APPENDIX-XI

Environmental Assessment

THE STUDY ON SABO AND FLOOD CONTROL
FOR WESTERN RIVER BASINS OF MOUNT PINATUBO
IN THE REPUBLIC OF THE PHILIPPINES

FINAL REPORT

SUPPORTING REPORT

APPENDIX XI ENVIRONMENTAL ASSESSMENT

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CHAPTER 1 EXECUTIVE SUMMARY

1.1 Brief Description of the Proposed Project

The aftermath of Mount Pinatubo eruption is still being felt by the affected communities surrounding the volcano. Efforts by the Government of the Philippines (GOP) to help these affected residents were more concentrated on the eastern side of Mount Pinatubo. As part of the continuing assistance being provided by the international community such as the Japan International Cooperation Agency (JICA), plans were proposed to focus on the plight of the hapless residents of the western river basins of Mount Pinatubo. Master plan was formulated on the construction of sabo and flood control facilities in these said areas. This particular project is aimed to provide engineering measures to combat the ravaging effects of the lahar especially during the wet season. This provision will ultimately uplift the existing conditions of these affected areas and will help the immediate economic recovery of the especially the agricultural capability of the region.

Under the master plan, several priority projects were selected including their alternatives. The Environmental Impact Assessment (EIA) was carried out for the whole proposed priority projects, while the report provided here mainly covered those for the priority structure measures. The proposed priority structure measures are summarized in Table 1.1.1 with the estimated value of construction costs for each project. Location of the selected priority projects are shown in Figure 1.1.1.

1.2 Brief Description of Methodology of the EIA

The Environmental Impact Assessment (EIA) was conducted under the guidelines of the Procedural Manual of the Department of Environment and Natural Resources (DENR) Administrative Order No. 37, Series of 1996. The EIA was done from December 2002 to June 2003, covering the environmental components: physico-chemical, biological and socio-economic. Consultations were also held with the stakeholders through the barangay and municipal officials.

The primary data gathered for this Environmental Impact Assessment (EIA) were used to supplement the primary data gathered from the previous Initial Environmental Examination (IEE) Study conducted for the master plan. The findings of the IEE are reproduced in this EIA Report especially for the Baseline Environmental Conditions of the study areas.

1.3 Brief Description of Baseline Environmental Conditions

1.3.1 Topography, Geology, and Hydrogeology

The project areas consist of rolling terrain and lies at the western flank of the Zambales range. The geology comprises of formation of shale and sandstone sequence, unconsolidated conglomerate and agglomerate materials. The area is mostly covered with lahar, having slope of 0-3%. The project sites are located in the three western river basins of Mount Pinatubo, namely: Bucao River, Maloma River and Sto. Tomas River.

1.3.2 Meteorology

The site falls under TYPE I climate based on the Modified Corona’s scheme of classification. This type of climate has two pronounced seasons, dry from November to April and wet during the rest of the year.

1.3.3 Air Quality & Noise Level

The existing conditions meet the ambient air quality standards of the DENR due to the absence of significant source of pollutants. Except for the three stations located at or near the main roads, the noise levels are also within the standards.

1.3.4 Water Quality

Generally, results of the water quality sampling showed that most of the tested parameters are within the DENR standards for both the freshwater and marine water. Exceedance with the standards observed for total coliform in marine waters may be attributed to the organic wastes washed off from the coastal areas and rivers.

1.3.5 Sediment and Soil Quality

There are no existing Philippine standards for sediment and soil. Concentrations for heavy metals were compared to the Dutch Intervention Values. Heavy metals concentrations in sediments as well as in soil are way below the Dutch Intervention Values. The soils in the project areas are generally low in fertility and most are unsuitable for agricultural crops.

1.3.6 Land Use and Aesthetics

The project sites are predominantly a mixed-use of residential and agricultural areas. There are still substantial portions of the project sites with unstable conditions which are under the threat of lahar flows.

1.3.7 Terrestrial Ecology

Terrestrial vegetation of the project areas distinctly bounded by Savannah ecosystem in all cardinal directions followed by streambank and hilly land ecosystems from Mount Pinatubo crater down to the South China Sea.

1.3.8 Aquatic Ecology

Due to the huge amount of lahar deposits, aquatic resources have decreased significantly compared to pre-eruption period coupled with the increase in the population.

1.3.9 Socio-Economic

The socio-economic activities are mostly geared towards agricultural production. Based on the socio-economic survey, 106 households will be directly affected by the priority projects. A draft resettlement plan has been formulated to address the issues on relocation including the compensation package for the directly affected people.

1.4 Matrix of Issues and Impacts Identified through the Environmental Screening

Table 1.4.1 presents the issues identified through the environmental screening process. This table becomes the basis for incorportating the issues that will be raised during the First Level and Second Level Scoping Meetings.

1.5 Summary Matrix of Major Impacts, and Mitigation/Enhancement Measures

Table 1.5.1 shows the matrix summarizing the major impacts, degree of impacts and mitigation and enhancement measures for the proposed project.

1.6 Summary Matrix of Environmental Management Plan

Table 1.6.1 shows the summary matrix of the Environmental Management Plan for the project.

1.7 Summary Matrix of Environmental Monitoring Plan

Table 1.7.1 shows the summary matrix of the Environmental Monitoring Plan for the project.

1.8 Scoping Report

For the purpose of public acceptance for an Environmentally Critical Project (ECP), the Procedural Manual of DENR Administrative Order No. 37, Series of 1996 requires the project proponent to carry out First Level Scoping Meeting with the DENR-EMB in charge for defining an authorized environmental checklist for the project EIA. After the authorized environmental checklist will have been prepared, the project proponent has to implement an EIA based on the checklist and to complete/prepare the Environmental Impact Statement (EIS) for submittal to the DENR-EMB for obtaining an Environmental Compliance Certificate (ECC). On the other hand, the project proponent has to carry out Second Level Scoping Meeting after the First Level Scoping Meeting. The Second Level Scoping Meeting is also called as Public Consultation Meeting, which must be open for the stakeholders, including concerned local government units (LGUs), NGOs, people organizations (POs), Indigenous People (IP) groups, and so on. .

The First Level Scoping Meeting for the EIA was held on January 31, 2003, with DENR-EMB Region III personnel in charge, for which the members of the "EIA Review Committee" (EIARC) also participated. The environmental checklist was prepared and authorized under the meeting. The Second Level Scoping Meeting (i.e. Public Consultation Meeting) was held by the project proponent on May 20, 2003 at the Capital Hall of Zambales Province. The representatives from most of concerned stakeholders participated and discussions were made mainly on resettlement issue and contents of structure measures. It should be noted that the First and Second Level Scoping Meetings are all indispensable for an EIA and its EIS for a project proponent for assuring an ECC from the DENR. Project proponent will have to prepare a detailed scoping report for securing the ECC.

1.9 Process Documentation Summary

The EIA was prepared under the guidelines of the Procedural Manual of DENR Administrative Order No. 37, Series of 1996. The EIA was conducted from December, 2002 to June 2003 covering the environmental components - physico-chemical, biological and socio-economic. Consultations were also held with the stakeholders through the barangay and municipal officials.

The environment within the perceived impact area was investigated by a team of specialists, which assessed the existing baseline physical, biological and social conditions at the site through a field data gathering program.

Primary data were gathered during the field survey wherein air, water and soil/sediment samples were obtained for laboratory analysis. Secondary data on the socio-economics of the following towns:

- Botolan
- San Felipe
- San Narciso, and
- San Marcelino.

Were gathered from the municipal records and used as background demographic information. A household survey was also done to obtain the community perception about and awareness of the project. The specific methodology for each component is discussed in its particular section.

Primary project information was provided by The JICA study team and DPWH. The national agencies from where secondary data were gathered include the Bureau of Soils and Water Management (BSWM), PAGASA, PHIVOLCS, National Water Resources Board (NWRB), National Statistics Office (NSO). At the local level, the Municipal Planning and Development offices and Municipal Health and Agriculture offices of the respective affected towns provided the data.

The matrix for Primary and Secondary Data are presented in Table 1.9.1.

1.10 Summary of Proof of Social Acceptability

1.10.1 Initial Public Consultation Meeting

The DPWH initiated the conduct of Public Consultation Meeting in coordination with the DENR EMB Region III last September 10, 2002 to provide information on the study on Sabo and Flood Control For Western River Basins of Mount Pinatubo. The said consultation meeting was held at the Provincial Capitol, lba, Zambales.

During the public consultation the Local Government Units (LGUs) e.g. the Provincial Governor, the Mayors of eight Municipalities of study area, Barangay Captains and other concerned parties participated in the deliberation and discussion of issues, views, ideas and perceptions on the likely environmental adverse and beneficial impacts that could result from the proposed sabo and flood control projects.

The JICA/DPWH Team presented the draft master plan, terms of reference (TOR) on EIA and the Philippine EIS System by DENR EMB representative. The course of the open forum, the provincial, municipal authorities, the IP's and other stakeholders made constructive comments on issues/relation to the community's environment and the proposed flood control projects. These were taken into consideration for the study.

With public consultation, DPWH as proponent has determined whether the project will encounter any difficulty in getting the approval or support of the local community. As it sets the tone of the EIA process, the proponent at the early stage of project development has already define the range of actions and alternatives undertaken by the study team.

1.10.2 Consultation Workshop and Household/Perception Surveys

Several activities were conducted for the EIA to supplement the socio-economic surveys conducted in the previous IEE Study. Table 1.10.1 shows the different activities that were conducted during the EIA Study.

The surveys conducted were more focused on the directly affected households or stakeholders. All the activities were documented and discussed in the Resettlement Plan which is attached to this report as a separate document.

CHAPTER 2 PROJECT DESCRIPTION

2.1 Basic Project Information

Project Name	:	**THE STUDY ON SABO AND FLOOD CONTROL FOR WESTERN RIVER BASINS OF MOUNT PINATUBO IN THE REPUBLIC OF THE PHILIPPINES**
Project Proponent	:	**Department of Public Works and Highways**
Main Office	:	Bonifacio Drive, Port Area, Manila
Site Office	:	DPWH District Engineering Office, Balili, Iba, Zambales
Representative / Contact Person	:	Engr. Efren Pacson District Engineer
Telephone	:	+63 (47) 811-1327
Fascimile	:	+63 (47) 811-1327
Consultants	:	**The Joint Venture of Nippon Koei Co., Ltd. and CTI Engineering International Co., Ltd.**
Main Office	:	4th Floor, Pacific Star Building, Gil Puyat cor. Makati Avenue, Makati City
Site Office	:	DPWH District Engineering Office, Balili, Iba, Zambales
Representative / Contact Person	:	**Mr. Shinsuke Hino** Team Leader
Telephone	:	+63 (47) 811-3244 & 45
Fascimile	:	+63 (47) 811-3245
Funding Agency	:	**Japan International Cooperation Agency**
EIA Preparer	:	JICA study team DPWH of the Government of The Philippines And JBJ Consulting, Inc.

2.2 Project Locations

The priority projects of the sabo and flood control plan will be located at the following western river basins of Mt. Pinatubo:

- Bucao River
- Maloma River, and
- Sto. Tomas River.

The location map is presented in Figure 1.1.1.

2.3 Project Description

The proposed structural measures will be implemented to prevent flooding and mudflow spreading to the flood/mudflow prone areas and also to improve the safety conditions along the National Highway No. 7.

(1) Bucao River Dike Construction and Heightening, Including Re-construction of the Bucao Bridge

The existing dike is located along the right bank for the 6 km stretch from the Bucao Bridge. The possibility of a dike breach remains for this stretch. Strengthening of the dike will be required to ensure safety against mudflow. New dikes will be constructed along both sides of the downstream of the Bucao Bridge.

A proposed new Bucao Bridge will be located at the downstream from the existing bridge site. This is because construction of a new bridge at the upstream site would require a longer one. In addition, replacement of the bridge at the existing location would require construction of a long detour bridge. The required under clearance has been determined to be more than 1.5 m for the Bucao Bridge. The increase in bridge length is 21 m.

Figure 2.3.1 shows the details of the proposed structure measures along the Bucao River.

(2) Sto.Tomas River Dike Construction, Heightening and Strengthening, Excluding Re-construction of the Maculcol Bridge

During the flood on 8 July 2002 the inland area at the left bank for the stretch from the Maculcol Bridge to the river mouth was inundated with 1.0 m thick sediment due to the breach of dike. In the Sto. Tomas River basin, the mudflow would swerve inland causing a considerable volume of sediment deposit if the dike breached because the riverbed elevation is higher than the inland elevation. Dike strengthening and heightening are still necessary along the both side banks though tiling existing dike has been raised since its construction.

In addition, new dikes will be constructed along both river banks in the downstream side of the Maculcol Bridge.

Figure 2.3.2 shows the details of the proposed structure measures along the Sto. Tomas River.

2.4 Description of Project Phases

2.4.1 Pre-Construction/Construction Phase

The pre-construction phase of the project basically covers the planning aspects. The pre-construction phase includes financial and marketing feasibility studies, planning and detailed architectural and engineering design, meetings with the local government and relevant government agencies, and consultations with affected communities and stakeholders. It also includes the preparation and submission of necessary documents to regulatory agencies to obtain the required permits. This phase involves preparation and submission of environmental impact statements and other related permits.

Further, this phase will include the initial mobilization and transport of construction equipment and supplies to the project site. Employment of contractual workers for the construction phase of the project will commence, with preference given to qualified local residents.

The project is currently under the pre-construction phase and is also developing the Feasibility Study for the project. The ouput of the study will determine the type of activities and schedule of the construction phase.

2.4.2 Operational Phase

Upon completion of the project, DPWH will take over the maintenance of the structures. Maintenance activities may involve intermittent lahar scraping after heavy rainfall or massive lahar movements and integrity testing of the structures to ensure safety of inland areas.

2.4.3 Abandonment Phase

Since this project is considered critical for the protection of the existing natural environment and the surrounding social communities, no abandonment phase is perceived for this type of project. The activities which could be considered after operational phase of the project will be to re-enhancement of the structures for keeping their soundness for further usage.

CHAPTER 3 BASELINE ENVIRONMENTAL CONDITIONS

3.1 Physical Environment

3.1.1 Location and Physiographic Setting

The Zambales province lies approximately between 14°44’36” to 15°53’26” north latitude and 119°46’02” to 120°26’08” east longtitude (Figure 3.1.1). The terrain is part of the northern portion of the Western Physiographic Province of the Philippines (Bureau of Mines and Geosciences, 1980). Dominating the landscape is the Zambales Range – rugged mountains extending 200 km south-southeast from the Lingayen Gulf towards the Bataan peninsula. A 50-km long, north-south chain of early Pliocene to Holocene volcanoes (De Boer and others, 1980; Wolfe and Self, 1983) dots the southern termini of the range with Pinatubo Volcano as the lone active volcanic peak. Narrow plains and beaches characterize coastal regions.

3.1.2 Topography and Drainage

Zambales is characterized by volcanic remnants and high relief mountain ranges named as the Zambales Range. It extends to the north from Lingayen Gulf and up to the south to Bataan Peninsula. The uncommon vertical faces of the Zambales range trending slightly west or north is approximately of 180 km long and 35 km wide. Generally the main crest of the Zambales range is a domal high surface reaching a highest peak of about 2,037 m called the High Peak. It is bounded by volcanic cone in the southeast portion composing Mount Pinatubo the second highest peak of the province with 1,745 m. It is particularly located between the boundary of Pampanga, Tarlac and Zambales province. Along the main highways are developed flat to gently sloping plain and valleys where the municipalities are located. The south coast of the province is very irregular with deep and coastal embayment (BSWM, 1988). The other prominent peaks within the range are Mt. Iba (1,606 m) and Mt. Natib (1,287 m). The topographic map is shown in Figure 3.1.1.

The province is drained by the main rivers of Nayon, Cabaluan, Lawis, Bucao and Anonang rivers which are all draining toward the South China Sea.

3.1.3 Mount Pinatubo Drainages

In Zambales, the principal channels affected by lahars were those that tap the new pyroclastic-flow deposits. These are the Bucao River system that drains the west and northwest sectors of the volcano, the Sto. Tomas River system, including the Marella River, that drains the southwest sector, and, to a much lesser extent, the Maloma River. The Bucao and Sto. Tomas Rivers are expected to continue experiencing destructive lahars for several years. In contrast, due to its limited access to new pyroclastic-flow deposits, the Maloma River did not have lahars as frequently as the other two but may become more active in the future if it beheads and captures part of the watershed area of the Marella River (Pierson and others, 1992; Rodolfo and Umbal, 1992). The spot image map is shown in Figure 3.1.2.

(1) The Bucao River System

The Bucao River system, a broad watershed with an area of 655 km^2, drains the west and northwest sector of Mount Pinatubo and surrounding ultramafic terrain. Its Pinatubo portion, with an area of 270 km^2, is by far the largest catchment basin on the volcano. The southern part of the Bucao watershed was drained by nine unnamed Pinatubo tributaries of the upper Balin Baquero River, many of which were buried in pyroclastic flows during the eruption. Immediately downstream and to the north of these tributaries, the Balin Baquero River is joined by its largest Pinatubo tributary, the Maraunot River, which alone drained an area of 42 km^2 prior to the eruption. The upper Bucao River, which has a catchment area of 128 km^2 situated to the north, joins the Balin Baquero River 26 km west-northwest of the former summit.

The Bucao Valley is narrowest (only a kilometer wide) immediately below the Balin Baquero junction, at the site of the former flood-plain sitio (hamlet) of Malumboy (now buried in lahar deposits). It widens to about 3 km, including lahar and fluvial terraces that flank both sides of the valley, downstream to the Baquilan River junction 9 km from the South China Sea. Along the Malumboy-Baquilan reach, the Bucao valley is confined between the steep flanks of the ophiolitic Zambales Mountains. The Baquilan River, with a 60-km^2 watershed north of the Bucao River, is its second largest tributary from outside the Pinatubo drainage system. It joins the Bucao River about 5 km downstream of the Balin Baquero confluence, where it further dilutes the flows. Downstream from the Baquilan confluence, the alluvial plain of the Bucao River widens to the north and is shared by other coastal rivers, but the Bucao River braids over the 1- to 2-km-wide southern portion of the plain and reaches the coast south of the Municipality of Botolan. This town has an aggregate population of 35,752, including the inhabitants of 22 barangays that survived the pyroclastic flows of 1991 and the subsequent lahars. In all, eight other barangays of Botolan no longer exist. Poonbato, Malumboy, and parts of two other upland barangays were destroyed by lahars, the rest by pyroclastic flows.

(2) The Maloma River System

The watershed of the Maloma River and its tributaries, 152 km^2 in area, drains almost exclusively ultramafic terrain. About 100 m wide along its middle reaches the flood plain broadens downstream to about 500 m at its junction, 8 km from the coast, with the Gorongorong-Kakilingan River. This largest tributary has a 42-km^2 watershed south of the trunk stream. The Gorongorong-Kakilingan River and other streams in the vicinity that are incised into ultramafic rocks are characterized by narrow, V-shaped valleys and sharp channel bends imposed by the structural fabric of the bedrock, mainly northwest-trending normal faults and fractures related to the Iba fracture zone (de Boer and others, 1980). In 1991, these bends became temporary impoundment sites for remobilized tephra-fall deposits eroded from its slopes. The broad, flat Maloma valley, old (pre-1991) pumiceous fluvial and debris-flow deposits exposed in its channel walls, and the continuing headward reestablishment of its tributaries up to the lower slopes of the volcano indicate that the river once drained larger portions of the southwest flank of the volcano, until a major, pre-1991 explosive eruption modified the terrain and diverted most flow away from the Maloma River.

(3) The Sto. Tomas River System

The primary lahar avenue of the Sto. Tomas River System, which has an aggregate watershed area of 262 km^2 above 50 m in altitude, is the Marella River, which drains a 31-km^2 area of the southwest slopes of Mount Pinatubo. About 19 km from the pre-eruption summit, the Marella River was joined by the Mapanuepe River, with a watershed of 88 km^2, forming the Sto. Tomas River. Partially contained by a narrow bedrock constriction at the junction, the lower Marella River acted as a natural debris basin for the 1991 and 1992 lahars, which aggraded rapidly and blocked the Mapanuepe River, forming Mapanuepe Lake.

Below the junction, the Sto. Tomas River flows along the northern margin of a broad, 235-km^2 alluvial plain that is populated by some 140,000 inhabitants in five municipalities, each with numerous barangays and sitios. The southern edge of the plain is marked by the irregular course of the Pamatawan

River as it follows the northern bases of the ophiolitic southern Zambales Mountains. Along this margin, several small, isolated hills trending west from Castillejos have peak altitudes of 80 to 143 m; otherwise, local relief is under 5 m, due mainly to a deranged system of numerous shallow, small creeks that drain the greater, southern portion of the plain, which is underlain by the deposits of pre-1991 lahars and normal streamfloods.

3.1.4 Geology and Geomorphology

(1) Regional Tectonic Setting

The Philippine archipelago represents the effects of complex convergence of the eastern, western and northern margins of the Eurasian-Sundaland, Philippine Sea and Indo-Australian plates, respectively (Figure 3.1.3). Presently, variably sized oceanic basins border the Philippines. These are, clockwise from the north, the Huatung, West Philippine, Molucca Sea, Celebes Sea, Sulu Sea, and the South China Sea basins (Figure 3.1.3). Oceanic crusts from these basins are currently consumed below the Philippines along trenches showing opposite polarities: subduction along the East Luzon Trough and the Philippine Trench generally dip toward the west, while those along the Cotabato and the Sulu-Negros-Manila trench systems dip toward the north and east, respectively.

Two major fault zones traverse the archipelago. The NNW-SSE oriented Philippine Fault is a left-lateral active strike slip fault system that cuts the whole length of the archipelago from extreme NW Luzon to SE Mindanao (Figure 3.1.3). Results of structural and geophysical studies on the fault during the last decade suggest that, as a whole, the slip rate of the system ranges from 2 to 3 cm/yr (Aurelio, 2000a and references therein).

(2) Principal Fault Structures in Luzon

The Philippine Fault is the most active principal fault feature in Luzon. It cuts the island from the Bicol Peninsula in the south through Central Luzon to extreme NW Luzon in the north (Figure 3.1.3 and Figure 3.1.4). Since 1901, the fault has recorded at least three earthquakes with estimated magnitudes either equal to or greater than 7.5 (Rimando, 1994) (Figure 3.1.4). In between the Philippine Fault Zone and Metro Manila lies the NNE-SSW trending trace of the Valley Fault System. It consists of two faults: a more than 30 km long West Valley Fault and around 18 km long East Valley Fault. Morphological features related to these faults suggest that the most recent sense of displacement was right-lateral (Nelson et al., 2000). However, the slip rate of current displacement remains poorly constrained. Nonetheless, paleoseismological data (i.e. stratigraphic, soil profiles and 14C datings) collected by Nelson et al. (2000) suggest a recurrence interval of 200-400 years for magnitude 6-7 earthquakes on the West Valley Fault. These authors postulate that the most recent of these events occurred ~200 years ago.

The East Zambales Fault, Bucao River Fault and the Subic Bay Fault Zone occur in the area immediately around Mount Pinatubo (Figure 3.1.4). These structures remain poorly constrained at present in terms of tectonic activity and extent. Other active fault systems in the vicinity of Luzon are the Lubang Fault and the Mindoro Fault (Figure 3.1.4). The former trends WNW and situates in the offshore area in-between Luzon and Mindoro, whereas the latter separates the mountain range and the plain located on the eastern part of the island.

(3) Seismicity in Luzon

Similar to other islands located in the zone of convergence around the Pacific Rim, Luzon is a site of very active seismicity. Figure 3.1.5 shows the locations of seismic events recorded in Luzon and neighboring islands during the period from 1990 up to March 2, 2003. Most of the events originated less than 33 km below the surface while a few were determined to have come from a depth of 150-300 km. A majority of the shallow earthquakes situated within Luzon were related to movement along the northern segment of the Philippine Fault System.

(4) Magmatic Activity in Luzon

The subduction of oceanic crusts underneath Luzon resulted to the emplacement of several ancient and modern magmatic arcs on the island. Among these arcs, three currently include active volcanic centers (Figure 3.1.6). The SE Luzon Volcanic Arc, which represents the easternmost lineament of volcanoes on the island, is related to the subduction of the Philippine Sea Plate below Luzon along the Philippine Trench (Andal, 2002). Volcanic centers located on extreme northern Luzon as well as islands north of Luzon compose the southern segment of the North Luzon-Taiwan Volcanic Arc. Volcanism along this arc is related to the recent subduction of the South China Sea crust along the northern portion of the Manila Trench (Yang et al., 1996). Farther south, subduction along the Manila Trench provides magmas for the volcanic centers of the West Luzon Volcanic Arc, which include Mount Pinatubo (de Boer, 1980; Defant et al., 1988; Yumul et al., 2003).

(5) Regional Stratigraphy

Unlike the complex stratigraphy of the terrane east of Central Luzon, the region around Mount Pinatubo displays a relatively simple ascension of lithologic units (Figure 3.1.7). Mount Pinatubo overlies an almost N – S trending sequence of ultramafic and mafic rocks that represent dismembered fragments of ancient oceanic upper mantle-crust materials collectively called the Zambales Ophiolite Complex. Isotopic dating constrains the age of the ophiolite to ~45 Ma, which agrees with the Eocene dating of faunal assemblages yielded by its pelagic sedimentary capping (Encarnación et al., 1993; Garrison et al., 1979; Schweller et al., 1983; 1984). Most of the volcanic peaks outcrop on the eastern side of the ophiolite where they form a 50 km – long Miocene to Holocene belt of volcanoes – the West Luzon Volcanic Arc. Limited exposures of plutonic rocks unrelated to the ophiolite occasionally occur among the thick piles of pyroclastic aprons, tephra fall beds and laharic debris deposited by more recent volcanic activities.

(6) Local Stratigraphy and Structures

Figure 3.1.8 shows the geology of the area immediately around Mount Pinatubo. The exposures of the Zambales Ophiolite Complex cover a large area west of volcano. However, Late Pleistocene to Holocene volcanic debris deposited by lahar, normal river and flood flows mantle the ophiolite along the channels of the principal tributaries that conduct surface water to the South China Sea such as the Bucao, Maloma and Sto. Tomas rivers. To the east, the ridges and flanks of peaks of the N – S oriented volcanic belt expose Late Miocene to early Pliocene volcanic materials as well as rare outcrops of Miocene – Pliocene granodiorite and diorite porphyry intrusive rocks. Most of the deposits along the flanks of the volcanic peaks show features typical of pyroclastic flow deposits. The composition of the volcanic materials is mostly dacites and andesites. Basaltic rocks are very rare in the outcrops.

Excluding the 1991 event, the modern Pinatubo eruptive history consists of 6 periods of activity based on the radiocarbon dating (14C) of deposits. These are given in Table 3.1.1.

Notable potential relatively large structural lineaments present near Mount Pinatubo are the NW-SE trending structures that appear to control the flow of the Bucao River, NNW-SSE oriented possible trace of the Subic Bay Fault Zone postulated to be traversing the floodplain of the Sto. Tomas River, and the NE – SW and N – S directed faults situated NE and N of the present Pinatubo caldera, respectively.

(7) Geomorphology

In general, the character of the bedrock and the effects of river, tectonic and volcanic processes, among others, combine to shape the geomorphology of a region. Figure 3.1.9 presents the geomorphologic elements in the Pinatubo area.

There are three main morphologic units around Mount Pinatubo. These are, from a generally east to west order; the Pinatubo Volcanic Complex, the Zambales Ultramafic Highlands, and the alluvial and coastal fans/plains of Zambales.

The Zambales Ultramafic Highlands occurs to the NW, west, and SW of the Pinatubo complex along a generally N – S axis. These massifs separate Pinatubo Volcano from the coastal area and acts as a barrier which confines the movement of volcaniclastic sediments to the west.

Three main river systems drain the Pinatubo Complex to the west. These are the Bucao-Balinbaquero, Maloma, and Marella-Sto. Tomas Rivers. These river systems act as conduits of volcanic debris which play a large role in the changing morphology of the middle to lower slopes extending all the way to the coast and beyond. The effects of lahars and sediment laden flooding along these rivers are evident in the constantly changing morphology within the valleys as well as along the alluvial fans formed as these valleys exit the confines of the Zambales Ultramafic Highlands.

As in the case of most areas undergoing active volcanism and subjected to coastal processes, the morphology of the area is highly dynamic and is expected to experience rapid changes especially during post eruption periods.

(8) Volcanic Sediments and Lahar Deposits

1) Volume of Volcanic Ejecta

The 1991 eruption of Mount Pinatubo deposited an estimated total bulk volume of 8.4 – 10.4 km3 of volcanic debris (Wolfe and Hoblitt, 1996). Pyroclastic flow materials emplaced on the higher slopes of the volcano and tephra fall deposited on the region around Pinatubo contributed 5 – 6 km3 and 3.4 – 4.4 km3 of the total ejecta, respectively (Scott et al., 1996; Paladio-Melosantos et al., 1996). Zambales received roughly two-thirds of the total volume of these new pyroclastic flow materials (Scott et al., 1991). They filled the channels of the upper reaches of major rivers and their tributaries that drain the volcano with pyroclastic debris as well as buried the pre-existing topography leaving a relatively smooth landscape broken only by occasional peaks and ridges. The details of the estimated areal extent, thickness and volume of pyroclastic flow deposits situated on the Zambales portion of Pinatubo is provided in Table 3.1.2.

2) Petrological and Geochemical Characteristics of the Volcanic Ejecta

The June 7 – 12, 1991 dome building stage and June 12 and 15, 1991 paroxysmal eruptions of Mount Pinatubo produced contrasting rock types. Pallister et al. (1992) reported that the growing dome was fed by juvenile components that crystallized andesites (59-60 wt% SiO2), which contained rare quenched inclusions of olivine-clinopyroxene basalts (50-52 wt% SiO2). Andesitic scoria composed most of the pre-paroxysmal surges. However, the bulk of the 1991 eruptive product was dacitic (~64.5 wt% SiO2) pumice (e.g. Bernard et al., 1996). David et al., (1996) noted that 80 – 90% of the medium to coarse-grained tephra fall deposits were white-colored and contained both large interconnected vesicles and coarse phenocrysts (> 3 mm in diameter). The rest of the tephra was tan colored and displayed small spherical vesicles along with small phenocrysts (< 2 mm). In addition, the more voluminous white pumice is richer in phenocrysts (up to 35%; Bernard et al., 1996) compared with the tan-colored pumice. Although both pumice types recorded bulk densities <1 g/cm3, the phenocryst-rich variety was slightly denser than the subordinate phenocryst-poor pumice (Pallister et al., 1992).

3) Morphology of Lahar Deposits

Umbal (1994), Remotigue (1995) and Rodolfo et al. (1996) conducted detailed work on lahars and their deposits situated in the Zambales portion of Mount Pinatubo. A summary of their observations and results are provided below.

Lahar deposits related to debris flows (contain >80% sediments by weight) form undulating surfaces that progressively become flatter in their distal portions where the debris flows are diluted to hyperconcentrated flows (contain 40 – 80% sediments by weight) and normal stream flows. These surfaces represent overlapping lobate structures. Individual lobes display convex-upward cross-sectional profiles (Figure 3.1.10). Their axes often show narrow U-shaped channels, which may be widened and disturbed by subsequent slumping. The lobes range from <1– 400 m and 5 – 8 m in width and thickness, respectively. Thin indurated crusts typical of hot lahar deposits observed elsewhere cap some of the lobes.

4) Textural Characteristics of Lahar Deposits

Lahar deposits at Pinatubo are often poorly sorted and rich in sand-sized particles (Figure 3.1.11). Additionally, they are mostly devoid of clay particles. Boulder-sized clasts occasionally occur in the deposit (Figure 3.1.12). Inverse grading of low-density pumice gravel is also often present, which suggests the similar effects of dispersive pressure in debris flows and pumice buoyancy in hyperconcentrated flows. Debris flow deposits generally lack internal flow structures while hyperconcentrated flow deposits sometimes display poorly developed stratification often paired with lenses of coarse-grained, clast supported pumice (Figure 3.1.13).

5) Grain Size Distribution of Lahar Deposits

The grain size distribution in debris flow and hyperconcentrated flow deposits of the 1992 lahar season emplaced in the Marella-Sto. Tomas River System show that the former tend to be coarser than the latter. As a whole, two-thirds of the 13 debris flow samples display bimodal grain size distribution with the separation occurring between the -2Φ and -1Φ interval. A trimodal distribution characterizes the remaining samples. They might represent materials from transitional debris flow and hyperconcentrated flow phases. Most of the hyperconcentrated flow samples display polymodal grain size distribution patterns. In addition, there is good correspondence of the fine-grained fractions between flow and deposit samples of debris flow events. By contrast, hyperconcentrated flow and deposit samples exhibit poor correspondence.

Consistent with the results obtained from the Marella – Sto. Tomas River System, most of the studied debris flow deposit samples associated with the 5-6 October 1993 lahar events at the Bucao River are generally coarser than their temporally associated hyperconcentrated flow counterparts. The debris flow deposit samples also show bimodal grain distribution as well. However, the hyperconcentrated flow deposit samples collected from the Bucao River are singularly moded. This greatly contrasts with the polymodal grain size distribution recorded by the Marella – Sto. Tomas River System deposits.

(9) Regional Pedology

a) Soil Information

Figure 3.1.14 shows the type of soils within the project sites. The general soil classification for each river basins is given in Table 3.1.3. These data are based on the information of BSWM and mostly are pre-eruption data.

b) Soil Types

1) Angeles Sand

Soil formed on level to nearly level recent alluvial fans, flood plains, or other alluvial deposits subject to river flooding having profiles underlain by unconsolidated materials. These soils have medium to coarse textures and are moderately well, well, or excessively drained. The relief is generally level to nearly level.

2) Antipolo Clay

Soils in upland areas developed from hard igneous bed rock materials. These soils are formed from the underlying igneous rock and rolling to steep topography. The Antipolo series is a good example formed from basaltic rocks. Soils in upland areas developed from hard igneous bed rock materials. The igneous rock may be andesite or basaltic rocks. The relief is generally rolling to hilly or mountainous.

3) Cabangan Sandy Loam

Soils formed on older alluvial fans alluvial plains, or terraces above river flooding. Shallow flooding from tributary creeks and impeded local runoff may occur. They have moderately developed profiles (moderately dense subsoil) underlain by unconsolidated materials. These are generally deep soils and that are not underlain by claypans or hardpans but the subsoils are dense or moderately dense.

c) Soil Fertility

The regional soil fertility map is shown in Figure 3.1.15. The project areas are characterized by low to medium fertility soil.

1) Soil Characterization

The soil sampling conducted and the results during the IEE are presented in the next sections.

d) Methodology

Two sampling stations (downstream and upstream) about 3 – 5 m away from the riverbanks were selected per river basin except for Sto. Tomas River where only one sampling site was selected since the upstream area is the location of Dizon Mines where soil conditions are considered toxic or hazardous. Sampling depth is about 0.5 m and was dug using a shovel instead of a hand auger due to the very coarse soil conditions. The soil samples were sent to CRL Environmental Corporation – a DENR accredited laboratory, and were analyzed for metals (chromium – hexavalent, copper, cadmium, lead, zinc, and mercury). Samples analyzed for pH, organic matter content, nitrogen, phosphorus, and potassium were sent to the Univeristy of the Philippines Analytical Soil Laboratory. The soil sampling map is shown in Figure 3.1.16. The analytical procedures conducted by the laboratory are presented in Table 3.1.4.

e) Laboratory Results

The laboratory results are presented in Table 3.1.5.

1) Soil Standards

There are no existing Philippine soil standards. Normally, in this case DENR would require comparison with a stringent standards being used in other countries such as the Dutch Intervention Values (DIV). The Dutch Intervention Value is the maximum tolerable concentration above which remediation is required. This occurs if one or more compounds in concentrations equal to or higher than the intervention value is found in more than 25 m^3 of soil. The available for comparison is only for metals. For other parameters such as the soil fertility and texture, there are rules of thumbs that are prescribed on agricultural applications.

2) pH

The pH of the soil reflects the intensity of acidity or alkalinity of a medium. Soil pH measurements assess the availability and toxicity or deficiency of elements for vegetation sustenance. Information on pH levels in soils is important because acidity/alkalinity has considerable influence on bacteria and fungal activities. It also provides information on symbiotic nitrogen fixation by leguminous plants and serves as indicator on the availability of various nutrients which include phosphorus, zinc, boron, and copper among others. Agricultural crops, however, have pH tolerance range where optimum yield could be obtained. A sample list of critical pH range for various crops is presented in Table 3.1.6. These pH ranges provide basis for soil-crop suitability.

Based on the results of the soil analyses, soil pH ranges from 6.0 – 8.0 (moderately acidic to moderately basic). These values are within the critical levels listed in Table 3.1.6 for the given crops.

3) Organic Matter

The amount of organic matter (OM) differentiates a productive and infertile soil. Organic matter holds most of the soil's carbon, nitrogen, sulfur, and phosphorus. It attracts and retains water, and it holds the gases and ions that are needed by the plants. It causes soil particles to aggregate, providing a workable soil. Nitrogen level in the soil is indirectly determined from OM values (total N is approximately 5% OM). A typical soil that is ideal for plant growth should at least contain 3-5% OM.

The OM ranges from 0.26% to 3.76 % which barely pass the ideal condition.

4) Nutrient Profile (N, P, K)

Nitrogen, phosphorus and potassium are the essential macro nutrients that significantly influence plant growth. The green leaf pigment, chlorophyll is a nitrogenous compound. Phosphorus on the other hand is necessary for cell division and for the production of sugar through photosynthesis while potassium is required for the formation and successful functioning of chlorophyll. It plays a vital role in carbohydrate and protein synthesis. It also improves water regime of the plant and increase tolerance to drought and salinity. A sample list of the critical levels of soil nutrients are given in Table 3.1.7.

Nitrogen levels range from 0.03% to 0.15% which is relatively adequate for the above given crops. Phosphorus content range from 1 ppm to 21 ppm which barely satisfy the critical levels for the given crops. Potassium levels range from 11.73 ppm to 66.47 ppm which are way below the critical levels for the given crops.

5) Grain Size Distribution and Texture

Soil Texture refers to the relative proportion of clay, silt and sand particles contained in the soil. Depending on these proportions, soil may be classified as sand, sandy loam, loam, clay loam, clay, etc. Soil texture is important in plant growth since it accommodates water entry, facilitate water transfer and adsorption. Coarse textured soils (sandy) do not retain water and nutrients well. Clayey types on the other hand, store moisture and nutrients well but are poor in drainage and aeration. Knowledge of soil texture could give farmers directions as to what crop(s) is best suited or could be planted to a particular type of soil. Generally, soil texture on-site consists mostly of sand due to its proximity to the river and due to the lahar.

3.1.5 Meteorology

(1) Climate Setting

a) Methodology

Secondary data for meteorology were obtained from PAGASA. The nearest synoptic/weather station from the project site is the Iba Synoptic Station. Data on meteorology are presented in the succeeding sections.

b) Climate Type

The province of Zambales is characterized by two distinct seasons: dry from December to April and wet from June to October with the months of May and November considered as transition months. This seasonal variation is classified as Type I under the modified Coronas Classification of Philippine climates. The nearest long-term weather (synoptic) station representative of the project site is the Iba weather station. Climatological normals are summarized in Table 3.1.8. The climatological extremes are summarized in Table 3.1.9. The climate map is shown in Figure 3.1.17.

c) Rainfall

The mean annual rainfall is 3610 mm. The rainy season runs from June to September with August normally as the wettest month of the year. Figure 3.1.18 shows monthly rainfall means.

d) Temperature

The average maximum temperature is 33.1°C (month of April) while mean minimum temperature is 20.4°C (month of January). April is the warmest month with temperature rising as high as 38.8°C. March is the coolest month, with temperature reaching 11°C. The mean annual temperature is 31.3°C.

e) Relative Humidity

Projected mean monthly relative humidity near the project area varies from a mean low of 73 percent in April to a mean high of 86 percent in August and September. Average annual relative humidity is about 79 percent.

f) Prevailing Wind

The mean monthly wind velocity is 3 mps. The wind rose diagrams are shown in Figure 3.1.19.

g) Tropical Cyclone Frequency

The Philippines is located within one the tropical cyclone belt of the Pacific region. Typhoons are intense tropical cyclones which normally form in the northwestern Pacific region although some form in South China Sea. Cyclones forming in the Pacific generally move with a northwesterly trajectory depending on the month of occurrence while those forming over the South China Sea normally move northward. The tropical cyclone frequency map is shown in Figure 3.1.20.

Based on PAGASA records (1948-82), five (5) cyclones are expected to pass through the Zambales region every three (3) years. While on the PAG-ASA records from 1992-2001, five (5) cyclones are expected to pass through the Zambales province every year. These generally affect the region between May to October.

3.1.6 Air Quality

(1) Methodology

The ambient air quality test was conducted according to the guidelines and procedures set forth in the

EMB Air Quality Monitoring Manual and DENR Administrative Order No. 81 Series of 2000. Specifically, the following parameters were monitored using the required conditions(Table 3.1.10):

The above parameters were monitored at five sampling stations on 9-10 January 2003. The coordinates of the five sampling stations are presented in Table 3.1.11. The sampling location map is shown in Figure 3.1.21. Handling, storage (i.e. observation of holding times for each parameter) and recording were based on the standard methods/procedures of the DENR-EMB Air Quality Monitoring Manual and DAO 2000-81. The samples were analyzed in a DENR-accredited laboratory.

(2) Laboratory Results

Table 3.1.2 presents the results of the laboratory analysis of the ambient air monitoring at the project site.

The locality meets the National Ambient Air Quality Standards as mandated in Table 3 of DAO 2000-81. Note that the concentrations of pollutants are way below the corresponding DENR standards since there are no significant sources of air pollution in the project areas. Minor sources are the vehicles and the dust from dried lahar.

3.1.7 Noise Environment

(1) Methodology

Noise level survey was conducted also during the ambient air quality monitoring at the same specified stations. A weighted-sound level meter was used during the survey as prescribed in Section 2.1.3 of the EMB Air Quality Monitoring Manual. The median of the base and peak readings were obtained from the measurements.

(2) Measurement Results

The results of the noise monitoring are presented in Table 3.1.13.

Noise levels were measured during morning time and daytime based on DENR division of periods for noise monitoring. The results showed that the noise levels in Stations 1, 2, and 3 are above the DENR standard for noise in a residential or commercial area. These sampling stations are along the roads thus, the major sources of noise pollution are the vehicles passing within these roads. Since these roads are either national or provioncial roads the volume of vehicles is relatively high especially during daytime.

3.1.8 Hydrology

(1) Local Hydrology

During the wet season, the combination of steep and upper slopes and typhoon-induced rainstorms in the project areas results in rapid run-off and frequent fluctuations in the level of the riverbed. This phenomenon is thought to be aggravated by the additional deposits and lahar flows.

The annual run-off characteristics in the three river basins are similar to those of the other basins draining from Mount Pinatubo. Historical data indicates that the coefficient of annual run-off is between 54% and 58% for the three river basins, while the Sacobia River basin, one of the other basins of Mount Pinatubo has a reported value of 62%.

(2) Groundwater

Based on the Rapid Assessment of Water Supply Sources in the Province of Zambales conducted by the

National Water Resources Board (National Water Resources Council) in 1982:

- the average static water level (SWL) in the province is 3.82 meters below ground surface (mbgs);
- specific capacity ranges from 0.43 liters per second per meter (lps/m) to 1.3 lps/m;
- well discharges range from 0.04 lps to 8.52 lps;
- some pertinent water well data summary for the target municipalities are given in Table 3.1.14 below.

Groundwater level measurements were also conducted by the JBJ Consulting, Inc. Agriculture Development and Research for Lahar Area Team from January to February 2003. The results showed that the average SWL in the 36 measured wells is 4.04 mbgs. The summary of the results are presented in Figure 3.1.22.

3.1.9 Land Use

(1) Land Resource

Total land area of Zambales is 371,440 hectares. Out of this total, 255,062 hectares or 68.60 percent forest land are presently vegetated with production forest (native species), forest plantation (exotic species) and non-forest uses like agricultural (pasture and kaingin) and mines. Alienable and disposable (A & D) lands are being used to paddy rice and fishponds, cultivated annual crops, perennial tree and vine crops, pasture lands and other uses like residential sites, industrial areas, quarries, economic and tourism zones. A & D lands covers 116,378 hectares or 31.40 percent. The land classification map is presented in Figure 3.1.23.

Wide areas of A & D lands north of the province from Sta. Cruz down to Botolan are suitable to rice production, fruit tree and vine crops. The rest of the province from Cabangan to Subic has majority areas suitable to cultivated annual crops. Pasturelands were also found suitable within A & D lands of all municipalities of the province.

Forestlands, on the other hand, are widely suitable to production forest. Forest plantations for exotic species were also found suitable but to a lesser extent. Pasturelands are suitable in many areas of forestland in the entire province. Olongapo City's production lands are suitable to production forest.

(2) Sustainability of Land Use

Sustainable land use is the form of land use that is able to continue into the future with the same level of productivity and without deterioration of the land resources. Majority of land used in Candelaria, Sta. Cruz and Palauig are sustainable with 82, 57 and 52 percent respectively of their total production lands. Olongapo City has 85 percent of sustainable land use (Figure 3.1.24).

Majority of under-used lands is found in Botolan and San Marcelino, which are about 67 and 65 percent of their total production lands. Municipalities of Cabangan, Castillejos, Masinloc, Iba, San Felipe, San Antonio and Subic have also large areas of under-used production lands. For over-used lands, only the municipality of San Narciso has 56 percent of production lands classified as over-used.

Province wide, total areas of sustainable, under-used and over-used lands are 41, 50 and 9 percent, respectively, of the total production lands.

3.1.10 Surface Water Quality

(1) Methodology

During the IEE Study, water samples were collected from a total of six sampling stations from the three rivers and two lakes: two in Bucao River (S-1 and S-2) and one each in Maloma River (S-3), Marella River (S-4), Lake Mapanuepe (S-5) and Pinatubo Crater Lake (S-6). Marella River is an upstream tributary of Sto. Tomas River. Lake Mapanuepe is located at the upstream section also of Sto. Tomas River. Sampling was done twice, once during the rainy season and once during the dry season. The locations of the water sampling stations are shown in Figure 3.1.16. Additional sampling of surface water was conducted within the Dizon Mines and Mapanuepe Lake. The corresponding sampling location map for the recent water sampling is shown in Figure 3.1.25.

Water samples were sent to FAST Laboratories and/or the Univeristy of the Philippines National Sciences and Research Institute's Laboratory and were analyzed for pH, color, conductivity, temperature, dissolved oxygen, BOD, COD and 20 other inorganic substances. These parameters were chosen to determine the possible contributions of the volcanic deposits and the mine tailings dam of the abandoned mining operation upstream of St. Tomas River to the water quality of the rivers draining Mount Pinatubo. The procedures followed for the analyses of surface waters are presented in Table 3.1.15.

(2) Laboratory Results

1) IEE Water Quality Sampling

Water flow through the three main rivers draining the western flank of Mount Pinatubo is largely a function of the amount of rainfall. That is, during the dry season when there is no precipitation, water flow is limited to a small, shallow stream. The river channel changes dramatically during the rainy season, with the large volume of flowing lahar filling the whole river bed. These seasonal changes in river flow affect the water quality.

By comparing the water quality of these rivers and lakes to the water quality criteria (DENR AO 34-90) set by the Department of Natural Resources of the Philippines for surface waters, the potential uses of these surface waters can be identified. Surface waters can be classified according to its beneficial use such as source of drinking water (Class AA and A), contact recreation (Class B), propagation and growth of fish and other aquatic resources (Class C), agriculture, irrigation, livestock watering (Class D). The best usage for the lahar affected surface waters can be evaluated using the criteria for Classes C and D. To supplement the DAO 34-90, some guidelines for the interpretation of water quality for irrigation were also used (Metcalf & Eddy, 1991).

The DAO 34-90 classifies the water quality parameters into two categories, those that contribute to aesthetics and oxygen demand of freshwaters, and those that are toxic and deleterious substances. By this classification, it is evident that there are some substances that should be guarded for the protection of public health (e.g. metals and pesticides) as opposed to other parameters that affect the aquatic organisms (e.g. dissolved oxygen, nitrates and phosphates). Such distinctions will be important in the suitability assessments of the surface waters.

Table 3.1.16 shows the water quality of three rivers, Bucao, Maloma, and Morela, and two lakes, Mapanuepe and Mount Pinatubo Crater, during the dry season when water flow is minimal. Among the 20 inorganic substances measured, only copper and manganese were elevated beyond the standards. Although no standards were set for both copper and manganese under DAO 90-34, their concentrations were beyond the acceptable limit of 0.2 mg/L for irrigation water according to Metcalf and Eddy (1991).

Figure 3.1.26 shows the changes in concentrations of copper and manganese from upstream to downstream. The upstream station was assumed to be either Mount Pinatubo Crater Lake for

Bucao River and Marella Rivers or Mapaneupe Lake for Marella River. Although the Bucao and Marella Rivers may not have a direct contact with the Crater Lake, it is assumed that somehow the eruption may have affected the head waters of the rivers. The graph suggests that the contribution of Mapanuepe Lake for both elements is higher than that from Mount Pinatubo Crtaer Lake. Mapanuepe Lake receives mine tailings from the abandoned impoundment dam which may partly explain the trendline.

Although no standards were set for phosphates and phenols for Class D, the one to two orders of magnitude higher than the Class C standard may be a cause for concern. The elevated levels of phosphates and phenols may have come from non-point sources of pollution within the watershed. Both compounds can be derived from wastes coming from anthropogenic activities, although natural phenols can be released from decaying vegetation.

The same substances, copper, manganese, nitrate, phosphate and phenols were also observed to have elevated levels during the wet season. Table 3.1.17 summarizes the water quality of the surface waters during the wet season when the rivers become filled by flowing lahar.

The dissolved oxygen (DO) levels in the rivers and lakes were always beyond the minimum limit of 5 mg/L. This implies that the required oxygen for the oxidation of materials in the water can be met. The presence of adequate amount of dissolved oxygen is critical to maintaining life and aesthetic quality of rivers and lakes. Reduction in DO is commonly observed in waters with high organic and inorganic matter load because of oxygen consumption. Sometimes, elevated oxygen consumption may exceed oxygen replenishment resulting to anoxic conditions, which could be fatal to aquatic life.

To estimate of the oxygen demand of the rivers and lakes, the biochemical oxygen demand (BOD) and chemical oxygen demand (COD) were measured. The BOD is a measure of the amount of oxygen consumed during the oxidation of organic matter by bacteria and other microorganisms under aerobic conditions at a specified temperature, whereas COD is a measure of the amount of oxygen required during the oxidation of organic and inorganic matter by strong oxidizing agents. The DAO 34-90 does not provide any standard for COD although it sets the standards for BOD at 7 mg/L and 10 mg/L for Class C and D, respectively.

BOD is elevated in all the sampling stations during the dry season, with the lowest at Mount Pinatubo Crater Lake (11 mg/L) and the highest at the highway station in Bucao River (35 mg/L). An opposite trend is observed for COD where the lowest was observed at the upstream station in Bucao River (31 mg/L) and the highest at Mount Pinatubo Crater Lake (77 mg/L). This data suggests that the oxygen demand in Mount Pinatubo Crater Lake is largely from the inorganic matter having a BOD to COD ratio of 1:7. Mount Pinatubo Crater Lake has very high levels of inorganic substances. As expected the BOD and COD levels decreased during the wet season, except in Maloma River where the COD increased from 38 mg/L to 63 mg/L. All BOD measurements were below the Class D standard. The COD decreased by as much as 27% in Mount Pinatubo Crater Lake, from 77 mg/L to 21 mg/L. Figure 3.1.27 summarizes the changes in BOD and COD concentrations from upstream to downstream.

Although some inorganic substances were still within the standard, it is quite interesting to note that variations occur with season (Table 3.1.16 and Table 3.1.17). That is, cyanide and magnesium decrease during the wet season, whereas arsenic, copper, iron, nitrate and phosphate increase during the wet season. A decrease during the rainy season implies dilution and that the contribution from the flowing lahar is negligible. An increase, on the other hand, implies a significant contribution by the lahar flow.

For arsenic and cyanide (Figure 3.1.28), only Mount Pinatubo Crater Lake has elevated levels beyond the standard. The graph may suggest that Mount Pinatubo Crater Lake contributes to the arsenic (wet and dry) and cyanide (dry) contents of the Bucao and Marella Rivers. During the wet season, however, the cyanide contribution of Mapanuepe Lake to Marella River maybe higher compared to the dry season results. The phenol content of the rivers can not be traced to the Mount Pinatubo Crater Lake. Apparently, there are other phenol sources in the watershed.

The phosphate and sulfate levels also vary from upstream to downstream as well as with season as shown in Figure 3.1.29. Although phosphate levels were above the standard for both wet and dry, the change in concentrations may not be significant except the doubling in concentration for Mapanuepe Lake. For sulfates, the contribution by the Mount Pinatubo Crater Lake may be significant than that of Mapanuepe Lake during the dry season. The increase in downstream of Bucao River suggests sulfate sources not lahar driven but maybe anthropogenic in origin.

Figure 3.1.30 shows the trendlines for other naturally occurring elements such as calcium, chloride, and magnesium. Calcium load of Marella River increases downstream, which can not be said for Bucao River. The chloride defintely increased during the wet season by as much as one order of magnitude in Mount Pinatubo Crater Lake which was not reflected in the loads of the rivers. The impact of lahar flow on manganese concentration is very obvious in the figure. The trendline varied with season, decreasing with increase river flow.

A very restricted comparison with the other rivers in the nearby provinces can be done because of limited number of common parameters. Only the elements, calcium, chloride, and magnesium can be compared simply because these are the only common parameters measured. The present concentrations of these elements in Bucao, Maloma, and Marella Rivers are generally one order of magnitude lower than those observed in the affected rivers. If the average concentrations observed in all rivers before the eruption were used as the baseline for comparison, the calcium concentrations for the dry season of Bucao and Marella Rivers are of the same order of magnitude. The opposite is true for manganese, the wet season levels are of the same order of magnitude. Still, another pattern is observed for calcium, the concentrations observed in this study are one order of magnitude lower in either dry or wet season.

2) EIA Water Quality Sampling

The results of the sampling conducted for this EIA is presented in Table 3.1.18.

Generally, most of the results showed that the measured values are within the DENR Standards for Class C and Class D Fresh Water, except for Lead and Copper. Lead concentrations exceeded the Class C standard for ALL sampling locations. Copper concentrations are above the standard except at the following locations in Mapanuepe Lake: Surface level at D/S near channel and inlet area. The high levels of copper in the Mapanuepe Lake may be due to effluents coming from the Dizon Mine's Tailings dam. Note that the copper levels in the reservoir area are very high. Probable seepage or overflow may have occurred from the dam going down to the lake. High lead values may have come more from the lahar deposited by the eruption of Mount Pinatubo than from the Dizon Mine's Dam since lead concentrations in the Mapanuepe Lake sampling locations are higher than that in the reservoir area.

3.1.11 Marine Water Quality

(1) Methodology

Water samples were collected at two depths, surface and mid-depth, from two sampling stations fronting each river mouth during the IEE Study. The locations for the marine sampling are presented in Figure 3.1.21. The same locations were used during this EIA Study for another round of sampling. The analytical procedures implemented by the laboratory for the analysis of the samples are presented in Table 3.1.19. The samples were sent to CRL Environmental Corporation for analysis. The same parameters were used during the EIA Study marine water sampling during 16 January 2003.

(2) Laboratory Results

1) Dry Season Sampling – June 2002

The western basin of Mount Pinatubo is drained by three major rivers, Bucao, Maloma, and Sto. Tomas Rivers, that empties into the South China Sea. Minimal flow, if any, is observed during the dry season. A sand bar or lahar bar, as it should be aptly called, formed along the mouth of the rivers during the dry season cuts the seaward connection of the surface waters.

Table 3.1.20 summarizes the results of the analysis of water samples collected from two sampling locations fronting the mouth of each river. The pH, DO, and total coliform are all within the standards set for Class SC waters by the Philippine as embodied in the DAO 90-34. Results were compared to the requirements for Class SC water which is suitable for commercial and sustenance fishing, fish and wild life sanctuaries, and recreation. Total nitrogen and phosphorus were below the method detection limits of 0.03 and 0.02, respectively.

The coastal water during the sample collection in 22-23 June 2002 was very rough. The abrupt drop in depth from about 20 m to 100 m after only about 50 m from shore favors strong wave surges. The strong water movement causes efficient mixing of materials and substances in water. Hence, the pH and DO levels did not vary much.

The chemical oxygen demand in the coastal waters (192-217 mg/L) is one order of magnitude higher than those observed in the rivers (21-63 mg/L) and lakes (21–77 mg/L). Since the sampling was conducted during the dry season when there is generally no surface connection to the sea, the high oxygen demand is entirely coastal in origin. Although the oxygen demand is relatively high, the dissolved oxygen concentration (6.4-7.0 mg/L) is still above the 5 mg/L DO minimum required for Class C water. This implies that the required oxygen for oxidation of both organic and inorganic materials can still be supplied by the coastal ecosystem. The strong water movement favors atmospheric oxygen dissolution into the water.

2) Wet Season Sampling – August 2002

Table 3.1.21 summarizes the results of the analysis of water samples collected from two sampling locations fronting the mouth of each river during the wet season. Samples were taken in 28-29 August 2002. Similar with the results for dry sampling, the pH, DO, and total coliform are all within the standards set for Class SC waters by the Philippine as embodied in the DAO 90-34. Results were also compared to the requirements for Class SC water which is suitable for commercial and sustenance fishing, fish and wild life sanctuaries, and recreation. Total nitrogen and phosphorus were below the method detection limits of 0.03 and 0.02, respectively. The pH and DO levels did not vary much due to the effective mixing of strong waves to materials/substances in the coastal areas.

The COD levels in this round of sampling are more than twice the dry sampling results. These may have been brought about by the materials washed off from the river discharge aside from the waste materials within the coastal areas. The DO remained basically the same as that of the dry season.

The high values for total coliform are due to the rampant rains which washed off the organic wastes materials on the soils to the river and eventually out to the open seas. The same explanation may apply to other parameters which exhibited higher values compared to that of the dry season sampling results.

3) Additional Sampling – January 2003

January is considered as a dry period. The sampling location map for this round of sampling is shown in Figure 3.1.21.

Table 3.1.22 summarizes the results of the analysis of water samples collected from two sampling locations fronting the mouth of each river. The pH values are within the standards set for Class SC waters by the Philippine as embodied in the DAO 90-34. Most of the DO levels are also within the standard except for one value in Sto. Tomas River which is 2.8 mg/L. Compared to the previous sampling results, the values of pH and DO are relatively the same.

The chemical oxygen demand values measured for this sampling round are significantly higher than the previous results. These may have been brought about by wastes washed off from the coastal area. Similarly, two observed values for coliform are above the standards. These are also due to the organic wastes that were washed off.

3.1.12 Sediments and Lahar Deposits

(1) Methodology

The same procedures were followed similar to the soil sampling activities (see Section 3.1.4.5) for the marine and river sediments. Another round of sampling for marine sediments was also conducted on January 16, 2003 to supplement the IEE Study results.

(2) Laboratory Results

The laboratory results for the river sediment sampling are presented in Table 3.1.23. The results showed that the metals are way below their corresponding Dutch Intervention Values. The texture is predominantly sand. pH ranges from 5.9 to 8.0 which is slightly acidic to slightly basic. Other parameters, NPK are generally below with the rules of thumb if used for agricultural purposes.

Tables 3.1.24, 3.1.25 and 3.1.26 present the laboratory results of the marine sediment analyses. Similar to the results in the river sediment, the results showed that the levels of specified metals in marine sediments are also way below their corresponding DIVs. Both dry and wet sampling results are unremarkable.

3.1.13 Contamination Analysis of Heavy Metals on Marine Fishes

Collection of endemic marine fishes for heavy metals contamination analysis was carried out on 28 August 2002 during the IEE Study. One fish for each river basin was collected as specimen. The results of the laboratory analyses are presented in Table 3.1.27. Except for zinc and copper contents of the Maloma and Sto. Tomas fish samples, the rest of the parameters are below the detection limit or not detectable. There are no existing Philippine standards for fish contamination of heavy metals.

The screening values for recreational and subsistence fishers of the U.S. EPA were used for comparison. Unfortunately, only cadmium and mercury have screening values. Both metals are below the detection limit of the laboratory.

3.2 Biological Environment

3.2.1 Terrestrial Flora and Fauna

(1) Methodology

1) Literature Review

Literature review was employed to determine related materials in relation to floral and faunal attributes of the three (3) major river systems west of Mount Pinatubo including the Maraunot notch of the crater lake. Most of the information were lifted from the IEE report of the same project. Other sources include materials from NGOs, DENR–CENRO/ PENRO and regional offices of DA, among others.

2) Map Retrieval and Procurement

Relevant maps were procured from offices such as NAMRIA–DENR, DPWH and LGUs. Boundaries as well as areas that will be affected by the development project for each major river systems were made and reflected in the map prior to field work. Various types of ecosystem within the western watersheds such as forest, savannah, grassland, riparian, riverine (floodplain), agroforestry (agro-ecosystem), and the coastal zone were also identified using the available maps.

3) Lay-out of boundaries and quadrat/plots placement

Working maps (land-use) were used to determine the area and number of plots/transects for assessing the floral and faunal attributes of each ecosystem with emphasis on the riverine and riparian zones. Determination on the number and plot design were based on the works of Cain (1938) and Smith (1966). For floral assessment, a line was drawn on the map parallel to the longest stretch of each major river systems that were used as baseline. Transect lies perpendicular to the baseline were drawn at regular interval to serves as guide to determining the placing of quadrants. A 10 x 10 meter quadrats were established at regular interval adopting the stratified random sampling where both random and systematic placement of quadrants was employed (Mueller-Dombois and Ellenberg, 1974). All trees in the 100 m^2 quadrant were listed together with the undergrowth (up to 3 m height) within 4 X 4 meter and herbs/grasses inside 1 X 1 meter (PCARRD, 1979).

For faunal population, time area count method for a number of transects in both side of each river systems was employed to list down the animal species encountered including those observed in the crater lake environs. Species listing made from previous works were also utilized for verification purposes.

(2) Flora

1) Plant Community Types

The three (3) target areas (rivers) namely: Bucao, Maloma and Sto. Tomas, are distinctly bounded by Savannah ecosystem in all cardinal directions followed by streambank and hilly land ecosystems from Mount Pinatubo crater down to the South China sea. Noticeable among the three (3) rivers are the presence of the floodplain ecosystem that dominate the flooded area which are inundated by lahar. These ecosystems are home of various kind of plant communities namely: grassland, savannah, brushland, woodland (natural and plantation), shrubs and aquatic /riparian group.

The headwater of Bucao river is dominated by second growth forest interspersed with savannah and grassland areas in eight (8) mountain ranges as shown in Table 3.2.1. The nine

(9) barangays around the Bucao River, however, serve as the watershed which are predominantly savannah and agro-ecosystem with a narrow coastal fringe at the mouth of the river. South of Bucao River, is Maloma River, the smallest of the three, that serves as the basin of the six (6) mountain ranges, namely: Mt. Labangan, Mt. Paete, Mt. Maquineng, Mt. Binawawang, Mt. Nagdayap and Mt. Piluca. Savannah type plant community dominates these mountain ranges with spots of second growth forest at the easternly side of the river. Similarly, Sto. Tomas River houses savannah type plant community and agro-grassland ecosystems from its headwaters- Mt. Nagbakil, Mt. Balakibok and Mt. Bitming. Dowstream is the coastal ecosystem at the mouth of the river between San Felipe and San Narciso towns.

2) Species Composition

Floral Landscape in and around Sto. Tomas and Marella Rivers

The headwaters of Sto. Tomas, particularly Mt. Balakibok, houses 132 species under 53 families which are predominantly from the group of Moraceae and Euphorbiaceae families. Few climax species is dominated by genera Shorea and Dipterocarpus (Dalmacio, 2001). Table 3.2.2 summarizes the most dominant species in Mt. Balakibok area. The floral attributes halfway down to the mouth of Sto. Tomas River is shown in Table 3.2.3. In total, 17 common plant species dominate the entire landscape under 9 families. All lifeforms represented in this landscape from trees to vines and forbs (weeds). Akleng parang (*Albizia procera*), Balinghasai (*Buchanania arborescens*) and Binayuyo (*Antidesma ghaesembi*) dominate savannah ecosystem interspersed with Cogon (*Imperata cylindrica*) and Talahib (*Saccharum spontaneum*) grasses. The streambanks are part of the riparian zones are blanketed with cover crops such as Ouko (*Mikania cordata*), Centrosema (*Centrosema pubescens*) and *Calopogonium muconoides* growing along with bamboo species namely: *Bambusa spinosa* and. *B. vulgaris*. These species, cover crops and bamboo plants are responsible for controlling soil erosion and maintaining the soil productivity as they continuously fix Nitrogen (N) from the atmosphere.

The Importance Value (IV) is the sum of relative density, relative dominance, and relative frequency for a species in the community. The larger the importance value, the more dominant a species is in the particular community (Krebs, 1994).

Periodic occurrence of wildfires has kept maintain the savannah type status of the community. *Antidesma ghaesembi*, for example, can withstand constant wildfire together with *Imperata cylindrica* that favors growth after each wildfire event. Conversely, the coastal area is dominated by Agoho (*Casuarina equisitifolia*) either planted or wild singly and in group. This species has been noted to dominate the coastal facing the South China Sea as they grow luxuriantly with sandy substrate. Their persistence has help maintain the ecology of the site as it also harbors wildlife and other plants that can withstand the known allelophaty of Agoho.

Upstream of the Sto.Tomas river is a river tributary –the Marella River, that hosts huge lahar deposits. Both sides of the river, referred as streambank and riparian zones, are dominated by Talahib (*Saccharum spontaneum*), Butuan (*Musa sp.*), and Anabiong (*Trema orientalis*), among others.

Floral Landscape in and around Maloma River

In total, the floral composition of Maloma River landscape includes 26 families with 50 species under various lifeforms. Table 3.2.4 shows the different species encountered along the streambank and agroecosystem together with the common plants inland of the Maloma River. Vividly, *A. ghaesembi* and *A. procera* dominate the savannah plant community especially inland of the Maloma River. The stream banks on both sides of the River host the group of Tan-ag (*Kleinhovia hospita*), Narra (*Pterocarpus indicus*), and Kamachile (*Pithecellebium dulce)*, among others, for tree lifeform. For vine group, *Mikania cordata* and Lambayong (*Ipomea pes-caprae*) serve as the cover crops along with Hagonoy (*Chromolaena odorata*) and Mangkit (*Urena lobata*). The agroforest farm areas in both side of the river are planted to fruit trees such as Mango (*Mangifera indica*), Duhat (*Syzygium cuminii*) and Guyabano (*Annona muricata*) interspersed with Coconut (*Cocos nucifera*) and Guava (*Psidium guajava*).

Floral landscape in and around Bucao River

All in all 61 species under 22 families were identified belonging to all types of lifeforms at various ecosystems (Table 3.2.5). The riparian and floodplain ecosystems, in particular, consist of forbs and low-lying group of plants as they are always subjected to constant flooding and inundation. These include Water lettuce (*Pistia stratiotes*), Ubod-ubod (*Cyperus difformis*) and Cat tail (Typha angustifolia), among others, in tandem with Poaceae spp. such as *Panicum maximum* and *Eluisine indica*. In streambanks, a combination of trees, shrubs, and vines dominate this ecosystem. Agoho (*Casuarina equisitifolia*) in particular, dominate the sloping side of the mountain ranges while Binayuyo (*A. ghaesembi*) and Akleng parang (*A. procera*) composed the savannah garden. Alongside these trees are Cogon (*Imperata cylidrica*), Centrosema (*Centrosema pubescens*) and Kawad-kawad (*Apluda mutica*).

The coastal zone is lined with Agoho (*C. equisitifolia*), as the dominant species, in tandem with Pandan dagat (*Pandanus tinctorium)*, Alagao dagat (*Prema odorata*) and Noni (*Morinda citrifolia*) which are all common in sandy and beach soil types.

Floral Diversity around the Mount Pinatubo Crater Lake

The riparian zones around the crater lake are dominated by Talahib (*Saccharum spontaneum*), Anabiong (*Trema orientalis*), Tiger grass (*Phragmites karka*), Pteridium, Fimbristylis and Pennisetum species (Table 3.2.6). *Trema orientalis* is prominently seen in the lower and midscope of the crater as they can easily adopt in almost all types of substrate even devoid of soil nutrients. Tiger grass plant species growing in tandem with *T. orientalis* and wild berry.

(3) Fauna

1) Faunal Vertebrates

The eruption of Mount Pinatubo has clearly brought havoc to the biological materials surrounding the volcano. The presence of the pyroclastic fans immediate to the volcano and ravaging lahar has inundated major rivers that drain to the South China Sea. The loss of plants and water volume in rivers that serves as habitat, perching and food source has remarkably affected the flight of wildlife species from birds to mammals. Migratory and permanent terrestrial wildlife are important components in the stability and productivity of all the ecosystems in the landscapes. Habitat destruction and disturbance commonly constitute the major root cause of dwindling population. Table 3-35 presents the common wildlife species in the areas near Sto. Tomas, Bucao, and Maloma Rivers. The common quail (*Coturnix chinensis)* dominates the low-lying vegetation in Savannah plant community while common Bulbul (*Hypsipetes philippinensis*), swift (*Apus affinis*) and King fisher (*Alcedo atthis*), among others, littered the sky and streambank ecoststem. Mammals *such* as Wild pig (*Sus celebensis*), Deer (*Cervus sp.*) and Monitor lizard (*Varanus salvador*) are common in these areas as shown in Table 3.2.7.

2) Faunal invertebrates

The loss of habitat and constant movement of lahar somehow affected also the invertebrate group of animals. This is particularly, due also to loss of food supply and plant biomass that serve as thermal cover, in both seasons, for their survival. The group of insect, based on actual visit, include Order Odonata (dragonfly), Hymenoptera (ant, honeybees), Orthoptera (grasshopper, crickets), Lepidoptera (butterflies, moth), Arachnida (spider), Annelid and Isoptera (termites), among others.

3.2.2 Freshwater Flora and Fauna

(1) Methodology

1) Phytoplankton

Two liter of water samples were collected from about 0.5 m from the surface and fixed with ethyl alcohol. The samples were allowed to settle for a week and then concentrated to about 50 mL prior to enumeration. Subsamples were observed and counted using a hemacytometer. Appropriate taxonomic keys were used to identify the samples to the lowest taxa possible.

2) Zooplankton

Zooplankton samples were collected by passing 100 L through a 56 um plankton net. Backwashing was done three times to ensure the collection of all organisms that has been entangled by the net. Plankton samples were fixed in ethyl alcohol in the field. In the laboratory, the samples were allowed to settle for a week prior to concentration. Subsamples of 1 ml were observed and counted in a counting chamber. Appropriate taxonomic keys were used to identify the zooplankton to the lowest level possible.

3) Benthos

Composite sediment samples, 1 L volume, were collected from each sampling site. The sediments were sieved on-site using a US Standard metal sieve with 300 μm mesh size. All materials collected were preserved in 70% ethyl alcohol. In cases where sediments could not be sieved on-site, the sediments were fixed in ethyl alcohol and sieved in the laboratory. Rose bengal was added to stain the organisms for easy sorting.

4) Riverine Fishery Resources and Fishing Activity

Unstructured interviews and focus group discussions with fishermen and local folks were conducted in the communities along the riverbank to determine the riverine fishery resources and fishing activities.

5) Freshwater Aquaculture

Interview with a fishpond operators/caretakers in Bucao and was conducted to determine the existing aquaculture practices in the area.

(2) Findings

During the dry season, much of the river beds dry-up. Hence, from an aquatic environment it shifts into a terrestrial environment. The shift from aquatic to terrestrial is seasonal, with the volume of rainfall the main driving force. During the dry season, the vegetation is predominated by terrestrial forms such as carpet grass, *cogon*, *kawad-kawad*, *malakawayan* and *ouko*. The aquatic fern, *Azolla*, and water hyacinth, *Eicchornia crassipes* , were observed in stretches with water in all the three rivers.

On the water surface, the water strider, Gerridae, was observed in the rivers. As the name implies, these insects are associated with the water surface. The non-wetting hairs on their footpads do not break the surface film but merely indent it, allowing the water striders to literally walk on water. Apparently, their distribution is unaffected by the lahar deposits below.

1) Phytoplankton

The phytoplankton observed belong to three divisions (see Table 3.2.8) green algae (Chlorophyta), euglenoids (Euglenophyta), and diatoms (Baccillariophyta). Generally, the diatoms are predominant in Bucao (63%-76%) and Sto.Tomas Rivers (60%), whereas green algae are predominant in Maloma River (83%). The predominance of diatoms in the phytoplankton community is important to the growth of other aquatic organisms such as fish and macroinvertebrates. The total phytoplankton density ranges from 150 - 663 x 10^6 cells per m^3. Maloma and Sto. Tomas Rivers had the lowest and highest densities, respectively. The relatively low density may be due to the very shallow depth of the river stretch. No phytoplanktons were observed in samples collected from Marella River which is generally very shallow and with no permanent water channel.

2) Zooplankton

The zooplankton species present in the streams is composed of representatives from three animal Phyla, Rotifera, Arthropoda, and Mollusca (see Table 3.2.9). The total zooplankton density ranges was highest at Sto.Tomas River at 31,731 organisms/ m^3 and lowest at Baquilan River at 2404 organisms/ $m^{3.}$ The presence of zooplankton, although very minimal both in abundance and diversity, is a sign that there is already improvement in the riverine biotic community eventhough these rivers are relatively unstable. A study conducted by Castillo in 1992 showed no zooplankton in the rivers.

3) Benthos

The macroinvertebrates comprising the benthic community (see Table 3.2.10) of the streams belong to three Phyla, Arhropoda (generally insect and crustacean larvae), Annelida (freshwater worms), and Mollusca (snails). Although these organisms are common macroinvertebrates of rivers, their presence in the lahar affected rivers indicate that colonization of the substrate at certain reaches is already possible. This also implies that other river sections may not yet provide the habitat requirements of the organisms. This may probably explain why no benthic organisms were observed in Marella, Sto. Tomas, and the downstream section of Bucao Rivers. The Creek, Maloma and Baquilan Rivers supported about 1200 to 2300 benthic organisms per m^2.

Among the insect larvae present, the chironomids or midges are the predominant forms which may not be surprising because midges as known to be stress tolerant. This is in contrast to the other insects such as may flies which require high dissolved oxygen levels and clean waters. The exposed river bed is actually being used for planting rice. As such, the nutrient inputs into the ricefield has probably somehow enriched the river to support other biological communities. The presence of these organisms, although only in low densities, signifies that certain sections of river may recover over a period of time from the negative impacts of lahar deposition.

4) Fishery Resources and Fishing Activity

Several freshwater fish species common to Philippine rivers are present in the three major rivers prior to the eruption of Mount Pinatubo in 1991 (see Table 3.2.11). Based on the interviews conducted, Maloma had the most diverse fish community, with three migratory fish species (i.e. eel, milkfish, and mullet) compared to Bucao and Sto. Tomas Rivers which had only migratory eels. The eruption and consequent siltation of the river beds, however, prevented the subsequent entry of the migratory fish. At present, no migratory fish species are caught from any of the three rivers.

After the eruption, Bucao River have lost all fish species present in the main river trunk unlike in Maloma and Sto. Tomas Rivers were some fish are still caught. Snake-head, tilapia, and goby can still be caught in both Maloma and Sto. Tomas Rivers, plus catfish, and carp in the latter. Although fish may still be available, the volume is said to have decreased dramatically after the eruption because of the general shallowing of the riverbed. Sometimes, fish are also caught in impoundments or lakelets formed after the eruption such as those in the Bucao River basin.

In the Baquilan section of Bucao River, fishing is a supplemental livelihood activity. Tilapia are caught using fish traps made of wire screens with commercial feeds as baits. A fisherman with only two screens can catch about 1 kg of Tilapia per hour of operation.

Edible molluscs such as bivalves and snails were not observed in Bucao and Sto. Tomas Rivers, unlike in Maloma River were there is active collection near the closed mouth by the locals. They use manual push nets made of either wire screen or bamboo, which they drag along the sediment. Every after a few minutes, they raise the pushnets to collect the bivalves. About 1 gallon can be collected after an hour of work. The collections are only for home consumption.

5) Freshwater Aquaculture

Tilapia culture in the Bucao and Sto. Tomas River basin areas is limited to extensive and semi-intensive cultural practices. Under extensive culture, the fishpond operators rely on natural fish food that grow in the pond. Very limited supplemental feeding is done and tilapia is harvested generally for home consumption rather than for the market. On the other hand, under semi-entensive culture, commercial feeds are regularly given at a ration to support the natural fish food. Harvest is regular and at a volume suitable for commercial purposes.

Harvests from fishponds along Bucao River that can be seen along the National Highway are generally for home consumption and are grown on natural fish food. The fishpond operators adjacent to them grow tilapia and catfish for commercial purposes. On the other hand, the fishpond operator in San Narciso provides commercial feeds, with enough volume of harvest for the market.

3.2.3 Marine Flora and Fauna

(1) Methodology

The 1991 eruption of Mount Pinatubo resulted to deposition of lahar materials over large tracts of land and coastal areas. The western coast was buried under several meters of lahar as well as the near-shore biotic communities. Since lahar flows are still being experienced along Bucao, Maloma, and Sto. Tomas Rivers, the periodic surges of massive sediment load provides a very unstable environment which can only support the soft bottom benthos. Hence, primary data collection was limited only to soft bottoms, whereas information on other coastal biological communities present in Subic Bay were based on secondary data.

About 52 km south of Iba is Subic Bay, an area that has been spared from the devastating effects of lahar. The coastal zone still supports seagrass, coral reef, and reef fish communities. These areas are potential sources of seeds, larvae, and fry that can repopulate the near-shore area once the sediment becomes stable. Although this is not within the area covered by the present assessment, the highlights for the seagrass, coral reef and coral reef fish assembly of the 2001 Resource Inventory Report by Woodward-Clyde for the Subic Bay Metropolitan Authrority (SBMA) is presented here.

1) Benthos

Sediment samples were collected by divers from the same coastal stations where samples for the water quality analyses were collected. The sediment samples were sieved using a US Standard metal sieve with 300 μm mesh size. All materials collected were preserved in 70% ethyl alcohol. In cases where sediments could not be sieved on-site, the sediments were fixed in ethyl alcohol and sieved in the laboratory. Rose bengal was added to stain the organisms for easy sorting.

2) Fishery Resources and Fishing Activity

A fishermen's survey was conducted by the Socio-economic Team to determine the fishing activity by the sustensnce fishermen. To supplement the structured interviews, informal interviews and focus group discussions with fishermen and local folks were also conducted.

(2) Findings

1) Soft Bottom Benthos

Sediment samples collected in 2001 and 2002 from the coastal area fronting the river mouths showed only the presence of polychaetes under Phylum Annelida. Polychaetes are usually the main component of the soft bottom community of coastal waters.

In 2001, Sto. Tomas (100 organisms/m^2) and Bucao (250 organisms/m^2) Rivers have relatively lower average densities than that of Maloma River (1275 organisms/m^2). The one order of magnitude difference may not be significant considering that there is a tendency for organisms to have a clumped distribution. The presence of polychaetes rather shows that marine organisms can colonize lahar given ample time for resettlement. It should be noted that the coast is regularly buried in new lahar deposits during the rainy season.

In 2002, another set of sediment samples were collected and again, polychaetes were observed. The densities were relatively lower at 50 to 150 organisms per m2. It should be noted that there was another major lahar flow that occurred in 2002 in these rivers when the Maranuot notch gave way to water flow. Again, the sediment load will ultimately be deposited in the coastal zone. The mere presence of the polychaetes already signifies that although the sediment is already very unstable, colonization is inevitable.

2) Seagrass Community

There are eight species of seagrass, nine species of green seaweeds, eight species of brown seaweeds and eleven species of red seaweeds. Of the seaweeds observed, eleven are said to be commercially important (e.g. Caulerpa racemosa, Hydroclathrus clathratus, Hydroclathrus tenuis, and Sargassum crassifolium).

3) Coral Reef

The Line Intercept Transect survey conducted in three out of six sites showed good hard coral cover, Camayan Pt. (51%), Sueste Pt. (61%), and Port Silanguin (60%). Coral cover consists mostly of table *Acropora*, massive, submassive and branching *Porites and* foliate *Montipora.* Other hard corals commonly observed were *Favia*, *Galaxea*, *Hydnopora*, *Merulina*, *Montastrea* and *Platygyra*. Soft corals, sponges, and marine invertebrates (e.g. *Diadema*) were also noted along the transect lines.

4) Coral Reef Fish Assembly

Associated with good coral cover is the presence of a very rich reef fish community. In the northeastern section of Port Silaquin alone, a total of 82 reef fish species was observed. Of the 689 fish observed, the top seven species are: twospot surgeon fish (20.6%); scaly damsel (10.2%); bicolor chromis (4.6%); sixbar wrasse (4.6%); twotone tang (4.5%); speckled damsel

(4.5%) and parrot fish (4.5%).

5) Sustenance Fishing

In the same Resource Inventory Report, Woodward Clyde reported a total of 49 fish species belonging to 27 Families observed in landing site and market surveys. A total of nine invertebrates (squid, crabs, bivalves, and jelly fish) were recorded from the surveys and experimental fishing conducted.

A comparative report for the second quarters of 2001 and 2002 for the both the municipal and commercial fishing identified the same ten fin fish harvested by fishermen. For the municipal fishers, the yellowfin tuna (6.2%) ranked first followed by skipjack tuna (3.9%). An opposite ranking was observed for the commercial fishers, skipjack (40.2%) ranked first, whereas yellowfin tuna (17.7%) ranked second. Crabs and squids were also caught in significant quantities by the municipal fishers.

Interviews conducted in San Narciso (La Paz), Botolan (Porac) and San Felipe (Maloma) showed that most fish caught are small pelagics and reef associated. Flying fish (*burador*), Indian anchovy (*dilis*), round scad (*galungong*), Spanish mackerel (*tanigue*), threadfin bream (*bisugo*) are the common fish species that are caught along the coast. Although snappers (*maya-maya*) and groupers (*sigapo*) are associated with coral reefs, they have also been reported to be caught from the coastal waters off La Paz to Cabangan. Depending on the season, catch composition varies also. Further, the fishermen also noted that although there were several fish species lost such as fusiliers (*dalagang bukid*), barracuda and hasa-hasa, there was an increase in the volume of catch of espada.

The volume of catch ranges from 1 to 150 kg, with the highest recorded for La Paz and the lowest from Lapaz and Maloma. A 3 hr operation of seine which involves about ten persons may yield a catch of 50 kgs. When asked whether there was a drastic decrease in catch volume, the fishermen gave opposing views, from no impact to fishery to high impact to fishery.

The survey also showed that nets, hook and line or long line, and traps are being used by sustenance fishermen. The nets include gillnets or *pante* either submerged or floating and seine or *pukot*. The lines include hook and line or *kawil*, longline or *kitang*. Use of these lines are enhanced by beating the water surface to force the fish to move towards the direction of the gears, an activity locally called *timbog*. Fish pots for crabs and fish corral are the only passive gears being used by the fishermen. There are also some reports that fish poison is being used in San Narciso.

3.3 Socio-Economic and Cultural Environment

The socio-economic and cultural information discussed in this section are focused mainly on the identified directly affected households. General information for the provincial and municipal profiles can be found in depth in the IEE Study for this project as well as the results of the previous socio-economic survey especially on the effects of the eruption of Mount Pinatubo.

3.3.1 Land Area and Population Density by Town

In the four towns directly affected by the Priority Projects, Botolan has the largest land area with 613.70 km^2, as well as the most populated town with 47,751 individuals. The population density of Botolan is 77.8 individuals/km^2. San Felipe has the smallest land area of only 71.60 km^2 and with 23,799 individuals but the densest with 332.3 individuals/km^2. San Marcelino is the less dense town with only

58.1 individuals/km^2 (see Table 3.3.1).

3.3.2 Population Growth Rate

Based on the actual number of population of 2001, the expected growth rate for the year two thousand ten (2010) for Botolan town is 99 individual per square kilometer lot; eighty one (81) individuals per square kilometer lot for San Marcelino; three hundred ninety individuals per square kilometer lot of San Narciso and 179 individuals per square kilometer lot in San Felipe. San Narciso is still the densest town after 10 years in terms of population density per square kilometer of land. San Marcelino will be the less populated town in the year 2010 (see Table 3.3.2).

3.3.3 Population, Sex Composition, Number of Households and Sources of Livelihood by Barangay

(1) Botolan

Botolan has a total population of 47,751 individuals, 11,096 households, 24,069 males and 24,480 females. It is composed 31 Barangay, wherein Taugtog is the most populated Barangay with 1,781 households, 3,254 females and 3,103 males. The less populated Barangay is Owaog-Nebloc with only 283 individuals, 138 males and 145 females and 78 households (see Table 3.3.3).

Farming is the major source of income of Botolan town; a total of 4,854 households or 46.97% of the population derived their income from agriculture. There are 712 enterprising households or 6.89% of the population is engaged in vending and other merchandising related activity. Another 397 households or 3.67% of the population are self-employed.

(2) San Felipe

San Felipe has a total population of 18,867 individuals composed of 9,344 males and 9,523 females with 4,237 households. It has 11 Barangays wherein Balincaguing is the less populated Barangay with only 153 households, 720 individuals with 368 males and 352 females. Maloma is the most populated Barangay with 962 households, 3,977 individuals composed of 1,992 males and 1,985 females (see Table 3.3.4).

Farming is the main source of income in San Felipe. Records from LGU shows that there are 3,719 households or 58.83% of the population is engaged in farming or agriculture related activity, 1,089 households or 17.23% of the population derived their income from employment and 316 households or 7% of the population sourced their income from construction works.

(3) San Marcelino

San Marcelino has a total population of 25,640 individuals, it is composed of 12,962 males and 12,688 females and a total of 6,322 households. The most populated Barangay is Aglao with 672 households, 2,365 individuals, 1,061 males and 1,304 females. The less populated Barangay is Central with only 167 households, 681 individuals, 339 males and 342 females (see Table 3.3.5).

The main source of income is farming with 3,719 households or 58.83% of Population are engaged in Agriculture related works, followed by 1,087 households or 17.23% of Population derived their income from employment and 316 households or 5.01% of population derived their income from construction works

(4) San Narciso

San Narciso has 17 Barangays with 5,682 households, a population of 23,799 individuals composed of 11,896 males and 11,903 females. Paite is the less populated Barangay with only 88 households, 367 individuals it is composed of 198 males and 169 females. La Paz is the most populated Barangay with 800 total households, 3,764 individuals composed of 1,861males and 1,903 females (see Table 3.3.6). The main source of income of San Narciso is Farming wherein records revealed that 2,128 households or 37.46% of the population sourced their income from farming or agriculture related works, followed by 608 households or 10.70% of the population derived their income from construction works and 522 households or 9.19% of the population sourced their income from employment.

3.3.4 Relocation Site

The relocation site as identified by the local government of San Marcelino and Botolan for the household that will be affected by the construction of Sto. Tomas and Bucao Dike are Barangay Macarang and adjacent provincial land in San Marcelino and Baquilan resettlement site and Boun Lawak in Barangay Burgos in Botolan (see Table 3.3.7). For details, refer to the ATTACHMENT "Resettlement Plan".

3.3.5 Vulnerable Group

(1) Population

The Aetas are superstitious their belief is based on the omnipresence of the spirits of the dead. For them, spirits called anitos inhabits all areas. Misfortunes, sickness, crops production failures are all attributed to spirits. Offerings for the spirits/anitos are very important before harvest and to cure for different sicknesses.

The Aetas are considered the vulnerable group in the area. They are the people that are heavily affected by the devastation of Pinatubo eruption. Their long stay and dependency in the area was totally disturbed by that natural disaster. It forced them to settle in the governments established resettlement centers. After many years of stay in resettlement areas most of the Aetas cannot cope up with the lowlander lifestyle and still finding their traditional and happy lifestyle in Mount Pinatubo. Most of the Aetas now are moving back to their original settlements along Sto. Tomas River and Marella River in San Marcelino town as well as in Maraunot and Bucao River of Botolan town. The NCIP provided the list of the Aetas that have returned to their settlements that are formerly devastated by lahar.

In San Marcelino town there are five hundred forty (540) households with the Aeta population of 1,786 individuals from 11 Sitio belong to the three (3) Barangay of San Rafael, Santa Fe and Aglao list of Sitio are as follows (see Table 3.3.8).

Sitio Palayan, Sitio Lawin and Sitio Itanglew in Barangay San Rafael with 122 individuals and 176 households; Sitio Baliwet, Sitio Banaba, Sitio Buag and Sitio Bacsil in Barangay Santa Fe have 614 individuals and 167 households; Sitio Paw-en, Sitio Cuartel and Sitio Kahapa in Barangay Aglao have 650 individuals and 194 households.

In Botolan town there are six hundred eighty (690) households composed of three thousand four hundred individuals belong to 10 Barangay that have returned to their original settlement and start tilling their land and resume their agricultural practices (see Table 3.3.9).

(2) Sources of income

Most of the Aetas income derived from gathering wild banana blossoms, charcoal production, selling tiger grass flowers for broom making, selling of bamboo (buho), cogon and hunting wild animals such as wild boar and jungle fowl, others are working as laborers to the neighboring towns and serve as farm workers to the lowlander. Aetas are planted watermelon, squash, gabi (taro), cassava, banana, cucurbits, legumes and other vegetables. They are also fishing within the naturally created small lakes.

(3) Pricing and marketing of produce

Their products are sold to the middleman or to the public market, banana blossoms are sold for 5 pesos per piece, charcoal are sold from 50 to 100 pesos per sack, tiger grass is sold for 40 pesos per bunch.

They bring their produce to the Agora market if not sold to the middlemen that are waiting in Baquilan resettlement.

(4) Transportation

They are using Carabao drawn cart to transport their produce or to rent a 4-wheel drive truck (WWII weapon carrier) to transport goods.

(5) Source of water

The sources of drinking water in the area are spring and brooks.

(6) Type of houses

Their houses are made from cogon and buho, no concrete structure has been observed in the area.

(7) Monthly average income

The monthly average income of households in the area ranges from PhP 800 to PhP 2,000.

(8) Land Ownership

The land they tilled and occupied are part of their Ancestral Domain. However, only Villar and Poon bato have their approved Certificate of Ancestral Land Domain Claim (CADC) and the Ancestral Domain Claim of the Aetas in San Marcelino is still on process but, still the land is neither for sale nor for lease.

They resumed tilling the land five years after the eruption of Mount Pinatubo, and it is very evident to the fruit trees like mangoes, cashew and jackfruit planted in their farmlot except for the old mango trees that are not buried from or affected by lahar.

(9) Illnesses

Illnesses that are being experienced in the area are Malaria, Fever and Flu, diarrhea, dengue fever and some cases of tuberculosis.

(10) Education

Most of them attended the basic literacy program, which is learning to read and to right. Literacy program is undertaken by Indigenous People's Apostolate headed by the Franciscan Missionary Movement.

(11) Community Projects

The on-going community projects are the following:

- Community Based Forest Management (CBFM) undertaken by the DENR provincial office.
- CADC Reforestation
- UNDP Reforestation funded by the Swedish government

- Animal dispersal and literacy program undertaken by the Indigenous Peoples Apostolate under the management of Franciscan Missionary Movement.

(12) Community situation

Communities within the safe or higher areas are sitio Bangued of Barangay Villar, sitio Paouwen of barangay Burgos, Cabatuan, Moraza and Malomboy. While those communities that are within the lower areas are Poon Bato, Maguisguis, Burgos, Villar, Palis and Nacolcol, because they are situated within or inside the divided rivers of Maraunot. In case a hard rain pours within the eastern part of Pinatubo the said barangays could be affected.

(13) Relocation

Households that are needed to be relocated are those that can possibly be affected by the construction of bridge and those that can possibly be affected by the construction of the dike will become eligible for proper compensation package in accordance with the existing and applicable laws. Barangay Macarang in San Marcelino is the prepared relocation site for the vulnerable group living near or along Sto. Tomas and Marella River. Baquilan resettlement area and Boun Lawak are the preferred relocation sites for Botolan.

3.3.6 Socio-Economic and Perception Survey of Directly Affected People

The socio-economic and perception survey questionnaires used during the interviews of the directly affected people are attached with the Resettlement Plan for the Priority Projects.

Table 3.3.10 shows that there were eighty-nine (89) households identified and surveyed to be affected by the improvement and construction of dikes under the identified Priority Projects. The location map of the directly affected households is shown in Figure 3.3.1.and 3.3.2

Twenty-eight (28) households were identified from the three (3) barangays of Botolan, as follows: eighteen (18) households from Barangay Porac, one (1) from Barangay Carael, and ten (10) from Barangay San Juan. Thirty-nine (39) households were identified from San Marcelino wherein thirty-eight (38) households come from San Rafael and one (1) from Rabanes.

Twenty (20) households were identified from San Narciso, wherein six (6) are from Barangay Alusiis, ten (10) from Barangay Paite and four (4) from Barangay San Pascual.

There is one (1) household to be affected in Barangay Manglicmot of San Felipe Town.

(1) Demographic Profile of Respondents

1) Age

Table 3.3.11 shows the age profile of the respondents. The age bracket of 31-40 years old has the most number of respondents with 34%; followed by the 61 and above bracket with 24% of the respondents. Mean age is 39.5 years old.

2) Gender

There were eighty-one (81) or 91% male respondents, and only eight (8) or 9% female respondents, as shown by Table 3.3.12.

3) Educational Attainment

Table 3.3.13 shows the profile of respondents according to highest educational attainment.

4) Livelihood

Table 3.3.14 reveals the source of livelihood of the respondents.

5) Income Range

Table 3.3.15 shows average monthly income range of the respondents.

The PhP 3,000 monthly income translates to PhP 300 daily income, which is 31% lower as compared with the 2002 Daily Cost of Living Standard for areas outside the National Capital Region, in the agricultural and non-agricultural sector. This means that for a family of six to survive on a daily basis, the households surveyed barely can make it with their average daily income. The IBON Foundation Data is presented for reference (see Table 3.3.16).

The respondents were asked if their household income is enough to support their family, only nine (9) or 10% said that yes, they can support their family, while sixteen (16) or 18% said no; and an even bigger number, sixty (60) or 68% revealed that they cannot support their family with their monthly income and they even have outstanding financial debts in order to survive. The remaining four (4) or 4% failed to answer.

(2) Problems Identified by the Respondents

Table 3.3.17 presents the problems as identified by the respondents. Problems identified can be classified into three (3) major categories: infrastructure, economic (livelihood) and social. Weight percentages of then are shown in the table.

(3) Health Information

The respondents were also asked to identify frequent illness experienced in their households. Table 3.3.18 presents these in greater detail.

(4) Source of Electricity

Table 3.3.19 provides information on the sources of electricity of the respondents.

(5) Land Ownership

Table 3.3.20 shows the percentages of different types of land ownership of the respondents.

Table 3.3.21 shows percentage of each different lot area being used by the respondents.

Table 3.3.22 shows the lot area to be affected by the project.

Table 3.3.23 shows the number of respondents who own other lands that are not within the project area.

The location of these other land properties is as follows: one (1) is located in Sta. Fe, San Marcelino; two (2) in San Rafael, San Marcelino; one (1) in Manglicmot, San Felipe; one (1) in Muraza, Botolan; one (1) in Balite, San Juan, Botolan; one (1) in Paite, San Narciso; and the last one (1) in Namatacan, San Narciso. Four (4) failed to indicate where their other lands were.

(6) House Information

Table 3.3.24 reveals the floor area of the houses where the respondents live.

Table 3.3.25 shows the affected floor area (in square feet) of the houses of the respondents in relation to the Sabo and Flood Control Project.

Table 3.3.26 indicates the number of years that the house structure has since been built.

Table 3.3.27 reveals the owner of the houses of the respondents.

Table 3.3.28 shows the distribution of respondents according to the type of house they are living in.

Table 3.3.29 shows the distribution of respondents according to the number of rooms their houses have.

Table 3.3.30 depicts the type of materials used for the roof, wall, and flooring.

Table 3.3.31 shows the value in pesos of the houses of the respondents.

(7) Other Structures

Different structures belonging to the respondents, other than houses, that will be affected by the Project were also identified as follows: six (6) pigpens; six (6) comfort rooms; one (1) stockroom; four (4) houses of kin; four (4) deep wells; eight (8) rest houses; three (3) restaurants/business establishments; four (4) stores; three (3) kitchens; and a fence. Twenty-four or 92% of these structures have a floor area of less than 300 to 300; one has a floor area of more than 600 to 900, and another one has a floor area of 3,000 and above. The estimated cost of these structures range from PhP 300 to more than PhP 3,000 with most (fifteen (15) or 58%) of the structures costing more than PhP 3,000 each. Most of the materials used to build these structures were 42% concrete, 9% steel, 9% GI sheets, 9% cogon and buho, 9% wood and cogon and 7% cogon, buho and concrete. Other materials were cogon, pawid, GI sheets and buho, steel and concrete, concrete and GI sheets.

(8) Property

Table 3.3.32 shows the kind of property that the respondents have.

(9) Respondents Identified Projects

The respondents identified projects that they want in order to uplift their current living conditions, in Table 3.3.33.

(10) Acceptance of the Project

Table 3.3.34 depicts the respondent's acceptance of the project with eighty-six (86) or 97% of the respondents signifying acceptance only three (3) or 3.4% find the project unacceptable.

Of the respondents who found the project acceptable, the following reasons were given: 18 or 20% said it will increase their income; 27 or 31% indicated it will protect their land and property from lahar damage; 27 or 31% said it will save lives. The projects acceptance is also perceived to lessen their problems, to improve marketing infrastructure, to improve the existing dike and to benefit the greater majority. Two (2) or 2% of the respondents shall accept the project as long as they are assured that they will not be removed from their location. There is an option for the affected people to consider relocating their property and will be paid based on existing market value (see Table 3.3.35).

CHAPTER 4 FUTURE ENVIRONMENT CONDITIONS WITHOUT AND WITH THE PROJECT

4.1 Future Environment Conditions without the Project

4.1.1 Physical

The existing conditions maybe aptly described as that of "decaying" state due to the destructive effects of the eruption of Mt. Pinatubo. The lahar problem which includes the perennial catastrophic effects such as flooding and erosion/siltation that will remain to be a part of the daily lives of the surrounding communities. No foreseeable improvement is seen if the proposed project is not implemented immediately. Further destruction of the existing environment and the properties of the residents within the western river basins await them.

Without the implementation of the project, geologic hazards in the various areas are expected to generally remain at present levels. In this respect, the non-implementation of certain components of the proposed project will result in the inevitable inundation of certain areas (e.g. parts of Botolan, and San Marcelino).

The rivers are conduits for the exit of lahar from the terrestrial environment into the open sea. As such, the rivers experience seasonal changes in flow regimes, from no flow at all during the dry season to very high flow surges during the rainy season.

With still so much lahar deposit in the western basin of Mt. Pinatubo, the seasonal episodes in riverine flow are projected to last for several more years. The flow of lahar through the rivers may affect the water quality three ways, by contributing substances directly because of its inherent quality, by physically bringing with it substances along its path, and by diluting the receiving water causing a decrease in concentration. The laboratory results suggest that the effects of lahar flow come from these ways.

Some inorganic substances such as arsenic and cyanide that are possibly inherent to lahar are loaded into the rivers through lahar flows. However, the low concentrations suggest that there is really no cause for alarm regarding these toxic substances. The levels are all below the Class C standard. What is more alarming is the concentration of some substances that are possibly swept by lahar along its path. Phenol, phosphate, and nitrate have elevated concentrations during the wet season. The decrease in BOD and COD (except in Maloma River) during the wet season clearly shows that lahar can have a diluting effect sometimes.

Such scenarios can be expected without the project. Lahar will bring with it substances into the rivers and out into the coastal environment. In effect, this may be considered as natural flushing which will bring about the renaturation of the rivers. However, it will take several years before renaturation is realized because of the volume of lahar that needs to be transported. The seasonality of the flow regimes also contributes to the unstable environmental condition.

4.1.2 Biological

Terrestrial attributes (plants and animals) losses and disturbances brought about eruption of Mt. Pinatubo, has slowed down the capacity of the entire landscape to recover and regain its incessant primary and secondary production. For sure, migrations of affected animals, particularly birds, to the other nearby mountain ranges, have been consummated and others did not make it at the time of the eruption. Similarly, plants with open and exposed stomata may have died in the process or simply degenerate to conserve its precious food (carbohydrate) in their biomass for future growth.

After a decade of continuous healing, plants and animals are back on their feet aiming to reach the climax condition, which may not be feasible in the very near future, as fans and lahar are still everywhere. Without the project, the threat of pyroclastic materials is still there but based on the prevailing situation in the field, faunal and floral population is visibly in order. The persistence of Talahib (*Saccharum spontaneum*) in both hilly and floodplain areas including the visible invasion of Anabiong (*Trema orientalis*) as a pitcher tree species, indicate an active natural plant succession. The apparent presence of Binayuyo (*Antidesma ghaesembi*) at the lower portion of the Mt. Pinatubo facing South China Sea, indicates that it gradually developed from pure grassland/rangeland to its current savannah plant community stage. The dominance of cover crops e. g. Desmodium, Centrosema, etc., along the periphery of the stream and river banks, shows an active transformation of marginal substrate into fertile state so that it can accommodate more biological materials (plant and soil animals) per unit area. Meanwhile, the thick canopies of the second growth forest east of the impact zone denote a gradual natural forest regeneration coping up with the rate of forest product extraction. In areas where swidden farming have been established, there is also a tendency for the cultivated lands/fields and surrounding areas to return to a secondary forest stature, as the swidden farmers have only tended for fruit trees and cash crops in their respective cultivated farms. In essence, the plant succession to reach a secondary growth forest, especially in the upper portion of the impact zone, may take a while but the prognosis is incessant improvement of plant biomass production. On the same vein, habitat and food sources shall have also been improved to maintaining and improving faunal population.

The biota of the surface waters within the western Pinatubo basin have been dramatically affected. Although the water quality is generally the main driving force affecting the existence of organisms, the high sediment load of lahar is more devastating. Lahar flows can literally sweep the habitat as well as all organisms along its path.

When superimposed on a time scale, the impact becomes more dramatic. That is, seasonal changes in lahar flows create a very unstable and extreme environment for the organisms. During the dry season, minimal surface water flow is expected because of the very porous sediment which results to a very dry river bed. Although the wet season brings water, the high turbidity and flow regimes will not allow plankton, macroinvertebrate and fish growth. Both extreme cases will not favor any meaningful build up of biota.

Without the proposed priority structural measures that will enhance the physical structure of the river, the development of biotic communities in Bucao and Sto. Tomas Rivers will largely be fragmented, as it is at present. That is, biotic communities will only be present in short stretches. Sections will have thriving plankton, benthic, and fish biotic communities, whereas other sections will be devoid of any living organism. As such, no significant plankton and benthic communities will develop that will support the fish community. Hence, without the project, long term recolonization and reestablishment of the biological communities can not be realized in the rivers and coastal environments. The communities will always be at the early stage of succession.

4.1.3 Socio-Economic

Economic woes will be compounded and a probable increase in the number of evacuation centers or resettlement areas looms due to the continuous destruction brought about by the rampaging lahar that causes further deterioration of the river/drainage system of the affected areas. Social problems will increase indefinitely as part of the inherent instability of the situation which may even bring exponential growth of various problems such as the deteriorating health conditions of the residents and the dwindling supply of food especially in the evacuation centers. Lesser opportunities will confront every person seeking for an income generating endeavor.

The economic conditions particularly the agricultural side within the three river basins will basically remain the same without dramatic improvement in the quality or fertility of the surrounding soil. It may be also surmised that deterioration of the existing environment will prevail, thus, loss of further source of livelihood in the lahar affected areas.

Within the next 10 years without the project, the project area may experience gradual change in land use and mixed land use. The change of the land use may promote increase of occupancy of the area in terms of commercial, agricultural and residential usage. Sand and volcanic stone quarrying will increase. Flooding in the low lying areas due to the seepage will also increase. Sediment transport and deposition of volcanic sand will be faster. Suffocating and irritating dust especially during summer be become intense and possibility of asthmatic related disease will increase.

4.2 Future Environment Conditions with the Project

4.2.1 Physical

The lahar perennial problems such as flooding and erosion/siltation which have been causing catastrophic effects on the natural environment and surrounding communities can be controlled and avoided. The flows of lahar and river water can be limited within the dikes and therefore inundation of surrounding farming and residential lands can be avoided.

4.2.2 Biological

Due to mush stable river water flow condition can be achieved, the biotic communities in and along Bucao and Santo Tomas Rivers, which are now present in short stretches, will be slowly recovered. Recovery of plankton and benthic communities will support the fish community. Hence, with the project, re-establishment of the biological communities can be realized in the river and coastal environments.

4.2.3 Socio-Economic

For implementation of the project, resettlement and compensation of PAPs will be needed. Therefore, the resettlement action plan must be established and well implemented. For details of the plan, refer to a separate document prepared and attached to this report.

With the project, the stability of the surrounding natural environment can be achieved and therefore the living environment of the communities can be stabilized.

The economic conditions particularly the agricultural activity within the three river basins will be dramatically activated, and therefore livelihood of the surrounding communities can be recovered and improved.

Various social development plans can be activated and thereby income sources of the communities can be diversified and enhanced. Various social services can also be improved.

Therefore, the project is the key to improve socio-economic conditions of the communities as a whole.

CHAPTER 5 IMPACT ASSESSMENT AND MITIGATION

5.1 Impact Zones

The primary impact zone consists of the entire project areas that are within the three western river basins of Mount Pinatubo. The rest of the surrounding communities will be indirectly affected (secondary impact zone). However, the socio-economic impacts in terms of employment generation, increase tax payments, improvement in basic services, etc. will spill over to the other towns and its neighboring municipalities.

The table below shows the result of environmental screening, which constitutes the basis of defining full scope of the EIA. The final TOR for the EIA has been completed through the First and Second Level Scoping Meetings held.

5.2 Potential Impacts on Physical Environment

5.2.1 Geology, Topography and Soils

(1) General Assessment

The various phases of the project will have varying scale and degree of impact on the natural environment. The project, being of a hazard mitigating nature, is expected to have significant impacts on the geologic environment. The main rationale behind the project is to mitigate the effects of lahars and flooding along the drainage systems of Mount Pinatubo, with proper design and location considerations, this purpose may be achieved.

Table 5.2.1 summarizes the possible impacts of the project on the geologic environment.

If the structures function as planned, the changes in topography and drainage will have both beneficial and adverse effects (beneficial effects being the greater) on the physical environment. Primarily, lahars and flooding are expected to have little or no impact on the protected areas. Areas that are spared inundation by lahars and flooding may be utilized and further developed. However, some areas, which will be subjected to increased lahar deposition (e.g. Poonbato-Burgos terrace along the Bucao-Balin Baquero), may be adversely affected).

Implementation of the project will affect the geologic hazard conditions in the area. If the project succeeds, the risk from lahar and flooding hazards will be greatly reduced in the immediate future. However, it must be clearly understood that the project alone cannot be expected to succeed permanently due to the nature of the hazards it is designed to mitigate. In the long term, aggradation of the river either through lahar or through gradual siltation of the downstream portions will eventually cause an increase in risks unless further mitigation measures are undertaken. If the structures do not function as planned, the risks from lahars and flooding may remain in the same level as if without the project or on the extreme end, risks may become greatly increased.

(2) Pre-Construction and Construction Phase

This phase of the project may have significant impact on the physical environment, as it would involve significant earth moving, access construction. These activities would result in the modification of the existing topography and waterways.

Timing and completion of construction to coincide with the dry season is highly recommended to minimize the possibility of flows occurring during construction.

There will be an increase in soil erosion risk with the grading/scraping procedure to be done, the area will be exposed making it highly vulnerable to both wind and water-driven soil erosion. There will be loss of some topsoil. The topsoil is considered as the most fertile portion of the soil. Since the topsoil of the green area will be replaced, the scrapped soil should be transferred to the open space and other area which does not require especial soil composition to take advantage of its fertility. Generally, the area was covered by at least 10 cm of these materials. During the construction period, these materials will have to be removed or get mixed with the natural soil in the area. These scrapped materials should be used as filler in non-sensitive areas. This will not only put this material into use but also eliminate the problem of finding a suitable disposal site for these materials.

(3) Operation Phase

The structures to be implemented are designed to retain sediment as well as to confine and/or divert future flows. It is therefore expected that alteration of topography and drainage will be the primary impacts. Changes in groundwater levels and gradients may also occur in varying degrees depending on the changes in topography and drainage.

Whether the effects of these changes in the physical environment will be beneficial or adverse will depend on the success of the structures to function as designed. Therefore, careful evaluation of design, construction, and location will be necessary to determine the viability of the proposed structures. It will also be necessary to regularly monitor and evaluate the integrity of the structures throughout their life span in order to minimize chances of failure. It will also be necessary to monitor and evaluate the physical environment and the prevailing physical processes to determine the relevance of the structures to the purposes for which they were constructed.

5.2.2 Climate and Air Quality

(1) Pre-Construction and Construction Phase

Trucks carrying construction materials are expected to lead to deterioration of the existing access road and will also cause dusty condition along the roadways. In addition, emission from these vehicles are also expected to slightly increase the NO_2 and SO_2 concentration in the vicinity.

A minor change in microclimate will be experienced during construction phase due to further loss of the marginal vegetation in the surrounding areas. There will be higher evapotranspiration losses during the project construction since more area will be exposed. This would mean that the area will be slightly hotter a meter above the ground.

(2) Operation Phase

No significant air pollution is expected during the operational phase. The emission from the vehicles to and from the area, and other fuel-burning equipment will be negligible and will not elevate the TSP, NO_2 and SO_2 concentration in the air. Since there are no major air pollution sources in the area, the carrying capacity of the site with respect to air pollution is still high.

5.2.3 Hydrology and Water Quality

The development plans proposed by the project are largely putting in place infrastructures to enhance the river channels. The priority projects aim to protect the river bed from further erosion, fix the river course, and regulate sediment transportation. These infrastructures are actually enhancement measures that will shorten the time to reach environmental stability for the rivers. With or without the project, lahar flows will be bringing with it organic and inorganic materials, which affect water quality. The proposed project will actually mitigate the negative impacts of lahar.

5.2.4 Noise

(1) Pre-Construction and Construction Phase

An increase in the noise levels will be experienced during construction phase due to the operation of heavy equipment. However, since the project areas are sparsely populated only a few residents will be affected. Furthermore, these directly affected residents will be relocated. Thus, only the workers will be exposed to the noise pollution.

(2) Operation Phase

No significant noise pollution is expected during the operational phase. The activities in the area will return to its normal functions.

5.3 Potential Impacts on Biological/Ecological Environment

5.3.1 Terrestrial Flora and Fauna

(1) General Assessment

The proposed implementation and development of Sabo and Flood Control Project in three (3) major western river basin of Mount Pinatubo including gabion mattress installation in Maraunot notch would have both negative (adverse) and positive (beneficial) effects on the biological components of the landscape. While the major developmental activities such as, dike heightening, bridge construction, channeling along the river, construction of check dams, consolidation dams and dikes, construction of canal network an development of alternative transportation route, are confine and focus in and around the major river basin, still the impact maybe felt from headwaters and nearby agro-ecosystem areas downstream. Among the project's environmental effects and impacts are summarized in the following tables under the pre-construction and maintenance/operation phases.

(2) Construction Phase

- **Flora**

The preparation for the construction entails already an enormous spatial disturbance on the biological materials such as removal of trees and disturbance/dislocation of wildlife habitat. Activities such as construction camps can also significantly affect the health of the ecosystem specific to the impacted areas.

The loss of standing timber near and within the construction areas and camps is inevitable to give space to equipment pool and aggregates required for construction. Plants of other lifeforms near the construction site that are sensitive to dust are also in great danger as their stomata are clogged or nearly clogged thereby reducing the ability of the plant to produce carbohydrates required for their growth. However, since the disturbance is only interim in nature, biological materials can easily rebound through natural succession starting from invasion of low statured plants followed by shrubs-type group of plants. Immediate rehabilitation should be employed by planting endemic and other appropriate species in the area.

For three (3) major river systems, the impacts and corresponding mitigation are very much related as they have more or less the same development intervention from the dike heightening to channel consolidation works.

Among the major impacts include the following:

a. Reduction of standing bio-mass
b. Reduction in plant bio-diversity and forest genetic resources

- **Fauna**

a. Disturbance of terrestrial fauna due to quarrying, blasting and general construction works in the area
b. Reduction of wildlife population due to destruction of habitat and loss of food sources

(3) Operation/Maintenance Phase

- **Flora**

Major impacts during operation and maintenance phases include the following:

a. Loss of standing bio-mass/timber and decline plant diversity composition
b. Disrupt the ecology and productivity e.g. nutrient cycling of the affected plant community

- **Fauna**

Major impact during operation and maintenance phases will be the disturbance of wildlife habitat and interim reduction of population.

5.3.2 Aquatic Flora and Fauna

The priority structural measures are envisioned to: 1) reduce sediment volume at the source; 2) stabilize the unstable sediment; and 3) transport the sediment up to the river mouth. Given such objectives, the priority projects actually aim to improve the physical structure of the river which will ultimately benefit the riverine biotic communities in the long term rather than be detrimental.

For any aquatic community to develop in the river, it is imperative that the river channel is relatively stable with continuous clear water flowing. That is, plankton (phytoplankton and zooplankton), benthos (i.e. insects and snails) and fish (tilapia) will easily colonize the rivers provided the environmental conditions are favorable for growth. This is only possible if the water is clear so that aquatic macrophytes and phytoplankton will grow which will be the base of the food chain since terrestrial plant detritus which is the common base of the riverine food chain is very limited in Bucao and Sto. Tomas Rivers. The presence of phytoplankton, zooplankton, benthos and fish in some river stretches and some polychaetes in the coastal zone shows that biotic communities survive, until the next lahar event. With the project, these biological communities will further grow so that eventually longer stretches will be colonized. These projections are based on the regulation of sediment load, stabilization of the river course, and minimization of water flow fluctuations which are necessary for the recolonization and ultimate settlement of the organisms. Eventually, it will pave the way for the regeneration or renaturation of the surface waters within the Mount Pinatubo watershed.

5.4 Socio-Economic

5.4.1 Population

There might be a possible increase in the local population brought about by the migration of workers especially during the construction phase of the project. Thus, there will be also a corresponding demand for social services and other basic necessities of life.

The socio-economic and perception survey conducted at the end of January 2003 showed that the directly project affected people in the project areas were 89 households with a total population of 379 persons that would be displaced by the improvement of existing dikes and construction of new dikes under the identified Priority Projects. To further determine the impact on these directly affected households, a Resettlement Plan was formulated. The Resettlement Plan is submitted as a separate report. As of the end of May 2003, it was found that the total number of affected people was 452 and of affected households became 106.

The proposed project requires relocation/resettlement of the affected people. But it does not mean that it will reduce the population because, the relocation areas prepared by the Local Government Units are also within or near the project area but in a higher or safer ground.

5.4.2 Labor and Employment

As regards to employment and source of income, temporary employment during the construction of the project phase is possible. A more acceptable scenario would happen if well-planned and workable and livelihood projects are incorporated in the Social, Institutional, and Resettlement Development Plan component of the over-all Project. The institutional framework for the community based livelihood program e.g., community based forest management and community based coastal resource management can be considered in the succeeding activities of the Project.

There will be brought about by employment of needed workforce in the construction and building activities. Employment opportunities will increase from both direct and indirect impact areas depending on the needed skills and expertise. This situation will bring about some degree of change in the socio-cultural atmosphere of the area due to the influx of temporary migrants of diverse origin, values, and behavior. At this stage, there will be increase in income and flow of cash and generation of livelihood opportunities. The income will be derived from wages of the workers and proceed from buyout schemes of affected lots. This temporary flow of cash will spell an increase in the purchasing power and economic position of the people.

5.4.3 Housing and Social Services

An increase in the population will require additional housing and social services. The outside workers will most likely live near the project area or within the place of work. Possible development of house structures near the project area due to the expected revenue that they temporarily gain from leasing their houses or part of their houses.

5.4.4 Infrastructure and Public Utilities

Similarly, additional infrastructure and public utilities will be required due to the increase in population.

5.4.5 Health and Education

Additional health services and provision of education are also needed due to the increase in population. The wages paid to its workers will have positive impacts on health through increased affordability of health services. Higher income will enable the population afford better food and medical care.

The wages received from the project will also increase the capability of economically active adults to support the longer years of schooling of their dependents. This is a long-term positive impact.

5.4.6 Culture and Lifestyle

There are no perceived drastic changes in the cultural and lifestyles of the community resulting from the implementation of the project.

5.4.7 Livelihood and Income

A likely increase in the livelihood in the form of services and vending will be brought about by the project especially during the construction phase. Additional income will be contributed to the LGU in the form of taxes.

If the unemployed people within the nearest Barangay will be employed the salaries and wages will channel cash to the local economy. The project is expected to employ workers at the minimum wage of PhP 250 per day. In average family spends 50% of the income on food. This means that about half of the total amount paid in the form of salaries and wages will redound to food producers such as fishers, farmers and small scale food industry operators, sari-sari stores and small canteen.

5.4.8 Archeological/Anthropological/Historical Sites

Preliminary assessment indicates that no historical sites will be affected.

5.4.9 Resettlement Issues

A summary of the resettlement issues on loss of land and other assets are listed below:

- Loss of land – temporary/permanent agricultural, residential, and/or commercial;
- Loss of houses and other structures – owners and tenants;
- Loss of crops and trees – owner or person with customary rights;
- Loss of common property resources – affected communities or concerned government agencies; and
- Rehabilitation assistance – disturbance compensation, financial assistance for those who opted to relocate, income restoration program.

The above factors are discussed in detail in a separated document (ATTACHMENT to APPENDIX XI “Resettlement Plan”).

5.5 Proposed Mitigation and Enhancement Measures

5.5.1 Physical Impacts

(1) Topography and Soil

Soil erosion has been identified as the negative impact which can occur especially during construction. When massive earth movement cannot be avoided especially during the construction of access road where vertical cuts are done, retaining walls or rip-rap will be necessary to control localized landslides.

The development should follow the contour for minimum cut and fill. To minimize spoils, well planned cut and fill operation should be implemented. In addition, the use of cut volume as filling materials should be maximized.

If possible, the scraped lahar/ashfall should be used as filling material to minimize the volume of waste generated.

(2) Air Quality and Noise

Ambient Air Quality

The effect of the project on air quality will be temporary and will occur mostly during the construction stage. Fugitive dust and exhaust from construction equipment maybe expected. Upon the completion of the project, when the land surface is already covered, air quality will be improved.

To minimize air pollution during the construction stage, the following measures must be undertaken:

1) Daily watering of exposed areas especially during the dry season.
2) Maintenance of vehicles and equipment - all equipment must be properly maintained.
3) Enclosure of the project area to dissipate the noise going to the nearby communities.
4) Proper planning of construction activities to limit the extent of impacts and to minimize the exposed areas at any given time

Noise Level

Regular maintenance of equipment/machineries will be carried out to minimize noise generation. For particular activities where workers will be exposed to significant noise levels, these workers will be provided with appropriate personal protective equipment – ear plugs.

(3) Hydrology and Water Quality

Increase in sediment load due to land clearing and other earth moving activities during the construction phase will increase turbidity of the water. Actually, the rivers naturally experience periodic increases in water turbidity, inorganic and organic substances. Hence, another episode of material loading during the construction phase may not be critical to the already degraded riverine ecosystem. A better water quality may be expected after a few years of operation

5.5.2 Biological Impacts

a. Minimization/alleviation of adverse disruption of behavior of birds and other terrestrial fauna due to removal of trees and other plants
b. Preservation of plant and genetic resources
c. Minimization of noise and disturbance to wildlife
d. Minimization of standing biomass loss
e. Possible positive impacts on aquatic ecology after stabilization of the river basins
f. Possible improvement in the aesthetic and visual effects

5.5.3 Socio-Economic and Cultural Impacts

The impacts of the project on the socio-economic environment are expected to be positive. In the macro-scale, the project will provide an impetus for economic growth. In the micro-scale, jobs will be provided to qualified local residents. The project will also provide income in the form of taxes and fees to the LGUs. There will also be significant purchases of supplies and materials during the construction phase.

For the directly affected households, a resettlement and compensation plan has been formulated to address the impacts of the loss of their land and other assets. The Resettlement and Compensation Plan has been reported in a separate document.

5.6 Residual and Unavoidable Impacts

There will be changes in groundwater levels/gradients which may be possibly long term, and may have significant impact depending on magnitude of changes in topography and drainage. Additional increase in the river bed is expected to occur resulting to a more elevated area compared to the inland areas. This situation poses a permanent risk to those who would reside near the dikes. Thus, sufficient buffer areas should be provided and declared not for habitable purposes.

5.7 Resettlement and Compensation Plan

The detailed Resettlement and Compensation Plan formulated for this project is prepared as a separate document. For details, refer to the “ATTACHMENT to APPENDIX XI : Resettlement Plan”.

CHAPTER 6 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

6.1 Environmental Management Program during Construction

6.1.1 General

Contractors to be hired by the proponent to carry out the construction must demonstrate the capacity to carry out the environmental management plan for construction described herein. A list of the general responsibilities of the contractor is presented below:

- Disposals of excavation spoils. Used materials should be disposed in a designated area where these will not be carried by surface run-off and into the drainage systems in the area.
- Watering of all exposed areas during windy days. The contractor should sprinkle all exposed unpaved areas to minimize the production of fugitive dusts during dry and windy days.
- Covering of delivery trucks. All delivery trucks of sand and gravel and other materials shall be appropriately covered to minimize the creation of dust.
- Proper waste disposal in workers' camp site. The contractor shall be responsible for the safe disposal of all solid and liquid wastes at the workers camp sites.
- Demobilization activities. The contractor shall be responsible for the proper disposal of all debris and waste material upon the completion of the construction phase. These shall be disposed of in a landfill/dump site designated by the proponent.
- Other ECC Conditonalities. The Contractor shall also carry out all other environmental mitigating and enhancement measures that may be added as special conditionalities of the ECC that will be issued for the project.

In addition, contractors are urged to give priority to residents of the area when hiring workers. Similar preference may be given to local businesses when sourcing food, services and other supplies.

6.1.2 Employment and Manpower Capability Building

Prioritization of the residents of Barangay San Rafael and Rabanes in San Marcelino town; Barangay Alusiis, San Pascual and Paite of San Narciso town; Barangay Manglicmot of San Felipe town; Barangay Porac, Carael, San Juan and the Aytas of Botolan and San Marcelino which are considered as vulnerable group for employment will maximize the positive impact of the project.

In case the project proponent and the Local Government Units could provide training opportunities for the local man power skills, in preparation for future development related to the ecotourism and agricultural industrialization of the area. It will bring more benefits to the local stakeholders.

6.1.3 Workers Quarter

The project contractor must provide housing and utilities to the workers. This will prevent the housing demand and competition for social services with the local population.

6.1.4 Workers and Public Safety

When the earthmoving and construction activities are undertaken, the workers must be outfitted with the standard safety gears as required by law and oriented on the standard safety and emergency measures that will be implemented. The safety gears and orientation of workers should ensure minimization and prevention of accidents caused by moving machines and heavy construction materials.

The general and special conditions of contract as well as the technical specifications are part and parcel of the construction contract for the Sabo and Flood Control Project. In these documents, provision for the safety of the public and the workers within the construction zone are stipulated. The Project Management must ensure that if such provisions are not incorporated in the contract document, the same must be amended to adequately address the problems.

6.1.5 Traffic Management Plan

The presence of hauling trucks during construction stage may change the present traffic situation. To mitigate the anticipated traffic related problems the following mitigating measures will be implemented:

- Proper coordination with the Local government traffic management unit.
- The contractor/project management must be considered the other mode or method of material handling and delivery.
- Posting of warning and directional signs near the entrance and exit points as well as to other critical and danger zones.
- Provision of traffic aide in maintaining the smooth flow of traffic near the entrance and exit points.
- Balancing the number of hourly trips against traffic situation; that is increase the number of trips during low traffic levels and decrease the number of trips during peak hours.
- To prevent traffic related accidents the drivers who will be commissioned for the delivery of construction materials will undergo periodic drug and alcohol abuse tests and education or guidance program on safe driving and traffic safety

6.2 Environmental Monitoring Program during Construction and Operation

Table 6.1 shows the summary matrix of the Environmental Monitoring Plan for the proposed project.

6.3 Risk Management Program

In the event of accidents during the construction phase, trained personnel will always be on stand-by to attend to the situation.

For safety precautions of the personnel, first aids will be available as well as vehicles to transport casualties. The employees will also be required to wear proper safety attire. Briefings will always be conducted regularly.

The sub-contractor(s) will be required to have their own construction safety protocol.

A potential area of concern during the construction phase is health and safety of personnel. As in any construction sites, possible occupational health hazards in some of the work processes are present. These include areas where individual workers maybe exposed to specific hazards.

6.4 Emergency / Contingency Response Plan

The contractor and its sub-contractors during construction phase will be required to have an emergency response plan in place and to form an emergency response team. This response plan will be disseminated through the conduct of in-house training and drills to ensure that everyone understands his specific role and actions to take in case of emergency. Emergency situation can be an accident, health emergency or disaster that may arise from natural events or construction-related activities.

For appropriate and timely response in case of emergencies, the following will be done:

- Provide first aid station and personnel trained and certified to administer first aid.
- Conduct training on first aid.
- Provide emergency response equipment such as stepladders, axes, crowbars, flashlights, etc. in the site at all time. Their locations should be made known to the workers.
- Provide a system for prompt transport of injured persons to a physician or hospital, or a communication system for contacting ambulance service in the absence of a physician or a medical facility at the site, and
- Simulate emergency exercises including response and evacuation procedures in case of disasters and major calamities.

6.5 Information, Education and Communication Plan

The dissemination of information regarding the Priority Projects will commence with the formal process of sending written communications and public meeting, consultation and workshops that involved the stakeholders.

To further pursue the efforts on the part of the proponent to build-up and widen awareness of the projects among affected stakeholders, community, offices and the public, the following plans should be implemented:

- The proponent (DPWH) shall publish the details of the Priority Projects in its newsletters, newspapers of national and regional circulation, radio and TV broadcasts as necessary. Public meeting(s) involving local officials and residents will be conducted to keep them and stakeholders updated on the project development.
- Billboard or sign-board will be erected or installed in strategic locations at and near the vicinity of the project area, indicating what project activities are going on at the site.
- Project briefing materials including audio-visual, flyers, and handout with text and graphic presentation of the project shall be produced by the proponent and made available to visitors.
- The proponent, for wider dissemination of the information, will hold regular media briefing.

6.6 Social Development Plan

6.6.1 General Plan

In term of effects of the project on communities or human settlements, the impact area is limited to the settlements near the Bucao and Sto. Tomas dikes and Macolcol Bridge. Large portion of the area is part of the Certificate of Ancestral Domain Claim (CADC) of Aetas awarded by the government under the Department of Environment and Natural Resources (DENR-DAO #02), and therefore any development activity within the CADC zone should generate benefits that in some tangible ways rebound to the welfare of the community.

Social development program can be applied to the Aeta and non-Aeta communities and shall include the following:

- Skill development training and among others, handcraft production. This will support the program for optimizing the utilization of certain raw materials abundant in the CADC zone for home-based handcraft manufacturing.

- Adult literacy training to improve the level of literacy in the community, as well as scholarship program for qualified children or students in the community would bring benefits to the poor but deserving individuals.
- Agriculture and aquaculture development program for both Aeta and non-Aeta that have returned to their original settlement and resume their agricultural activity.
- Establishment and improvement of community health centers for the delivery of basic health services.
- Strengthening of the organizations and cooperatives to support the future agro-industrial and agro-forestry endeavors.
- Strengthening of the people's knowledge and preparedness on disaster prevention especially for the community leaders.

6.6.2 Resettlement and Compensation Plan

A Resettlement Plan which includes the compensation packages for the directly affected households has been formulated and prepared as a separate document. For details, refer to the document "ATTACHMENT to APPENDIX XI".

6.6.3 Mango Production

Mango is one of the most important products in the project area. Therefore mango production is a great livelihood opportunity for the communities in the area affected by the lahar. Selection of good mango species and establishing a good program for production and sales, mango will provide a promising future for the area.

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ATTACHMENT LISTS OF MAJOR ENVIRONMENTAL LAWS

This JICA study is conducted under consideration of the following environmental laws.

Framework Laws

- Constitution of the Republic of the Philippines-various provisions
- PD 1151, Philippine Environmental Policy (6 June 1977)
- PD 1152, Philippine Environmental Code-Natural Resource Management and Conservation (6 June 1977)
- PD 1067, Water Code of the Philippines
- Commonwealth Act No.141, The Public Land Act (An Act to Amend and Compile the Laws relative to Lands of the Public Domain)
- Executive Order No.192, the Reorganization Act of the Department of Environment and Natural Resources (1987)
- RA 6657, The Comprehensive Agrarian Reform Law of 1988 (10 June 1988)
- EO 15/1992, Creating the Philippine Council for Sustainable Development (PCSD)
- DAO 30/1992, Providing Guidelines for the Transfer and Implementation of DENR Functions to the Local Government Units
- DAO 36/1992, Assignment and Supervision of the DENR-Non Governmental/People's Organization (NG/PO) Desk
- DAO 32/1994, Creation of an Office to Coordinate DENR Commitments to Inter-Agency Committees, Task Force and Special Projects
- DAO 35/1994, Guidelines Governing the Implementation and Monitoring of the DENR National Crime Reporting System
- EO 291, Creating Environmental Units in National Government Agencies (1996)

Environmental Impact Assessment (EIA) Legislation

- PD 1586, Establishing an Environmental Impact Statement System, Including Other Environmental Management Related Research and for Other Purposes (11 June 1978)
- Proclamation 2146, Proclaiming Certain Areas and Type of Projects as Environmentally Critical and Within the Scope of the Environmental Impact Statement System Established under PD 1586
- DENR Office Circular No.3, Series of 1983, Technical Definitions and Scope of the Environmentally Critical Projects and Areas Enumerated in Proclamation 2146
- EO291, Improving the Environmental Impact Statement (EIS) System (12 January 1996)
- DAO 37/1996, Revising DAO 21/1992 to Further Strengthen the Implementation of the Environmental Impact Statement (EIS) System

- EO 342, Declaring Golf Courses as Environmentally Critical Projects and Creating the Golf Course Committee for Environmental Protection Programs (1996)
- Golf Course Committee Resolution 1 of 1997, Rules and Standards in Reviewing Proposed Golf Course Projects

Pollution Control and Hazardous Substances

- PD 984, National Pollution Control Decree, Providing for the Revision of RA 3931 Commonly Known as the Pollution Control Law and for Other Purposes
- EO 374, Creating the Presidential Task Force on Water Resource Development and Management (to provide a harmonious and coordinated approach to water resources management)
- DAO 14/1993, Revising Chapter II, Sections 57-66 of the 1978 Implementing Rules and Regulations for PD 984 (revision of air quality standards)
- DAO 14A/1993, Amending DAO 14/1993 and Clarifying its Scope and Coverage
- PD 1181, Providing for the Prevention, Control and Abatement of Air Pollution from Motor Vehicles and for Other Purposes (Anti Smoke-Belching Law of 1977)
- DAO 12/1996, Prescribing Organizational and Management Arrangement of the Pasig River Rehabilitation Program
- Laguna Lake Development Authority Resolution No. 33 of 1996, Prescribing Use of Environmental User Fees for Facilities under the Jurisdiction of the Laguna Lake Development Authority
- Resolution Procedural Rules of the PAB in Pollution Cases
- DAO 5/1997, Procedures in the Retention of Areas within Certain Distances along the Banks of Rivers, Streams and Shores of Seas, Lakes and Oceans for Environmental Protection
- RA 6969, Toxic Substances and Hazardous and Nuclear Wastes Control Act of 1990
- DAO 29/1992, Implementing Rules and Regulations of RA 6969
- DAO 28/1994, Interim Guidelines for the Importation of Recyclable Materials Containing Hazardous Substances
- DAO 38/1997, Chemical Control Order for the Mercury and Mercury Compounds
- DAO 39/1997, Chemical Control Order for Cyanide and Cyanide compounds

Protected Areas and Wildlife

- RA 7586,National Integrated Protected Areas System Act of 1992 (NIPAS)
- DENR Memorandum Circular No.20/1990, Guidelines on the Restoration of Open and Denuded Areas within National Parks and Other Protected Areas for the Enhancement of Biological Diversity
- DAO 13/1992, Regulations Governing the Establishment of Buffer Zones within Forest Lands
- DAO 25/1992, National Integrated Protected Areas System (NIPAS) Implementing Rules and Regulations (29 June 1992)

- DENR Memorandum Circular No.45/1992,Clarifications on Some Provisions of RA 7586, DAO 25/1992, and Other Related Guidelines
- DAO 13/1993, Guidelines in the Conduct of Census and Registration of Protected Area Occupants (12 March 1993)
- DENR Memorandum Circular No.16/1993, Guidelines on the Establishment and Management of Buffer Zones for Protected Areas (13 May 1993)
- DENR Memorandum Circular No.22/1994, Delegation of Authority Regarding the Implementation of Foreign Assisted Integrated Protected Area Projects (IPAS)
- DAO 3/1995, Procedural and/or Documentary Requirements, Guidelines and/ or Criteria to be Observed and/ or Followed in the Selection of Local Government Units, Non-Governmental Organizations and People's Organizations to the Protected Areas Management Board (PAMB)
- DAO 5/1995, Guidelines for the Selection, Awards, Monitoring and Evaluation of Host Non-Government Organizations in the Conservation of Protected Area Projects
- DENR Memorandum Order No.8/1995, Clarifications on the Provisions of the NIPAS Law regarding the Modification of Boundary of the Protected Area and Its Buffer Zone
- DAO 31/1996, Amendment of Section 31 of DAO 25/1992, Re ; Implementing Rules and Regulations of RA 7586 (National Integrated Protected Areas Act of 1992)
- DAO 142/1989, Guidelines on the Disposition of Confiscated Wildlife Species
- DAO 36/1991, Guidelines Governing the Confiscation, Seizure and Disposition of Wild Flora and Fauna Illegally Collected, Gathered, Acquired, Transported and Imported including Paraphernalia

Forestry

- PD 705, Revised Forestry Code of the Philippines (Revising PD 389)(19 May 1975)
- DAO 4/1989, Revising Regulations Governing Rattan Resource (10 January 1989)
- DAO 4A/1989, Special Provisions for the Processing of Rattan (12 January 1989)
- DAO 59/1990, Providing Guidelines on the Confiscation, Forfeiture and Disposition of Conveyances Used in the Commission of Offences Penalized under PD705, as amended by EO 277, and Other Forestry Laws, Rules and Regulations (22 June 1990), amended subsequently by DAO 54/1993(16 September 1993)
- DAO 4/1991,Revising Regulations Governing the Integrated Social Forestry Program(27 February 1991)
- DAO 24/1991, Shift in Logging from the Old Growth (Virgin) Forests to the Second Growth (Residual) Forests (3 May 1991)
- DENR Memorandum Circular No.17/1992, Delineation of Functions and Implementation of the Integrated Social Forestry Program after the Devolution of Functions to the Local Government Units(15 October 1992)
- DAO 23/1992, Institutionalizing the Master Plan for Forestry Development within the DENR and Defining Functions of Offices for the Purpose

- DAO 27/1992, Management of Mossy Forests
- DAO 35/1992, Prescribing Guidelines for Community Reforestation contract under the low Income Upland Communities Project (LIUCP)
- DAO 22/1993, Revised Guidelines for Community Forestry Program (27 April 1993)
- DAO 23/1993, Forest Land Management Program (27 April 1993)
- DENR Memorandum Circular No.1/1994, Guidelines for the Prosecution of Illegal Logging and Related Cases
- DAO 7/1994, Revised Guidelines Governing the Issuance of Certificates of Origin for Logs, Timber, Lumber and Non-Timber Forest Products (17 February 1994)
- DAO 30/1994, Implementing Guidelines for Non-Government Organization Assisted Community-Based Mangrove Forest Management (NGO-Assisted CBMFM) for the DENR (2 September 1994)
- DENR Memorandum Circular No.34/1994, General Outline for the Formulation of Initial Protected Area Plan
- DAO 15/1995, Revised General Guidelines in the Implementation of the Sub-Classification of Forestlands and Other Inalienable Lands of the Public Domain(10 may 1995)
- DAO 17/1995, Institutionalization of the Multi-Sectoral Forest Protection Communities Within the DENR System (20 May 1995)
- DENR Memorandum Order No.4/1995, Creation and Constitution of the National Federation of Multi-Sectoral Forest Protection Communities (NFMFPC)(2February 1995)
- EO 263, Adopting Community-Based Forest Management as the National Strategy to Ensure the Sustainable Development of the Country's Forestlands Resources and Providing Mechanisms for its Implementation (19 July 1995)
- DAO 24/1996,Rules and Regulations Governing the Socialized Industrial Forest Management Program(23 August 1996)
- DAO 29/1996, Rules and Regulations for the Implementation of Executive Order 263, Otherwise Known as the Community-Based Forest Management Strategy (CBFMS) (10 October 1996)
- DAO 4/1997, Rules and Regulations Governing the Industrial Forest Management Program
- DAO 1/1998, Forest Resource Securitization Strategy

Fisheries

- RA 8550, The Philippine Fisheries Code of 1998
- DAO 3/1998, Implementing Rules and Regulations Pursuant to RA 8550
- RA 8435, Agriculture and Fisheries Modernization Act of 1997

Ancestral Domain and Indigenous People's Rights

- DENR Circular No.3/1990, Rules on the Acceptance, Identification, Evaluation and Delineation of

Ancestral Land Claims by the Special Task Force Created by Virtue of DENR Special Order Nos.31A, Series of 1990(27 April 1990)

- DAO 61/1991, Rules on the Acceptance, Identification, Evaluation and Delineation of Ancestral Land Claims in the Province of Palawan (7 November 1991)
- DAO 2/1993, Rules and Regulations of for the Identification, Delineation And Recognition of Ancestral Land and Domain Claims (15 January 1993)
- DAO 34/1996, Guidelines for Management of Certified Ancestral Domain Claims (12 November 1996)
- DENR Memorandum Circular No.26/1994, Flagship Program for the Indigenous Cultural Communities under the Social Reform Agenda
- RA 6734, Providing for an Organic Act for the Autonomous Region in Muslim Mindanao
- RA 8371, Indigenous Peoples Right Act of 1997(29 October 1997)

Mining

- PD 512, Declaring Prospecting and Other Mining Operations of Public Use and Benefit and Establishing the Basis and Prescribing the Rules and Procedures and Establishing the Basic and Prescribing the Rules and Procedures relating to Acquisition and Use of Surface Rights in Mineral Prospecting, Development and Exploitation, and Providing Protection and Compensation to Surface Owners (16 January 1981)
- RA 7942, Philippine Mining Act of 1995(3 March 1995)
- DAO 40/1996, Revising the Implementing Rules and Regulations of the Mining Act of 1995 (20 December 1996)
- Mines Adjudication Board Rules on Pleding, Practice and Procedure before the Pnael of Arbitrators and the Mines Adjugication Board (12 August 1997)
- RA 7076, People's Small-scale Mining Act of 1991 (27 June 1991)
- DAO 34/1992, Rules and Regulations to Implement RA 7076 (6 August 1992)

Tables

Table 1.1.1 List of Proposed Priority Structure Measures

No	River Basin	Priority Projects	Project Cost (Million Pesos)
1	Bucao	The Bucao River dike construction and heightening, including re-construction of the Bucao Bridge	1,678 (Equivalent to US$ 33.2 million)
2	Sto. Tomas	The Sto. Tomas River dike construction, heightening and strengthening, excluding re-construction of the Maculcol Bridge	1,960 (Equivalent to US$ 38.8 million)

Table 1.4.1 Issues and Impacts Identified through the Environmental Screening

Impacts	Project Phases					
	Construction			Operational		
	1	2	3	1	2	3
1. Soil						
a) Soil erosion	N	S	St	N	L	M
b) Increase risk of soil failure/instability	N	S	St	N	L	M
c) Generation of excavation spoil	N	S	M	-	-	-
d) Scraping of lahar/ashfall	P	L	St	-	-	-
2. Terrestrial Flora and Fauna						
a) Loss of vegetation	N	L	St	-	-	-
b) Disturbance of faunal composition	N	S	St	-	-	-
c) Introduction of new plant species	N	L	I	N	L	I
d) Introduction of new faunal species	-	-	-	P	L	M
e) Effect on plant growth	N	S	M	-	-	-
3. Hydrology/Water Quality						
a) Depletion of water supply						
b) Increase turbidity/sedimentation	N	S	St	-	-	-
c) Contamination by effluents	N	S	St	N	L	M
d) Fertilizer and pesticide contamination	N	S	M	N	L	M
	-	-	-	N	L	M
4. Air Quality/Aesthetics						
a) Creation of fugitive dusts						
b) Microclimate change	N	S	St	N	L	I
c) Noise creation	N	S	I	N	L	I
d) Improvement of scenic vista	N	S	M	N	L	I
e) TSP, NO_2 and SO_2 emission	-	-	-	P	L	M
	N	S	M	N	L	I
5. Socio-economics						
a) Job creation	P					
b) Appreciation of land values	P	S	St	-	-	-
c) Induce land use change and development	P	S	I	P	L	St
d) Increase demand on resources	N	S	I	P	L	M
e) Generation of small-scale ventures	P	S	I	N	L	M
f) Inconvenience to local residents	N	S	I	P	L	I
g) Increase in population	N	S	M	N	L	I
h) Improvement of basic service	P	S	I	N	L	M
i) Increase income of the community/LGU	P	S	I	P	L	M
		S	M	P	L	St
j) Resettlement of directly affected residents	N	S	St	-	-	-
6. Waste Generation						
a) Domestic waste generation (solid and liquid)	N	S	M	-	-	-
b) Generation of toxic and hazardous waste	N	S	I	-	-	-

Notation: 1- Nature: Positive (P), Negative (N); 2 – Duration: Long-term (L), Short-term (S); 3 - Level of Significance: Significant (St), Moderate (M), Insignificant (I)

Table 1.5.1 Summary Matrix of the Major Impacts and Mitigation/Enhancements Measures(1/2)

Project Phase/ Activity	Environmental Aspect	Projected Impacts: Acceptable Impacts	Projected Impacts: Non-Acceptable Impacts	Mitigation Plan for Non- Acceptable Impacts
Pre Construction/Construction	Geology, Hydology, Pedology and Land Uses		Erosion due to land clearing	Use of slope protection works during construction
			Slope instability from the excavation and earthworks	Use of slope protection works during construction
			Changes in flow paths and possible flooding patterns in case of heavy rains and/or dam breaching during construction	Excavation, stockpiling, and disposal of earth material must be monitored, evaluated, and properly conducted to prevent possible channeling of lahars and/or floodwaters where they can cause damage. Proper timing of construction to avoid extending into the rainy season
	Air Quality		Air pollution due to gaseous emissions (NO_2, SO_2, TSP, PM_{10})	Air pollution due to gaseous emissions (NO_2, SO_2, TSP, PM_{10})
			Increase in dust generation	Regular wetting of bare surfaces
	Noise Level		Increase in noise level	Proper selection and regular maintenance of equipment
				Use of Personal Protective Equipment (PPE) such as earplugs Limit construction activities during daytime
	Water quality		Pollution of water body by organic wastes from workers' camp	Installation of septic tank facilities
			Increase in sedimentation or turbidity	Provision of siltation/erosion control measures
	Terrestrial Ecology		Loss of existing terrestrial ecosystem	Minimal site clearing of remaining vegetation
		Re-establishment of lost ecosystem in certain areas through landscaping		

Table 1.5.1 Summary Matrix of the Major Impacts and Mitigation/Enhancements Measures(2/2)

Project Phase/ Activity	Environmental Aspect	Projected Impacts: Acceptable Impacts	Projected Impacts: Non-Acceptable Impacts	Mitigation Plan for Non- Acceptable Impacts
	Aquatic Ecology		Sediments could increase nutrient load and contribute to euthropication	Sediment traps, riprapping of development areas, particularly along riverbanks; proper engineering plans/designs
	Solid Waste Generation		Increase in waste generation	Implementation of Solid Waste Management Plan
	Socio Economics	Generation of income and employment	Lack of working skills	Conduct man-power skills training. Prioritization of Barangay near the project area on employment
		Wage increase capability to support education		Implement adult literacy program and scholarship program
		Increase in livelihood activities		
		Increase in revenue of the host LGU		
		Increase in population	Influx of land speculators	Census and tagging of houses and structures within the project area
		Home improvement, increase demand of basic social services	Overpricing of lease rate and services	Provide quarters for workers from far away areas
		Removal of houses and other structures with proper compensation	Removal of houses and other structures without proper compensation	Proper Implement good Resettlement/Relocation Plan
		Unavoidable accident	Fatal accidents that cause death of workers and public, exposure of construction personnel to occupational hazards	Implement proper safety and health orientation programs
Project Phase/ Activity	**Environmental Aspect**	**Projected Impacts: Acceptable Impacts**	**Projected Impacts: Non-Acceptable Impacts**	**Mitigation Plan for Non- Acceptable Impacts**
			Increase road accident due to the project mobilization	Implement good traffic management plan
Operation	No perceived significant negative impacts due to the operation of the project. Operation phase consists of maintenance of the structures constructed. Most impacts are positive due to stability of the river basins preventing destructive effects of lahar flows.			
Abandonment	Not applicable for this type of project.			

Table 1.6.1 Summary Matrix of the Environmental Management Plan (1/6)

Project Phase/ Activity	Environmental Aspect	Potential Impact	Mitigation/Enhancement Plan	Estimated Cost of Mitigation or Enhancement	Responsible Institution	Schedule	Guarantees – MOAs, Contracts, etc.
Pre-Construction/ Construction	Noise Level	Increased noise levels	Minimal use of noisy equipment by selection of equipment with low-rate noise level	Included in project cost	Contractors	During site preparation	Contractor's Environmental Program
			Equipment operation scheduling by prohibiting unnecessary operation of the equipment or minimize operation at nighttime (if any).	Included in project cost	Contractors	Throughout construction	Contractor's Environmental Program
			Institutionalization of equipment maintenance	Included in project cost	Contractors	Regular or at least once a week depending on the type of equipment	Contractor's Environmental Program
			Reduction of noise from vehicle and equipment by imposing as a matter of policy the use of silencers and mufflers	Included in project cost	Contractors	Throughout construction	Contractor's Environmental Program
			Protection of project personnel by imposing as a company policy the regular use of earplugs or mufflers by workers in areas where noisy equipment are being operated	Included in project cost	Contractors	Throughout construction	Safety & Health Policy
			Modification of noise pathway through enclosure of the construction site through fencing (if possible)	Included in project cost	Contractors	Onset of construction	Contractor's Environmental Program
			Post warning signs and fliers in areas where noisy equipment are being used	Included in project cost	Contractors	Throughout construction	Contractor's Environmental Program
			Conduct of noise survey at regular interval to determine the impacts and extent of noise pollution in areas with high noise level, the result of which will determine the adequacy of the mitigation measures and ascertain alternative abatement scheme	Included in project cost	Pollution Control Officer (PCO)	Regular during construction	EMoP

Table 1.6.1 Summary Matrix of the Environmental Management Plan (2/6)

Project Phase/ Activity	Environmental Aspect	Potential Impact	Mitigation/Enhancement Plan	Estimated Cost of Mitigation or Enhancement	Responsible Institution	Schedule	Guarantees – MOAs, Contracts, etc.
Pre-Construction/ Construction			Survey of affected communities by documenting the comments from nearby residents/stakeholders and evaluate its validity. Consequently, devise measures to abate their method of implementation	Included in project cost	Contractors	Quarterly	EMoP
	Air Quality	Air pollution due to gaseous emissions (NO_2, SO_2, TSP, PM_{10})	Regular maintenance of equipment and transport vehicles	Included in project cost	Contractors	Throughout construction	Contractor's Environmental Program
		Dust generation	Minimize source of dust through phase development. Proper scheduling of site development or phase development to minimize pen or bare area at any given time	Included in project cost	Contractors	Project development phase	Contractor's Environmental Program
			Minimize dust generation through wetting of bare surface. Continuous sprinkling of bare areas located near residential areas especially during the dry season	Included in project cost	Contractors	Daily during the dry season	Contractor's Environmental Program
			Proper handling and delivery of construction materials. Require all cargo/delivery trucks of sand/gravel to be properly covered with canvass or tarpaulin	Included in project cost	Contractors	Throughout the construction phase	Contractor's Environmental Program
			Prevent dust re-suspension by imposing speed limits on all cargo/delivery within the project site to prevent re-suspension of dusts	Included in project cost	Contractors	Throughout the construction phase	Contractor's Environmental Program
	Geology and Soil	Siltation and erosion	Provision of engineering measures to prevent erosion. Construction and/or enhancement of embankment and slope stabilization.	Included in project cost	Contractors	At the initial stage of construction	Contractor's Environmental Program
			Minimize clearing of vegetation. Impose selective tree-cutting and clearing of vegetative cover (if any)	Included in project cost	Contractors	Throughout construction phase	Contractor's Environmental Program

Table 1.6.1 Summary Matrix of the Environmental Management Plan (3/6)

Project Phase/ Activity	Environmental Aspect	Potential Impact	Mitigation/Enhancement Plan	Estimated Cost of Mitigation or Enhancement	Responsible Institution	Schedule	Guarantees – MOAs, Contracts, etc.
Pre-Construction/ Construction			Immediate re-vegetation of exposed and bare areas (if possible)	Included in project cost	Contractors	Right after construction	Contractor's Environmental Program
			Provision of drainage system. Construction of drainage systems prior to the start of construction to divert runoff water away from the construction areas	Included in project cost	Contractors	Onset of construction	Contractor's Environmental Program
		Alteration of topography and prevailing drainage pattern	Excavation, stockpiling, and disposal of earth material must be monitored, evaluated, and properly conducted to prevent possible channeling of lahars and/or floodwaters where they can cause damage. Proper timing of construction to avoid extending into the rainy season	Included in project cost	Contractors	Onset of construction	Contractor's Environmental Program
	Water Quality	Water Pollution	Provision of temporary sewage collection and disposal facility. Provision on the interim of adequate temporary toilet facilities for workers with proper disinfectants and to be collected and disposed of by accredited waste haulers	Included in project cost	Contractors	Before development phase	Contractor's Environmental Program
			Proper location of toilet facilities away from water sources whether surface or underground.	Included in project cost	Contractors	Before development phase	Contractor's Environmental Program
			Water quality monitoring of receiving water body. For precautionary measures, possible receiving water sources will be regularly monitored including biological analysis for fecal coliforms to determine the extent of possible contamination and to serve as the basis for the formulation of alternative mitigating measures	Included in project cost	Contractors/ PCO	Quarterly	EMoP
	Solid Waste Minimization	Solid waste generation	Encourage the implementation of solid waste minimization especially bulky solid wastes resulting from demolitions	Included in project cost	Contractors	Throughout the construction phase	Contractor's Environmental Program

Table 1.6.1 Summary Matrix of the Environmental Management Plan (4/6)

Project Phase/ Activity	Environmental Aspect	Potential Impact	Mitigation/Enhancement Plan	Estimated Cost of Mitigation or Enhancement	Responsible Institution	Schedule	Guarantees – MOAs, Contracts, etc.
Pre-Construction/ Construction			Proper management, storage and disposal of construction spoils. Heaping of spoils for temporary storage should be in flat areas and far from water bodies. Disposal of construction spoils in identified sanitary landfill; materials provide as filling for construction sites or reclamation areas. Recycling of recyclable materials such as scrapped iron, wood, G.I. sheet, etc., and proper disposal of non-recyclables in properly identified landfill sites.	Included in project cost	Contractors	Throughout the construction phase When the volume merits transport of spoils Regular disposal of solid waste and auctioning of recyclables at least twice a year	Contractor's Environmental Program
			Disposal of non-recycled materials in approved landfill site thru accredited waste hauler.	Included in project cost	Contractors	Before start of construction	Enter MOA with accredited waste hauler for proper disposal of non-recyclable materials
			Regular inspection and monitoring of contractors compliance on proper dumping and collections of dumped debris	Included in project cost	PCO	Regular	
			Priority hiring of contractors with high capability and above commitment towards environmental protection	Included in project cost	Contractors	Prior to project implementation	

Table 1.6.1 Summary Matrix of the Environmental Management Plan (5/6)

Project Phase/ Activity	Environmental Aspect	Potential Impact	Mitigation/Enhancement Plan	Estimated Cost of Mitigation or Enhancement	Responsible Institution	Schedule	Guarantees – MOAs, Contracts, etc.
Pre-Construction/ Construction			Information campaign on waste handling by conducting seminar or training for workers and operators.	Included in project cost	PCO/ Contractors	Prior to project implementation	
			Provision of adequate garbage bins that are properly labeled	Included in project cost	PCO/Contractors	Throughout the construction phase	
	Terrestrial Ecology	Loss of remaining vegetation	As much as possible, cutting of trees and clearing of vegetation will be avoided relative to site development	Included in project cost	Contractors	During development phase	Contractor's Environmental Program
			Re-vegetation of open areas. Planting of appropriate tree species in all exposed areas. All necessary permits will be secured prior to cutting of trees.	Included in project cost	Contractors	During development phase	Contractor's Environmental Program
			Establishment of a buffer zone between nearest residential areas; planting of fast-growing plant species on all open areas will also be done to help reduce noise levels and absorb some pollutant emissions	Included in project cost	Contractors	During development phase	Contractor's Environmental Program
	Socio-Economics	Generation of employment.	Qualified local residents of the host barangay will be given priority in the hiring of construction personnel and workers with adequate compensation package	Included in project cost	Contractors	Onset of construction phase	
		Income generation of local suppliers.	Encourage the purchase of materials from local suppliers to help stir the local economy	Included in project cost	Contractors	During development phase	
		Housing needs of migrant workers.	Construction of makeshift housing or barracks to house migrant worker and provision of shuttle buses for itinerant construction personnel	Included in project cost	Contractors	Onset of construction phase	

Table 1.6.1 Summary Matrix of the Environmental Management Plan (6/6)

Project Phase/ Activity	Environmental Aspect	Potential Impact	Mitigation/Enhancement Plan	Estimated Cost of Mitigation or Enhancement	Responsible Institution	Schedule	Guarantees – MOAs, Contracts, etc.
Pre-Construction/ Construction		Medical emergency	Provision of adequate medical facilities and services to answer any emergency medical cases	Included in project cost	Contractors	During development phase	Safety & Health Policy
	Safety & Health	Accidents	Sub-contractors will be required to have their own construction health and safety protocol/program. Wearing of protective gears such as safety helmets, post safety signs and warnings, conduct weekly short sessions to remind workers of safety requirements, monitor accident frequency and severity and implement	Included in project cost	Contractors	Throughout construction phase	Safety & Health Policy
			appropriate corrective measures if possible				
			Establishment of a comprehensive occupational health program, to include	Included in project cost	Project Manager/PCO/ Safety Officer	Prior to the project construction	Safety & Health Policy
			among others: Identification of health and safety risk areas within the construction sites. Identification of vulnerable or at risk personnel Formulation of action plan for the prevention, control and mitigation of identified hazardsIdentification of responsible persons for the implementation of the action plan including monitoring				
	Emergency Response Procedures	Disasters and major calamities	Provision of simulated emergency drills including response and evacuation procedures in cases of disasters and major calamities. An in-house trained team to handle all the emergency exercises will be formed.	Included in project cost	Contractors	Regular during development phase (at least once a year)	Contingency Plan
Operation	Maintenance	Structural breaching	Regular structural integrity tests. Provisions of emergency response procedures.	Included in Government budget	DPWH	As needed depending on previous results of testing	Emergency Response Plans

Table 1.7.1 Summary Matrix of the Environmental Monitoring Plan (1/3)

Parameter	Location	Schedule and Frequency	Procedure	Applicable Standard	Responsible Party	Estimated Annual Cost (PhP)
Noise Levels	Construction areas exposed to heavy equipment	Daily	Using Weighted-Sound Level Meter	NPCC 1978	PCO	100,000
Air Quality						
TSP	Along the road of construction sites	Quarterly	Gravimetric Method/High Volume Air Sampling	DAO 2000-81	PCO	1,000,000
PM_{10}	Along the road of construction sites	Quarterly	Gravimetric Method/High Volume Air Sampling	DAO 2000-81	PCO	
NO_2	Along the road of construction sites	Semi-Annual	Griess-Saltzman, or Chemiluminescence Method/ Gas Bubbler(s) or Gas Impinger(s) or Chemiluminescence $NO/NO_X/NO_2$ analyzers	DAO 2000-81	PCO	
SO_2	Along the road of construction sites	Semi-Annual	Gas Bubbler and Pararosaniline Method (West and Gaeke Method), or Flame Photometric Detector / Gas Bubbler(s) or Gas Impinger(s)	DAO 2000-81	PCO	
CO	Along the road of construction sites	Semi-Annual	Non-dispersive Infra-red Spectrophotometry (NDIR), USEPA 40 CFR, Part 50, Appendix C	DAO 2000-81	PCO	
Lead	Along the road of construction sites	Semi-Annual	Atomic Absorption Spectrophotometry, USEPA 40 CFR, Part 50, Appendix G	DAO 2000-81	PCO	
Water Quality						
pH	Discharge points At least two river locations (upstream and downstream) per construction site	Quarterly	Glass Electrode Method	DAO 90-35	PCO	1,000,000

Table 1.7.1 Summary Matrix of the Environmental Monitoring Plan (2/3)

Parameter	Location	Schedule and Frequency	Procedure	Applicable Standard	Responsible Party	Estimated Annual Cost (PhP)
BOD_5	Discharge points At least two river locations (upstream and downstream) per construction site	Quarterly	Azide Modification (Dilution Technique)	DAO 90-35	PCO	1,000,000
TSS	Discharge points At least two river locations (upstream and downstream) per construction site	Quarterly	Gravimetric Method (dried at 103°-105°C)	DAO 90-35	PCO	
Phenols	Discharge points At least two river locations (upstream and downstream) per construction site	Quarterly	Chloroform Extraction	DAO 90-35	PCO	
Oil and Grease	Discharge points At least two river locations (upstream and downstream) per construction site	Quarterly	Gravimetric Method (Petroleum Ether Extraction)	DAO 90-35	PCO	
Total Coliforms	Discharge points At least two river locations (upstream and downstream) per construction site	Quarterly	Multiple-Tube Fermentation Technique or Membrane Filter	DAO 90-35	PCO	
Cd	Discharge points At least two river locations (upstream and downstream) per construction site	Semi-annual	US EPA 6010B (ICP), 7470/1 (CVAA)	DAO 90-35	PCO	

Table 1.7.1 Summary Matrix of the Environmental Monitoring Plan (3/3)

Parameter	Location	Schedule and Frequency	Procedure	Applicable Standard	Responsible Party	Estimated Annual Cost (PhP)
Cr^{+6}	Discharge points At least two river locations (upstream and downstream) per construction site	Semi-annual	US EPA SW846 or APHA Standard Method 19th Ed. 1995	DAO 90-35	PCO	
Hg	Discharge points At least two river locations (upstream and downstream) per construction site	Semi-annual	US EPA 6010B (ICP), 7470/1 (CVAA)	DAO 90-35	PCO	1,000,000
Pb	Discharge points At least two river locations (upstream and downstream) per construction site	Semi-annual	US EPA 6010B (ICP), 7470/1 (CVAA)	DAO 90-35	PCO	
Soil Quality						
Cd	At least three locations near Mapanuepe Lake	Semi-annual	US EPA 6010B (ICP), 7470/1 (CVAA)	DIV	PCO	
Cr^{+6}	At least three locations near Mapanuepe Lake	Semi-annual	US EPA SW846 or APHA Standard Method 19th Ed. 1995	DIV	PCO	300,000
Hg	At least three locations near Mapanuepe Lake	Semi-annual	US EPA 6010B (ICP), 7470/1 (CVAA)	DIV	PCO	
Pb	At least three locations near Mapanuepe Lake	Semi-annual	US EPA 6010B (ICP), 7470/1 (CVAA)	DIV	PCO	

Table 1.9.1 Matrix of Primary and Secondary Data

Data	Primary	Secondary	Method (if primary)/ Source (if secondary)
Land			
Geology	☑	☑	Field survey and mapping/MGB
Soils	☑	☑	Field survey and mapping/BSWM
Seismicity		☑	PHIVOLCS, MGB
Terrestrial Ecology	☑	☑	Field survey and mapping
Land Use/Cover	☑	☑	Field survey and mapping/ NAMRIA, BSWM
WATER			
Surface Water	☑	☑	Field survey and mapping/NWRB
Hydrology		☑	Field survey, interviews and mapping/ NWRB
Hydrogeology		☑	Field survey, interviews and mapping/ NWRB
Water Quality	☑	☑	Sampling, lab analyses
Aquatic Ecology	☑	☑	Field survey and mapping
AIR			
Climate		☑	PAGASA, NWRB
Air Quality	☑		Field Survey
Noise	☑		Field Survey
PEOPLE			
Demography	☑	☑	Survey of representative sample/NSO, Municipal Planning and Development Offices
Settlements	☑		Field mapping
Socio-economic Conditions	☑	☑	Survey of representative sample, interviews/ NSO
Perception of the Project	☑		Survey of representative sample, interviews

Table 1.10.1 Socio-Economic Surveys and Other Consultative Activities

Date	Activity	Location
Jan. 25, 2003	Consultation Workshop for Botolan Resettlement Centers	Botolan South Central School
Jan. 28, 2003	Consultation Workshop for Bucao Midstream Area	Baquilan Multipurpose Hall
Jan. 30, 2003	Consultation Workshop for San Felipe Resettlement Centers	Maloma National High School
Feb. 1, 2003	Consultation Workshop for Pure Aeta	San Marcelino Terraces
Feb. 4, 2003	Consultation Workshop for Sto. Tomas Midstream Area	San Marcelino Terraces
Feb. 7, 2003	Household Survey of PAPs	San Juan and Carael, Botolan
Feb. 8, 2003	Household Survey of PAPs	San Rafael, San Marcelino
Feb. 9, 2003	Household Survey of PAPs	San Rafael, San Marcelino and Alusiis, San Narciso
Feb. 10, 2003	Survey of Landowners Affected	Owner's residence
Feb. 11, 2003	Interview of Barangay Captains	(Aglao, Manglicmot, Alusiis, etc.)
Feb. 12, 2003	Survey of Landowners Affected	Owner's residence
Feb. 13, 2003	Survey of Landowners Affected	Owner's residence
Feb. 14, 2003	Perception Survey on Integrated Resettlement Center	(Tektek, Lalec, and Bantay Carmen)

Table 3.1.1 Radiocarbon Dating of Samples Collected from the Different Eruptive Periods of Modern Pinatubo

Eruptive Period	Age (years)	Sample	Analytical Technique	Reference
1. Buag	570±70	uncharred wood	^{14}C	Newhall et al. (1986)
2. Maraunot	2,660±110[1]	charcoal	^{14}C	Newhall et al. (1986)
	3,590±110[2]	charcoal	^{14}C	Newhall et al. (1986)
3. Crow Valley	4,800±60[1]	charcoal	^{14}C	Newhall et al. (1986)
	5,130±80[2]	charcoal	^{14}C	Newhall et al. (1986)
4. Pasbul	8,980[3]	charcoal	^{14}C	Ebasco Services, Inc. (1977)
	8,380±80	charcoal	^{14}C	Newhall et al. (1986)
5. Sacobia	17,350[3]	charcoal	^{14}C	Newhall et al. (1986)
6. Inararo	30,390±890	charcoal	^{14}C	Newhall et al. (1986)
	>35,000[4]	charcoal	^{14}C	Newhall et al. (1986)

[1]youngest sample dated

[2]oldest sample dated

[3]calibrated age

[4]more reliable according to the authors

Table 3.1.2 Area, Mean Thickness and Volume Estimates of the 1991 Pyroclastic Flow Deposits Situated on the Zambales Portion of Pinatubo (after Scott et al., 1996)

Valley	Area (km^2)	Mean Thickness (m)	Bulk Volume (km^3)
1. Marella and Maloma	21.6	58.0	1.26
2. Upper Balin Baquero tributaries	8.2	20.7	0.17
3. Major Balin Baquero tributary south of Maraunot	23.4	32.3	0.76
4. Maraunot	10.6	44.1	0.47
5. Tributaries of Bucao southwest of main fork	13.2	37.8	0.50
6. Bucao	9.9	37.9	0.38

Table 3.1.3 General Soil Classification in the Three River Basins

River Basin	Soil Types	Land Management Unit (LMU)
Bucao	Angeles Sand	170
Maloma	Antipolo Clay and Cabangan Sandy Loam	07
Sto. Tomas	Angeles Sand	170

Source: Bureau of Soils and Water Management (1988)

Table 3.1.4 Analytical Procedure Followed for Analysis of Metals in Soil Samples

Parameter	Analytical Procedure	Method Detection Limit (MDL)	Detection Limit for Reporting (MDLxDF[1])
Chromium, Cr^{+6} (ppm)	Colorimetry – Diphenycarbazide	0.05	0.05
Cadmium, Cd (ppm)	Flame AAS	2.5	2.5
Lead, Pb (ppm)	Flame AAS	3.0	3.0
Copper, Cu (ppm)	Flame AAS	1.0	1.0
Mercury, Hg (ppb)	AAS Cold Vapor	50	50
Zinc, Zn (ppm)	Flame AAS	2.5	2.5

[1]DF – Dilution Factor = 1.0

Table 3.1.5 Results of Soil Analysis

	Station					Dutch Intervention Values
River	**Bucao**	**Maloma**	**Sto. Tomas**			
Parameters	**Downstream**	**Upstream**	**Downstream**	**Upstream**	**Downstream**	
Station Designation	***BSO1***	***BSO2***	***MSO1***	***BSO2***	***SSO1***	
Fertility Test						
pH	8.0	6.0	7.4	6.0	6.1	-
% Organic Matter	0.26	1.89	0.73	3.76	1.26	-
Nitrogen, N (%)	0.03	0.09	0.04	0.15	0.06	-
Potassium, K (ppm)	35.19	66.47	11.73	66.47	31.28	-
Phosphorus, P (ppm)	6	21	8	1	2	-
Metals						
Chromium, Cr^{+6} (ppm)	BDL*	BDL	BDL	BDL	BDL	380
Cadmium, Cd (ppm)	BDL	BDL	BDL	BDL	BDL	12
Lead, Pb (ppm)	BDL	BDL	BDL	BDL	BDL	530
Copper, Cu (ppm)	0.22	0.50	0.14	0.32	3.5	190
Mercury, Hg (ppb)	BDL	108	60	BDL	85	10,000
Zinc, Zn (ppm)	23	32	13	26	19	720
Particle Size Distribution, %						
Sand (0.05 - 2.0 mm)	84.7	77.1	89.9	58.6	42.5	-
Silt (0.002 - 0.05 mm)	10.2	12.7	7.5	25.8	31.4	-
Clay (< 0.002 mm)	5.1	10.2	2.5	15.5	28.2	-
Soil Texture	Loamy sand	Sandy loam	Sand	Sandy loam	Loam	-

*BDL = Below Detection Limit, the detection limits are: Cr^{+6} < 0.05 ppm; Cd < 2.5 ppm; Pb < 3.0 ppm; and Hg < 50 ppb.

Table 3.1.6 Critical Soil pH Levels for Different Crops

Crop	Lower Limit	Upper Limit
Coconut	5.0	8.0
Banana	5.2	7.0
Rice	4.5	7.5
Corn	3.0	8.0
Cassava	3.0	6.5
Sugarcane	4.0	8.0

Source: Philippine Council for Agricultural Research and Development

Table 3.1.7 Critical Soil Nutrient Levels (N, P, K) for Different Crops

Crop	N (%)	P (ppm)	K (ppm)
Coconut	0.05	5	234
Banana	0.1	7	780
Rice	0.1	10	156
Corn	0.1	9	75
Cassava	-	8	117
Sugarcane	0.1	20	150

Source: Philippine Council for Agricultural Research and Development

Table 3.1.8 Climatological Normals at Iba, Zambales

Station : 324 - Iba, Zambales
Coordinates : 15° 20' N, 119° 58' E
Period of Records : 1971-2000
Elevation : 4.7 m

Month	Rainfall (mm)	No. of Rainy Days	TEMPERATURE (°C)						R. H. (%)	Mean Sea Level Pressure (mbs)	Prevailing Wind		Cloud (okta)	Days with	
			Max	Min	Mean	Dry Bulb	Wet Bulb	Dew Point			Dir	Speed (m/s)		TSTM	LTNG
Jan	3.3	1	30.8	20.4	25.6	25.5	22.1	20.7	74	1012.4	NW	3	4	0	0
Feb	5.2	1	31.3	20.7	26	25.9	22.5	21.1	75	1012.4	NW	3	3	0	0
Mar	16	2	31.9	21.6	26.7	26.8	23.3	22	74	1011.8	E	3	3	1	2
Apr	31.6	4	33.1	23.2	28.2	28.5	24.6	23.2	73	1010.2	E	3	3	5	8
May	297.8	12	32.7	23.5	28.1	28.3	25.1	24	77	1008.8	E	3	5	14	19
Jun	489.2	18	31.4	23.3	27.4	27.5	25	24.1	82	1008.0	E	3	6	14	17
Jul	840	24	30.4	22.8	26.6	26.7	24.7	24	85	1007.5	E	3	6	15	17
Aug	1019.3	25	29.8	22.7	26.3	26.4	24.6	23.9	86	1007.5	E	3	7	13	14
Sep	544.7	21	30.5	22.8	26.7	26.6	24.7	24	86	1008.3	E	3	6	14	17
Oct	273.7	14	31.3	23.1	27.2	27.1	24.7	23.8	82	1008.8	E	3	5	8	15
Nov.	74.5	6	31.4	22.5	26.9	26.9	23.9	22.8	78	1010.2	E	3	4	2	6
Dec	14.9	3	31.1	21.5	26.3	26.1	22.9	21.6	76	1011.7	E	3	4	0	2
Annual	**3610.1**	**131**	**31.3**	**22.3**	**26.8**	**26.9**	**24**	**22.9**	**79**	**1009.8**	**E**	**3**	**5**	**86**	**117**

Notes: R.H. – relative humidity, Dir – direction, TSTM – thunderstorm, LTNG - lightning
Source : **PAGASA**

Table 3.1.9 Climatological Extremes at Iba, Zambales

Station : 324 - Iba, Zambales
Coordinates : 15° 20' N, 119° 58' E
Period of Records : 1971-2000
Elevation : 4.7 m

Month	TEMPERATURE (°C)				Greatest Daily Rainfall (mm)		HIGHEST WIND (m/s)			SEA LEVEL PRESSURE (mbs)			
	High	Date	Low	Date	Amount	Date	Speed	Direction	Date	High	Date	Low	Date
Jan	37.2	30-71	13	18-92	29.7	24-35	18/	NW	19-74	1020.9	14-55	1002.1	5-99
Feb	37.2	20-72	13	2-93	27	7-00	16/	E	11-74	1020.0	4-64	1004.2	7-00
Mar	38.5	27-73	11	8-93	87.1	17-49	16/	SE	27-94	1019.6	3-68	1001.3	6-99
Apr	38.8	22-73	16	5-93	72	30-99	24/	SW	20-78	1018.2	8-65	1001.5	21-56
May	38	11-93	15	31-92	543.4	23-76	41/	SW	22-78	1015.3	7-57	989.6	17-89
Jun	38.2	29-95	13	4-95	356.4	22-60	47/	SW	23-76	1015.6	6-66	980.9	29-64
Jul	38.6	2-95	14	21-92	325.4	20-92	36/	W	25-80	1014.5	7-53	992.7	13-65
Aug	35.7	27-69	14	26-92	437.7	31-70	29/	S	25-78	1014.6	22-53	980	29-59
Sep	35.6	24-72	12.3	10-78	623.7	21-35	30/	SW	16-77	1015.1	1-71	990	27-78
Oct	37	23-72	17.8	21-60	325.9	13-60	40/	SE	27-78	1017.4	30-61	983.8	11-89
Nov	38.3	7-72	15	30-92	291.4	14-77	31/	NNW	4-80	1018.4	24-57	981.2	4-67
Dec	38.1	20-71	15	7-92	138.5	4-36	18/	E	25-80	1019.7	10-67	996.6	14-64
Annual	38.8	4-22	11	3-8	623.7	9-21	47/	SW	6-23	1020.9	1-14	980	8-29
		1973		1993		1935			1976		1955		1959
Period of Record	1910-2000				1903-2000		1966-2000			1949-2000			

Source : PAGASA

Table 3.1.10 Ambient Air Quality Parameters

Parameter	Equipment	Averaging Time (h)	Laboratory Method of Analysis
TSP	High Volume Air Sampler	1	Gravimetric, USEPA 40 CFR, Part 50, Appendix B
PM_{10}	High Volume Air Sampler with 10 µm particle-size inlet	1	Gravimetric, USEPA 40 CFR, Part 50, Appendix J
SO_2	Gas Bubbler	1	Pararosaniline Method (West and Gaeke Method), USEPA 40 CFR, Part 50, Appendix A
NO_2	Gas Bubbler	1	Griess-Saltzman, USEPA 40 CFR, Part 50, Appendix F
CO	CO Monitoring Equipment	-	Non-dispersive Infra-red Spectrophotometry (NDIR), USEPA 40 CFR, Part 50, Appendix C
Pb	High Volume Air Sampler	1	Atomic Absorption Spectrophotometry, USEPA 40 CFR, Part 50, Appendix G

Table 3.1.11 Ambient Air Sampling Locations

Station Number	Location	
	Description	Coordinates
1	Bucao Bridge	N 15° 15.871', E 120° 02.210'
2	Malumboy Creek	N 15° 15.612', E 120° 10.299'
3	Maloma Bridge	N 15° 07.002', E 120° 03.744'
4	5km upstream of Maculcol Bridge	N 15° 01.311', E 120° 07.102'
5	Marella River	N 15° 00.174', E 120° 15.310'

Table 3.1.12 Ambient Air Monitoring Laboratory Results

Parameters	Concentration (µg/Ncm)					DENR Standard
Station	1	2	3	4	5	
TSP	6.8	3.4	4.5	9.1	15.7	300
PM_{10}	20.3	23.7	6.8	10.2	6.7	200
SO_2	3.1	1.6	1.1	3.4	BDL	340
NO_2	5.8	4.9	0.55	BDL	BDL	260
CO	BDL	BDL	5.9	0.70	BDL	35[1]
Pb	BDL	BDL	BDL	BDL	BDL	20[2]

[1]CO standard value is taken from Table 1 of DAO 2000-81 with averaging time of 1 hour.

[2]Pb standard value is taken from Table 3 of DAO 2000-81 with averaging time of 30 min.

BDL = Below Detection Limit: for SO_2 and NO_2< 0.11 µg/Ncm; CO < 0.10 µg/Ncm; Pb < 0.06 µg/Ncm

Table 3.1.13 Noise Level Measurement Results

Sampling Station ID	Noise Level (dbA)	Time of Sampling	Source(s)
1	**63.0**	3:43pm-3:45pm	Vehicles, gushing water
2	**67.3**	12:02pm-12:04pm	Wind
3	**67.3**	11:34am-11:36am	Vehicles, gushing water, wind, chirping birds, barking dogs
4	**40.4**	8:56am-8:58am	Chirping birds, wind
5	**48.9**	5:50pm-5:52pm	Chirping birds, wind, gushing water
DENR Standards[1]	50/60	Morning[2]	
	55/65	Daytime[3]	

[1]DENR standards for residential/commercial areas. Values in bold print exceed the standards.

[2]Morning Time: 5 am to 9 am

[3]Daytime: 9 am to 6 pm

Table 3.1.14 Groundwater Well Data in Zambales

Municipality	Specific Capacity (lps/m)		Well Depth (m)		SWL (mbgs)	
	average	range	average	range	average	range
Botolan	0.50	0.315-0.757	14.19	7.62-46.34	5.35	1.52-24.39
Cabangan	0.67	0.504-0.757	19.99	8.84-28.90	3.29	1.85-5.18
Castillejos	0.63	0.44-0.940	24.88	11.59-48.17	3.10	0.3-6.1
San Narciso	0.59	0.15-1.26	28.79	10.67-73.17	2.84	0.61-7.62

Table 3.1.15 Analytical Procedure Followed for Analysis of Parameters in Surface Water Samples

Parameter	Analytical Procedure
Inorganic	
Arsenic	AAS, Hydrite generation
Cadmium	ASV
Calcium	AAS
Chlorides	Titrimetric
Chromium (hexavalent)	Colorimetric
Copper	AAS
Cyanide	Ion-Selective
Fluoride	Colorimetric
Iron	AAS
Lead	ASV
Magnesium	AAS
Manganese	AAS
Mercury	AAS, Cold Vapor Technique
Nitrate	Colorimetric
Nitrite	Colorimetric
Ammonia	Titrimetric
Phosphorus	Colorimetric
Sulfate	Colorimetric
Zinc	AAS
Organic	
Phenols	Colorimetric
Others	
Conductivity	Conductivity meter (*in-situ*)
pH	pH meter (*in-situ*)
Temperature	Thermometer (*in-situ*)
BOD_5	Azide Modification
COD	Open reflux dichromate
Dissolved Oxygen	Azide Modification
Color	Visual Comparison

Table 3.1.16 Water Quality of Surface Waters within Mt. Pinatubo Watershed Area, May 2002(1/2)

Parameters	Unit	DENR Class C (Fishery Water/ Manufacturing)	DENR Class D (Agriculture/Irrigation)	Bucao River @ Malumbay	Bucao River @ H-Way Bridge	Maloma River	Mapanuep e Lake	Morela River	Pinatubo Crater Lake
Station Designation				***S-1***	***S-2***	***S-3***	***S-4***	***S-5***	***S-6***
Inorganic Constituents									
Arsenic	mg/L	0.05	0.01	0.0046	0.011	0.0011	0.00095	0.012	0.32
Cadmium	mg/L	0.01	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Calcium	mg/L	ns	-	160.6	178	12.3	113	272.1	137
Chloride	mg/L	350	350	13.5	43.4	1.1	3.9	68.2	1582
Chromium (VI)	mg/L	0.05	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Copper	mg/L	0.05	0.2	<0.04	0.07	<0.07	0.45	0.17	<0.04
Cyanide	mg/L	0.05	-	0.01	0.02	0.01	0.005	0.01	0.07
Fluoride	mg/L	ns	1	<0.5	<0.5	<0.5	<0.5	<0.5	1.13
Iron	mg/L	ns	5	0.83	1.71	0.52	0.09	19.4	0.55
Lead	mg/L	0.05	5	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Magnesium		ns	-	46.7	43.8	24.7	25.5	40.4	40.3
Manganese	mg/L	ns	0.2	0.3	0.09	0.34	4.02	2.1	1.32
Mercury	mg/L	0.002	0.002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nitrogen as Nitrite	mg/L	ns	-	0.095	0.27	<0.06	<0.06	0.58	<0.06
Nitrogen as Nitrate	mg/L	ns (10)	-	0.37	1.33	<0.09	<0.09	1.9	<0.09
Nitrogen as Ammonia	mg/L	ns	-	0.32	0.36	<.01	0.04	0.18	0.47
Phosphate	mg/L	0.4	-	13.6	11.3	8.6	4.5	15.2	11.7
Sulfate	mg/L	ns	-	131	262	357	121	246	746
Zinc	mg/L	ns	2	<0.02	0.05	<0.02	0.46	0.08	0.05
Organic Compound									
Phenols	mg/L	0.005	-	0.03	0.11	0.05	<0.02	0.18	0.10
Other Parameters									
pH			6-9	6.92	6.88	7.18	6.9	6.8	7.15
Temperature	^{o}C	$3^{o}C$ max rise	-	25	25	25	26	25.5	24
BOD_5	mg/L	7	10	14	35	16	33	17	11

Table 3.1.16 Water Quality of Surface Waters within Mt. Pinatubo Watershed Area, May 2002(2/2)

Parameters	Unit	DENR Class C (Fishery Water/ Manufacturing)	DENR Class D (Agriculture/Irrigation)	Bucao River @ Malumbay	Bucao River @ H-Way Bridge	Maloma River	Mapanuep e Lake	Morela River	Pinatubo Crater Lake
Station Designation				***S-1***	***S-2***	***S-3***	***S-4***	***S-5***	***S-6***
COD	mg/L	ns	-	31	51	38	51	58	77
Dissolved Oxygen	mg/L	5	3.0 min	7.4	6.9	5.9	7.6	8.6	6.9
Color	PtCo	no abnl discolor.	-	50	20	50	5	50	10
Conductivity	S/cm	ns	300	1476	1800	300	1000	2400	6667

Table 3.1.17 Water Quality of Surface Waters within Mt. Pinatubo Watershed Area, August 2002(1/2)

Parameters	Unit	DENR Class C (Fishery Water/ Manufacturing)	DENR Class D (Agriculture/Irrigation)	Bucao River @ Malumbay	Bucao River @ H-Way Bridge	Maloma River	Mapanuepe Lake	Morela River	Pinatubo Crater Lake
Station Designation				***S-1***	***S-2***	***S-3***	***S-4***	***S-5***	***S-6***
Inorganic Constituents									
Arsenic	mg/L	0.05	0.01	0.0097	0.033	0.0027	0.00055	0.034	0.39
Cadmium	mg/L	0.01	0.05	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Calcium	mg/L	ns	-	52	128.7	12.7	60	302	109
Chloride	mg/L	350	350	14.4	119	1.9	4.8	90.4	1532
Chromium (VI)	mg/L	0.05	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Copper	mg/L	0.05	0.2	0.24	0.21	0.16	0.72	0.67	<0.04
Cyanide	mg/L	0.05	-	<0.001	<0.001	<0.001	0.021	0.03	<0.001
Fluoride	mg/L	ns	1	<0.5	<0.5	<0.5	0.91	1.08	1.2
Iron	mg/L	ns	5	3.6	4.8	2.3	0.13	26.1	1
Lead	mg/L	0.05	5	<0.005	0.012	<0.005	<0.005	0.025	<0.005
Magnesium		ns	-	5.7	12.6	4.8	13.5	13	28.2
Manganese	mg/L	ns	0.2	0.36	0.67	0.02	2.1	1.05	1.35
Mercury	mg/L	0.002	0.002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nitrogen as Nitrite	mg/L	ns	-	<0.06	0.11	0.094	0.13	<0.06	0.06
Nitrogen as Nitrate	mg/L	ns (10)	-	14	97	23	1.2	73	46
Nitrogen as Ammonia	mg/L	ns	-	0.17	0.2	0.1	0.12	0.27	0.1
Phosphate	mg/L	0.4	-	11.1	11.7	11.5	8.7	13.3	15.2
Sulfate	mg/L	ns	-	62.6	459	47.3	222	800	363
Zinc	mg/L	ns	2	0.04	0.06	<0.02	0.28	0.17	<0.02
Organic Compound									
Phenols	mg/L	0.005	-	0.02	0.27	<0.02	<0.02	0.45	0.08
Other Parameters									
pH			6-9	7.3	7.2	7.16	6.5	6.9	6.6
Temperature	^oC	3^oC max rise	-	27	30	29	25	28.5	27.6
BOD_5	mg/L	7	10	5	10	6	10	8	6

Table 3.1.17 Water Quality of Surface Waters within Mt. Pinatubo Watershed Area, August 2002(2/2)

Parameters	Unit	DENR Class C (Fishery Water/ Manufacturing)	DENR Class D (Agriculture/Irrigation)	Bucao River @ Malumbay	Bucao River @ H-Way Bridge	Maloma River	Mapanuepe Lake	Morela River	Pinatubo Crater Lake
Station Designation				***S-1***	***S-2***	***S-3***	***S-4***	***S-5***	***S-6***
COD	mg/L	ns	-	21	49	63	21	53	21
Dissolved Oxygen	mg/L	5	3.0 min	7.8	8	8.3	9.2	6.9	7.5
Color	PtCo	no abnl discolor.	-	15	50	15	5	50	5
Conductivity	S/cm	ns	300	1200	1500	200	600	2500	6500

Table 3.1.18 Results of Water Quality Survey at Mapanuepe Lake and the Reservoir of Dizon Mine Tailing Dam (1/2)

Parameters	Unit	Sampling Location/Results										Standards	
		Dizon Mining Dam		Mapanuepe Lake									
		A. Reservoir Area		B. U/S near dam		C. Central area		D. D/S near channel		E. Inlet area			
		Surface	*Mid-depth*	*Surface*	*Mid-depth*	*Surface*	*Mid-depth*	*Surface*	*Mid-depth*	*Surface*	*Mid-depth*		
Total Water Depth during sampling		***14.9 meters***		***11.0 meters***		***14.0 meters***		***4.0 meters***		***13.0 meters***		**Class C**	**Class D**
pH	-	3.57	4.19	6.3	6.16	6.02	6.26	6.36	6.65	6.23	6.56	6.5-8.5	6.0-9.0
BOD_5	mg/l	1	1	3	2	1	1	6	1	3	2	7	10
COD	mg/l	9	9	9	9	12	8	16	16	12	16	none	none
Dissolve Oxygen	mg/l	8.4	8.3	8.2	7.7	8.4	8.1	8	7.3	7.3	8.1	5.0 (min)	3.0 (min)
Color	PCU	15	25	20	25	25	15	25	25	20	15	none	none
NO_2^- - N	mg/l	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	none	none
NO_3^- - N	mg/l	7.6	7.9	1.6	1.4	0.96	1	0.46	0.66	<0.40	<0.40	10	none
NO_4^- - N	mg/l	0.12	0.08	<0.01	0.04	0.01	0.01	0.05	<0.01	<0.01	0.01	none	none
Chlorides (Cl)	mg/l	1.4	1.4	6.1	6.8	6.8	6.4	7	7	6.2	6.4	350	350*
Cyanide (CN)	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	none
Mercury (Hg)	mg/l	0.26	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	0.42	<0.0004	<0.0004	<0.0004	0.002	0.002
Phosphorous (P)	mg/l	0.16	0.19	<0.16	0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	0.4	none
Sulfate (SO_4)	mg/l	130	138	80	75	80	81	92	96	74	79	none	none
Iron (Fe)	mg/l	579.9	617	0.14	0.32	0.16	0.1	0.11	0.13	0.09	0.05	none	5.0*
Manganese (Mn)	mg/l	880	880	361	341	331	310	310	320	268	259	none	0.2*

Table 3.1.18 Results of Water Quality Survey at Mapanuepe Lake and the Reservoir of Dizon Mine Tailing Dam (2/2)

Parameters	Unit	Sampling Location/Results										Standards	
		Dizon Mining Dam		Mapanuepe Lake									
		A. Reservoir Area		B. U/S near dam		C. Central area		D. D/S near channel		E. Inlet area			
		Surface	*Mid-depth*	*Surface*	*Mid-depth*	*Surface*	*Mid-depth*	*Surface*	*Mid-depth*	*Surface*	*Mid-depth*		
Total Water Depth during sampling		*14.9 meters*		*11.0 meters*		*14.0 meters*		*4.0 meters*		*13.0 meters*		Class C	Class D
Zinc (Zn)	mg/l	1.7	1.7	0.31	0.32	0.32	0.45	0.28	0.3	0.3	0.32	none	2.0*
Lead (Pb)	mg/l	0.06	0.06	0.11	0.07	0.1	0.14	0.14	0.12	0.15	0.15	0.05	5.0*
Chromium (Cr VI)	mg/l	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	0.05	none
Cadmium (Cd)	mg/l	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.01	0.05
Arsenic (As)	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	0.01
Flouride (Fl)	mg/l	0.95	1	0.6	0.54	0.52	0.72	0.8	0.5	0.53	0.5	none	none
Phenols	mg/l	<0.02	<0.02	<0.02	<0.02	<.02	<0.02	<0.02	<0.02	0.03	0.03	0.02	none
Calcium (Ca)	mg/l	64.2	61.2	63.8	63.4	63	63.8	87	84	62	62	none	none
Magnesium (Mg)	mg/ml	40.8	49	32	38	38	38	43	46	41	49	none	none
Copper (Cu)	mg/l	391.4	407	0.54	0.5	0.53	0.53	0.04	0.19	<0.04	<0.04	0.05	0.2*
EC	µS/cm	1120	1110	610	590	630	610	680	700	610	580	none	300*
Water Temperature	°C	26	26	21.5	21.5	26	22	27	27	26.5	26	-	-
Air Temperature	°C	31	31	31	31	29	29	31	31	31	31	-	-

Note: Standards are based on DENR Administrative Order #34 (Class C - intended uses are for Fishery, Recreation and Industrial; Class D - For Agriculture/ Irrigation)

* - Based on Guidelines for Interpretation of water quality for irrigation, Wastewater Engineering

Table 3.1.19 Analytical Procedure Followed for Analysis of Parameters in Marine Water Samples

Parameter	Analytical Procedure	Method Detection Limit (MDL)	Detection Limit for Reporting (MDLxDF[1])
pH	Glass electrode (25°C)	0.10	0.10
DO (mg/mL)	Titrimetry	-	-
COD (mg/mL)	Open Reflux	5.0	5.0
Total N (mg/mL)	Kjeldahl Method	0.03	0.03
Total P (mg/mL)	Colorimetry – Stannous Chloride	0.02	0.02
Total Coliform (MPN)	APHA 9221B	-	-

[1]DF – Dilution Factor = 1.0

Table 3.1.20 Marine Water Laboratory Results, June 2002

River	Sampling Locations	Layer	Parameters (units)					
			pH	DO (mg/l)	COD (mg/l)	Total N (mg/l)	Total P (mg/l)	Total Coliform (MPN/ 100 ml)
Bucao	1	Surface	8.1	6.4	193	BDL[a]	0.1	80
		Middle	8.1	6.7	217	BDL	BDL	22
	2	Surface	8.1	6.2	231	BDL	BDL	2
		Middle	8.1	6.2	217	BDL	BDL	14
	Average		8.1	6.4	215	BDL	BDL	30
Maloma	1	Surface	8.1	6.2	222	BDL	BDL	80
		Middle	8.1	6.4	207	BDL	BDL	17
	2	Surface	8.1	6.2	212	BDL	BDL	7
		Middle	8.1	7.1	227	BDL	BDL	7
	Average		8.1	6.5	217	BDL	BDL	28
Sto. Tomas	1	Surface	8.1	6.3	212	BDL	BDL	240
		Middle	8.1	7.8	169	BDL	BDL	≥1,600
	2	Surface	8.1	6.5	212	BDL	BDL	240
		Middle	8.1	7.3	174	BDL	BDL	5.16
	Average		8.1	7.0	192	-	-	162
DENR Std Class SC			6.0 - 8.5	5.0 min.	-	-	-	5,000

[a] BDL - Below Detection Limit: N < 0.03; P < 0.02

Table 3.1.21 Marine Water Laboratory Results, August 2002

River	Sampling Locations	Layer	Parameters (units)					
			pH	DO (mg/l)	COD (mg/l)	Total N (mg/l)	Total P (mg/l)	Total Coliform (MPN/ 100 ml)
Bucao	1	Surface	8.3	6.2	815	5.5	BDL	300
		Middle	8.3	8.2	141	157	BDL	1,600
	2	Surface	8.3	6.5	601	13	0.07	500
		Middle	8.3	6.5	451	23	0.03	**50,000**
	Average		8.3	6.9	502	50	-	13,100
Maloma	1	Surface	8.3	5.9	1180	179	BDL	**8,000**
		Middle	8.3	6.7	19	93	BDL	**30,000**
	2	Surface	8.3	6.2	751	192	BDL	**50,000**
		Middle	8.3	6.5	263	104	BDL	900
	Average		8.3	6.3	553	142	-	22,225
Sto. Tomas	1	Surface	8.3	6.4	432	194	0.04	**$\geq$ 1.6 x 10^5**
		Middle	8.3	7.8	56	239	BDL	2,400
	2	Surface	8.3	6.3	413	5.5	0.04	**13,000**
		Middle	8.3	6.9	432	5.5	BDL	**80,000**
	Average		8.3	6.9	333	111	-	-
DENR Std Class SC			6.0 - 8.5	5.0 min.	-	-	-	5,000

[a] BDL - Below Detection Limit: N < 0.03 mg/L; P < 0.02 mg/L

Table 3.1.22 Marine Water Laboratory Results, January 2003

River Mouth Area	Sampling Location ID	Parameters (units)					
		pH	DO (mg/L)	COD (mg/L)	Total N (mg/L)	Total P (mg/L)	Total Coliform (MPN/ 100 mL)
Bucao	1	8.2	7.5	3,900	3.1	BDL	BDL
	2	8.2	8.2	3,610	2.0	BDL	BDL
Maloma	3	8.1	8.5	3,710	2.4	BDL	**50,000**
	4	8.1	9.2	3,610	3.1	BDL	BDL
Sto. Tomas	5	8.2	7.2	3,900	7.2	BDL	**1,600,000**
	6	8.2	2.8	3,900	3.1	BDL	70
DENR Std Class SC		6.0 - 8.5	5.0 min.	-	-	-	5,000

[a] BDL - Below Detection Limit: P < 0.006 mg/mL; Total Coliform < 20 MPN/100 mL

Table 3.1.23 Results of River Sediment Analysis, January 2003

	Station							Dutch Intervention Values
River	**Bucao**		**Maloma**		**Sto. Tomas**			
Parameters	Downstream	Upstream	Downstream	Upstream	Downstream	Upstream	Lake	
Station Designation	***BSE1***	***BSE2***	***MSE1***	***MSE2***	***SSE1***	***SSE2***	***SSE3***	
Fertility Test								
pH	7.8	8.0	8.0	6.0	6.4	5.9	6.1	-
% Organic Matter	0.04	0.39	0.04	0.42	0.02	0.50	0.46	-
Nitrogen, N (%)	0.02	0.01	0.02	0.04	0.05	0.03	0.04	-
Potassium, K (ppm)	11.73	7.82	7.82	97.75	15.64	39.10	89.93	-
Phosphorus, P (ppm)	9	4	6	120	34	1	9	-
Metals								
Chromium, Cr^{+6} (ppm)	BDL*	BDL	BDL	BDL	BDL	BDL	BDL	380
Cadmium, Cd (ppm)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	12
Lead, Pb (ppm)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	530
Copper, Cu (ppm)	0.06	0.09	0.15	0.25	0.40	0.83	7.6	190
Mercury, Hg (ppb)	115	75	80	BDL	215	BDL	BDL	10,000
Zinc, Zn (ppm)	13	7.4	11	20	13	29	16	720
Particle Size Distribution, %								
Sand (0.05 - 2.0 mm)	97.5	95	97.5	62.2	97.4	22.3	41.1	-
Silt (0.05 - 0.002 mm)	2.5	5.0	2.5	32.7	0.0	40.1	50.9	-
Clay (< 0.002 mm)	0.0	0.0	0.0	5.0	2.6	37.6	8.0	-
Soil Texture	Sand	Sand	Sand	Sandy loam	Sand	Clay loam	Silt loam	-

*BDL = Below Detection Limit, the detection limits are: Cr^{+6} < 0.05 ppm; Cd < 2.5 ppm; Pb < 3.0 ppm; and Hg < 50 ppb.

Table 3.1.24 Results of Marine Sediment Analysis, June 2002

	Station						Dutch Intervention Values
River	**Bucao**		**Maloma**		**Sto. Tomas**		
Parameters							
Station Designation	***BS1***	***BS2***	***MS1***	***MS2***	***STS1***	***STS2***	
Fertility Test							
Organic Matter (ppm)	2400	501	697	601	200	100	-
Nitrogen, N (ppm)	340	170	120	140	180	300	-
Potassium, K (ppm)	BDL	BDL	BDL	BDL	BDL	BDL	-
Phosphorus, P (ppm)	4.8	37	42	14	230	14	-
Metals							
Chromium, Cr^{+6} (ppm)	BDL	24	BDL	8.7	BDL	9.9	380
Cadmium, Cd (ppm)	BDL	BDL	BDL	BDL	BDL	BDL	12
Lead, Pb (ppm)	BDL	4.8	BDL	BDL	BDL	4.9	530
Copper, Cu (ppm)	7.2	BDL	BDL	BDL	BDL	BDL	190
Mercury, Hg (ppb)	BDL	BDL	BDL	BDL	BDL	BDL	10,000
Zinc, Zn (ppm)	9.9	6.8	6.4	7.1	12	12	720

*BDL = Below Detection Limit, the detection limits are: Cr^{+6} < 0.05 ppm; Cd < 2.5 ppm; Pb < 3.0 ppm; and Hg < 50 ppb.

Table 3.1.25 Results of Marine Sediment Analysis, August 2002

	Station						Dutch Intervention Values
River	**Bucao**		**Maloma**		**Sto. Tomas**		
Parameters							
Station Designation	***BS1***	***BS2***	***MS1***	***MS2***	***STS1***	***STS2***	
Fertility Test							
Organic Matter (ppm)	1,240	1,420	288	671	582	871	-
Nitrogen, N (ppm)	118	87	104	192	175	159	-
Potassium, K (ppm)	358	763	100	BDL	175	210	-
Phosphorus, P (ppm)	BDL	2.5	BDL	BDL	BDL	BDL	-
Metals							
Chromium, Cr^{+6} (ppm)	0.15	0.19	0.37	0.11	BDL	BDL	380
Cadmium, Cd (ppm)	BDL	BDL	BDL	BDL	BDL	BDL	12
Lead, Pb (ppm)	BDL	4.7	BDL	BDL	BDL	BDL	530
Copper, Cu (ppm)	10	75	1.7	BDL	8.5	16	190
Mercury, Hg (ppb)	BDL	BDL	BDL	BDL	BDL	BDL	10,000
Zinc, Zn (ppm)	9.7	34	12	7.7	10	11	720

*BDL = Below Detection Limit, the detection limits are: Cr^{+6} < 0.05 ppm; Cd < 2.5 ppm; Pb < 3.0 ppm; and Hg < 50 ppb.

Table 3.1.26 Results of Marine Sediment Analysis, January 2003

	Station						Dutch Intervention Values
River	**Bucao**		**Maloma**		**Sto. Tomas**		
Parameters							
Station Designation	***BS1***	***BS2***	***MS1***	***MS2***	***STS1***	***STS2***	
Fertility Test							
Organic Matter (ppm)	608	1,410	1,120	534	1,240	1,000	-
Nitrogen, N (ppm)	217	268	87	173	139	48	-
Phosphorus, P (ppm)	BDL	BDL	BDL	BDL	BDL	BDL	-
Metals							
Chromium, Cr^{+6} (ppm)	BDL	BDL	BDL	BDL	BDL	BDL	380
Cadmium, Cd (ppm)	BDL	BDL	BDL	BDL	BDL	BDL	12
Lead, Pb (ppm)	BDL	BDL	BDL	BDL	BDL	BDL	530
Copper, Cu (ppm)	11	36	14	6.3	18	20	190
Mercury, Hg (ppb)	BDL	BDL	BDL	BDL	BDL	BDL	10,000
Zinc, Zn (ppm)	9.0	18	8.9	7.1	9.1	12	720

*BDL = Below Detection Limit, the detection limits are: P < 0.60 ppm; Cr^{+6} < 0.05 ppm; Cd < 1.0 ppm; Pb < 3.0 ppm; and Hg < 50 ppb.

Table 3.1.27 Results of the Contamination Analysis of Heavy Metals on Marine Fishes

Parameters River	Concentration			US EPA Screening Value for Recreational Fishers[1]	US EPA Screening Value for Subsistence Fishers[2]
	Bucao	Maloma	Sto. Tomas		
Sample ID	**BF**	**MF**	**STF**		
Chromium, Cr^{+6} (ppm)	BDL[2]	BDL	BDL	-	-
Cadmium, Cd (ppm)	BDL	BDL	BDL	4.0	0.491
Lead, Pb (ppm)	BDL	BDL	BDL	-	-
Copper, Cu (ppm)	BDL	0.39	0.26	-	-
Mercury, Hg (ppm)	BDL	BDL	BDL	0.4	0.049
Zinc, Zn (ppm)	BDL	0.86	0.25	-	-

[1]Based on fish consumption rate of 17.5 g/d, 70kg body weight. Source: US EPA Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 1: Fish Sampling and Analysis, 3rd ed.

[2]Based on fish consumption rate of 142.4 g/d, 70kg body weight. Source: US EPA Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 1: Fish Sampling and Analysis, 3rd ed.

[2]BDL = Below Detection Limit, the detection limits are: Cr^{+6} < 0.10 ppm; Cd < 0.125 ppm; Pb < 0.15 ppm; Cu < 0.05 ppm and Hg < 0.10 ppm.

Table 3.2.1 Mountain ranges that Serve as Headwaters of the Bucao River

Mountain Ranges	
1. Mt. Bunglo	5. Mt. Mankirat
2. Mt. Mulbao	6. Mt. Cahapatan
3. Mt. Lanitoc	7. Mt. Cawayen
4. Mt. Pera	8. Mt. Culianan

Table 3.2.2 Twelve Most Dominant Species in Balakibok Area

Species	Family	Importance Value (IV)
Dipterocarpus grandiflorus	Dipterocarpaceae	63
Ficus variegate	Moraceae	59
Shorea contorta	Dipterocarpaceae	56
Schizostachyum sp.	Graminae	54
Ficus nota	Moraceae	53
Schizostachyum lumampao	Graminae	52
Symphorema luzonicum	Verbenaceae	50
Dinochloa acutiflora	Graminae	45
Mikania cordata	Compositae	40
Mangifera altissima	Anacardiaceae	36
Dracontomelon edule	Anacardiaceae	34
Anisoptera thurifera	Dipterocarpaceae	31

Table 3.2.3 Listing of Common Plants in the Sto. Tomas River

Common Name	Scientific Name	Family Name
Agoho	*Casuarina equisitifolia*	Casuarinaceae
Kakuate	*Glericidia sepium*	Fabaceae
Ipil-ipil	*Leucaena leucocephala*	Fabaceae
Talahib	*Saccharum spontaneum*	Poaceae
Hagonoy	*Chromolaena odorata*	Compositae
Ouko	*Milcania cordata*	Asteraceae
Rain tree	*Samanea saman*	Fabaceae
Centrosema	*Centrosema pubescens*	Fabaceae
Calopogonium	*Calopogonium sp.*	Poaceae
Narra	*Pterocapus indicus*	Fabaceae
Auri	*Acacia auricoliformis*	Fabaceae
Bugawak	*Evodia confusa*	Rutaceae
Hauili	*Ficus septica*	Moraceae
Kawayan tinik	*Bambusa spinosa*	Poaceae
Kawayan killing	*Bambusa vulgaris*	Poaceae
Teak	*Tectona grandis*	Verbenaceae
Mango	*Mangifera indica*	Anacardiaceae
Akleng parang	*Albizia procera*	Fabaceae
Balinghasai	*Buchanania arborescens*	Anacardiaceae
Binayuyo	*Antidesma ghaesembi*	Euphorbiaceae
Olasiman	*Portulaca oleraceae*	Potulacaceae

Table 3.2.4 Listing of Plants in the Maloma River at Various Ecosystem Types (1/2)

Common Name	Scientific Name	Family Name
Plants along Streambanks and near River mouth		
Narra	*Pterocarpus indicus*	Fabaceae
Anabiong	*Trema orientalis*	Ulmaceae
Tan-ag	*Kleinhovia hospital*	Sterculiaceae
Mango	*Mangifera indica*	Anacardiaceae
Binayuyo	*Antidesma ghaesembi*	Euphorbiaceae
Kasoy	*Mischocarpus brachyphyllus*	Sapindaceae
Acacia	*Acacia auricoliformis*	Fabaceae
Lambayong	*Ipomea pes-caprae*	Convolvulaceae
Niog	*Cocos nucifera*	Arecaceae
Calopogonium	*Calopogonium pubescens*	Fabaceae
Makahiya	*Mimosa pudica*	Mimosaceae
Malapinggan	*Trichadenia philippinensis*	Flacourtiaceae
Kamachile	*Pithecellobium dulce*	Fabaceae
Guava	*Psidium guajava*	Myrtaceae
Takip-asin	*Macaranga grandifolia*	Euphorbiaceae
Hagonoy	*Chromolaena odorata*	Compositae
Sapinit	*Lantana camara*	Verbenaceae
Ipil-ipil	*Leucaena leucocephala*	Fabaceae
Kamias	*Averrhoa balimbi*	Oxalidaceae
Sampalok	*Tamarindus indica*	Fabaceae
Duhat	*Syzygium cuminii*	Myrtaceae
Saging	*Musa sp.*	Musaceae
Panicum	*Panicum maximum*	Poaceae
Mahogany	*Sweitenia macrophylla*	Meliaceae
Eucalyptus	*Eucalyptus deglupta*	Myrtaceae
Guyabano	*Annona muricata*	Annonaceae
Is-is	*Ficus ulmifolia*	Moraceae
Kawayan tinik	*Bambusa spinosa*	Poaceae
Tibig	*Ficus nota*	Moraceae
Talahib	*Saccharum spontaneum*	Poaceae
Bolon	*Alphonsea arborea*	Annonaceae
Kalios	*Streblus asper*	Moraceae
Lambang	*Aleurites moluccana*	Euphorbiaceae
Bangkal	*Nauclea orientalis*	Rubiacea
Ouko	*Mikania cordata*	Asteraceae
Plants inland of Maloma River along the banks		
Talahib	*Sacchaum spontaneum*	Poaceae
Banaba	*Lagerstroemia speciosa*	Lythraceae
Hamindang	*Macaranga grandifolia*	Euphorbiaceae
Kawayan kiling	*Bambusa vulgaris*	Poaceae
Hauili	*Ficus speciosa*	Moraceae
Anabiong	*Trema orientalis*	Ulmaceae
Kakauate	*Glericidia sepium*	Fabaceae
Rain tree	*Samanea saman*	Fabaceae
Duhat	*Syzygium cuminii*	Myrtaceae
Hagonoy	*Chromolaena odorata*	Compositae
Kalios	*Streblus asper*	Moraceae
Bakawan gubat	*Corallia brachiate*	Rhizophoraceae
Tambulain	*Eusideroxylon zwageri*	Lauraceae

Table 3.2.4 Listing of Plants in the Maloma River at Various Ecosystem Types (2/2)

Common Name	Scientific Name	Family Name
Small leaf malugai	*Pometia pinnata*	Sapindaceae
Amamali	*Leea aculeate*	Malvaceae
Mangkit	*Urena lobata*	Malvaceae
Bangkal	*Nauclea orientalis*	Rubiaceae
Uray	*Achyranthes sp.*	Amaranthaceae
Bulak manok	*Verninia cinera*	Compositae
Akleng parang	*Albizia procera*	Fabaceae
Balinghasai	*Buchania arborescens*	Anacardiaceae

Table 3.2.5 Listing of Plants in the Bucao River at Various Ecosystem Types (1/2)

Common Name	Scientific Name	Family Name
Plants in Riparian/Floodplain Ecosystem		
Talahib	*Sacchaum spontaneum*	Poaceae
Ouko	*Mikania cordata*	Asteraceae
Paragis	*Eleusine indica*	Poaceae
Ulasiman	*Portulaca oleraceae*	Portulaaacaceae
Cyperus	*Cyperus rotundus*	Cyperaceae
Guinea grass	*Panicum maximum*	Poaceae
Baho-baho	*Verninia cinera*	Compositae
Uray	*Achyranthes sp.*	Amaranthaceae
Cat tail	*Typha angustifolia*	Typhaceae
Pickered weed	*Monochoria vaginalis*	Pontaderiaceae
Ubod-ubod	*Cyperus difformis*	Cyperaceae
Water lettuce	*Pistia stratiotes*	Araceae
Water primrose	*Ludwigia adscendens*	Compositae
Plants in Streambank/Hillside Areas		
Agoho	*Casuarina equisitifolia*	Casuarinacea
Misamis grass	*Capillepedium parviflorum*	Poaceae
Banaba	*Lagerstroemia speciosa*	Lythraceae
Bani	*Pongamia pinnata*	Fabaceae
Anonang	*Cordia dichotoma*	Ehretiaceae
Balinghasai	*Buchania arborescens*	Anacardiaceae
Binayuyo	*Antidesma ghaesembilla*	Euphorbiaceae
Bayag usa	*Voacanga globosa*	Apocynaceae
Pandakaki	*Ervatamia pandacaqui*	Apocynaceae
Sapinit	*Lantana camara*	Verbenaceae
Calabash	*Crescentia cujete*	Bignoniaceae
Hagonoy	*Chromolaena odorata*	Compositae
Buslot	*Syzygium linnatum*	Myrtaceae
Lingo-lingo	*Vitex tuczaninowii*	Verbenaceae
Raintree	*Samanea saman*	Fabaceae
Batino	*Alstonia macrophylla*	Apocynaceae
Bayok	*Pterospermum diversifolium*	Sterculiaceae
Anabiong	*Trema orientalis*	Ulmaceae
Banaba	*Lagerstroemia speciosa*	Lythraceae
Kawad kawad	*Apluda mutica*	Poaceae
Kakauate	*Glericidia sepium*	Fabaceae
Ipil-ipil	*Leucaena leucocephala*	Fabaceae
Dikit	*Desmodium gangeticum*	Fabaceae
Suag kabayo	*Hyptis suaviolema*	Lamiaceae
Centrosema	*Centrosema pubescens*	Fabaceae
Is-is	*Ficus ulmifolia*	Moraceae
Duhat	*Syzygium cuminii*	Myrtaceae
Devil's tongue	*Amorphophallus revieri*	Araceae
Cogon	*Imperata cylindrica*	Poaceae
Palis	*Callicarpa eriocioma*	Euphorbiaceae
Paguringon	*Cratoxylym celebicum*	Guttiferae
Kahoy dalaga	*Mussaenda philippica*	Rubiaceae
Kalios	*Streblus asper*	Moraceae

Table 3.2.5 Listing of Plants in the Bucao River at Various Ecosystem Types (2/2)

Common Name	Scientific Name	Family Name
Katong matsing	*Chisocheton pentandrus*	Meliaceae
Pahutan	*Mangifera altissima*	Anacardiaceae
Tambalian	*Eusideroxylon zwageri*	Lauraceae
Kawayan tinik	*Bambusa speciosa*	Poaceae
Kasoy	*Anacardium occidentale*	Anacardiaceae
Lamog	*Planchonia spectabilis*	Lecythidaceae
Gmelina	*Gmelina arborea*	Verbenaceae
Acacia	*Acacia auricoliformis*	Fabaceae
Bugawak	*Evodia confusa*	Rutaceae
Plants in Coastal Areas		
Umbrella tree	*Terminalia cattapa*	Combretaceae
Agoho	*Casuarina equisitifolia*	Casuarinacea
Talahib	*Sacchaum spontaneum*	Poaceae
Pandan dagat	*Pandanus tinctorium*	Pandanaceae
Alagao dagat	*Premna odorata*	Verbenaceae
Noni	*Morinda citrifolia*	Rubiaceae

Table 3.2.6 Listing of Plants around the Mt. Pinatubo Crater Lake

Common Name	Scientific Name	Family Name
Anabiong	*Trema orientalis*	Ulmaceae
Talahib	*Saccharum spontaneum*	Poaceaea
Pako buwaya	*Pteridium aquilimum*	Pennstaedtiaceae
Fimbristylis	*Fimbristylis dichotoma*	Cyperaceae
Tiger grass	*Phragmites karka*	Poaceae
Commelina	*Commelina sp.*	Commelinaceae
Scirpus	*Scirpus sp.*	Cyperaceae
Lygodium	*Lygodium sp.*	Schizaeaceae
Bolohan	*Malandra fasciata*	Malvaceae
Is-is	*Ficus ulmifolia*	Moraceae
Moss spp.		

Table 3..2.7 Common Wildlife Species in Terrestrial Landscapes of the Sto. Tomas, Bucao and Maloma Rivers

Common Name	Scientific Name	Status	Occurrence
Hanging parakeet	*Loriculus philippinensis var. regulus*	Resident	Common
Fantail	*Rhipidura cyaniceps*	Resident	Common
House swifts	*Apus affinis*	Resident	Common
Brush cuckoo	*Cacomanthis merulinus*	Resident	Common
Common Quail	*Coturnix chinensis*	Resident	Common
Wild chicken	*Gallus gallus*	Resident	Common
Phil. Deer	*Cervus marianus*	Endemic	Common
Wild pig	*Sus celebensis var. philippinensis*	Resident	Common
Monitor lizard	*Varanus salvador*	Resident	Common
Phil. Python	*Python reticulatus*	Resident	Common
Vine snake	*Dryophis presinus*	Resident	Common
River king fisher	*Alcedo atthis*	Resident	Common
Monkey	*Macaca fascicularis*	Resident	Common
Ricefield rat	*Rattus mindanensis*	Resident	Common
Civet cat	*Viverra tangalunga*	Resident	Common
Phil. Bulbul	*Hypsipetes philippinus*	Endemic	Common
Tailor bird	*Orthotomus derbianus*	Resident	Common
Pond turtle	*Coura amboinensis*	Resident	Common
Phil. Geckoo	*Cyrodactylus philippinicus*	Resident	Common

Table 3.2.8 Phytoplankton Density (Organisms x 10^6) Observed in Samples Collected from Rivers in Western Zambales, December 2002.

General	Bucao			Maloma	Sto. Tomas
	Downstream	Creek	Upstream		
Div. Chlorophyta	**88**	**113**	**100**	**125**	**225**
	21.2	**64.3**	**29.6**	**83.3**	**34.0**
Chlamydomonas	12.5	12.5	25.0	12.5	37.5
Coelastrum	-	12.5	-	12.5	-
Hyalotheca	25.0	-	-	62.5	50.0
Scenedesmus	-	-	-	12.5	-
Schroederia	-	-	-	-	12.5
Selenastrum	-	-	-	-	12.5
Staurastrum	-	12.5	-	-	-
Tetraedron	-	37.5	62.5	12.5	112.5
Trochiscia	50.0	37.5	12.5	12.5	-
Div. Euglenophyta	**12.5**	**-**	**25.0**	**-**	**37.5**
	3.0	**-**	**7.4**	**-**	**5.7**
Lepocynclis	-	-	-	-	12.5
Trachelomonas	12.5	-	25.0	-	25.0
Div. Bacillariophyta	**312.5**	**62.5**	**212.5**	**25.0**	**400.0**
	75.8	**35.7**	**63.0**	**16.7**	**60.4**
Achmanthes	-	12.5	-	25.0	25.0
Cocconeis	12.5	-	-	-	-
Cyclotella	-	-	-	-	25.0
Cymbella	-	-	25.0	-	37.5
Gomphonema	12.5	-	12.5	-	25.0
Hantzschia	87.5	12.5	50.0	-	37.5
Melosira	-	-	-	-	12.5
Navicula	25.0	25.0	25.0	-	37.5
Nitzschia	75.0	12.5	62.5	-	125.0
Pinnularia	-	-	-	-	12.5
Rhoicosphenia	12.5	-	-	-	12.5
Rhopalodia	12.5	-	-	-	25.0
Surirella	75.0	-	37.5	-	25.0
Total	**412.5**	**175.0**	**337.5**	**150.0**	**662.5**

Note that there are no phytoplanktons observed in the samples collected from Marella River.

Table 3.2.9 Zooplankton Density (Organisms x 10^3) Observed in Samples Collected from Rivers in Western Zambales, December 2002.

General	Bucao			Maloma
	Downstream	Creek	Upstream	
	17788	4808	-	24519
Asplanchna	3846	-	-	9615
Colurella	2404	-	-	2404
Keratella	2404	-	-	-
Lecane	6250	2404	-	2404
Monostyla	1442	2404	-	8654
Mytilina	-	-	-	1442
Philodina	1442	-	-	-
	1442	**2404**	**2404**	**2404**
Arachnida	1442	-	-	-
Crustacean nauplii	-	2404	2404	2404
	-	-	-	**4808**
Gastropoda	-	-	-	4808
	19231	**7212**	**2404**	**31731**

Note that there are no zooplanktons were observed in the samples collected from Sto. Tomas and Marella Rivers.

Table 3.2.10 Benthic Macroinvertebrate Density (Organisms per m^2) Observed in Sediment Samples Collected from Three Rivers in Western Zambales and the Coastal Areas Facing the River Mouths, December 2002

Taxon	River			Coastal Area	
	Bucao Creek	Baquilan	Maloma	Station 3	Station 5
Phylum Arthropoda					
Order Diptera	1500	900	1600	-	-
Order Ephemeroptera	-	-	450	-	-
Phylum Annelida					
Class Polychaeta	-	-	-	50	150
Class Oligochaeta	50	-	-	-	-
Phylum Mollusca					
Class Gastropoda	150	300	250	-	-
Total	1700	1200	2300	50	150

Table 3.2.11 Fish Present in the Three Major Western Rivers

River	Family	Genus	Common Name	Local Name
Bucao River				
*	Anguillidae	*Anguilla*	Freshwater Eel	Palos
*	Ophicephalidae	*Ophicephalus*	Snake-head	Dalag
*	Clariidae	*Clarias*	Air breathing Catfish	Hito
*	Cichlidae	*Oreochromis*	Cichlid	Tilapia
*	Gobiidae	*Glossogobius*	Goby	Biya
Maloma River				
*	Anguillidae	*Anguilla*	Freshwater Eel	Palos
	Ophicephalidae	*Ophicephalus*	Snake-head	Dalag
*	Channidae	*Chanos*	Milkfish fingerling	kawag-kawag
	Cichlidae	*Oreochromis*	Cichlid	Tilapia
*	Scatophagidae	*Scatophagus*	Spotted scat	Kitang
*	Mugilidae		Mullet	Banak
	Gobiidae	*Glossogobius*	Goby	Biya
			Fish	Luka-ok
			Clam	paros
Sto. Tomas River				
*	Anguillidae	*Anguilla*	Freshwater Eel	Palos
	Ophicephalidae	*Ophicephalus*	Snake-head	Dalag
	Cyprinidae	*Cyprinus*	Carp	Carpa
	Clariidae	*Clarias*	Air breathing Catfish	Hito
	Cichlidae	*Oreochromis*	Cichlid	Tilapia
	Gobiidae	*Glossogobius*	Goby	Biya
			Snail	kuhol
			Snail	suso

*Lost after the eruption of Mt. Pinatubo in 1991

Table 3.3.1 Land Area and Population Density by Town

Town	Land area (km^2)	Population	Population density
1. Botolan	613.70	47,751	77.8
2. San Felipe	103.70	17,360	58.2
3. San Narciso	71.60	23,799	332.4
4. San Marcelino	440.90	25,640	167.4

Source: a) Zambales PPDO; b) Municipal IRAF 2001; Population Density =Population/Land area

Table 3.3.2 Population Growth Rate and Population Density

Town	Land area (km^2)	Population (2001)	Population density (2001)	Growth rate	Population density after 10 years (yr 2010)	Population after 10 years (2010)
Botolan	613.70	47,751	77.8	2.76	99.40	21,005
San Felipe	103.70	17,360	167.4	1.22	179.64	19,346
San Narciso	71.60	23,799	332.3	1.81	390.55	27,964
San Marcelino	440.90	25,640	58.1	3.86	81.75	36,047

Table 3.3.3 Botolan Socio-Economic Profile

Municipality: **Botolan, Zambales**

Total Population: 47,751

Households sources of income

Farming: 4,854 households 46.97%

Vending: 712 households 6.89%

Self-Employed: 397 households 3.67%

Barangay	Population	Male	Female	Households
1. Bangcal	910	451	459	194
2. Bangan	1,586	789	797	420
3. Baton Lapoc	1,170	582	588	263
4. Belbel	729	377	452	148
5. Beneg	1,414	712	702	274
6. Binuclotan	958	459	499	221
7. Burgos	591	299	292	142
8. Cabatuan	662	339	323	162
9. Capayawan	820	401	419	183
10. Carael	1,723	868	855	394
11. Danacbunga	2,306	922	1,384	530
12. Maguisguis	1,437	728	709	306
13. Malomboy	3,598	1,752	1,846	816
14. Mambog	2,254	1,118	1,136	524
15. Moraza	612	330	282	175
16. Nacolcol	377	213	164	88
17. Owaog-Nebloc	283	138	145	78
18. Paco	2,298	1,113	1,185	478
19. Palis	338	120	218	97
20. Panan	2,037	1,112	925	436
21. Parel	816	345	471	190
22. Paudpod	558	291	267	117
23. Poonbato	2,487	1.326	1,161	666
24. Porac	2,034	1.058	976	402
25. San Isidro	1,152	593	559	215
26. San Juan	2,530	1,710	820	518
27. San Miguel	997	500	497	241
28. Santiago	1,666	823	843	361
29. Tampo	1,173	529	644	290
30. Taugtog	6,257	3,103	3,154	1,781
31. Villar	1,977	967	1,010	386
Total	**47,750**	**21,686**	**23,782**	**11,096**

Source: Integrated Rural Accessibility Planning Information System Accessibility Data 2001 Botolan, Zambales

Table 3.3.4 San Felipe Socio-Economic Profile

Municipality: **San Felipe, Zambales**

Total Population: 18,867

Households sources of income:

Farming: 3,719 households or 58.83%

Employment: 1,089 households or 17.23%

Construction works: 316 households or 7%

Barangay	Population	Male	Female	Households
1. Amagna	1,285	626	659	290
2. Apostol	1,594	778	816	333
3. Balincaguing	720	368	352	153
4. Faranal	1,690	851	839	382
5. Feria	1,126	535	591	289
6. Maloma	3,977	1,992	1,985	962
7. Manglicmot	1,219	575	643	251
8. Rosete	1,173	579	594	280
9. San Rafael	935	481	454	206
10. Sto. Nino	3,641	720	787	767
11. Sindol	1,507	1,838	1,803	324
Total	**18,867**	**9,343**	**9,523**	**4,237**

Source: Integrated Rural Accessibility Planning Information System Accessibility Data 2001 San Felipe, Zambales

Table 3.3.5 San Marcelino Socio-Economic Profile

Municipality: **San Marcelino, Zambales**

Total Population: 25,640

Households sources of income:

Farming: 3,719 households 58.83%

Employment: 1,087 households 17.23%

Construction works: 316 households 5.01%

Barangay	Population	Male	Female	Households
1. Aglao	2,365	1,061	1,304	672
2. Buhawen	2,424	1,237	1,287	533
3. Burgos	1,903	1,009	894	417
4. Central	681	339	342	167
5. Consuelo Norte	1,292	607	685	299
6. Consuelo Sur	1,247	661	586	298
7. La Paz	1,019	538	481	255
8. Laoag	1,820	874	946	419
9. Linasin	2,011	1,046	965	484
10. Linusungan	1,247	649	598	290
11. Lucero	1,387	723	664	375
12. Nagbunga	1,036	503	533	242
13. Rabanes	707	368	339	215
14. Rizal	807	420	387	177
15. San Guillermo	786	377	409	193
16. San Isidro	1,416	723	693	505
17. San Rafael	1,523	792	731	329
18. Santa Fe	1,969	1,025	944	452
Total	**25,640**	**12,952**	**12,788**	**6,322**

Source: Integrated Rural Accessibility Planning Information System Accessibility Data 2001 San Marcelino, Zambales

Table 3.3.6 San Narciso Socio-Economic Profile

Municipality: **San Narciso, Zambales**

Total Population: 23,799

Households sources of income:

Farming: 2,128 households or 37.46%

Laborer: 608 households or 10.70%

Employment: 522 households 9.19%

Barangay	Population	Male	Female	Households
1. Alusiis	1,204	603	601	270
2. Beddeng	2,477	1,266	1,211	544
3. Candelaria	870	407	453	191
4. Dalipawen	733	387	346	175
5. Grullo	1,609	767	842	379
6. La Paz	3,764	1,861	1,903	800
7. Libertad	631	293	338	181
8. Namatacan	1,446	749	697	382
9. Natividad	1,375	690	685	385
10. Omaya	757	369	388	159
11. Paite	367	198	169	88
12. Patrocino	2,114	1,066	1,048	491
13. San Jose	563	277	286	142
14. San Juan	1,237	642	595	288
15. San Pascual	1,853	936	917	552
16. San Rafael	1,387	674	713	318
17. Simminublan	1,412	711	701	379
Total	**23,799**	**11,896**	**11,893**	**5,724**

Source: Integrated Rural Accessibility Planning Information System Accessibility Data 2001 San Naciso, Zambales

Table 3.3.7 Relocation Site Preferred by the Local Government

Town	Relocation area
Botolan	a) Baquilan Resettlement site b) Boun Lawak
San Marcelino	c) Provincial land adjacent to San Rafael d) Barangay Macarang

Source: MPDO Gilbert Villena, San Marcelino,Zambales; MPDO Arthur Delos Reyes, Botolan Zambales February 4, 2003

Table 3.3.8 Aeta Community along the Sto. Tomas River and Marella River

Barangay	Sitio	Household	Individuals
San Rafael	Palayan	27	63
	Lawin	26	59
	Itanglew	126	400
Santa Fe	Baliwet	98	334
	Banaba	29	123
	Buag	25	104
	Bacsil	15	53
Aglao	Paw-en	70	244
	Ibad	47	150
	Cuartel	43	138
	Kahapa	34	118
	Total	**540**	**1,786**

Source: NCIP San Marcelino service center 2002 records c/o Larvin Villanueva

Table 3.3.9 Aeta Community along the Maraunot and Bucao Rivers

Barangay	Households	Individuals
Villar	19	95
Moraza	55	275
Nacolcol	110	550
Maguisguis	75	375
Poon bato	196	930
Palis	34	170
Belbel	36	180
Owaog	38	190
Burgos	45	225
Cabatuan	82	410
Total	**690**	**3,400**

Source: NCIP Botolan and Cabangan service center 2002 records c/o Myrna Encinares

Table 3.3.10 Barangays with Number of Affected Households as of the end of January 2003

Town	Barangay	Households
BOTOLAN	San Juan	10
	Carael	1
	Porac	18
SAN MARCELINO	San Rafael	38
	Rabanes	1
SAN NARCISO	Paite	10
	San Pascual	4
	Alusiis	6
SAN FELIPE	Manglicmot	1
Total		**89**

Table 3.3.11 Profile of Respondents According to Age

Age Bracket	Frequency	Percentage
18 to 20	2	2.27
21 to 30	17	18.18
31 to 40	30	34.09
41 to 50	14	15.91
51 to 60	5	5.68
61 and above	21	23.86
Total	**89**	**99.99**

Table 3.3.12 Profile of Respondents According to Gender

Gender	Frequency	Percentage
Male	81	90.91
Female	8	9.09
Total	**89**	**100.00**

Table 3.3.13 Profile of Respondents According to Highest Educational Attainment

Educational Attainment	Frequency	Percentage
No formal schooling	19	21
Elementary Undergraduate	4	4.5
Elementary Graduate	27	30.68
High School Undergraduate	4	4.55
High School Graduate	18	20.45
College Undergraduate	6	6.8
College Graduate	11	11.36
Total	**89**	**100.00**

Table 3.3.14 Profile of Respondents According to Livelihood

Livelihood	Frequency	Percentage
Agriculture	36	40.4
Small Entrepreneurs	5	5.6
Construction Work	8	8.9
Cottage Industry	5	5.6
Service Oriented Jobs	12	13.5
Social Security	6	6.7
Elected Office	1	1.1
Regular Employment (private)	6	6.7
Unemployed	10	11.2
Total	**89**	**100.0**

Table 3.3.15 Profile of Respondents According to Monthly Income Range

Monthly Income Range	Frequency	Percentage
Below PhP 300 to PhP 300	8	9
PhP 301 to PhP 600	7	8
PhP 601 to PhP 900	3	3
PhP 901 to PhP 1,200	8	9
PhP 1,201 to PhP 1,800	2	2
PhP 1,801 to PhP 2,100	8	9
PhP 2,101 to PhP 2,400	1	1
PhP 2,401 to PhP 3,000	16	18
PhP 3,001 and above	36	40
Total	**89**	**100**

Table 3.3.16 Vital Statistics, Daily Cost of Living for a Family of Six

(As of April 2002, in peso)

Area	**Daily Cost of Living**		
Year	2002	2001	2000
Philippines	434.67	419.70	414.45
NCR	530.01	505.17	495.43
Areas Outside Metro Manila			
Agricultural	395.63	383.74	380.22
Non-Agri	416.25	403.74	400.04

Source of Basic Data: IBON Foundation, Inc. , National Wage Commission, NSO

Table 3.3.17 Problems as Identified by the Respondents

Problems	Frequency	Percentage
Lahar Related		
Irritating Dust	7	8
Flooding	6	7
Scoured/Very rough roads	3	3
Deterioration of protective dike	1	1
Economic		
Lack of livelihood opportunities	40	45
Unemployment	40	44
Lack of irrigation facilities	12	13
No farmland	2	2
No farm animal	1	1
No market for products	1	1
Social		
Lack of source of potable water	24	27
Food shortage	13	15
Lack of medicines	7	8
No electricity	7	8
Poor peace and order situation	3	3
Drug addiction	2	2
High price of commodities	1	1
Lack of education	1	1

Table 3.3.18 Illness Experienced by the Respondents and their Household

Illness	Frequency	Percentage
Flu	41	17.4
Malaria	38	16.1
Cough	36	15.3
Fever	34	14.4
Colds	29	12.3
Diarrhea	29	12.3
Arthritis	6	2.5
Headache	5	2.1
Asthma	5	2.1
Skin Allergy	3	1.3
High Blood Pressure	3	1.3
Tuberculosis	1	0.4
Chicken Pox	1	0.4
Ulcer	1	0.4
Parasitism	1	0.4
Cyst	1	0.4
Stomach ache	1	0.4
Stroke	1	0.4

Table 3.3.19 Source of Electricity

Source	Frequency	Percentage
Kerosene	50	56
Local Power Grid	35	39
Automobile Battery	4	5
Total	**89**	**100**

Table 3.3.20 Land Ownership

Ownership	Frequency	Percentage
Owned	20	22.5
Government	41	46.1
Leased	22	24.7
No answer	6	6.7
Total	**89**	**100.0**

Table 3.3.21 Lot Area (in square meters)

Lot Area	Frequency	Percentage
Less than 100 to 300	46	51.7
More than 300 to 600	7	7.9
More than 600 to 900	5	5.6
More than 900 to 1,200	3	3.4
More than 1,200 to 1,500	3	3.4
More than 1,500 to 2,400	1	1.1
More than 2,400 to 3,000	1	1.1
More than 3,000 and above	22	24.7
No answer	1	1.1
Total	**88**	**100.0**

Table 3.3.22 Size of Affected Lot (in square meters)

Affected Area	Frequency	Percentage
Less than 300 to 300	53	59.6
More than 300 to 600	6	6.7
More than 600 to 900	4	4.5
More than 900 to 1,200	7	7.9
More than 1,200 to 1,800	3	3.4
More than 1,800 to 2,400	1	1.1
More than 2,400 to 3,000	1	1.1
More than 3,000 and above	14	15.7
Total	**88**	**100.0**

Table 3.3.23 Other Owned Land Outside of the Project Area

Other Land?	Frequency	Percentage
Yes	12	13.5
No	57	64.0
No Answer	20	22.5
Total	**89**	**100.0**

Table 3.3.24 Size of House (in square feet)

Floor Area	Frequency	Percentage
Less than 300 to 300	68	76.4
More than 300 to 600	16	18.0
More than 600 to 900	1	1.1
More than 900 to 1,200	3	3.4
More than 1,200 to 1,500	1	1.1
Total	**89**	**100.0**

Table 3.3.25 Size of House to be Affected (in square feet)

Affected Floor Area	Frequency	Percentage
Less than 300 to 300	72	80.9
More than 300 to 600	12	13.5
More than 600 to 900	1	1.1
More than 900 to 1,200	3	3.4
More than 1,200 to 1,500	1	1.1
Total	**88**	**100.0**

Table 3.3.26 House Age

Number of Years	Frequency	Percentage
Less than 1 to 5 years	67	75.3
More than 5 to 12 years	9	10.1
More than 12 to 20 years	6	6.7
More than 20 years and above	1	1.1
No answer	6	6.7
Total	**88**	**99.9**

Table 3.3.27 House Ownership

Owner	Frequency	Percentage
Respondent	80	89.9
Leased	1	1.1
Free Occupancy	2	2.2
No Answer	6	6.7
Total	**89**	**99.9**

Table 3.3.28 Type of House

Type	Frequency	Percentage
Single-story house	84	94.4
No Answer	5	5.6
Total	**89**	**100.0**

Table 3.3.29 Number of Rooms

Rooms	Frequency	Percentage
None	29	32.6
One Room	34	38.2
Two Rooms	20	22.5
Three Rooms and above	5	5.6
No Answer	1	1.1
Total	**89**	**100.0**

Table 3.3.30 Roof, Wall and Floor Materials

Materials	Roof	%	Wall	%	Floor	%
Steel Trusses	2	2.2				
GI Sheets	43	47.3	4	3.6		
Cogon	41	45.1	21	19.1		
Sawali	1	1.1				
Nipa	3	3.3				
Tent	1	1.1				
Concrete			29	26.4	28	34.6
Wood			17	15.5	6	7.4
Buho			32	29.1	1	1.2
Bamboo			7	6.4	8	9.9
Soil					38	46.9

Table 3.3.31 House Value (in pesos)

Value	Frequency	Percentage
Less than 500 to 5,000	41	46.1
More than 5,000 to 10,000	10	11.2
More than 10,000 to 15,000	1	1.1
More than 15,000 to 20,000	4	4.5
More than 20,000 to 25,000	2	2.2
More than 25,000 to 40,000	4	4.5
More than 40,000 to 50,000	7	7.9
More than 50,000 and above	19	21.3
No Answer	1	1.1
Total	**89**	**99.9**

Table 3.3.32 Kind of Property

Property	Frequency	Percentage
Land	88	28.8
Store	6	2.0
House	72	23.5
Rest House	18	5.9
Comfort Room	8	2.6
Pigpen	6	2.0
Stockroom	2	0.7
Trees	45	14.7
Fishpond	9	2.9
Deep Well	4	1.3
Crops	33	10.8
Restaurant/Business Establishment	1	0.3
Dug Well	1	0.3
Kitchen	3	1.0
Videoke Bar	1	0.3
Fence	1	0.3

Table 3.3.33 Identified Projects to Uplift Current Living Conditions

Projects	Frequency	Percentage
Farm Input Support (seed dispersal, fertilizer provision)	30	35.7
Sari-sari store	1	1.2
Capital lending	13	15.5
Farm Equipment Provision	6	7.1
Animal Dispersal Program	12	14.3
Potable water supply system	4	4.8
Medical Supplies and Facilities	1	1.2
Marketing assistance	2	2.4
Literacy program	1	1.2
Electricity	2	2.4
Livelihood programs	5	6.0
Street lighting/ paved roads	6	7.1
Provision of fishing equipment	1	1.2

Table 3.3.34 Acceptance of the Project

Do you accept the project?	Frequency	Percentage
Yes	86	96.6
No	3	3.4
Total	**89**	**100.0**

Table 3.3.35 Reasons of Respondents who found the Project Acceptable

Reasons	Frequency	Percentage
Raise income	18	46.1
Protect land and property	27	11.2
Save lives	27	1.1
Generally lessen problems	3	4.5
Improve marketing infrastructure	1	2.2
Improve the existing dike	2	4.5
As long as they will not remove us from our place	2	7.9
As long us they would pay the existing market values of our land and property	4	21.3
Will benefit the majority	2	1.1
Total	**86**	**99.9**

Table 5.2.1 Summary Matrix of Potential Geo-hazards to Structures (Dams / Dikes)

Hazard	Potential	Adverse Factors	Potential Impacts	Possible Mitigation Measures
Differential Settling	Moderate - high	- underlying soft , loose sediments/soil - shallow water table - water saturation of sediments/soil - abrupt variations in load bearing capacity of underlying material	- fissuring / cracking of concrete finish - subsidence of structure - possible failure of portions of the dike	- ground preparation (compaction)
Intense Ground Shaking	Moderate	- proximity to active earthquake generator - magnitude of earthquake - poor ground conditions	- damage to, or collapse of structures	- ground preparation - use of proper design and construction materials
Liquefaction	Moderate Low	- intense ground shaking - shallow water table - thick, loose, fine grained, well sorted, water saturated underlying material	- subsidence of structures - possible collapse of structure	- ground preparations - foundation depth to consolidated material - floating foundations
Lahars	High	- availability of large amounts of loose debris - intense and prolonged rainfall - sudden release of impounded water (e.g. dam breaching)	- burial of structures - erosion and possible failure of structures - in-channel aggradations can cause piping in the structures	- appropriate design and location
Flooding and Erosion	High	- high rainfall - high concentration of sediment and other debris	- possible erosion, overtopping, and consequent failure of structure	- appropriate design