9% of dams with known heights were attributed dams with 30-60 m height or within the 40 m height of the proposed Project. (**Table 4-6**). The probability of dam failure by age can be deduced from the distribution of dam failure by age (**Table 4-7**). This implies that there is a high chance of failure (44.5%) during the first five years of a dam, or the chance to long life of a dam over 40 years decreases.

Table 4-5. Reservoir Capacities of the Failed Earth Dams

Capacity range million m^3	Number of Cases	Percentage of Total Cases, %	Percentage of Known capacities, %
>1000	7	1.2	2.8
100 - 1000	19	3.2	7.7
10 - 100	62	10.5	25.1
1 - 10	63	10.6	25.5
<1	96	16.2	38.9
Unknown	346	58.3	
Total	593	100.0	100

Table 4-6. Heights of the Failed Earth Dams

Height Range, m	Number of Cases	Percentage of Total, %	Percentage of Known Dam Heights, %
>100	4	0.7	0.8
60-100	10	1.7	2.0
30-60	44	7.4	8.9
15-30	135	22.8	27.3
<15	301	50.8	60.9
Unknown	99	16.6	
Total	593	100.0	100.0

Table 4-7. Ages of the Earth Dams at Failure

Age Range, years	Number of Cases	Percentage of Total Cases, %	Percentage of Cases with Known Age, %
0-1	85	14.3	20.9
1-5	96	16.2	23.6
5-10	36	6.1	8.8
10-20	62	10.5	15.2
20-40	58	9.8	14.3
40-60	31	5.2	7.6
60-80	16	2.7	3.9
80-100	7	1.2	1.7
100-150	10	1.7	2.5
>150	6	1.0	1.5
Unknown	186	31.3	
Total	593	100.0	100.0

From 593 cases failed earth dams worldwide, the cases of dam failures were categorized into six: overtopping, quality problems, poor management, disasters, others, and unknown, as follows:

1. Overtopping
   a. Insufficient spillway capacity
   b. extreme flood exceeding design criteria
2. Quality problems
   a. piping in dam body
   b. sliding of dam body
   c. piping in foundation
   d. piping around spillway
   e. quality issues in spillway
   f. piping around culvert and other embedded structures
   g. quality issues in culvert and other embedded structures

3. Poor management
   a. decrease of reservoir capacity for flood control due to over storage
   b. prior to flood season
   c. poor maintenance and operation
   d. temporary heightening of spillway crest not removed in time
   e. organization issue: nobody responsible for management of dam

4. Disasters

   a. earthquake
   b. war and terrorist attack
   c. breaching of upstream dam
   d. rodent den

5. Others
   a. spillway blockage due to bank slide in reservoir
   b. breach due to excavation on dam for discharging
   c. poor planning of general layout of project

6. Unknown

Highlights of dam failures are found in the study, and quoted as follows:

i. It is difficult to identify a distinct, single cause for a dam failure. Often, several causes are involved in a failure and these causes are interrelated with each other.

ii. The only difference is that disasters are considered as a typical cause. This is due to that natural disasters and terrorist attacks are likely to become more frequent.

iii. Most of the cases are caused by either overtopping or quality problems. These two causes led to nearly 80% of all failure (**Figure 4-2**)

iv. It is clearly seen that 58% of quality problems are associated with piping in the dam body or foundation (**Figure 4-3**)

v. Overall, the most common causes of earth dam failures are overtopping and piping in the dam body or foundation. The principal influence factor on overtopping is insufficiency of spillway capacity (**Table 4-8**). **Figure 4.4** is a diagram of the potential locations at risk in a dam system.

vi. For piping in the dam body or foundation, the most single adverse factor is crack, which can be caused by differential settlement, material shrinkage, foundation defects, and imperfect interface.

vii. Note that for earth dams, failure by either overtopping or piping does not occur all of a sudden.

viii. The failure process for earth dams often lasts for a period of time from within one hour to several hours, which gives a chance to mitigate the losses from the failure.

ix. The Bayesian method may be used to update the probability of failure of the dams by monitoring the conditions of the dynamic dam system

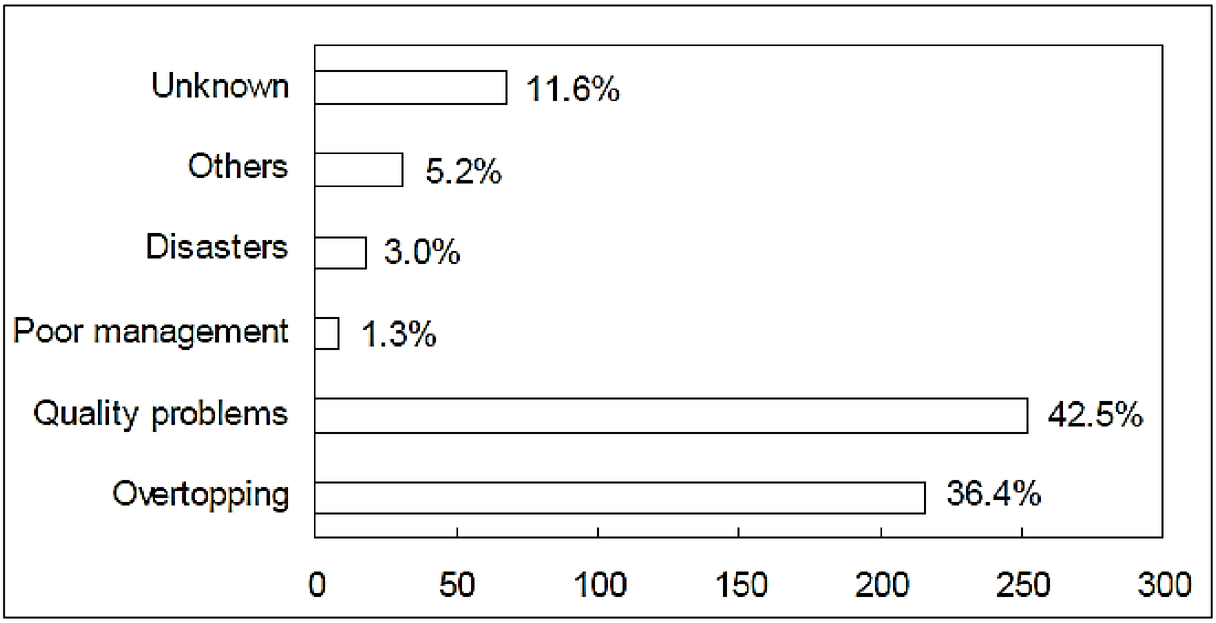


Figure 4-2. Percent of Dam Failure by Cause Category

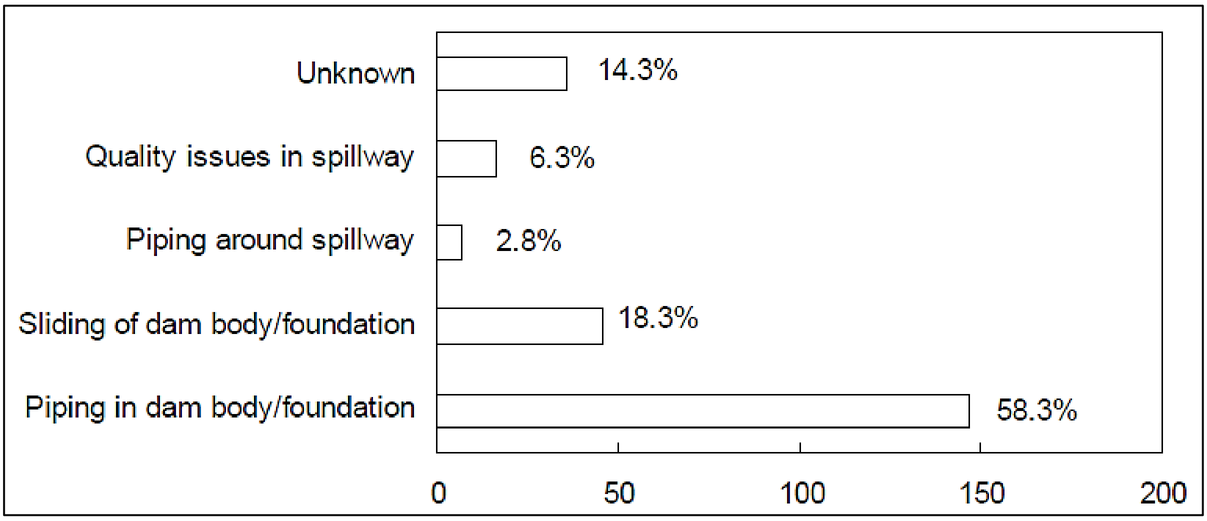


Figure 4-3. Percent of Dam Failure by Quality Problems

Table 4-8. Summary of Failure Causes for the Four Typical Earth Dams (61 cases)

Earth Dam Type	Overtopping	Quality Problem		Poor Management	Disasters	Total
		Piping in Dam body/foundation	Others			
Homogenous earthfill	13	22	2	1	-	38
Zone earthfill	3	6	-	-	-	9
Earthfill with corewall	8	2	1	-	1	12
Concrete faced earthfill	-	2	-	-	-	2

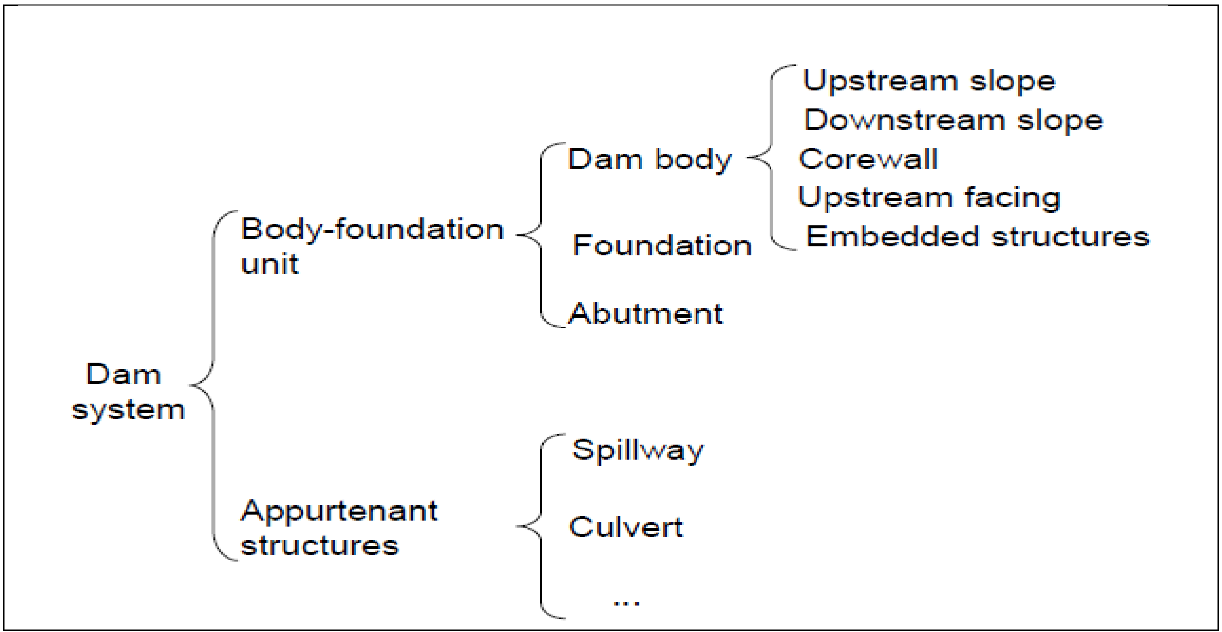


Figure 4-4. Potential Locations at Risk in a Dam System

4.4 Preliminary Dam Break Flood Simulation

The 2015 Feasibility Study for the proposed Project contains a flood simulation for dam failure using the Simplified Dam Break Flood Forecasting Model (SMPDBK) developed by the US National Weather Services (NWS). The model estimates the approximate flood predictions at a given point of interest and provides an estimate of the dam breach width and the time of failure using relationships obtained from actual dam failures in the past.

The basic inputs to the model were:

Dam crest elevation	-	93.20	m
River bed elevation	-	45.49	m
Volume of storage	-	11.50	million m^3
Surface area at full capacity	-	77.68	ha
Dam breach width (approximately equal to 3 x H	-	118	m
Dam failure time (approximately equal to H/3)	-	43.20	minute

These inputs assume the breach or opening formed in a failing dam encompass the entire dam and occurred instantaneously. Earthen dams generally do not fail completely nor instantaneously.

Nine river cross-sections at distance from the dam were selected for the computation of maximum water discharge flow, maximum (surface) water elevation, riverbed elevation, maximum depth, and maximum depth time from total failure. The results are show in **Table 4-9. Figure 4-5** shows the trend of the discharge profile by distance, and **Figure 4-6,** the maximum water level elevation, riverbed elevation, and maximum depth by distance from the dam. The results demonstrate, for example, a 5.86 m maximum water depth in 26.38 masl river bed elevation at the 3.48 km distance from the dam. This is about 44.03 minutes from the start of dam breach. With the average elevation of 30.6 masl of the residential area, the flood depth is about 1.6 m.

Table 4-9. Dam Break Analysis Summary Result

Distance Km	Maximum Water Discharge Flow m^3/sec	Maximum Water Elevation masl	Riverbed Elevation masl	Maximum Depth m	Maximum Depth Time from Total Failure minutes
0.00	8,474	62.86	45.00	17.86	0.72
0.34	8,029	55.90	42.44	13.46	0.73
0.80	7,949	50.59	38.71	11.88	0.75
1.58	7,854	37.38	31.68	5.70	0.83
2.63	7,178	35.61	28.71	6.90	0.97
3.48	7,106	32.24	26.38	5.86	1.03
4.04	7,035	28.56	22.67	5.89	1.05
4.67	6,386	16.81	10.26	6.55	1.06
7.00	6,322	13.85	6.70	7.15	1.49

Basically, this is a preliminary or screening or rapid simulation so that during the Project Operations Phase, a more detailed and actual site conditions simulations, with flood maps will be prepared for preparations and emergency response planning.

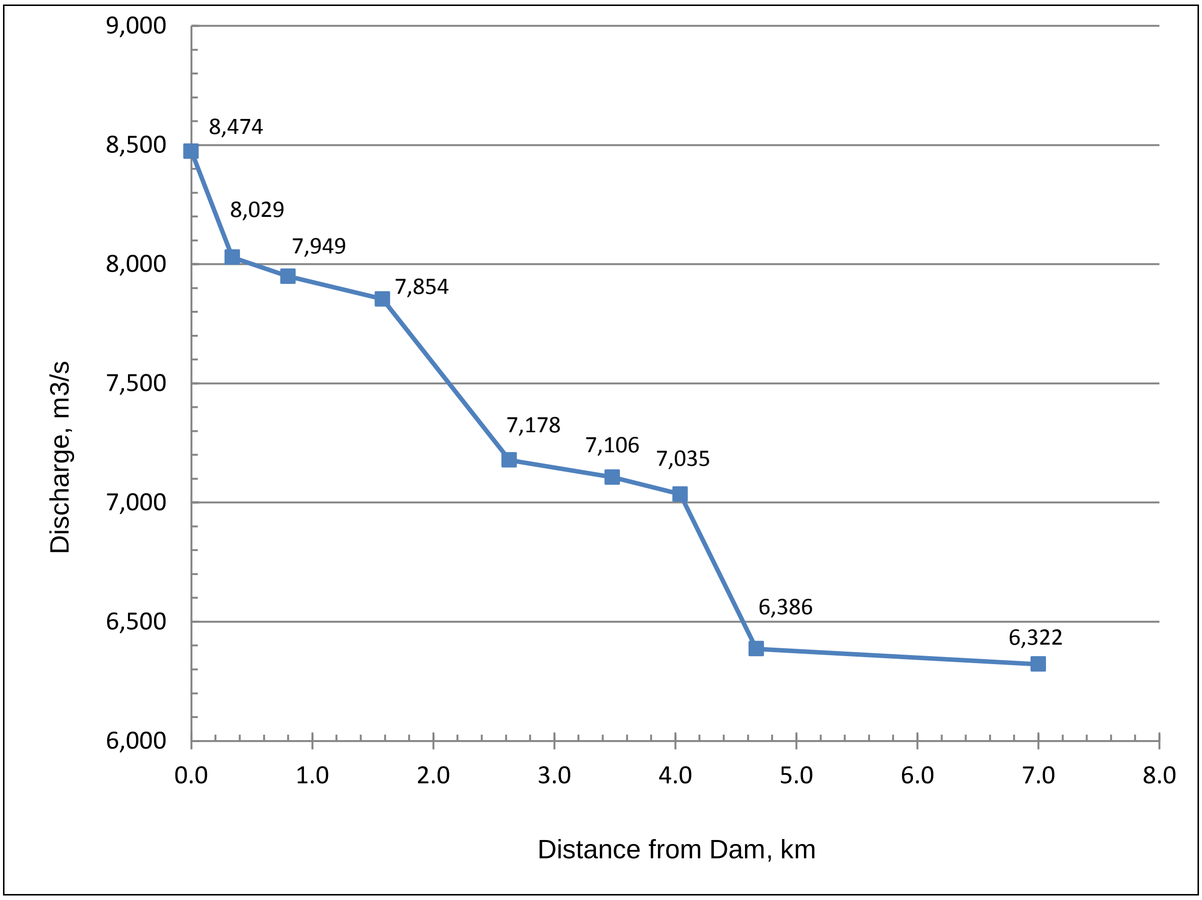


Figure 4-5. Peak Discharge Profile

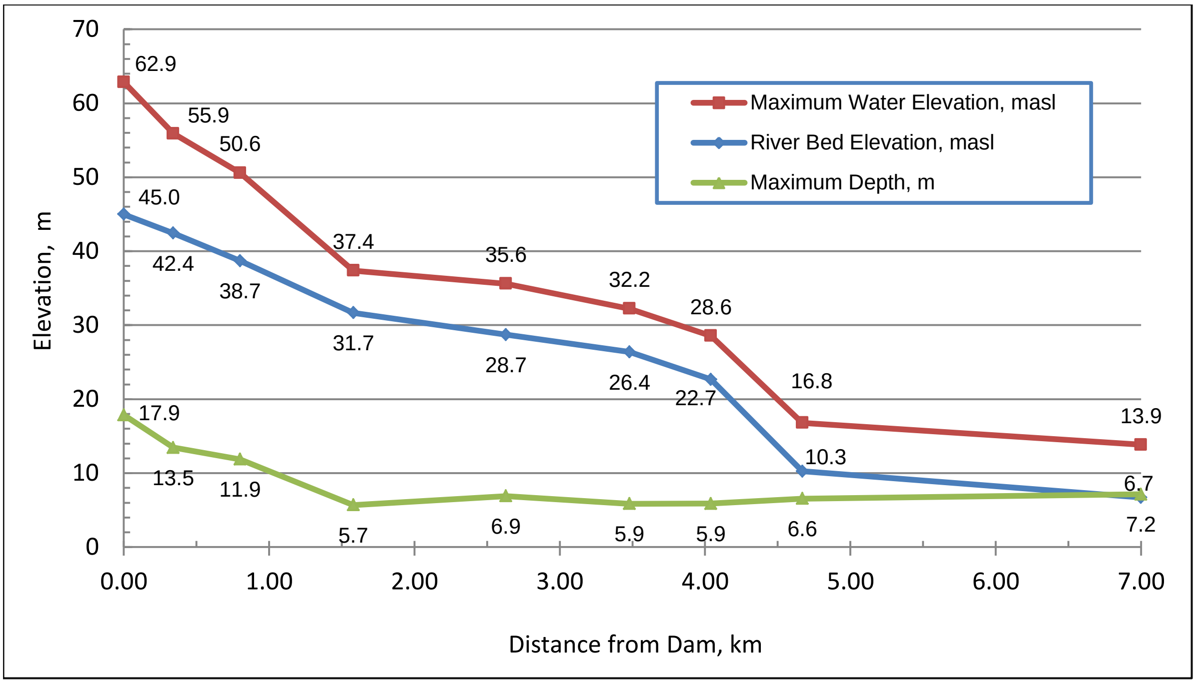


Figure 4-6. Maximum Water Level Elevation, Riverbed Elevation, and Maximum Flood Depth by Distance from the Dam

4.5 Emergency Response Policy and Guidelines

For dam safety and integrity, NIA issued the following Memorandum Circulars :

- MC 2017-18. Adoption of the NIA Standard Terms of Reference (TOR) for the Conduct and Undertaking of Detailed Engineering Studies / Design (DES/DED) of Storage/Reservoir Type Irrigation Projects to be Procured Through Outsourcing Scheme
- MC 2017-19. NIA Standard Process and Procedure for the Preparation and Conduct of Detailed Engineering Design (DED) and Review of Plans/Drawings Including the Design Documentation / Report of Storage/ Reservoir Dams
- MC 2012-18. Monitoring / Upkeeping the Structural Safety of Small Reservoir Dams (**Annex 4**) , with the following outline:

1.0 Rationale
  1.1 Need for Climate Change Intervention
  1.2 Need for Dam Condition Monitoring
2.0 Policy Statement
  2.1 Dam Instrumentation Systems Maintained/Observed
  2.2 Dam Observation Data Analyzed and Verified
3.0 Mechanics
  3.1 On Dam Instrumentation Maintenance
  3.2 On Dam Instrumentation Monitoring
  3.3 On Data Observation Analysis
  3.4 During Dam Spill Situations

For the Emergency Response Policy and Guidelines, NIA issued on May 21, 2019 MC 2019-35 or NIA Disaster Risk Reduction and Management Plan (NIADRRMP) 2019-2023 [133 pages], for disaster prevention and mitigation, disaster preparedness, disaster response, and disaster rehabilitation covering dams. This will be a basis in developing situation and location-specific scenarios for emergency planning and preparations for BSRIP. The circular took reference to the following policies:

- National DRRM Plan based on RA 10121 of 2010 that provides a legal basis for policies, plans and programs to deal with disasters;
- The Philippine Disaster Management System from the Office of Civil Defense - National Disaster Coordinating Council (OCD-NDCC);
- MC No. 49 s. 1972 "Implementation of Projects under the Calamity Fund Act, Designating Special Project Coordinator and Project Engineers to undertake the same"
- MC No. 41 s. 1981 "Compliance with the Standard Operation Procedure for Calamity Mitigation Relief
- MC No. 47 s. 1993 "Guidelines on the Reporting of Typhoon Damages and Implementation of Repairs/Restoration Works"
- MC No. 58 s. 2006 "Contingency Measures during Calamity/Typhoons"
- MC No. 18 s. 2012 "Monitoring/Upkeeping the Structural Safety of Small Reservoir Dams"
- MC No. 1 s. 2014 "Creation of a Committee of Dam Safety, Risk Assessment and Emergency Preparedness"
- MC No. 52 s. 2015 "Creation of Task Force Calamity and the Guidelines on the Reporting of Calamity Damages and Implementation of Repair/Restoration Works"
- Memorandum Circular No. 58 s. 2018 Creation of the Interim NIA Dam Safety Group Organization (INDSGO)

MC 2019-35 has the following outline:

1.0 Introduction
  1.1 Background
  1.2 Plan Objectives
  1.3 Legal Basis
2.0 Risk Profile and State of DRRM
  2.1 Basic DRRM Terms
  2.2 Risk Profile
  2.3 Disaster Risk and Vulnerability Assessment Report
3,0 NIA Risk Reduction Management Plan
  3.1 Thematic Area 1: Disaster Prevention and Mitigation
  3.2 Thematic Area 2: Disaster Preparedness
  3.3 Thematic /^rea 3: Disaster Response
  3.4 Thematic Area 4: Disaster Rehabilitation and Recovery
  3.5 NIA DRRMP Priority Plans and Programs
  3.6 Resource Mobilization
4.0 Monitoring and Evaluation
  4.1 NIA DRRM Plan Monitoring and Evaluation Organizational Structure
  4.2 Monitoring and Evaluation Framework
  4.3 NIA Disaster Risk Reduction Monitoring and Evaluation Process Flow
5.0 DRRM Sustainability and Contingency Plan
  5.1 Sustainabllity Plan
  5.2 Contingency Plan
6.0 References

Some provisions in Section 3 were extracted to show the thematic areas with the goals, objective, outcome and responsible office, (exclusive of the details of outputs, activities and timelines), as follows:

Thematic Area 1: Disaster Prevention and Mitigation

Goal	Prevent hazard and mitigate their potential impact by reducing vulnerabilities and exposure as well as enhancing capacities of all stakeholder
Objective	• Reduce vulnerability and exposure of irrigation facilities to all hazards • Enhance capacities of stakeholders to reduce their own risks and cope with the impacts of all hazards
Outcome 1	Mainstreamed and integrated NIA DRRM and Climate Change Adaptation in project development, construction, operations of irrigation projects/systems
Responsible Offices	Central, Regional and Irrigation Management Offices
Outcome 2	Adapted and environmentally-friendly managed NIADRRM Plan responsive of Climate Change
Responsible Offices	Central, Regional and Irrigation Management Offices
Outcome 3	Established and improved forecasting and early warning devices through end-to-end monitoring
Responsible Offices	Central, Regional and Irrigation Management Offices

Thematic Area 2: Disaster Preparedness

Goal	Establish and strengthen capacities of all stakeholders to anticipate, cope and recover from the negative impact of calamities and disasters
Objective	Increase the level of awareness and equip NIA personnel and irrigation communities with the necessary skills to cope with the threats and impact of all hazards, risk and vulnerabilities through strengthening partnership among all key players by implementing comprehensive disaster preparedness plicies, plans and systems
Outcome 6	Increased level of awareness and enhanced capacities of NIA personnel and irrigators association to the threat and impact of all hazards
Responsible Offices	Central, Regional, Irrigation Management Offices and Irrigators Associations

Thematic Area 3: Disaster Response

Goal	Provide life preservation and meet the basic needs of affected stakeholders based on acceptable standards during or immediately after disaster
Objective	Provide basic subsistence needs of affected stakeholder by immediately coordinate with the LGUs and other government agencies in the national and local level to provide basic social services
Outcome 9	Well established disaster response operations
Responsible Offices	Central, Regional nd Irrigation Management Offices
Outcome 10	Adequate and prompt assessment of stakeholder needs and damages of irrigation and drainage facilities
Responsible Offices	Regional, Irrigation Management Offices and Irrigators Associations
Outcome 11	Evacuated safely and on time the affected irrigation communities and temporary shelter addressed
Responsible Offices	Regional and Irrigation Management Offices [p. 59]

Thematic Area 4: Disaster Rehabilitation and Recovery

Goal	Restore irrigation and drainage facilities, and strengthen organizational capacities of affected stakeholders, and reduce disaster risks in accordance with the "building back better" principles.
Objective	Repair and rehabilitate irrigation system facilities to sustain farming activities of Irrigators Associations
Outcome 12	Reconstructed disaster and climate change resilient irrigation systems
Responsible Offices	Central, Regional, Irrigation Management Offices and IAs

These are the provisions for the Dam Contingency Plan

2. Contingency Plan for Dams (Diversion Dams, Storage Dams and its appurtenant structures) and Irrigation/Drainage/River Training Works/Access Roads Facilities):

   - Conduct regular periodic and special dam and appurtenances and irrigation/drainage related infrastructures facilities inspection, instrumentations readings, monitoring, observation, recording and evaluation;

   - Prepare and submit/furnish observation reports to higher Dam Safety Offices/Officials;

   - Undertake preliminary and in-depth studies of visually identified and suspected potential defects such as deteriorations, excessive/colored seepage, structural distress, abnormal spillway and outlet works structure hydraulic behavior and adjacent dangerous geologic conditions;

   - Identify and establish evacuation centers/sites;

   - Participate with the concerned LGUs/affected communities/government agencies/stakeholders in the development and formulation of new and updating of existing Emergency Preparedness Plan/Emergency Action Plan (EPP/EAP) and in undertaking exercise/simulations, test/trial runs and the actual implementation the same;

   - Initiate the declaration of emergency situation and the execution of the emergency notification/warning and mobilize the communication networks/systems and facilities; and

   - Initiate and participate in recommending the declaration/termination of emergency condition/situation.

2.1 Guidelines for the Fire Emergency and Disaster

2.2 Guidelines for Typhoon and Flood Related Disaster [p. 84

2.2.1 Objectives

- To identify areas at risk of flooding (overtopping of dams, damage to structures)
- To develop and evacuation plan for all its constituents and be prepared when dam brakes, severe flooding, storm surge or tsunami occur within the area
- Identify/Establish evacuation centers/sites
- To develop a system of saving lives and properties that could be damaged by typhoons and floods, storm surges and tsunamis
- To develop a recovery plan after sever flooding

2.2.2 Prevention/Mitigation

- Conduct Risk Assessment – Identify vulnerable areas to typhoon and floods. ddress causes related to flooding (especially anthropogenic causes) such as waterways (dredging), drainage (declogging).
- Inspection and Maintenance (Buildings and Facilities) – Check appropriate locations and recommend transfer of generators as soon as possible (long term) to ensure the proper maintenance of generators

- Dam Safety/Integrity Inspection and Evaluation

2.2.3 Preparedness Guidelines

2.2.3.1 Written Plan - Written Plan should cover evacuation plan, post recovery plan to enhance awareness and facilitate preparedness among NIA employees. These shall also include information dissemination such as Public Storm Warning Signals, Heavy Rainfalls Warning Levels, Thunderstorm Warning Levels and Safety Tips in preparing for floods

2.2.3.2 Risk Reduction Plan

- Designate accessible and safe areas for possible evacuation sites. The concrete building walls could withstand voluminous water pressure during the passage and the upper floors could be haven during disaster. These buildings have facilities that could provide shelter, protection and basic needs for water, shelter and basic life protection

- Reay transportation services and accessories (extra tires, jacks and etc)

- Ready floor evacuation plans to directly guide evaucess to evacuation sites with less delay

2.2.2.3 Evacuation Plan (Site to evacuation building) - Provide evacuation plant to render safe and orderly passage of evacuees from affected site to designated evacuation buildings

2.2.2.4 Post Disaster Recovery Plan – Recovery Team must have to undertake the following:

- Accounting of missing persons including identifications
- Conduct inspection to post affected areas to account for lost equipment/damage facilities

2.2.3.5 Rehabilitation Plan – The Rehabilitation Team is tasked to undertake the following:

- To inspect all buildings, equipment and facilities to recommend for repairs required through projects. Close coordination with the Engineering Department and Internal Audit is highly recommended;

- To restore all basic services in irrigation, power (electricity) communications and transportation services to normalize operation; and

- Recommend rehabilitation for projects require large government funds.

2.3 Guidelines for Earthquake Related Disaster [p.86]

2.3.1 Dangers Associated with Earthquake – The actual movement of the ground in an earthquake is seldom the direct cause of injury or death Injuries from ground shaking are commonly caused by:

- Dam break
- Partial building collapse such as falling masonry, collapsing walls, falling ceiling plaster, etc

- Flying glasses from broken windows
- Overturned bookcases, filing cabinets, fixtures, furniture, office machines and appliances
- Fires, broken galss lines, etc. These dangers may be aggravated by lack of water due to broken mains
- Fallen power lines
- Inappropriate actions resulting from panic

2.3.2 Structural Mitigation

- Inspection
- Maintenance
- Risk assessment of dams and other structures

2.3.3 Preparedness Guidelines

- Evacuation Plan
- Earthquake Drills. Regular earthquake evacuation drill should be conducted at least 2-4 times a year. In coordination with the Bureau of Fire Protection (BFP), PHIVOLCS, NDRRMC, OCD, and LGU (Local Government Units)

5. SOCIAL DEVELOPMENT PLAN/FRAMEWORK AND IEC FRAMEWORK

The NIA program for supporting farmers and Project Affected People (PAP) is divided into two Frameworks: the Social Development Program, and the Information, Education and Communications.

5.1 SOCIAL DEVELOPMENT PLAN/FRAMEWORK

The SDP for the proposed Project is directed towards prevention and mitigation of adverse impact, and enhance positive impacts on people's livelihood, health and environment. This takes into account the concerns and issues raised by the community in the Perception Surveys, IEC, Public Scoping and FGD. The priority stakeholders will be those directly affected by the project footprint, like the lot owners of the access road to damsite and sources of earth materials, farmers at the irrigation intakes, lot owners in small improvement works for the canals, and upland operators for the National Greening Program. The SDP will include a comprehensive large scale mapping of the area from the irrigation canals to the headwater of Bayaoas River, as a basic common working and levelling-off document tool, in digital and printed versions.

The SDP will cover those usually provided services, as follows:

i. training on

   a. farming technologies;
   b. watershed management, including watershed mapping and monitoring;
   c. management of the irrigation system, canals, dam, membership, management systems;
   d. communication, life skills, organizational management, and leadership;

ii. funding for farm inputs to improve the yield of land, improve the IRR of the irrigation system, improve the return of the effort of the farmers; and

iii. providing support for access to market.

The Project-specific services will cover the following:

i. ventilate and resolve risk perception by community members about project design, and dam breakage;

ii. employment of local residents during project construction;

iii. advocating support for watershed management program;

iv. assess and address gaps in social services delivery: education, sanitation, public health, nutrition, and potable water, to wit:

   a. look for farmers who have been marginalized much more than others, such as those whose lands are too small, who had less access to water, whose yields have been too limited in quantity, and quantity per unit area, whose knowledge is too limited;

b. validate if there are households who should be covered by 4Ps but are not getting covered or are not receiving full coverage;

c. validate poverty incidence data generated by PSA and the LGU (2003, 2006, 2009, 2012, 2015, 2018), and project scenarios on what might happen without intervention, and what can happen with intervention, and plan to support these vulnerable households;

d. look into farmer households whose situation is challenged such as those who are: illiterate, no sanitation facilities, no access to water and electricity, who have no access to health and social services; check on those who may be ill or seriously ill, who are malnourished

v. Right-of-way;

vi. Gender Responsive Livelihood / Employment and Credit Facilities (Men, Women, Youth & elderly; and

An item not usually included as part of SDP, in local projects is progress tracking articulated as follows:

vii. Preparation and Implementation of a Monitoring and Evaluation Framework for tracking progress on SDP delivery.

Table 5.1-1 provides the SDP Framework lists the interventions under social development including 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 2003-30. The priority items identified are based on the results of Focus Group Discussions and the results of surveys and data analysis from official sources.

The plans will be flexible, updated and adaptive to prevailing site-specific social conditions and in coordination with various stakeholders. NIA shall assess the staff complement needed for the project, and shall hire initially full-time Community Relations Officer, with support staff. NIA shall hire personnel based on a roadmap of the required personnel, which has yet to be prepared as part of the regular project operations planning of the agency.

Table 5-1. Social Development Plan/Framework

CONCERN	Responsible Community Member / Beneficiary	Government Agency/ Non-government Agency and Services (indicate specific services)	PROPONENT	Indicative Timeline	Source of fund
Right of Way	Barangay Chairman • Project affected families • Project affected farms	• LGU Municipal Planning, Housing a NHA (R.A 7279 Memo Circular 1070, settlement and Institutional Framework for local Government units) • DSWD • DPWH	Community Relations Officer	• Pre-construction	LGU-NHA / NIA (GAA)
Employment of local residents during project construction	Barangay Chairman / Irrigators Association Officers/ Farmers Association Officers	• LGU	Community Relations Officer, with the contractors	• During project construction	NIA/ no cost
Capacity Building related to the construction and operation of the Project	Irrigators' Association	• DA • BSWM • DENR	Various Departments of NIA depending on the topic	• Starting from Pre-construction	General Appropiation Fund
Advocating support for watershed management program	Barangays covered by the project NGP Operators	• MENRO • DENR	National Irrigation Administration	• Before, during and after project construction	NIA/ included in current budget
Livelihood/Employment/Credit Facilities for beneficiaries;	Association Chairperson Qualified Project Affected Men, Women, Youth & Elderly	• LGU Municipal Planning Office • MSWD • TESDA	Community Relations Officer	• Operation	LGU –IRA/ Proponent
Assess and address gaps in social services delivery: education, sanitation, public health, nutrition, and potable water	Barangay Chairman / Social Welfare Assistants	• LGU/ Municipal Planning	Municipal Social Welfare and Development Office (MSWDO)/ Local Chief Executive	• Before, during and after project construction	LGU/ DSWD/ for budgeting
Preparation and Implementation of Monitoring and Evaluation Framework covering the delivery of the various social development components and IEC activities.	Barangay Chairman / Irrigators Association Officers/ Farmers Association Officers	• LGU	Community Relations Officer	• Pre-construction • Construction • Operation	NIA/ included in current budget

5.2 IEC FRAMEWORK

The IEC concerns for the communities shall essentially cover the background of the project, and addressing risk perception associated to dam breakage, which forms part of the SDP Framework, and thus it is also integrated into the SDP Framework. The IEC shall be guided by the following provisions of Annex 2-19 of RPM for DAO 2003-30.

1) The objective of conducting IEC is not limited to information dissemination. The conduct of IEC shall provide feedback to the preparer and the proponent about the stakeholders' understanding of the EIA process and project, the issues and concerns about the project, as well as their suggestions and other inputs.

2) IEC methods may include the following:
   a) Individual methods, e.g. home visits, personal letters, one-on-one interviews,
   b) Group methods, e.g., meetings, study tours, group workshops, group discussions, and
   c) Mass media, e.g., newspaper publication, radio broadcast, web posting.

3) The proponent or preparer may use any or all kinds of IEC materials in conducting IEC campaigns. IEC materials may be in print (e.g. flyers, pamphlets, comics, posters, newspapers, banners) or in other forms, such as video, film, and sound slides.

4) These materials should be:

   a) Prepared in a manner and language that can be easily understood by everybody and should contain balanced and complete information. The information material on EIA should, as much as practical, be in the local language or dialect.

   b) Contain sufficient information including a description of the proposed project, the proponent, the EIA process, and the expected outputs. It shall also include such appropriate studies as evaluation of public health, environment, population, gender, socio-economic, and cultural impacts of the project or undertaking and the appropriate mitigation and enhancement measures.

5) The information drive should at the same time inculcate value formation by making the members of the community aware of their responsibilities as stakeholders.

6) In the conduct of IEC, it is beneficial to the proponent to engage the services of locally-based Communication or IEC specialist or Community Organizer in planning, implementing, assessing and documenting the conduct of IEC.

Table 5.2-1 provides an IEC Framework including Target sector, key messages, scheme/strategy/methods, Information, timelines and frequency, cost based on Annex 2-19 of RPM for DAO 2003-30.

Table 5-2. IEC Framework

Target Sector Identified as Needing Project IEC	Major Topic/s of concern in Relation to Project	IEC Scheme / Strategy / Methods	Information Material	Indicative Timelines and Frequency	Indicative Cost
1. Residents of affected barangays, and LGUs	• Project description & status • Emphasize: project risks and dam design • EIA findings • Performance against ECC / EMP Actual Impacts & Measures	• Individual methods	• Invitation letters • One-on-one meetings • Key Informant Interviews	At least 1 month prior to start of project construction; or Annually	• Project expected number of attendees • Cost of meals • Cost of venue • Cost of IEC Materials • Allocate approximately 10 x PhP 25,000 per barangay = PhP 150,000, increased by 10% p.a.
		Group methods	• Hand-outs Audio-visual presentations		10 x PhP 5,000 per brgy = PhP 25,000/year, increased by 10% p.a.
		• Mass media	• Comics on EIA in local language • Illustrative primer about the project • Newspaper publication • Radio broadcast • Posters • Flyers		10 x PhP 50,000 per brgy = PhP 250,000/year, , increased by 10% p.a.

6. ENVIRONMENTAL COMPLIANCE MONITORING

The Environmental Compliance Monitoring presents the commitment of the Proponent to conduct a self-monitoring as regard to the following objectives under Section 2.3 of the Revised Procedural Manual:

a) project compliance with the conditions set in the ECC;

b) project compliance with the Environmental Management Plan (EMP);

c) determination of effectiveness of environmental measures on prevention or mitigation of actual project impacts vis a vis the predicted impacts used as basis for the EMP design; and

d) continual updating of the EMP for sustained responsiveness to project operations and project impacts.

6.1 Self-Monitoring Plan

The self-monitoring plan will be guided by the requirement of ECC, EMB-required Self-monitoring report, requirements of other environmental safeguards agencies, and other issues for the overall environmental soundness, during the different project phases. A preliminary Environmental Monitoring Plan (EMop) is presented as **Table 6.1-1** and will be updated, and improved for operational use on an annual basis, and for input for the General Appropriation Act for the following year.

Monitoring cover the sources of impacts and impact assessment for the land, water, air, and people with reference to the Environmental Management Plan (EMP). Special studies are proposed as more appropriate alternatives to certain situations like the siltation in Bayaoas River and ecology of the reservoir. The frequency of monitoring of pollutive activities is more pronounced during the temporary construction stage. The during the operations phase, monitoring will be guided by the overall study on the ecology at the dam site and reservoir, flood control function of the dam as induced benefit, and the sufficiency and equitable distribution of irrigation water supply, as the primary benefit.

Results of monitoring shall be reported in the Quarterly Self-Monitoring Report (SMR) by the PCO, as may be required, and Compliance Monitoring Report (CMR). SMR is more applicable to projects with routine generation of pollutants, although the SMR has a module on PD 1586.

6.2 Multi-Partite Monitoring Team (MMT)

With the ECC issued, the proponent initiates the formation of its MMT by holding a meeting with the concerned EMB Office. The Project Proponent will adhere to the requirements Article 4 of DAO 2017-15 on Public Participation in Monitoring of Impact of Project with ECC, inclusive of the formation and operationalization of a Multi-Partite Monitoring Team consisting of the primary stakeholders, BSRIP being an Environmentally Critical Project (ECP).

The MMT is an independent entity whose membership are representative stakeholder / public with added credibility by being open and transparent in monitoring environmental impact and compliance with the Philippine EIS System requirement. The main functions of the MMT are as follows:

i. conduct quarterly ocular site visit to validate the proponent's compliance with the ECC conditions and Environmental Management and Monitoring Plan including the requirement to conduct self-monitoring and submit corresponding reports regularly; MMT may observe sampling activities conducted by the project proponent.

ii. prepare and submit its report to EMB-CO and EMB-RO concerned using EMB-prescribed format at least semi-annually not later than July for the first semester report and January for the 2nd semester report; and

iii. institute an environmental emergency and complaints receiving and management mechanism which shall include systems for transmitting recommendations for necessary regulatory action to EMB in a timely manner to prevent adverse environmental impacts

The composition of the MMT shall be rationalize to be representative of relevant stakeholder groups as identified on Section 10 of DAO 2017-15 regarding updating of stakeholder identification and stakeholder analysis. A Memorandum of Agreement (MOA) will be forged in this respect, with preparation of Manual of Operations (MOO). A template for MOA is presented in **Annex 6**.

DAO 2017-15 provides the following guidelines in the composition of MMT to ensure it is a truly independent third party entity,

a. The LGU representatives

- one representative each from the Municipality/City and Natural Resources Officer MENRO/City ENRO (for projects whose DIA is limited to the City or Municipality) and Provincial Government (PG) ENRO (for projects whose DIA is covers more than 2 municipalities). In cases where there is no PG-ENRO, MENR/City ENRO, the Municipal/Provincial Planning and Development Officer (MPDO/PPDO) or the chairman of the environment committee of the Sanguniang Bayan may be designated as representative to the MMT.
- the Rural Health Unit (RHU) Chief and
- concerned Barangay Captain

All existing LGU representatives to the MMT shall be replaced by these officers or their representatives

b. One representative from the LGU-accredited local NGOs with mission/s specifically related to environmental management and/or to the type and impacts of the proposed undertaking/project may be designated as representative to the MMT. In cases, where there is no such NGOs, it shall be open to other NGOs.

c. Maximum of two representatives from locally recognized community leaders who can represent vulnerable sectors including indigenous populations, women and senior citizens and representatives from academe may be included as member of the MMT in addition to the LGU-accredited NGO.

d. Maximum of three representatives from government agencies with related mandate on the type of project and its impacts during project implementation shall be included in the MMT membership, it not yet included. Examples of these government agencies are DOE for energy projects, MGB for mining projects, and PCG, BFAR, BMB or FMB, depending on the location. DENR participation/membership shall be limited only in cases where there are specific concerns related function related to biodiversity and forestry as endorsed by he concerned Bureau Director.

The MMT shall not exceed ten members except in cases where the location of project facilities covers more than on Barangay. In such cases, the additional member shall come from the additional Barangay/s and MEMRO.

In addition, the DENR PENRO and CENRO shall particapte in the MMT under Section IV.A of DENR Adminsitrative Order (DAO) 2018-18, Establishing a Centralized Management and Coordinative Mechanism at the Regional Offices of DENR, MGB, and EMB, and Designating the DENR Regional Director as the Regional Execuive Director Proving Overall Command of Regional Operations.

As a general rule, representative from the MENRO/City ENRO, the PG-ENRO or the representative from the lead agency government agency (e.g. DOE for energy projects, DOT for Tourism Projects) shall serve as the MMT Chair. In cases where the said representatives do not accept the chairmanship, the members of the MMT elect among themselves and specify the procedures in its Manual of Operations (MOO).

Priority local stakeholders that will compose the MMT are Barangay Laoag, Barangay Bayaoas, Barangay Buer, and Barangay Pogonsili, NGP operators and irrigators associations

6.3 Environmental Monitoring Fund

For the formation and operationalization of the MMT under the Environmental Monitoring Fund, the Project Proponent would budget an initial amount of P250,000.00. The annual budget for EMF would depend on the proposed program of the MMT in accordance with the guidelines set in Annex 3-5 of DAO 2003-30 Revised Procedural Manual or prevailing guidelines of EMB, outlined, as follows:

A. Management and Administration of EMF
B. Guidelines for the Disbursement of EMF
C. Allowable Expenses under the EMF

1. Cost of Transportation
2. Board and Lodging
3. Monitoring Costs
4. Allowances
5. Other Costs

6.4 Environmental Guarantee Fund

The establishment of the Environmental Guarantee Fund (EGF) shall be guided by Annex 3-5 of DAO 2003-30 Revised Procedural Manual, and in consideration with the prevailing guidelines and practices, with the following outline:

A. Presumption of Public Risk
B. Purpose of the EGF

C. Determination of the Amount to be Set-up for the EGF
D. Procedure for the Establishment of EGF
   1. The proponent shall prepare a Memorandum of Agreement (MOA)
   2. Establishment of the Fund Management Committee
E. Functions of the EGF Committee
F. Fund Management
   1. Claims/Withdrawals to the EGF
   2. Withdrawals by the Proponent from the EGF
   3. Processing of Claims

The EGF shall be established and used for the following risk-management related purposes:

1) the immediate rehabilitation of areas affected by damage to the environment and the resulting deterioration of environmental quality as a direct consequence of project construction, operation, and abandonment;
2) the just compensation of parties and communities affected by the negative impacts of the project;
3) the conduct of scientific or research studies that will aid in the prevention or rehabilitation of accidents and/or risk-related environmental damages; or
4) for contingency clean-up activities, environmental enhancement measures, damage prevention program including the necessary IEC and capability building activities to significantly minimize or buffer environmental risk- related impacts.

During the construction phase, the Contractor will be required to set-up its own EGF in the form of Trust Fund and Cash Fund.

During the Project Operations or dam operations, the environmental risk would be the dam failure scenario that would cause flash flood and flooding. A detailed simulation study will be conducted for the estimation of EGF. Based on the serious experience of other countries on dam collapse, an initial PhP 2,000,000.00 Trust fund and PhP 2,000,000.00 cash fund will be set aside until a detailed simulation study is done.

Table 6-1. Environment Monitoring Plan for the Proposed BSRIP

Key Environmental Aspects per Project Phase	Potential Impacts Per Environment 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
1.0 PRE-CONSTRUCTION PHASE													
1.1 Siting and negotiation of the Project Development Footprint and location of support facilities; access roads to damsite, access irrigation canals, staging area, basecamp, quarry site, spoil disposal site	LAND The proposed Project would cause permanent and change in land use to built up area from agricultural area, and idle areas for the access road at the alienable disposable land , and from NGP areas for damsite and reservoir area in the forest land.	Exact location and area to be opened up	ground verification with LGU during geodetic surveys	once	covered site	Environmental Officer	included in project budget	n/a	n/a	n/a	n/a	n/a	n/a
	PEOPLE Loss of private property, income at the proposed access road	Exact location and extent of property	ground verification with landowners during geodetic surveys	one time	covered site	NIA Engineering	included in project budget	n/a	n/a	n/a	n/a	n/a	n/a
	Loss of planted trees and vegetation by NGP Operators	Inventory of vegetation	ground verification	one time	covered site	Forester	included in project budget	n/a	n/a	n/a	n/a	n/a	n/a

Key Environmental Aspects per Project Phase	Potential Impacts Per Environment 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
	Change in the access route of NGP Operator, the reservoir as a barrier of access	Exact location of access route	ground verification with NGP Operators during geodetic surveys	one time	covered site	NIA Engineering	included in project budget	n/a	n/a	n/a	n/a	n/a	n/a
	NIA as an added entity in the institutional jurisdiction of the area	Right-of-Way, Special Land Use Permit	Document review	once	n/a	Environmental Officer	Part of EO duty	n/a	n/a	n/a	n/a	n/a	n/a
2.0 CONSTRUCTION PHASE													
2.1 Piloting, land clearing , earth excavations, at the proposed access road, staging area, basecamp, quarry site, spoil disposal site and dam, with the following associated civil works: • Disposal of excavated materials to spoil disposal area • Quarrying Works as source of rocks for the dam • Stockpiling of construction concreting	LAND Removal of vegetation leading to wildlife habitat loss and fragmentation, reduction in the natural soil erosion control, acceleration of soil erosion, and decrease in carbon sequestration capacity of the area.	Inventory of actual trees/vegetation removed with photos	According to FMB procedure	once	site of trees/vegetation	NIA Environmental Officer, hired Forester		cutting of trees outside the designated area			stoppage tree cutting and investigation		

Key Environmental Aspects per Project Phase	Potential Impacts Per Environment 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
materials (gravel and sand) • Filling of earth materials at dam site This would cause localized vegetation removal; emission of dust, criteria pollutants and GHG; noise production; accelerated soil erosion; destruction of habitats; use of earth materials for the dam													
	LAND Localized change in topography by the addition of dam, quarrying, and spoil disposal area	Elevation topic graphic map	general topographic survey	before and after construction	affected site	NIA Engineering	part of project cost	n/a	n/a	n/a	n/a	n/a	n/a
	WATER/PEOPLE Increase in siltation in TSS and browning of Bayaoas River especially during rainy season.	TSS	water sampling and gravimetric analysis	weekly at the start of dam construction	upstream of the dam, Don Quiron Intake, Calsib Buer Intake	Environmental Officer		66 -80 mg/L during dry season	81-110 mg/L	more than 110 mg/L	check mitigation measures	intensify mitigation measures	intensify mitigation measures
	Heavy siltation downstream of the	Plot a map the	visual	weekly	Dam to affected	Contractor	Part of EO Job						

Key Environmental Aspects per Project Phase	Potential Impacts Per Environment 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
	damsite along the river would discourage recreational activities (picnic and swimming)	qualitative length and depth of eroded soil,			channel	Environmental Officer	Description						
		volume of excavated earth materials	inquiry from contractor, visual	weekly	n/a	Contactor Environmental Officer	Part of EO Job Description	n/a	n/a	n/a	n/a	n/a	n/a
		hauling of excavated materials	inquiry from contractor, visual	weekly	n/a	VEnvironmental Officer	Part of EO Job Description	volume of hauled excavated earth material unreasonably lesser than the excavation rate		no hauling of spoils			suspension of excavations
	AIR/PEOPLE Intermittent increase in dust emission and total suspended particulates (TSP) in the nearby residential area along the proposed access road to the dam site during the dry season or periods of the 3-year	Dust Emission TSP 1-hr TSP 24-hr	visual high volume air sampler	spot checks during and after road widening/construction TSP 1-hr (at north prevailing wind)	AQ-1 nearest residential area in the	Environmental Officer	P100,000	observable high dust emission towards residential areas, especially during wind condition			excavations be done when wind blows northward towards Bayoas River		

Key Environmental Aspects per Project Phase	Potential Impacts Per Environment 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 period.												
	The operation of heavy equipment would cause emissions of criteria air pollutants at nuisance levels in in the proposed access road near the residential areas. the impact would just be about a month in the 200-m segment.	characteristic of vehicle smoke	visual	spot checks	proposed access road near residential area	Environmental Officer	no cost, part of EO	No equipment maintenance schedule	excessive black smoke emitting from heavy equipment		Advise contractor to have scheduled maintenance of equipment	replacement of heavy equipment operation	
	Intermittent increase noise levels the residential areas near the proposed access road.	noise	use of noise meter	spot checks	road side near operation heavy equipment, and at distances from the road, at morning, daytime, evening, nighttime	Environmental Officer	P50,000	>45 dBA			avoid nighttime operation		
	PEOPLE The construction	number of local residents	inquiry from contractor, document	monthly	n/a	Environmental Officer	no cost	no local resident hired in the			justification from contractor		

Key Environmental Aspects per Project Phase	Potential Impacts Per Environment 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
	phase will provide opportunity in hiring qualified residents	hired	reviews and validation					first month					
2.2 Repairs and improvements of existing irrigation canals, involving the following: • Quarrying works as source of gravel and sand from Bayaoas River. • Stockpiling of construction concreting materials (gravel and sand) • Concreting of Irrigation canal	LAND/PEOPLE The potential impacts of the repairs and improvements of existing canal on the natural environment will be within the work site. There may be cases of vegetation removal	vegetation removal	visual and validation with tree owner	once per worksite	worksite	Environmental Officer	Part of EO Job Description	vegetation not part of the programmed remove			Negotiate with the owner of vegetation		
	WATER/PEOPLE There could be temporary disruption in the irrigation water supply	Water supply disruption	visual, programmed	once per work site	work site	Environmental Officer	part of EO Job Description	No documented schedule of improvement and prior notice to farmers	improvements being done without prior notice to farmers		EO to advise Engineering and notify farmers	stop improvement works and notify farmers	
2.3 Operations of Construction Support Facilities													
• Maintenance of Refueling Station	LAND/WATER	presence of adequate	ocular inspection	during the installation	refueling station	Environmental	Part of EO Job	No spill containment			Contractor to place spill		

Key Environmental Aspects per Project Phase	Potential Impacts Per Environment 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
for vehicles and heavy equipment, with risk of spillage	Fuel spillage on ground and into the groundwater to Bayaoas River is a risk during refueling and leaks	spill containment		on of refueling station		Officer	Description				containmen t		
	Risk of fire due to grass fire	Location of refueling station away from grass fire area	arrangement with contractor	once	n/a	Environm ental Officer	Part of EO Job Description	n/a					
• Onsite maintenance of heavy equipment at dam site, as source of solid and liquid wastes	LAND Replacement of parts of vehicles Increase in the local solid waste	Contractor proper handling, containment and disposal of solid wastes	ocular inspection with a Checklist	routine	equipmen t maintena nce area	Environm ental Officer	Part of EO Job Description	improper practices			call the attention of contractor in writing		
	WATER Maintenance of heavy generates waste oil and washings that may pose risk of contaminating the ground, groundwater and Bayaoas River	Contractor proper handling, containment and disposal of liquid wastes	ocular inspection	spot checks	equipmen t maintena nce area	Environm ental Officer	Part of EO Job Description	improper practices			call the attention of contractor in writing		
• Operation of on-site Batching Plant, with stockpiling of	LAND/WATER The operation of a batching plant	Soil erosion characteristi cs of earth stockpiles	ocular inspection	spot checks	stockpile area	Environm ental Officer	Part of EO Job Description	Stockpiles near Bayaoas River			call the attention of contractor in writing		

Key Environmental Aspects per Project Phase	Potential Impacts Per Environment 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
erodible materials	generate stockpile of earth materials that may erode cause siltation in Bayaoas River												
• Provision of package construction materials, generating solid wastes	LAND Packaging materials would cause an increase in the local solid wastes	Proper segregation, storage and disposal of solid waste, housekeeping	ocular inspection	spot checks	sources of used packing materials	Environmental Officer	Part of EO Job	No program of proper segregation, storage and disposal			call the attention of contractor in writing		
• Use of basecamp at dam site, generating solid and liquid wastes	LAND Basecamp would be a source of food, solid waste, sanitary waste, and medical waste	Proper collection and disposal of solid liquid waste	ocular inspection	spot checks	sources of used packing materials	Environmental Officer	Part of EO Job	No program for proper collection and disposal of solid liquid waste			call the attention of contractor in writing		
	WATER Basecamp would be temporary, insignificant source of sewage, laundry washings, vehicle washings, and laundry;	Presence of appropriate control of sewage, laundry washings, approximate volume of discharges	ocular inspection	spot checks	basecamp	Environmental Officer	Part of EO Job	visible flow of wastewater to Bayaoas River			call the attention of contractor in writing		
		BOD, fecal coliform of effluent and in Bayaoas River,	grab sampling and laboratory analysis,	spot checks for validation of insignificance of	effluent, and upstream and downstre	Environmental Officer	P100k	significant increase call the attention of contractor			call the attention of contractor in writing		

Key Environmental Aspects per Project Phase	Potential Impacts Per Environment 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
		Flowrate of Bayaoas River		discharges	am of mixing zone in Bayaoas River			in writingin the BOD, fecal coliform from upstream to mixing zone					
• Demobilization Works. as source of solid waste and used oil	LAND Demobilization after construction works would generate solid waste and increase the volume of municipal solid waste	Proper handling of used oil for final disposal to DENR accredited disposer	review of demobilization program, ocular inspection										
	WATER Stored used oils may pose risk of spillage when left at the site.	Proper handling of used oil for final disposal to DENR accredited disposer	review of demobilization program, ocular inspection										
3.0 OPERATION PHASE													
3.1 Commissioning with initial filling of dam to operational level	LAND Submersion of vegetation leading to wildlife loss and displacement.	quantity of vegetation/trees submerged	tree inventory procedure by FMB, coordination with DENR CENRO	once with possible review	affected vegetation	Environmental Officer	to be determined						

Key Environmental Aspects per Project Phase	Potential Impacts Per Environment 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
			Dagupan and NGP Operators										
	Submersion of would also reduce GHG sequestration capacity	Loss GHG sequestration capacity	IPCC method	once with reviews	n/a	Environmental Officer	to be determined as part of a special study	n/a	n/a	n/a	n/a	n/a	n/a
	WATER Increase in depth of Bayaoas River, as initial change in the aquatic characteristics	Reservoir Depth	dam instrumentation	daily	dam	Dam Operator	Part of Project routine activities	n/a	n/a	n/a	n/a	n/a	n/a
		distance of inundation from the dam, and surface area of inundation	field survey	to be programmed for the correlation with depth	reservoir	Environmental Officer	Part of Job Description of EO	n/a	n/a	n/a	n/a	n/a	n/a
	PEOPLE Safety risk	Number of people going to dam and reservoir and activities	dam visitors logbook, ocular survey	monthly	dam/reservoir	Dam Operator	Part of Project protocol	n/a	n/a	n/a	n/a	n/a	n/a
3.2 Dam Operation and Maintenance	LAND Emergence of new riparian area	Typical characterization	to be developed based on	seasonal		Environmental Officer	to be determined as part of a	n/a	n/a	n/a	n/a	n/a	n/a

Key Environmental Aspects per Project Phase	Potential Impacts Per Environment 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
			BMB guide				special study						
	WATER The dam serves as a flood control structure, with rising water level during the rainy season and decreasing during the dry season	rainfall	rainfall gauge with electronic recording	part of a special study		Environmental Officer	to be determined as part of special study	n/a	n/a	n/a	n/a	n/a	n/a
		depth of reservoir	dam instrumentation										
		volume of reservoir	mathematical estimate										
		discharge rate at main supply canal	dam flow instrumentation										
	The water reservoir would have a different water quality and ecology than the other segments of Bayaoas River. There maybe thermal stratification and nutrient enrichment along the water column	A special study will be done to assess the prevailing water ecology	to be outsourced			Environmental Officer	to be determined as part of a special study	n/a	n/a	n/a	n/a	n/a	n/a

Key Environmental Aspects per Project Phase	Potential Impacts Per Environment 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
	of the reservoir.												
	The proposed dam will be a barrier to fish passage	presence of fishes along the main irrigation water supply	sampling with net	part of a special study	main supply canal	Environmental Officer	to be determined as part of a special study	n/a	n/a	n/a	n/a	n/a	n/a
	The proposed dam will be a barrier replenishment of earth materials downstream	dam sedimentation	sounding	annual	dam	Environmental Officer	to be determined as part of a special study	n/a	n/a	n/a	n/a	n/a	n/a
	Risk of dam failure	parameters as defined in dam structural integrity monitoring as will be provided in a manual	as defined in a manual of operations	as defined in a manual of operations	as defined in a manual of operations	Dam Operator	Part of job description	as defined in a manual of operations	as defined in a manual of operations	as defined in a manual of operations	as defined in a manual of operations	as defined in a manual of operations	as defined in a manual of operations
	AIR/Climate The proposed Project may result in a change in microclimate.	for future consideration in a special study						n/a	n/a	n/a	n/a	n/a	n/a
	PEOPLE Induced long-term proliferation of settlement at concrete road	presence of structure	site patrolling/ drone	weekly	dam/reservoir	Environmental Officer	to be determined as part of activities with NGP Operators	n/a	n/a	n/a	n/a	n/a	n/a

Key Environmental Aspects per Project Phase	Potential Impacts Per Environment 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
	side without regard of setback or safe distance from the road												
3.3. Damsite office and workshop use with generation of solid and liquid wastes	LAND/WATER Generation of solid and liquid waste from the damsite office and workshop would be environmentally insignificant	Proper housekeeping, handling and disposal of solid and liquid wastes	inspection	spot check	office and workshop	NIA PIMO management	Part of Job Description	n/a	n/a	n/a	n/a	n/a	n/a
3.4 Supply of reservoir water to irrigation networks	LAND/WATER The availability of irrigation water during the dry season would increase rice production by total area and tons/ha	Dry season water flow from main supply canals and distribution	calibrated gauges	seasonal	irrigation canals	NIA PIMO management in coordination with famers	Project routine program	No distribution program	Alleged inequitable distribution of water supply		Distribution program to be prepared with farmers	Investigations and resolution of allegation	
	Risk of excessive use of fertilizers and pesticides which may serve as pollutants into Bayaoas River and groundwater	to be determined as part of a special study	to be determined as part of a special study	to be determined as part of a special study	to be determined as part of a special study	Environmental Officer	to be determined as part of a special study	n/a	n/a	n/a	n/a	n/a	n/a
	WATER	water flow into Calsib-	calibrated weir/gauge	weekly	Calsib-Buer	Environmental	Part of EO Job	no program environme	insufficient flow during		provision of program for	coordination	

Key Environmental Aspects per Project Phase	Potential Impacts Per Environment 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
	The separate intake of Buer-Calsib irrigation system in Bayaoas River may be deprived of water supply	Buer Intake	post		Intake and main main channel of Bayaoas River	Officer	Description	ntal flow provision	dry season		environmental flow provision	with Casib-Buer farmers	
	PEOPLE The supply of water would cause a chain of benefits from the opportunity to irrigate more ricefield, increase in farm labor, increase in rice production, to commercial activities to an increase taxes for the LGU.	to be determined as part of a special study	to be determined as part of a special study	to be determined as part of a special study	to be determined as part of a special study	Environmental Officer	to be determined as part of a special study	n/a	n/a	n/a	n/a	n/a	n/a

7. DECOMMISSIONING / ABANDONMENT / REHABILITATION POLICY

It is the policy of NIA to achieve well-designed, well-constructed, well-maintained and monitored embankment dams. The dam physical characteristics and condition will be continually recorded. Time will come dams will have to be decommissioned in consideration of structural integrity of the dam, public safety, cost of maintenance, replacement, Act of God and other decision factors. The policy of decommissioning is coupled with the policy of achieving safe and environmentally sound removal of the dam.

Removal of part or entire dam would cause complex impact as in the following:

- generation earth materials to hauled to designated disposal area that may result in long term accelerated soil erosion;
- generation of solid wastes from dam instrumentation solid waste that would cause localized shot-term physical effects on the aquatic ecology;
- release of accumulation sediments , settled logs and vegetation upstream as additional impact on the local aquatic ecology;
- long-term threat of landslide;
- exposure of submerged areas with the emergence of another ecology, with long-recovery as wooded land;
- threat to public safety;
- cessation of dam functions as source of irrigation water supply, flood control, source of water for NGP operations.

As a policy, this activity will be treated like a separate project with the engineering and environmental considerations (impact assessment, management measures, monitoring, responsibilities and cost estimates). The plan will be done in coordination with experts and stakeholders (with MMT) in accordance with best international practices and regulatory requirements, with approval of DENR and other government agency. Among the activities include the following:

i. Decision making
ii. Timely notice of Decision / IEC to local and government agencies
iii. Planning (engineering and environmental)
iv. Budget Appropriation
v. Contracting
vi. Acquisition of clearances from government agencies
vii. Social Preparations
viii. Mobilization
ix. Reservoir dewatering
x. Dam earth removal to disposal areas
xi. Any rehabilitation works in the inundated areas
xii. Social review of the removal activities
xiii. Final government inspections
xiv. Contractor Demobilization
xv. Final Notice to Stakeholders

Dewatering involves removal of a part of the dam disable the storage / flood control function of the dam. This is done during the dry season to avoid flash floods for public safety.

8. INSTITUTIONAL PLAN FOR EMP IMPLEMENTATION

Section 3 on the Environmental Management Plan identifies the lead entity in the implementation of the options for the environmental mitigating measures for the proposed Project. This section covers the organizational scheme of the Proponent including line of command and reporting procedures as well as manpower complement and relationships with other operating departments in the EMP implementation in the pre-construction, construction and operation phases of the proposed Project.

In principle the Pangasinan Provincial Irrigation Management Office (PIMO) together with the Regional Irrigation Office 1 (RIO), with guidance of the NIA Central Office, will supervise all project activities and the Environmental and Institutional aspects of the Project. Presently, there is no plantilla position of an environmental unit under PIMO, but there is a designated contractual staff (to be designated as Social and Environmental Officer or SEO for this EIS), handling social environmental matters, among others, directly reporting to PIMO Division Manager A, with two support contractual staff for this project.

For the construction phase the SEO will report directly to PIMO Manager and coordinate with other units including Bayaoas SRIP PMO staff to be composed of a Resident Engineer, Office Engineer, Material Testing Engineer, Construction Engineer and Geologist (on call basis), complemented with support staff (**Figure 8-1**).

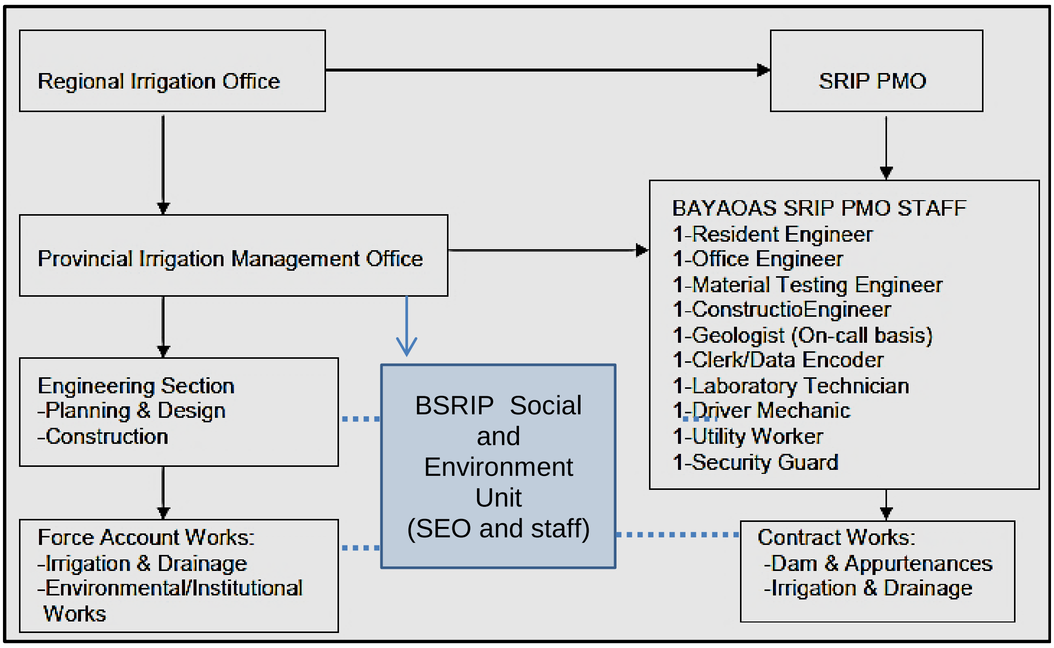


Figure 8-1. Proposed BSRIP Social and Environment Unit and Lines of Coordination

Bids and contracts with Contractors will have environmental provisions for implementation of EMP. They will implement the civil works and engineering aspect of the mitigating measures and their own sources of impacts. The designated Contractor Environmental Officer shall provide the NIA SEO information on the measures applied for reportorial requirements and assessment of the effectiveness of measures. Thus, prior to the construction proper the SEO and Contractor EO would plan out on the ground the detailed site-specific measures to be adopted, and develop a checklist for performance monitoring, guided by the EMP, ECMP (Environmental Compliance Monitoring Plan), ECC conditions, other government permits conditions, and MMT monitoring plan. A weekly coordination meeting will be done with spot checks of mitigating measures.

Among the functions of the SEU will include the following:

i. take the lead in securing the Road Right-of-Way with the private lot owners and environmental permits like the Special Land Use Permit, tree-cutting permits, and Water Permit;
ii. coordinate with the Engineering in preparing large scale working base maps for thematic plotting like the project lay out, tree inventory, and engineering measures;
iii. continually update the EMP and Monitoring Plans;
iv. attend to the formation and operationalization of MMT
v. submit to EMB the Compliance Monitoring Report and Self-Monitoring Report;
vi. continually interface with the community, NGP Operators, farmers, and other stakeholders, with the implementation of SDP and IEC;
vii. implement the Environmental Compliance Monitoring Plan;
viii. timely prepare proposed budget for the various environmental activities,
ix. preparation of social and environmental manual; and
x. maintain environmental data base and records management.

During the Project Operations Phase a different environmental set-up will apply that will be entirely by PIMO. The SEU will have the following functions, among others:

i. prepare annual environmental program including budgetary requirements
ii. continually attend to the assessment of the ecological impacts of the reservoir and Bayaoas River, with special studies
iii. environmental monitoring
iv. risk assessment of dam failure scenario
v. attend to the replacements of loss trees with NGP operators
vi. attend to the implementation of SDP and IEC
vii. attend to community issues
viii. continue attendance to MMT concerns
ix. risk assessment of dam failure scenario
x. attend to EGF requirements
xi. attend to reportorial requirements on environment
xii. coordinate with the other PIMO units
xiii. updating of social and environmental manual, and
xiv. continue maintenance of environmental data base and records management

The PIMO and RIO will ensure provision of reasonable budgetary, logistical, personnel, technical, and administrative support to social and environmental matters of the proposed Project. As there will be other similar proposed projects in Pangasinan, the PIMO will endeavor to obtain a plantilla positions for the SEU.

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