PART III
Feasibility Study for Priority Projects

CHAPTER 15 FEASIBILITY DESIGN OF PRIORITY PROJECTS

15.1 Mudflow Control of the Bucao River

15.1.1 General

Three alternatives for structural measures in the Bucao River have been formulated in the master plan study. In terms of economic assessment, Alternative-1 for "Heightening of Existing Dike" has been selected as the priority scheme to proceed to this feasibility study.

15.1.2 Design Conditions in the Bucao River

(1) Design Discharge

The probable design discharge with a 20-year return period is applied to the Bucao River improvement work, which is tabulated for relative reaches as follows:

Probable Design Discharge in the Bucao River

River Sections	Design Discharge
From River mouth to Confluence of the Baquilan River (Sta.-2.4 km to Sta.+6.0 km)	3,800 m^3/s
From Baquilan River to Confluence of the Balin-Baquero River (Sta.+6.0 km to Sta.+11.2 km)	2,900 m^3/s
From the Balin-Baquero River (Upstream of Sta.+11.2 km)	1,300 m^3/s

(2) Proposed Dike Alignment

1) Downstream from the Bucao Bridge

This section from the river mouth to the Bucao Bridge does not have a dike system yet in either bank. The alignment of a proposed new dike follows the natural river terrace along the edge of the current watercourse.

The proposal is for lengths of approximately 2.4 km on the right bank and 1.9 km on the left bank.

2) From the Bucao Bridge to the Confluence of the Baquilan River

This section follows the existing dike alignment, because the section has hydraulic requirements for a river width to allow the flow of design discharge at present. The essential watercourse of the Bucao River is still not fixed because there has been violent riverbed movement in the channel and it is too unpredictable to expect to be able to determine the future watercourse for 20 years time.

Commonly, the required river width to accommodate flow of the design discharge is shown by the engineering empirical standard (as in the following table) based on the existing river channel width investigations.

Required River Width

Design discharge (m^3/s)	Required river width (m)
300	40 to 60
500	60 to 80
1,000	90 to 120
2,000	160 to 220
5,000	350 to 450

Source: Technical Standards for River and Sabo Works, River Association of Japan

The above table shows that the river width in the vicinity of the Bucao Bridge is sufficient to allow the flow of the design discharge under the empirical standard.

However, in the section 1.7 km upstream from the existing dike end point (Sta.+4.8 km) new alignment is provided to protect the existing community road and existing irrigation channel from flooding and/or mudflow.

Figure 15.1.1 shows the general plan of the proposed river improvement in the Bucao River.

(3) Presumptive Riverbed Elevation after 20 Years

The sediment deposits have remained as a thick layer in the Bucao River channel since the Mount Pinatubo eruption in 1991. The thickness has ranged from a few meters to approx. 30 m in the upstream reaches. Currently, in the rainy season, the sediment deposits are furiously swept away and deposited elsewhere or scoured by flooding and/or mudflow.

To obtain the proposed design water level, the riverbed movement after 20 years is computed with one-dimensional sediment transport analysis. The results presume the design riverbed in order to compute the proposed design water level. Figure 15.1.2 shows presumptive riverbed change after 20 years.

It is presumed that the riverbed still has a tendency of riverbed aggradation in the lower reaches of the Bucao River from the Mount Pinatubo eruption, because there are huge amounts of sediment deposits in the middle to upper reaches of the Bucao River.

The future maximum riverbed aggradation may be about 4.0 m high from the existing riverbed in 2002 between the river mouth and the Baquilan River.

(4) Design Water Level

To fix the design dike crest elevation, the design water level for the Bucao River is computed with non-uniform flow analysis based on the following:

- The initial water level in the river mouth corresponds with the maximum predicted tide occurring on August 9 and 10, 2002. The water level is EL+1.43 m.
- A roughness coefficient is applied as n = 0.035.

The value of the roughness coefficient in this feasibility study corresponds with the value adopted in "The Master Plan and Feasibility Study on Flood and Mudflow Control for the Sacobia-Bamban and Abacan Rivers draining from Mount Pinatubo" undertaken by JICA in May 1996. This is because the above project is located in the same neighborhood and is a similar project to this project. The quoted project is contributing flood and/or mudflow management in the eastern Mount Pinatubo area. The proposed numerical design water level is shown in Table 15.1.1

A summary of the design water level at each significant point is tabulated as follows:

Summary of the Design Water Level in the Bucao River

Station	Existing Riverbed in 2002	Presumptive Riverbed after 20 years	Design Water Level	Remarks
Sta.–2.40 km	EL+0.54 m	EL+1.40 m	EL+2.80 m	River Mouth
Sta.+0.00 km	EL+6.40 m	EL+10.16 m	EL+13.23 m	Bucao Bridge
Sta.+2.00 km	EL+13.64 m	EL+17.56 m	EL+18.90 m	
Sta.+4.00 km	EL+18.95 m	EL+21.92 m	EL+25.92 m	
Sta.+5.50 km	EL+26.80 m	EL+26.67 m	EL+30.92 m	Baquilan River (Right Bank)
Sta.+7.00 km	EL+34.01 m	EL+35.01 m	EL+35.92 m	
Sta.+10.00 km	EL+50.15 m	EL+51.69 m	EL+54.41 m	Malomboy (Right Bank)
Sta.+12.00 km	EL+63.80 m	EL+66.98 m	EL+69.00 m	Upper Bucao River

Note: Elevations of existing riverbed and presumptive riverbed indicate average values in the cross section.

Summary of presumed water depth between the existing riverbed in 2002 and design water level, and presumed sediment deposit depth from the existing riverbed are tabulated as follows:

Sediment Deposit Depth and Water Depth

River Stretch	Sediment Deposit Depth	Water Depth
River mouth to Bucao Bridge	Ave. 2.3 m	Ave. 4.4 m
Bucao Bridge to Baquilan River	Ave. 3.3 m	Ave. 6.5 m
Baquilan River to Malomboy	Ave. 1.0 m	Ave. 3.3 m
Malomboy to Upper Bucao River	Ave. 3.8 m	Ave. 6.1 m

Note: Base line is corresponding with existing riverbed in 2002.

(5) Freeboard

This is a margin against a sudden overtopping wave in flooding. The required height of the freeboard is 1.2 m under the design flood of 3,800 m^3/s according to the design standard of the Philippines.

Figure 15.1.3 shows the longitudinal profile of the proposed river improvement in the Bucao River.

(6) Required Dike Height

The required dike height, for each design condition, in each section is summarized in the following table:

Required Dike Height

River Stretch	Freeboard	Required Dike Height	Possible Measure
River mouth to the Bucao Bridge	1.2 m	Ave. 5.6 m	New Dike
Bucao Bridge to the Baquilan River	1.2 m	Ave. 7.7 m	Dike Heightening

15.1.3 Preliminary Design for the Bucao River

(1) New Dike Downstream from the Bucao Bridge

The proposed new dike is to be provided in the section where there is no dike system at present, to protect flooding and/or mudflow from coming into the land area beside the river.

The sections of the proposed new dike are tabulated as follows:

Sections of Proposed New Dike

Location	River Sections	Proposed Distance
Left Bank	River mouth to natural levee (Sta.-0.6 km)	1.91 km
	Vicinity of proposed Bucao Bridge	0.17 km
Right Bank	River mouth to Bucao Bridge (Sta.+0.0 km)	2.35 km

Slope protection is to protect the lahar embankment from high flow velocity of flooding and/or mudflow caused by heavy rainfall in the rainy season.

The proposed slope protection on the proposed new dike is grouted riprap in the riverside and sodding on the land side.

The grouted riprap for the proposed slope protection is provided for the existing dike protection along the Bucao River. It is conceivable that boulder stones as the main material of the grouted riprap is available in the Bucao River neighborhood. The new dike is proposed as shown in Figure 15.1.4 in accordance with the following design dike dimensions:

Design Dike Dimensions

Structural Item	Description
Top width of dike	8 m (in accordance with existing dike crest width)
Proposed dike height	In accordance with design dike crest level
Side slope gradient	H : V = 2.0 : 1 (with revetment)
	Less than H : V = 3.0 : 1 (without revetment)
Embankment material	Lahar sediment deposits (principally)
Slope protection (Riverside)	Grouted riprap or equivalent
Slope protection (Land side)	Covering borrow soil and sodding
Provision of inspection road	Gravel pavement on the top of the dike

Figure 15.1.5 shows computed results for land side slope failure including estimated phreatic surface. The slope gradient is designed to be stable against landslide with a safety factor of 1.32. The detailed design calculation is described in Appendix VI in this report. The computed results recommend that the proposed land side slope gradient is less than H : V = 3.5 - 4.5 : 1 to satisfy the required safety factor, because the different water depth is in a range from 2.3 m to 6.8 m deep.

In this study, the case of dike stability in earthquake is not taken into account for the following reasons:

- The proposed dike is basically constructed with lahar embankment material carried from the vicinity of the dike location. If the dike becomes damaged by earthquake, it will be easily rehabilitated with the same embankment material.
- There is little possibility that flooding and earthquake will occur at the same time.
- The result of water level observation in 2002 shows that maximum water depth in the river channel is about 0.3 m in the rainy season excluding flooding and/or mudflow times.

Alternative plan for dike strengthening is also studies to minimize the land acquisition on the land side by provision of steel sheet-piles at the riverside foundation. However, the cost is far expensive compared to the proposed dike strengthening method, and it was judged the alternative method is not feasible from the economic viewpoint.

(2) Heightening of Existing River Dike

The proposed dike heightening should take place in the section where the existing dike height is

insufficient to protect against flooding and/or mudflow coming into the land area beside the river.

The sections of proposed dike heightening are tabulated as follows:

Sections of Proposed Dike Heightening

Location	River Sections	Proposed Distance
Right Bank	Bucao Bridge (Sta.+0.0 km) to Sta.+5.0 km	5.80 km
Right Bank	Sta.+5.0 km upstream	1.65 km
Total		7.45 km

The slope protection works on the existing dikes have been constructed along the Bucao River since the Mount Pinatubo eruption. These are to protect the lahar embankment from high flow velocity of flooding and/or mudflow caused by heavy rain in the rainy season.

The proposed dike heightening should include slope protection work with grouted riprap in the riverside and sodding on the land side of the dike.

The dike heightening is proposed as shown in Figure 15.1.6 in accordance with the following design dike dimensions:

Design Dike Dimensions

Structural Item	Description
Top width of dike	8 m (in accordance with existing dike crest width)
Proposed dike height	In accordance with design dike crest level
Side slope gradient	H : V = 2.0 : 1 (with revetment)
	Less than H : V = 3.0 : 1 (without revetment)
Embankment material	Lahar sediment deposits (principally)
Slope protection (Riverside)	Grouted riprap or equivalent
Slope protection (Land side)	Covering borrow soil and sodding
Provision of inspection road	Gravel pavement on the top of dike

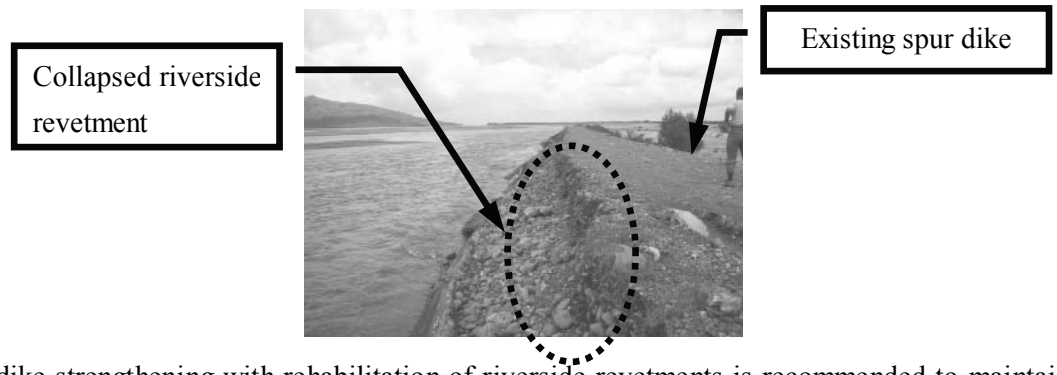
The results of the riverbed movement analysis show that the maximum sediment deposits might be about 4.0 m high from the existing riverbed within 20 years in these sections. The difference between the design water level and the existing land side ground will reach 7.1 m at the maximum.

Then, the safety of the dike for land side slope failure (refer to Figure 15.1.5) was analyzed. The computed result shows that the land side slope gradient should be less than H : V = 4.5 : 1 to secure the required safety factor, because the difference in water depth is a maximum 7.6 m.

(3) Strengthening of Existing Spur Dike

1) Existing Spur Dike

There is an existing spur dike in the upper end portion of the existing river dike. The existing spur dike length is about 200 m. The spur dike functions to control the water flow from the Baquilan River and upper reaches of the Bucao River. However, the existing riverside protection of the spur dike has been damaged by the annual flood in the rainy season. Therefore, at present, the collapsed riverside revetments and dike embankment exposed to the watercourse can still be observed. The following photo (taken on July 29, 2002) shows present damage of the existing spur dike.



Spur dike strengthening with rehabilitation of riverside revetments is recommended to maintain the function of the spur dike. Spur dike strengthening is proposed in accordance with the following design dike dimensions:

Design Dike Dimensions

Structural Item	Description
Top width of dike	6 m (in accordance with existing dike crest width)
Proposed dike height	In accordance with design dike water level
Side slope gradient	H : V = 2.0 : 1 (with revetment)
Embankment material	Lahar sediment deposits (principally)
Slope protection (Riverside)	Grouted riprap or equivalent
Slope protection (Land side)	Grouted riprap or equivalent
Provision of inspection road	Grouted riprap or equivalent

Figure 15.1.7 shows a typical cross-section of the proposed spur dike strengthening.

15.2 Reconstruction of the Bucao Bridge

The existing Bucao Bridge was constructed in 1939. The bridge length is 300 m and it is mainly of steel truss type. After 64 years of service, the slab is now damaged severely with honeycomb and other cracks.

The clearance between soffit the girder soffit and design flood level has become about 0.5 m since July 2002 when the Maraunot Notch collapsed and a huge volume of sediment was conveyed downstream. The bridge has a risk of collapse during floods due to insufficient clearance so there is a great need for reconstruction of the Bucao Bridge. A preliminary design for the Bucao Bridge reconstruction is as stated below.

(1) Design Conditions

The new Bucao Bridge is to be designed under the following conditions:

(a) Hydrological Conditions

1) Station of the river: 2.4 km
2) Design discharge: 4,900 m^3/s
   (50-year probable flood)
3) Flood water level: El. 13.50 m
4) Existing River bed level (as of 2002): El. 6.40 m
5) Presumed Riverbed level:
   after 50 years: El.10.16 m
6) Depth of water: 3.34 m
7) Vertical clearance: 3.45 m

8) Top of dike: El. 14.43 m

(b) Geometric Design Conditions

1) Design speed : 50 km/h
2) Minimum horizontal radius : 80 m
3) Maximum vertical slope : 7%
4) Maximum rate of transition for super-elevation : 0.65% (1/154)

(c) Geological Design Conditions

1) Bearing layer of abutment on Manila side : El. - 10.0 m
2) Bearing layer of abutment on Iba side : El. - 20.0 m
3) Bearing layer of pier : El. - 20.0 m

(d) Design of Existing Bridge

1) Bridge length : 300 m
2) Bridge type : Steel Pony Truss, Steel Plate Girder, RC T Girder
3) Span : 9 span x 25 m, 1span x 21 m, 3 span (16 m + 22 m + 16 m)
4) Construction year : 1939, 1992, 1993

(e) Design Condition of Proposed Bridge for Reconstruction

a. Bridge location : Downstream side of Existing Bridge
b. Bridge length : 321 m
c. Bridge type : Steel Plate Girder
d. Span : (46 m + 2 x 50 m), (50 m + 72 m + 53 m)
e. Width : 9.54 m (0.35 + 0.76 + 0.30 + 3.36 x 2 + 0.30 + 0.76 + 0.35)
f. Foundation type : Cast in situ pile

(f) Design Conditions of Proposed Road for Reconstruction

a. Approach road length on Olongapo side : 280 m
b. Approach road length on Iba side : 346 m
c. Width of carriageway : 6.7 m
d. Width of shoulder : 1.65 m x 2
e. Actual horizontal radius : 105 m

(2) Selection of Abutment Location for Alternative Bridges

Two bridge locations have been compared, one on the downstream side of the existing bridge (alternative 1), and the other on the upstream side (alternative 2).

The front face of the abutment wall is set at the shoulder of the dike as seen in Figures 15.2.1 and 15.2.2. The abutment of alternative-2 is set some distance from the riverside shoulder on the Iba side as seen in Figure 15.2.3, because the abutment should be located in safe place to avoid erosion due to skewed river flow.

(3) Selection of Bridge Location

The most suitable location for the new bridge is near the existing bridge because the distance between the river banks is shorter than it would be in any other location. If the bridge were reconstructed at the same location as the existing bridge, the construction cost would be higher than in alternatives 1 and 2 due to the need for a bridge detour. The distance is 15 m between the new bridge center line and the existing bridge center line for both the alternatives. Location, plan and vertical curvature are shown in Figures 15.2.4 to 15.2.7 for alternatives 1 and 2.

A comparison table is shown in Table 15.2.1. The downstream side, alternative 1, is recommended, mainly from the cost aspect and hydrological advantage.

(4) Selection of Approach Road Alignment

The applied design speed is 50 km/h according to the DPWH Standard and Olongapo-Bugallon Highway Standard. The minimum radius is 80 m and minimum curve length is 80 m in horizontal curvature. The maximum slope is 7%, the minimum radius 80 m and minimum curve length 40 m in vertical curvature.

A comparison table of the two alignments for the approach road on the Olongapo side is shown in Table 15.2.2. The alignment alternative-1 is the best possible alignment for its reasonable cost and safety. It can afford the minimum stopping distance for the design speed at all points on the bridge. The alignment being coordinated with the profile provides adequate sight distance, safety and comfort to the driver.

(5) Selection of Pier Location

The piers of the reconstructed bridge must be aligned in the same upstream-downstream line with the existing pier so that blocking of water is minimized during construction of the bridge and the safety of the bridge is maintained. The pier location is shown in Figure 15.2.8. The average span length is 53.5 m. This span length is sufficient for passing flood discharge as shown in Figure 15.2.9.

(6) Selection of Superstructure Type

Steel plate girder (alternative 1) and pre-stressed concrete box girder (alternative 2) options were compared for the design of the reconstructed superstructure with a span of 53.5 m as seen in Table 15.2.3. The steel plate girders of alternative-1 would be erected by a truck crane with an extension while the pre-stressed concrete box girders of alternative-2 would be erected by extruder. A comparison table is shown in Table 15.2.4. Alternative 1 using steel plate girders is recommended, mainly for its economic advantage. The steel material will be a non-paint type.

(7) Selection of Foundation Type

Cast in situ pile has been selected considering the subsoil conditions, bearing strata and external forces transmitted by the superstructure.

(8) Removal of Existing Bridge

The existing bridge must be removed after reconstruction because it has a risk of collapsing during flood or earthquake and it might affect the new bridge.

15.3 Mudflow Control of the Sto. Tomas River

15.3.1 General

Three alternatives for structural measures in the Sto. Tomas River have been formulated in the master plan study. In terms of economic assessment, Alternative-1 for “Heightening / Strengthening of the Existing Dike” has been selected as the priority scheme to proceed to this feasibility study.

15.3.2 Design Condition in the Sto. Tomas River

(1) Design Discharge

The probable design discharge with a 20-year return period is applied to the Sto. Tomas River improvement work, which is tabulated in relative reaches as follows:

Probable Design Discharge in the Sto. Tomas River

River Sections	Design Discharge
From River mouth to Confluence of the Santa Fe River (Sta.-1.5 km to Sta.+11.5 km)	1,200 m^3/s
From the Santa Fe River to Confluence of Lake Mapanuepe (Sta.+11.5 km to Sta.+21.0 km)	860 m^3/s
The Marella River (Upstream of Sta.+21.0 km)	680 m^3/s

(2) Proposed Dike Alignment

Figure 15.3.1 shows the general plan of the proposed river improvement in the Sto. Tomas River.

The section from the river mouth to the Maculcol Bridge does not currently have a dike system on the right bank. Alignment of the proposed new dike on the right bank follows the natural river terrace along the edge of the current watercourse. The length is approximately 1.9 km from the river mouth. On the left bank, there is the existing dike constructed by the DPWH with lahar sediment deposits along the watercourse.

In the vicinity of the Maculcol Bridge, the proposed dike alignment plan is to widen the river width by about 30 m at both banks, based on the reconstruction plan of the Maculcol Bridge.

The reconstruction plan of the Maculcol Bridge has been planned by the DPWH Region-III. According to the detailed drawings of the New Maculcol Bridge, the proposed bridge length is about 60 m longer than the existing bridge. The new bridge length will be 430.8 m.

For other sections, the current river width is sufficient to allow flow of the design discharge. Alignments of the proposed dike heightening and dike strengthening are following the existing dike alignment.

(3) Presumptive Riverbed Elevation after 20 years

To determine design water level, riverbed movement after 20 years was computed with one-dimensional sediment transport analysis, and the results presume the design riverbed eventuates in order to compute the proposed design water level. Figure 15.3.2 shows the presumptive riverbed change after 20 years.

It is presumed that the riverbed is still tending to rise between the river mouth and the Santa Fe River. The maximum riverbed aggradation may be about 1.5 m above the existing 2002 riverbed.

On the other hand, in the section between the Santa Fe River and the outlet of Lake Mapanuepe, the results show that the riverbed movement has been repeating aggradation and/or degradation. The maximum riverbed aggradation is about 0.7 m upward, and the maximum degradation is about 2.0 m from the existing riverbed in 2002.

(4) Design Water Level

To fix the design dike crest level, the design water level of the Sto. Tomas River was computed with non-uniform flow analysis in accordance with the same design conditions as the Bucao River.

The proposed numerical design water level is shown in Table 15.3.1. A summary of the design water level at each significant point is tabulated as follows:

Design Water Level in the Sto. Tomas River

Station	Existing Riverbed in 2002	Presumptive Riverbed after 20 years	Design Water Level	Remarks
Sta.–1.50 km	EL +1.98 m	EL +1.98 m	EL +3.95 m	River Mouth
Sta.+0.00 km	EL +6.42 m	EL +7.25 m	EL +8.95 m	Maculcol Bridge
Sta.+7.25 km	EL+27.03 m	EL+28.26 m	EL+29.68 m	Paete Hill (Right Bank)
Sta.+10.50 km	EL+41.46 m	EL+40.89 m	EL+42.48 m	Vega Hill (Left Bank)
Sta.+11.50 km	EL+46.65 m	EL+46.12 m	EL+46.83 m	Santa Fe River (Right Bank)
Sta.+18.00 km	EL+90.22 m	EL+90.04 m	EL+90.66 m	Lawin (Left Bank)

Note : Elevations of existing riverbed and presumptive riverbed indicate average values in cross section.

A summary of the presumed water depth, between the existing riverbed in 2002 and the design water level, and the presumed sediment deposit depth from the existing riverbed is tabulated as follows:

Sediment Deposit Depth and Water Depth in the Sto. Tomas River

River Stretch	Sediment Deposit Depth	Water Depth
River mouth to Maculcol Bridge	Ave. 0.3 m	Ave. 2.1 m
Maculcol Bridge to Paete Hill	Ave. 0.8 m	Ave. 2.5 m
Paete Hill to Vega Hill	Ave. 0.5 m	Ave. 2.0 m
Vega Hill to Lawin	Ave. -0.4 m	Ave. 0.6 m

Note : Base line is corresponding with existing riverbed in 2002.

(5) Freeboard

The required height of the freeboard is 1.0m under a design flood of 1,200 m^3/s according to the design standard of the Philippines. Figure 15.3.3 shows a longitudinal profile of the proposed river improvement in the Sto. Tomas River.

(6) Required Dike Height

Above each design condition, the required dike height in each section is summarized in the following table:

Required Dike Height

River Stretch	Freeboard	Required Dike Height	Possible Measure
River Mouth to Maculcol Bridge	1.0 m	Ave. 3.1 m	New Dike/ Dike Strengthening
Maculcol Bridge to Paete Hill	1.0 m	Ave. 3.5 m	Dike Heightening/Dike Strengthening
Paete Hill to Vega Hill	1.0 m	Ave. 3.0 m	Dike Heightening
Vega Hill to Lawin	1.0 m	Existing Dike Height	Dike Strengthening

15.3.3 Preliminary Design of the Sto. Tomas River

(1) New Dike Downstream from the Maculcol Bridge

The proposed new dike is to be provided in the section where there is no dike system at present, to prevent flooding and/or mudflow coming into the land area beside the river.

The section of the proposed new dike is tabulated as follows:

Section of Proposed New Dike

Location	River Section	Proposed Distance
Right Bank	River mouth to Maculcul Bridge	1.95 km

The slope protection is to protect the lahar embankment from a high flow velocity from flooding and/or mudflow caused by heavy rainfall in the rainy season.

The new dike is proposed in accordance with the following design dike dimensions:

Design Dike Dimensions

Structural Item	Description
Top width of dike	8 m (in accordance with existing dike crest width)
Proposed dike height	In accordance with design dike crest level
Side slope gradient	H : V = 2.0 : 1 (with revetment)
	Less than H : V = 3.0 : 1 (without revetment)
Embankment material	Lahar sediment deposits (principally)
Slope protection (Riverside)	Grouted riprap or equivalent
Slope protection (Land side)	Covering borrow soil and sodding
Provision of inspection road	Gravel pavement on the top of dike

The results of the riverbed movement analysis show that the maximum sediment deposits might be about 0.8 m high from the existing riverbed within 20 years in these sections. The difference between the design water level and the existing ground level beside the river is 2.5 m at a maximum.

The safety against slope failure on the land side of the dike (refer to Figure 15.1.5) was analyzed and the results indicate the slope gradient should be less than H : V = 3.5 : 1 to secure the required safety factor.

Figure 15.3.4 shows a typical cross section of the proposed new dike.

(2) Heightening of Existing River Dike

The proposed dike heightening is provided in the section where the existing dike height is insufficient to protect against flooding and/or mudflow coming into the land area beside the river. The sections of proposed dike heightening are tabulated as follows:

Sections of Proposed Dike Heightening

Location	River Sections	Proposed Distance
Left Bank	Sta+1.5 km to Vega Hill (Sta.+10.5 km)	9.00 km
Right Bank	Sta.+3.0 km to Paete Hill (Sta.+7.3 km)	4.30 km
Total		13.30 km

The slope protection work on the existing dikes has been undertaken along the Sto. Tomas River since the Mount Pinatubo eruption. This is to protect the lahar embankment from high flow velocity from flooding and/or mudflow caused by heavy rain in the rainy season.

The proposed slope protection is by using grouted riprap in the riverside and sodding on the land side.

The dike heightening is proposed in accordance with the following design dike dimensions:

Design Dike Dimensions

Structural Item	Description
Top width of dike	8 m (in accordance with existing dike crest width)
Proposed dike height	In accordance with design dike crest level
Side slope gradient	H : V = 2.0 : 1 (with revetment)
	Less than H : V = 3.0 : 1 (without revetment)
Embankment material	Lahar sediment deposits (principally)
Slope protection (Riverside)	Grouted riprap or equivalent
Slope protection (Land side)	Covering borrow soil and sodding
Provision of inspection road	Gravel pavement on the top of dike

The results of riverbed movement analysis show that the maximum sediment deposits may reach about 1.5 m high on the existing riverbed within 20 years in these sections. The difference between design water level and existing land side ground is 3.2 m at a maximum.

To secure safety against land side slope failure (refer to Figure 15.1.5), it is recommended that the proposed land side slope gradient is in the range of H : V = 4.0 to 4.5 : 1.

Figure 15.3.5 shows a typical cross section of the proposed dike heightening.

(3) Strengthening of Existing River Dike

Dike strengthening is proposed in the section where the existing dike height is sufficient to protect against flooding and/or mudflow.

However, it can be observed that:

- Some portions without riverside revetments have been damaged by annual flooding and/or mudflow in the lower reaches of the river.
- Land side slopes have been damaged by seepage flow in the dike body along the existing dike in the upper reaches of the river.

Thus strengthening of the existing river dike is recommended for rehabilitation of the existing dikes against high flow velocity during flooding and/or mudflow and land side slope failure caused by seepage flow.

The sections of proposed dike strengthening are tabulated as follows:

Sections of Proposed Dike Strengthening

Location	River Sections	Proposed Distance
Left Bank	River mouth to Sta. +1.5 km	2.80 km
	Vega Hill to Lawin	8.00 km
Right Bank	Maculcol Bridge to Sta. +3.0 km	3.10 km
Total		13.90 km

In these sections, there are two kinds of existing revetment, concrete facing and gabion mattress, respectively.

Dike strengthening is proposed in accordance with the following design dike dimensions:

Design Dike Dimensions

Structural Item	Description
Top width of dike	8 m (in accordance with existing dike crest width)
Proposed dike height	In accordance with design dike crest level and/or existing dike crest
Side slope gradient	H : V = 2.0 : 1 (with revetment)
	Less than H : V = 3.0 : 1 (without revetment)
Embankment material	Lahar sediment deposits (principally)
Slope protection (Riverside)	Grouted riprap or equivalent
Slope protection (Landside)	Covering borrow soil and sodding
Provision of inspection road	Gravel pavement on the top of dike

1) Between the Maculcol Bridge and Sta.+3.0 km on the Right Bank

a) Proposed Riverside Slope Protections

The existing gabion mattress facing was constructed in 2001 between the Maculcol Bridge and Sta.+3.0 km on the right bank.

The revetments are newest in the Sto. Tomas River. However, design velocity under probable design flood is around 2.0 m/s. It is possible that abrasion caused by sweeping sediment deposits could break the main steel wire of the existing gabion mattress and it is also possible that the gabion mattress may be damaged.

Thus, it is recommended that the existing gabion mattress protection be replaced with grouted riprap, which is more durable than gabion mattress.

The proposed riverside slope protection should be corresponding with the slope protection proposed for the new dike in the Bucao River.

b) Proposed Land Side Slope Protection

The results of the riverbed movement analysis show that the maximum sediment deposit might be about 1.5 m high on the existing riverbed within 20 years. The difference between design water level and existing land side ground is 3.5 m at a maximum.

According to the result of the safety analysis against land side slope failure (refer to Figure 15.1.5), it is recommended that the land side slope gradient should be H : V = 4.0 : 1.

2) Between Vega Hill and Lawin on the Left Bank

a) Riverside Slope Protection

The existing concrete facing on the left bank was done between 1997 and 1998 between Vega Hill and Lawin .

It is conceivable that the revetment is able to withstand the flow velocity caused by flooding and/or mudflow and attrition caused by sweeping sediment because the revetment is recently constructed and there are no damaged portions able to be observed at present.

The existing riverside revetments in these sections are to be preserved as the riverside slope protection.

b) Proposed Land Side Slope Protection

The results of the riverbed movement analysis show that the maximum sediment deposit might be less than 1.0 m high on the existing riverbed within 20 years.

However, it has been observed that the difference between the existing riverbed and existing land side ground is greater than with the other sections in the Sto. Tomas River. The

difference in height is in the range of 5.0 to 11.0 m at present.

Figure 15.3.6 shows the site inspection measurements of height difference between the existing riverbed and the existing land side ground.

Because of the above mentioned fact, there is some possibility of huge slope failure due to seepage.

To prevent the occurrence of seepage failure on the land side, enlargement of the land side dike against seepage flow is proposed.

According to the results of the safety analysis against land side slope failure (refer to Figure 15.1.5), it is recommended that the proposed land side slope gradient is in the range of H : V = 4.0 to 5.0 : 1.

Figure 15.3.7 shows typical cross sections of the proposed dike heightening in the above-mentioned sections.

(4) Diversion Channel of the Gabor River

1) Existing Conditions

The Gabor River is one of the tributaries of the Sto. Tomas River in the right downstream section below the Maculcol Bridge. The confluence point of the Gabor River has been buried by sediment deposits about 1.5 m deep because of repeated riverbed movement in the Sto. Tomas River since the Mount Pinatubo eruption. Clogging at the river mouth due to sediment deposits occurs with flooding in the vicinity of the downstream from the Gabor River due to the river overflowing in the rainy season.

The following photo (taken on February 12, 2003) shows the present state of river mouth clogging in the Gabor River:

Furthermore, according to the results of riverbed movement analysis in the Sto. Tomas River, in this reach, sediment deposits have been predicted to be about 0.3 m high from the existing riverbed. The total sedimentation depth may be about 1.8 m.

2) Countermeasure

As a result of the above, it is difficult to preserve the Gabor River function of accelerating the discharge into the Sto. Tomas River at the original confluence point because of the riverbed aggradation in the Sto. Tomas River.

Hence, a diversion channel system bypassing to the seashore along the proposed dike is recommended instead of the confluence river system. The shape of the proposed diversion

channel is trapezoidal open channel.

Additionally, based on field investigation, the Gabor River channel downstream of Gabor Bridge is not affected by clogging at the river mouth. Therefore, the proposed improvement stretch is about 1.7 km long from the seashore.

Figure 15.3.8 shows a general plan of the proposed diversion channel of the Gabor River.

3) Design Discharge

For design discharge, the standard for the DPWH shows that the kinds of drainage channel are divided into three classifications as follows:

Required Design Flood

Kinds of drainage channel	Required design scale
Open waterways	For a 50-year return period
Roadside drainage channel	For a 10-year return period
Others	For a 10-year return period

Source : Design Guidelines Criteria and Standards for DPWH, Volume-II, Section 3.121.

The above table shows that a 10-year return period is to be applied as the design scale for the proposed diversion channel.

The probable mean daily rainfall in the Sto. Tomas River basin is tabulated as follows:

Probable Mean Daily Rainfall in the Sto. Tomas River

Basin	Return Period (mm/day)						
	2 yr	5 yr	10 yr	20 yr	30 yr	50 yr	100 yr
Sto. Tomas	202	305	395	500	568	665	814

Design discharge of the proposed diversion channel is estimated at 112.1 m^3/s with the following equation:

$$Q_{10} = \frac{1}{3.6} C \times R \times A = 112.1 \ m^3/s$$

where:

Q_{10} : design discharge (m^3/s)

C : runoff coefficient (= 0.75 as paddy field)

R : design rainfall intensity (= 16.5 mm/hr: 10-year return period)

A : catchment area (= 32.6 km^2)

4) Preliminary Design

The proposed design water level and channel section scales are provided from non-uniform flow calculations under the conditions that the computed flow velocity in each section is less than 3.0 m/s in accordance with the design criteria for the DPWH.

Additionally, the roughness coefficient applied to the flow calculation is n=0.035 except in the proposed box culvert section.

For freeboard in the diversion channel, because the design discharge is less than 200 m^3/s, the freeboard for an open channel section is adopted at 0.6 m. The height of barrel in the proposed box culvert is designed so that the design flood water level is set at 80% of the

height of the barrel to provide suitable freeboard.

On the bank of the diversion channel, bank protection of grouted riprap is proposed because the associated flow velocity in the diversion channel is around 2.20 m/s and the proposed revetment will avoid bank erosion caused by flow velocity.

Figures 15.3.9, 15.3.10 and Table 15.3.2 show the longitudinal profile of the proposed diversion channel together with typical cross sections and the numerical design water level.

15.4 Warning and Evacuation System

15.4.1 Outline of Warning System

The recommended system will consist of four monitoring stations, seven rain gauges, and six water level gauges. The outline of this system and other related matters are described below.

(1) Location of Hydrological Observation Stations

New hydrological observation stations will be installed under the recommended system; namely, six water level gauging stations and seven rainfall gauging stations. Their locations are as shown in Figure 9.2.1, taking into account the following:

(a) Accessibility of the gauging stations is one of the most important factors for maintenance work.
(b) A water level gauge shall be placed just downstream of the bridge where discharge measurement can be conducted easily.
(c) The overflow from the Dizon Mine Tailings Dam and the crater lake of Mount Pinatubo may involve disastrous calamities; hence, a water level gauging station is necessary at these sites.
(d) The rainfall gauging stations are to be distributed uniformly in the whole three river basins (Bucao, Maloma, Sto. Tomas).
(e) The rainfall intensity around Mount Pinatubo seems to be higher than in other areas according to the hydrological analysis (referred to Appendix 5); hence, one rainfall gauging station is necessary around the summit of Mount Pinatubo.
(f) The adequate number of stations is assumed using the WMO guideline for flood forecasting and warning as reference. The density of rain gauge stations is 130 km^2 per station in the study area, which is enough in comparison with the required minimum rain gauge station density (250 km^2 per station) in terms of area for mountainous zones in accordance with the WMO guideline.

The hydrological observation stations to be installed are listed in the table below.

Hydrological Observation Stations

Name of Observatory (Temporary)	Measuring Devices to be Installed	Remarks
Baquilan Station	Rainfall Gauge	
Burgos Station	Rainfall Gauge	
Mount Pinatubo Station	Water Level Gauge; Rainfall Gauge	The Col at the outer rim of Mount Pinatubo crater
Maloma River Bridge Station	Water Level Gauge	
Belbel Station	Rainfall Gauge	
Apostol Station	Rainfall Gauge	
Sto. Tomas River Bridge Station	Water Level Gauge	
Mapanuepe Lake Station	Water Level Gauge; Rainfall Gauge	
Dizon Mines Dam Station	Water Level Gauge	
San Marcelino Station	Rainfall Gauge	
Bucao Bridge Station	Water Level Gauge	

(2) Monitoring Sites and Dissemination of Information

The establishment of monitoring sites has two purposes: (1) to transfer information related to flood/mudflow quickly to the inhabitants in order to contribute to the efficiency of the evacuation system; and (2) to share information with the related organizations (refer to table below), so that measures to prevent flood/mudflow are reinforced at the Barangay level.

To achieve these purposes, a dissemination system for flood/mudflow warning can be as illustrated in Figure 9.2.2. As can be seen in the figure, it is recommended that a website be set up for the PDCC in Iba Station as the key station for data/information dissemination to enable access to warning information by anybody. On the other hand, the warning information to each Barangay needs to be disseminated by media through the radio company for ordinary residents who do not possess their own computers.

Monitoring Sites

Monitoring Site	Monitoring Sites	Remarks
PDCC in Iba	All data from above-stated stations	Iba Central Station
PAGASA (Manila)	All data from above-stated stations except data from Mt. Pinatubo Station	
PHIVOLCS (Manila)	The data from Mt. Pinatubo Station only	Operation and maintenance of this station will be shouldered by this agency.
RDCC (Region III)	All data from above-stated stations	

Additionally, it is proposed to install sirens at appropriate locations in consideration of the range of signal access and the safety of equipment. The siren shall be sounded whenever a warning is issued through the Iba Central Station (see Figure 9.2.1 for the location of Iba monitoring site). The range of signal access is presumed at 1.5 km and the equipment will be set at the public office (Barangay Office).

Incidentally, there is an idea to integrate the observatory stations at Mount Pinatubo Crater Lake into the seismic monitoring system under PHIVOLCS since this agency is continuously monitoring various scientific aspects regarding the activities of Mount Pinatubo, even before its eruption. In fact, PHIVOLCS is also interested in integrating rainfall and lake water level observation stations into the seismic monitoring system.

(3) Field Investigation

Two major cellular phone carriers were selected for investigation; namely, the GLOBE and SMART communication companies, which are widely accepted in the Philippines. Through this investigation, it was found that the GLOBE system is preferable for the area where the system will be installed.

The GLOBE GSM system is available for almost all of the proposed observation stations, that is except the stations at Dizon Mine Tailings Dam in the Sto. Tomas River basin and Mount Pinatubo Crater Lake.

Figure 15.4.1 shows the availability of the existing GLOBE Cellular Phone system for the proposed sites for rain and water level gauges.

(4) Data Transmission System

It is proposed that the central station of the system (data processing site) be located at the provincial office in Iba, which is responsible for the activities of monitoring and warning. It is also proposed that a transmission system sending observed data through the existing cellular phone network be used instead of the exclusive nationwide network for warning systems applied by PAGASA.

Through field investigation, it was found that the existing cellular phone network is not available at the Mt. Pinatubo and Dizon Mine Tailings Dam stations. Therefore, the ordinary radio wave system for data transmission to the nearest monitoring station (Burgos and Mapanuepe sites as repeater stations) needs to be adopted for these stations.

Figure 15.4.2 shows the general idea of data transmission by cellular phone.

(5) Data Processing System

The data processing system will serve: (1) to collect raw data, (2) to foresee the possibility of flood on an as-needed basis using the information, (3) to create a visual image for display, and (4) to transfer it into the website managed by Iba Central Station. This data processing system is roughly divided into three subsystems function-wise.

To implement the data processing system, the following points should be taken into account:

(a) The computers to be introduced must be PCs in view of maintenance services at the site and staff familiarization.
(b) Flood/mudflow phenomena are very fast. Thus, to monitor flash floods and mudflow, a quick response of the system is necessary. The processing should be done automatically with limited manual intervention.
(c) A backup system needs to be implemented to cope with system breakdown and failure, which could be caused by power failure because of a typhoon, heavy rain, earthquake, etc., or by miss-operation.
(d) The processing data and information will be displayed in Web form. Thus, the PDCC staff should be accustomed to working with the Internet. The system must be on the defensive with respect to computer viruses prevailing in the Philippines nowadays.
(e) As for the data processing, the introduction of a Geographic Information System (GIS) database is recommended because this system can accommodate all related information concerning the monitoring and warning activities.

15.4.2 Stage-wise Development for Warning System

(1) Warning System as a Current Issue

Although it is primitive and no quantifiable value is obtained, people can be warned against flood and mudflow if some personnel capable of transmitting the prevailing flow conditions at a particular site through radio communication are designated to do so by the responsible authorities.

By this method, the maximum utilization can be made of measures presently available, against calamities, until advanced/accurate measures are provided.

Available sources of information for this purpose are:

(a) The watch points maintained by the AFP/PNP (Armed Forces of the Philippines/Philippine National Police)
(b) The watch point for the condition of Dizon Mine Dam Site.
(c) The rainfall measuring point set by the study team.

(2) Upgrading Procedures with the Present Available System

It is expected that personnel assigned at the watch points maintained by the AFP/PNP are to carry out their duties at regular intervals every day. For watch points (b) and (c), the following considerations and improvement measures may be needed:

(a) Personnel assigned to watch the conditions of Dizon Mines Dam are workers of the private company (Dizon) so that an understanding with the company may also be required. Besides, the location is out of the dissemination area of the cellular phone company. Therefore, the required information has to be transmitted first to the private company's main office by radio, as is presently being done, and the main office should transmit the information to the PDCC.
(b) In the case of the rainfall gauging station set by the study team in the hilly area in the Mapanuepe river basin, the rainfall gauges are maintained by a watchman residing near the station and cellular phone service is available in the area. Therefore, the PDCC can obtain accumulated data on rainfall from the watchman directly by cellular phone.

(3) Recommendation for Stage-wise Development of Warning System

The operation and maintenance of the warning system by GSM is not easily carried out continuously from the viewpoint of technical competence and financial difficulties in Zambales. First of all, therefore, the existing system should be improved with the aim of warning, at the civic level, of flood/mudflow and the staff in charge of the warning should gain experience so as to get used to the operation/activities concerning the flood/mudflow warning. After the improved existing system is working well and there is a secure and reasonable dissemination path, the GSM system should be introduced so that the system is utilized as a more than adequate, effective flood/mudflow warning system.

The Calamity Fund, which normally goes on the budget in cases of calamity (18 mil. pesos per year), should be made good use of, for the cost of operation and maintenance.

Figure 15.4.3 shows the general concept of the above method in comparison with the currently available warning system, as well as the system proposed by the study team.

15.4.3 Development Plan for Evacuation System

Based on the results of the master plan study, the following sequence of construction of new centers should be applied:

(a) Inundation areas outside of the coverage area of the evacuation center should be the highest priority for the construction of new evacuation centers. This is to be defined as Initial Stage Development.
(b) The percentage rates obtained by dividing the available capacities of evacuation centers by the total number of evacuees in each area, as described below, vary to a large extent, as shown in Figure 15.4.4. Therefore, it is recommended that the construction of new evacuation centers start in the area where the above rate is low to attain fairness among the inhabitants. This is to be defined as Mid-term Development.
(c) Once the percentage rate between the areas becomes almost even, construction work for all remaining evacuation centers may be executed simultaneously. This is to be defined as Long-term Development.

The development cost for the respective stages is summarized as follows:

Construction and Renovation Costs

(Unit: Million Pesos)

River Basin	Renovation Cost	Construction Cost				Grand Total
		Initial	Middle Term	Long Term	Total	
Bucao	52.6	37	162.8	150.1	349.9	402.5
Maloma	0.4	12	33.5	17.6	63.1	63.5
Sto. Tomas (R)	2.9	23.2	70.6	46.7	140.5	143.4
Sto. Tomas (L)	122.8	71.5	175.6	387	634.1	756.9
Total	178.7	143.7	442.5	601.4	1,187.6	1,366.3

The details of the cost estimate are described in Appendix-VIII in this report. The total cost for the evacuation system is estimated at 1,366 million Pesos. Among them, 1) renovation of existing evacuation centers at a cost of 179 million Pesos, and 2) Initial development of new evacuation centers for 10 locations at 143 million Pesos, are considered as the priority development components for the evacuation system.

Total investment for the priority scheme at a cost of 322 million Pesos, is, however, too expensive to implement taking into account the annual budget of the calamity fund of Zambales Province, which is about 18 million Pesos per year.

For the implementation of the evacuation system development, it is therefore recommended that existing public buildings in the priority development areas be assigned as evacuation centers instead of undertaking the construction of new evacuation centers. For the renovation of the existing evacuation centers, the activities are to be done under the program of elementary school improvement under DECS as almost all the existing evacuation centers are elementary schools.

15.4.4 Institutional Arrangement for Project Implementation

Provincial Disaster Coordinating Council (PDCC) of Zambales should be responsible for the project implementation. The system should be based on the existing system for mudflow monitoring and warning system. The mudflow monitoring system is currently under the responsibility of OCD Region-III. However, there is no activity of OCD on mudflow monitoring at present as time passes after the eruption because mudflow has hardly occurred recently and the current condition is judged as not critical. PDCC shall mobilize the warning system by means of the existing observatory and dissemination facilities under the technical support of OCD, PAGASA, PHIVOLCS, and DPWH.

For the evacuation system, PDCC, MDCC and BDCC are currently responsible for the operation.

Improvement of the existing evacuation system should be conducted by PDCC in collaboration with MDCC and BDCC with a technical assistance by OCD. Dissemination of the hazard map to the people would be the first action to improve the system.

15.5 Community Infrastructure Development at Tektek Resettlement Center

15.5.1 Outline of the Project

Based on the questionnaire survey to the existing resettlement centers, which was conducted in the master plan stage, the differences in the living conditions between the government's established centers and NGO resettlement centers have obviously been identified. The NGO resettlement centers are suffering from the lack of community infrastructures such as elementary school, electricity supply, and community roads in the NGO resettlement centers.

The government resettlement centers are generally large scale centers with more or less 1,000 families in the centers. On the other hand, the scale is generally small for the NGO resettlement centers, which are generally less than 100 families per center. This has been identified as the main reason why no community infrastructure has been facilitated in the NGO resettlement centers.

The idea of integration of NGO resettlement centers is therefore proposed to encourage development of community infrastructure for those residents in the NGOs resettlement centers.

15.5.2 Results of Field Investigation & Direct Interview with the People

The proposed integration was discussed in PCM workshop No.3 which included representatives from the three NGO resettlement centers. The participants, however, were apprehensive about the idea. They said they would prefer their present area of residence. It was suggested that the idea be presented to their community for further discussion. In order to get a more representative consensus, the study team came out with the perception survey to be conducted house-to-house among the residents of the three resettlement centers, Bantay-Carmen, Lalek and Tektek.

The perception survey was conducted on 15 February with a total number of samples of 105 families, which is equivalent to 52.5% of the total number of families in the three centers.

As a result, more than 90% of the residents opposed a move to the other area rather than staying in their present locations. On the other hand, about 30% of the respondents basically agreed with the idea of integration for a better arrangement for social facilities though all of them insisted on their place as the area to integrate.

Another particular issue in the NGO resettlement centers is the matter of land registration. All the government resettlement centers are established in the area owned by the government. Many of the residents in the center are currently acting to get land title of residential lots in the center. On the other hand, the land registration for the NGO centers is rather unknown, and the residents are apprehensive as to whether they can permanently stay in the present area or not.

15.5.3 Conclusion of the Feasibility Study

From the social viewpoint, the proposed integration of NGO resettlement centers will require more study, particularly regarding the issue of land title. In this study, therefore, the proposed integration of NGO resettlement centers is not feasible from the social and legal viewpoints though there is a strong need to solve these issues, which should be processed under the responsibility of LGUs.

15.6 Extension of CBFM Program

15.6.1 Basic Concept of CBFM Program

The nation-wide CBFM program is currently on-going as an effective measure for forest management under the concept of **"People first and sustainable forestry will follow"**. The Government believes that by addressing the needs of local communities, they will join hands to protect and manage the very source of their livelihood.

The CBFM program is, therefore, not a simple forestry program but integrated with the livelihood development program for the upland communities. Since livelihood development is identified as the most urgent and essential for sustainable community-based disaster management activities, the extension of the CBFM program to severely affected communities on the mountain was selected as the priority project in the master plan.

According to DENR, the ultimate goal of the CBFM program is as follows:

1) Sustainable management of forest resources,
2) Social equity and welfare of communities, and
3) Strengthening the partnership between DENR and local communities.

As a national strategy, the CBFM is applicable to all the forest areas in the country, including the reservation area for which no private ownership rights have been identified. There are the following characteristics in the CBFM program:

1) The people's organization will be given the utilization right for the forest for 25 years based on an agreement with DENR. It can be extended another 25 years after expiration of the first lease agreement.
2) Social equity will be given top priority by DENR. The ownership and utilization of the forest resources should be equitably distributed to all members of People's organizations, or among the People's organizations in the forest.
3) Partnerships between DENR and LGUs are an essential matter for successful implementation of the CBFM program. They are responsible for supporting and cooperating with the People's organizations for forest management activities conducted by the People's organizations.
4) The government is responsible for participation in initial investment, and supporting the promotion and marketing activities for the forest products.

Taking into account the above concept and objectives, the CBFM program would be one of the best measures to apply in this study for further disaster prevention and sustainable basin management activities through livelihood development in the mountain area.

15.6.2 Potential Development Area for CBFM in the Study Area

The potential development areas for CBFM in the study area have been identified using the following procedures:

1) All the forest area, grass land and bare land was listed from the GIS database as the initial potential area for development of CBFM,
2) The area that is highly affected by pyroclastic deposit in the foothills of Mount Pinatubo was excluded from the potential development area identified in 1) above, because it is still unstable from the geological viewpoint, and was judged as not suitable for agro-forestry development yet. It was identified from a landsat image taken in 2002. It is recommended that the area be included

only after natural forest has recovered in the future.

3) The gentle slope area with less than 30% slope was selected as the potential development area for CBFM from the identified area of 1) and 2). This is because, the slopes in the forest of more than 30% slope are not suitable for agro-forestry development in terms of the operation and maintenance activities. It is rather difficult to maintain agro-forestry on a steep slope. This was learned from previous experience with the CBFM project. Since the immediate objective of the CBFM proposal in this study is to develop the livelihood of the severely affected communities, it is proposed that the area that is not suitable for agro-forestry development is excluded from the priority area.
4) Only 20% of the gentle slope area, identified in 2) above, has been selected as the agro-forestry area, based on the instruction from DENR. As the ultimate goal of the CBFM program is to strengthen forest management, agro-forestry development in the forest area is limited to up to 20% of the whole forest area.

Based on the above, the potential area for CBFM development in the study area was identified as shown in Figure 15.6.1. The total potential area is about 25,000 ha.

15.6.3 Priority Area for CBFM Extension

In this study, the CBFM program is identified as the livelihood support program for severely affected people due to the eruption of Mount Pinatubo. At the same time, improvement of the watershed condition of the three river basins is expected, in view of the effect on water retention in the basin, flood mitigation, and sediment yield mitigation.

Based on the poverty assessment in the study area, the mountain areas in the Bucao and Sto. Tomas River basins are identified as the areas that are suffering most severely from poverty as described in Section 19.3. As shown in the poverty ranking map in Figure 19.3.1, most of the barangays located in the upstream areas of the Bucao and Sto. Tomas Rivers are given low ranking. On the other hand, the barangays classified as "Remote Barangay", which have been identified as the poorest barangays in the study area, have a large area of forest. They are recognized as high potential areas for agro-forestry though access to the market has not been considered, so far, for assessment of development potential. The following barangays are, therefore, recommended as the priority areas for development of CBFM to improve the watershed condition through livelihood development activities.

Proposed Priority Areas for CBFM Extension

No.	Municipality	Barangay	Barangay Ranking	Poverty Value	CBFM potential Area (ha)	Agro-Forestry Potential Area (ha)	Ranking after CBFM	Poverty Value after CBFM
1	Botolan	Maguisguis	122	-2.62	2,720	544	114	-1.54
2	Botolan	Moraza	121	-2.27	1,405	281	112	-1.40
3	Botolan	Villar	120	-2.20	745	149	117	-1.94
4	Botolan	Poonbato	119	-2.18	2,820	564	112	-1.24
5	Botolan	Palis	118	-2.14	745	149	113	-1.44
6	Botolan	Nacolcol	117	-2.11	1,145	229	111	-1.12
7	Botolan	Belbel	116	-1.84	240	48	115	-1.71
8	Botolan	Burgos	115	-1.74	520	104	112	-1.38
9	Botolan	Owaog-Nebloc	114	-1.55	480	96	110	-1.04
10	Botolan	Cabatuan	113	-1.49	145	29	113	-1.41
11	S-Marcelino	Santa Fe	112	-1.41	5,135	1,027	32	+0.43
12	S-Marcelino	Aglao	111	-1.15	550	110	110	-0.95
13	S-Marcelino	Buhawen	110	-1.10	240	48	110	-1.00
14	Botolan	Malomboy	109	-0.70	960	192	104	-0.39
	TOTAL				18,370	3,674		

Location of the priority areas is shown in Figure 15.6.2. All the priority areas are located in the upstream areas of the Bucao and Sto. Tomas River basin. That is favorable from the viewpoint of watershed management for disaster prevention, including improvement of water retention capability, flood peak mitigation and mitigation of sediment yield in the basin, even though the priority area was selected from the viewpoint of poverty reduction in the severely affected areas.

Implementation of the priority area development, however, seems quite difficult because of high investment cost. It is therefore recommended to implement a pilot project for the area of 2,200 ha, 10% of the priority areas.

15.7 Agricultural Development in Lahar Area

15.7.1 Selection of Appropriate Crops for Lahar Agriculture

In the course of field investigation, it was found that substantial quantities of pyroclastic materials have moved down and the deposits along the river have started to show signs of stability. On the face of it, in some areas investigated by the study team, cultivation had started as early as 1996 or five years after the eruption and rehabilitation has been going on, although slowly, ever since. Changes in the physical condition of the lahar and establishment of pioneer plants are positive signs that such areas are now ready for agricultural development. Such development, however, as indicated in several studies in lahar agriculture, would necessarily entail some time, effort and costs.

It is noted that the utilization of lahar high water channel is recommended only for agriculture purpose. No residential use is recommended due to high potential hazard area by the flood and mudflow compared to the other residential areas. Proper arrangement by LGUs for the zoning regulation will be essential for the appropriated development of lahar agriculture.

The soil analysis indicates that while the fertility level is very low to support crops, it can be managed and brought back to crop production level with the application of technologies that will improve the soil conditions, physically and chemically, and by provision of basic needs like water and fertilizer with properly fitted cropping patterns.

The following crops are accordingly listed as appropriate crops for production on the lahar area.

Appropriate Crops for Production on the Lahar Area

Categories	Seasons	Crops	Expenses (Peso/ha)	Revenue (Peso/ha)	Net Income (Peso/ha)	Remarks
Cereals	Wet Season	Rice	21,972	58,800	36,828	
	Dry Season	Corn	26,973	40,670	13,697	
Vegetable	Dry Season	Onion	79,056	375,000	295,944	*1)
	Dry Season	Garlic	102,640	300,000	197,360	
	Dry Season	Tomato	49,429	405,000	355,571	*1)
	Dry Season	Squash	31,056	72,000	40,944	*1)
Fruits	Dry Season	Watermelon	28,042	225,000	196,958	*1)
Legumes	Dry Season	Mungbean	17,566	30,000	12,434	
	Dry Season	Peanut	22,615	50,000	27,385	
Root crops	Annual	Sweet Potato	33,741	223,200	189,459	*2)
	Annual	Cassava	48,966	180,000	131,034	*2)
	Annual	Gabi	45,371	225,000	179,629	*2)

Notes: *1) Crop is not appropriate in areas with poor access to market, such as the middle stream area of Bucao, and upstream of Sto. Tomas area.
*2) Crops are not appropriate in the areas where share tenancy is the dominant land tenure.

The labor and material requirements for different production activities and yield data for various annual crops were taken from Aganon et.al. (1995: Crop Production Technologies in Ash and Lahar Laden Areas). The prevailing market prices in Iba, Zambales for seeds, fertilizers, chemicals, diesel and oil were used to determine the material costs while existing wage rates for hired labor were taken from direct interviews and were used to determine the labor cost of production operations. The market prices of crops were taken from the Municipal Agriculture Office of Iba, Zambales and were applied in determining the value of total crop yield.

Forage grasses, pasture legumes and possibly fodder trees are not included in the appropriate list above, but they also should be selected as appropriate crops in the area where livestock, particularly cattle and goats, are common. These plants thrive with a minimum of water. Leguminous crops will provide basic nitrogen into the soil, which would contribute greatly to improving the soil condition. Forage crops will be continued for 7 to 10 years, and they will raise livestock by grazing. The livestock waste will be naturally distributed to the lahar pasture land and it will enhance fertility of the lahar pasture land. This method for lahar agricultural development was also recommended in the eastern Pinatubo area (refer to "Agricultural Development Planning for Sabocia-Bamban River Basin", DPWH / Nippon Koei / PHILKOEI International, March 1998).

15.7.2 Key Issues for Development Plan Formulation

For plan formulation, it is important that the plan should be reviewed in terms of (1) technical, (2) economical, (3) environmental, and (4) social viewpoints.

In terms of the technical viewpoint, the negative effects of high concentrations of sulfate in soil and water would be one of the key issues. In addition, to increase Nitrogen (N) in the soil will be important for making the soil fertile for agriculture. "How to provide more organic matter in the lahar area" is another key issue from the technical viewpoint.

In terms of the viewpoint of the economy, the marketing issues should be considered for formulation of the development plan. According to the farmers' interview and field investigation, many places in the study areas have no good access to the market, so cash crop production such as vegetables and fruit will not be feasible as an income generation measure.

From the environmental viewpoint, it is necessary to pay special attention to irrigation development in such areas as have a high concentration of sulfate in soil and water. Appropriate cropping patterns should be well considered taking into account the water and soil quality and the considerable negative environmental effects of excess soil acidity, etc.

For groundwater quality, a high electric conductivity (EC) is required to consider it for irrigation development. The EC level is generally considered as the guideline for chloride concentration for paddy rice production, and the NIA usually measures the EC value to assess chloride concentration. In the case of the study area, however, the chloride concentration in groundwater is generally low and much below the limit set by the NIA. Accordingly, some other minerals might be causing a high EC level, so this needs further investigation.

In addition, particularly in the Sto. Tomas River basin, the water quality of the Mapanuepe Lake is a rather critical condition for irrigation development. Based on the water quality survey in this study, some heavy metals were detected beyond the standard upper limit for irrigation water. The water quality is discussed in Section 15.8, Community development in the Mapanuepe Lake Basin. For irrigation development in the Sto. Tomas River basin, therefore, further detailed assessment of the water quality will definitely be required.

From a sociological viewpoint, it was found that rice production is the most preferred by the farmers,

and there are some difficulties in changing crops to cash crops, such as vegetables and fruit, due to the difficulty of access to market. Irrigation development is, therefore, highly desired by the farmers as an improvement measure. On the other hand, there might be some environmental constraints due to the water quality in the area, as mentioned above. Further detailed assessment will, therefore, be needed to encourage irrigation development as required by the farmers.

For improvement of productivity on lahar agricultural land, some research was undertaken by conducting productivity experiments for paddy rice and chili (as cash crops) under different conditions. The results are summarized as follows:

Results of Productivity Research by Basket Farming (Compost)

Soil Condition	Paddy pot (g/pot)	Chili pot (g/pot)
Only Lahar	3	6
Lahar + kitchen garbage(5kg) + red clay (1 kg)	28	**41**
Lahar + kitchen garbage(5kg) + fowl droppings (1kg)	**35**	2
Lahar + kitchen garbage(5kg) + fowl dropping (1kg) + red clay (1kg)	21	18
Lahar + kitchen garbage(5kg) + bio-enzyme (10%) + red clay (1kg)	19	21
Lahar + chemical fertilizer	25	3

Source: Environmental Recovery on the Lahar Affected Areas due to the Eruption of Mount Pinatubo in 1991 (Published in Japan, April 2002, edited by Dr. Masao YOSHIDA and others)

The above result indicates that there are some ways to improve the agricultural productivity through input to the lahar area cultivation. Based on the former research, provision of kitchen garbage and fowl droppings, and red clay will improve the productivity of lahar agricultural land.

15.7.3 Proposed Development Plan

(1) Development Area

The areas for lahar agricultural development were selected as follows:

Area for Lahar Agricultural Development

No.	Place	Barangay	Area	Area condition	Market Access	Land Tenancy	Others
1	Bucao, Middle (right)	Poonbato	225 ha	Pioneer plant	Poor	None	
2	Bucao, Middle (right)	Malomboy	31 ha	No Plant	Poor	None	21+10 ha
3	Bucao, D/S-1 (right)	San Juan	200 ha	Pioneer plant	Good	Full	Acid soil
4	Bucao, D/S-2 (right)	San Juan	120 ha	No Plant	Good	None	
5	Marella , (Left)	Aglao	300 ha	No Plant	Poor	None	Influensive by Mapanuepe
6	Sto.Tomas, middle (Right)	Santa Fe	600 ha	Pioneer plant	Poor	None	
7	Sto.Tomas, middle (Left)	San Rafael	250 ha	Pioneer plant	Good	None	
	TOTAL		1,726 ha				

The areas where the cultivation activities have already started, such as Maloma, mid-stream of Bucao left side, and Balin-Baquero right side were not selected for consideration as the target development

area.

A location map of lahar agricultural development in the study area is shown in Figure 15.7.1.

(2) Development Plan

Agricultural development on the lahar area requires the following sequence of activities:

1) River training work
2) Land development activities
3) Soil improvement work
4) Fertilizer provision
5) Water supply
6) Cropping and harvesting

Details of each activity are described as follows:

1) River Training Work

As all the proposed area was within a high water channel area on which thick lahar is fully covered, river training work was essential prior to utilization for agricultural activities. A training dike or spur dike was constructed to separate the flood / mudflow channel from the target development area. For river training work, the maximum required river channel width was determined based on the 100-year probable flood capacity, although it is not considered in the master plan for flood and mudflow control. The maximum required river width was then defined by the following formula:

$$14 \times Q_{100} \wedge 0.5$$

Accordingly, the required river width for the Bucao and Sto. Tomas River was determined as 1,100 m for the Bucao, and 800 m for the Sto. Tomas River. It is noted that the calculated maximum river width was considered only for development plan formulation for lahar agriculture along the river, and not for the flood and mudflow control work.

For the river training work, the following structures were considered to change / fix the flood / mudflow channel:

a) Training Dike / Spur Dike

A training dike / Spur dike was proposed to change the course of flood / mudflow in the river. A gabion made training dike with 5 m height (3 m from the present ground level, and 2 m below the ground level) was proposed. The top width of the training dike was designed as 2 m.

b) Separation Dike

A separation dike was proposed at the confluence of the main stream and the tributaries. Some of the proposed development areas, such as Poonbato, Malomboy along the Bocao River are located at the confluence, and channel work for the tributary will be required to utilize the area between the main stream and the tributary.

The separation dike was designed as a lahar embankment dike with a slope of 1:2. The surface of 50 cm will be covered by mountain soil. Boulder riprap will be provided on the slope of the tributary side. The dike height was tentatively designed at 3 m and the top width was designed as 6 m.

The work quantity and cost for the river training work for each development is shown in Table 15.7.1.

2) Land Development Work

Land development for the target lahar agricultural area is required as the initial development activity. Clearing of pioneer plants, scraping, deep plowing, leveling and establishment of boundaries (foot path) and perimeter fencing are included in this work. The cost for land development is basically for labor cost. The estimated cost for land development per ha is as follows:

Cost Estimate of Land Development

No.	Activity	Cost (Pesos/ha)
1	Scraping	6,000
2	Clearing of pioneer plants	1,500
3	Deep plowing	2,500
4	Leveling	1,500
5	Establishment of boundaries	5,000
	TOTAL	16,500

3) Soil Improvement Work

Prior to cropping activities, a soil improvement period of one season is considered. Enriched fallow in addition to the application of fertile soil, domestic waste and green manure using residue of the mungbean crop has been proposed for plant-less as well as pioneer plant areas. The cost for soil improvement work was estimated as follows:

Cost Estimate of Soil Improvement

No.	Activity	Cost (Pesos/ha)
1	Green manuring using Mungbean	2,000
2	Enriched Fallow + Composting	1,500
3	Mixing with imported fertile soil / with red soil	1,200
4	Mixing with domestic waste	500
	TOTAL	5,200

4) Fertilizer Provision

Together with the soil improvement work, fertilizer provision to support crop growing on the poor lahar soil will be definitely required. Full fertilizer provision for rice and mungbean following the recommended rate in "Crop Production Technologies in Ash and Lahar Laden Areas" (Aganon, et.al. 1995) is to be applied. In addition, the use of coco green organic fertilizer plus inoculant for mungbeans is planned. The cost for fertilizer provision was established as follows:

Cost Estimate for Fertilizer Provision

No.	Activity	Cost (Pesos/ha)
1	Commercial Inorganic	
	1, Single (4 bags)	2,080
	2. Complete (8 bags)	3,840
2	Commercial Organic	
	1. Chicken Manure (20 bags)	2,400
	2. Coco Green (8 bags)	1,060
	3. Inoculant	60
	TOTAL	9,980

5) Water Supply

As the most expected crop of the farmers is identified as paddy rice, the water supply system

is also considered for lahar agriculture development. For some of the area river water of the tributary, which is not affected by the lahar, such as the left side of the Bucao River and the right side of Sto. Tomas River at Barangay Santa Fe, may be available. For the cost estimate for water supply in this case, a shallow tube well (40-foot, 4-inch diameter for irrigation up to 5 ha) has been considered. For the actual development, however, the water quality of a shallow tube well should be assessed and deep well may be required if the water quality is not favorable for irrigation use. The cost of one unit of water supply system (up to 5 ha irrigation) is as follows:

Cost Estimate for Water Supply System (for 5 ha)

No.	Activity	Cost (Pesos)
1	Materials and labor for STW drilling	12,000
2.	Pump (Popular brands)	4,000
3	Prime Mover (6-8 Hp brand new Japanese diesel engine)	42,500
4	Pump-prime mover base	1,000
	TOTAL	59,500

6) Cropping and Harvesting

Appropriate crops for the lahar area were discussed in sub-section 3.3.6 in Appendix IX. The actual cropping pattern shall be determined by the farmers' cooperative considering the needs of farmers as well as marketing ability. For selection of cropping pattern, it is necessary to be consulted by the agriculture specialists in the municipality and provincial offices. The details of the cost, revenue and net income calculation for respective appropriate crop is shown in Table 15.7.2.

7) Priority Development Area

Economic viability for the agricultural development on the lahar area was assessed for each respective potential development area as shown in the following table. The project cost is highly dependent on the work quantity for river improvement work. The benefit is dependent on the selected cropping pattern but, it is actually dependent on the accessibility to the market from the farm land. For those areas far from the market it is difficult to produce cash crops as it is difficult to transport to the market, and their choice for cropping would be limited only to storable crops such as rice and root crops.

The following are the results of the economic comparison among the potential development areas, and it is concluded that the area that is accessible to the market would be higher viability from the economic viewpoint, and was, therefore, selected as the priority area.

Figure 15.7.2 shows the general development plan for the downstream of the Bucao River side, and the middle stream of the Sto.Tomas both river banks.

Summary of Cost / Benefit, Economic Evaluation

No.	Location	Barangay	Area (ha)	Project Cost (mil. Pesos)	Annual Benefit (mil. Pesos)	EIRR	Cropping Pattern
1	Bucao-middle (R)	Poonbato	225	92.5	30.7	3.7%	Rice-bean
2	Bucao-middle (R)	Malomboy	31	77.5	13.2	- 0.9%	Cassaba
3	Bucao-d/s-1 (R)	San Juan	200	75.7	203.1	33.3%	Onion
4	Bucao-d/s-2 (R)	San Juan	120	105.8	81.3	11.6%	Sweet potato
5	Marella (L)	Aglao	300	79.1	40.9	7.6%	Rice-bean
6	Sto.Tomas, middle (R)	Santa Fe	600	55.1	81.8	22.5%	Rice-bean
7	Sto.Tomas, middle (L)	San Rafael	250	220.5	253.9	16.9%	Onion

The above table shows that the areas of rather high economic viability are areas No. 3, 4, 6 and 7. This fact is caused by the low construction cost for river structures and the ability to plant cash crops owing to good access to the markets. Among these four areas, No. 4 and 7 were selected as the priority areas in view of their better access. Their development cost is 326 million pesos for the development area of 370 ha.

It seems, however, to be difficult for Zambales Province to implement the said agricultural development costing 326 million pesos for the priority areas of 370 ha by their own funds. Furthermore, the implementation requires careful monitoring on river flows and floods in the high water channel in which the agricultural development is to be implemented.

The recommended project is, therefore, a pilot development of 10 ha for each of areas No. 4 and 7. By accumulating the results of the experiments in the pilot development areas, full development in the priority areas is expected with the financial assistance of the national government and lending institutes.

15.8 Community Development in the Mapanuepe Lake Basin

15.8.1 Proposed Development Plan

The proposed community development plan for the Mapanuepe Lake basin was described in the preceding Section 10.5 Proposed Overall Plan for Community Disaster Prevention. Then, in this section, only the major issues related with the lake basin development will be focused.

15.8.2 Major Issues for Mapanuepe Lake Basin Development

For community/tourism development in the Mapanuepe Lake basin, there are two major issues to be clarified as follows:

1) Water Quality of Mapanuepe Lake
2) Safety Condition of Dizon Mining Dam

In the course of the study, water quality tests at the proposed irrigation intake site were conducted, and it was found that the quality was within the acceptable range for irrigation use. However, the water quality of the inflow from the copper mine area to the lake is in question. To promote various developments in the Mapanuepe lake basin, it is therefore essential to conduct a detailed study of water quality.

Regarding the issue of the safety of the dam against failure, DENR commented that countermeasures should be taken by the owner of the dam. Although the issue of the dam safety is not taken into account in detail in the study, active involvement of the national government is strongly required.

15.8.3 Water Quality Survey

(1) Sampling Location and Item

A water quality and bottom material survey was conducted in January 2003. The samples were collected at the Dizon Copper Mining Dam reservoir (one location) and the Mapanuepe Lake (four locations) to determine the appropriateness of the Mapanuepe Lake water for irrigation, fish hatchery and recreation use.

The locations of the samples are shown in Figure 15.8.1. At each location, two water quality samples

(surface and mid-depth) and one bottom material sample were obtained. The analysis of samples was carried out in a laboratory in Manila. Water samples were analyzed for 28 parameters and the bottom material was analyzed for 16 parameters.

Based on site inspection, there are no large-scale municipal or industrial discharge sources around the Mapanuepe Lake. The Dizon Copper Mining Company dam is located on the eastern side of the Mapanuepe Lake. According to local authorities, the reservoir had been used for storage of mine tailings. Operations were ceased in 1997 and at present, the mine is not in operation.

(2) Comparison to Standard

Table 15.8.1 shows the water quality results with Philippine Class C standards for fishery and Class D standards for irrigation. Table 15.8.2 shows the bottom sediment results.

For the Dizon Dam reservoir, the water quality standards were exceeded for pH, mercury, lead, iron, manganese, fluoride and copper. For the Mapanuepe Lake, standards were exceeded for mercury, lead, manganese, phenols and copper. Although values that exceed standards are very important, four of the results in particular are noteworthy.

First of all, mercury was detected in two samples. The values were approximately two orders of magnitude greater than the Philippine standards. Further, if compared to the more stringent Japanese environmental standard of 0.0005 mg/l, the values would be three orders of magnitude greater. Such levels would be even greater than normal industrial levels. At these levels, one can say that levels are abnormally high and that the Mapanuepe Lake water would be very harmful for fishery and for irrigation.

The second noteworthy value was for manganese. All samples were far greater than the Philippine standard for agriculture/irrigation by three orders of magnitude. The values are about 900 mg/l for the Dizon Dam reservoir and around 300 mg/l for the whole portion of Mapanuepe Lake though the Philippine standard for agriculture and irrigation was limited to 0.2 mg/l. It, also, would be harmful for fishery though there is no water quality standard for fishery, recreation and industry.

The third noteworthy value was for lead. All samples were greater than the Philippine standard for fishery. The Japanese environmental standard for rivers is 0.01 mg/l and the standard for freshwater fish is 0.001mg/l. For fear of lead poisoning, the Mapanuepe Lake water should not be used for irrigation or fishery without prior treatment.

The fourth noteworthy value was for copper. The Philippine standard for fish is exceeded in seven of the ten values. Compared to the Japanese standard for rice growing, 0.02 mg/l[1], all values are exceeded. Due to the toxicity of copper to fish and to rice, again the Mapanuepe Lake water should not be used without prior treatment.

The pH levels at the Mapanuepe Lake were between 6.02 and 6.65 which would be considered somewhat low. The Dizon Dam pH was measured to be 3-4 and would be considered abnormally low for natural waters. Commonly, a value below 5 would indicate that some external factor is influencing the pH. In this case, the dam tailings would be the major suspect, while the eruption material and natural geology may also have some effect but to a lesser degree. A low pH is significant because it could cause an increase in concentration of metals, as the water would ionize the metal solids contained in the bottom material. This may be part of the reason for the high concentrations of mercury, iron, manganese, zinc, lead and copper.

[1] 'Mizu Syori Binran' (Water Treatment Handbook, in Japanese) , Maruzen Publications.

15.8.4 Conclusions for the Feasibility Study

The laboratory results indicated that seven parameters exceeded Philippine standards for fishery and irrigation at the Dizon Dam and four parameters exceeded standards in the Mapanuepe Lake. Of the exceeded results, the results for mercury, lead and copper showed cause for concern. Only two samples contained mercury but the values were abnormally high. All samples contained manganese, lead and most of the samples contained copper. Apart from the above three parameters, levels of zinc were also found to be high.

Based on the discussion in the preceding sections, it can be said that the sampled area is not typical of that in natural river water, indicated by the relatively low overall value of pH. Since there are no municipal or industrial discharge sources in the area, it can be said that the high values are caused by a combination of the Dizon Copper Mining Dam tailings, the erupted material and the background geology.

Based on the results, it is recommended that the Mapanuepe Lake not be utilized for irrigation, fish hatchery or recreation. The detected results are extremely high for mercury, manganese, lead and copper.

Since the samples were taken only once, and since some inconsistency was noted in the results, it is recommended that additional sampling and laboratory analysis be conducted. It would be preferable to conduct sampling at short regular intervals, say monthly or even bi-weekly, in order to detect any seasonal trends. In addition, it would be desirable for the laboratory to acquire a measuring device that has a lower detection limit for mercury than that used during the survey.

Another recommendation is that a regular health check for the people residing around the Mapanuepe Lake should be conducted. It is a worry that heavy metal contained in the water might be accumulated in the human body through food / water, which may be affected by the water quality. Also a regular examination of fish and crops in and around the lake is recommended.

If the results are verified, and if it is still desired to use the water for irrigation, fish hatchery or recreation, treatment prior to use would be required. In such cases, chemical treatment such as flocculation or precipitation removal would be required. Such treatment processes are generally expensive and would not be economically justified. Under the financial conditions, it may be preferable to let the concentration values decrease over time.

15.9 Community Road Development in Mountain Area

15.9.1 Proposed Community Road Rehabilitation Network

Figure 15.9.1 shows the proposed community road rehabilitation network. Three routes are identified in the master plan as follows:

(1) Route-A

A community road for the Upper Bucao area is proposed from Sitio Baquilan of Barangay Malomboy to Barangay Nacolcol / Moraza in the foothills of Mount Pinatubo along the Upper Bucao / Balin-Baquero Rivers. The total length of the proposed community road is 48 km. At 16 km from the starting point, the Poonbato Bridge crossing over the Upper Bucao River is planned. The bridge existed before the eruption, but it was completely buried in 1991 due to thick deposition of lahar flow after the eruption.

In the plan formulation the section is divided into two parts; one is from Sitio Baquilan to the

Poonbato Bridge as Route-A1 for 16 km and the other is from Poonbato Bridge to Barangay Nacolcol/Moraza as Route-A2 for 32 km.

There are seven barangays along the community road with a total registered population of 11,079 as shown in the following breakdown:

Seven Barangays along Community Road, Route- A

No.	Barangay Name	Population
1	Malomboy	3,598
2	Poonbato	2,487
3	Burgos	591
4	Maguisguis	1,437
5	Nacolcol	377
6	Villar	1,977
7	Moraza	612
	TOTAL	11,079

All the residents in the above seven barangays were moved to resettlement centers after the eruption of Mount Pinatubo. Currently, about 10% of them have permanently returned to their original barangays, and about 50% of them are settled in the resettlement centers but are seeking for livelihood in the original barangays.

As there is no community road connecting from the town center, the communities are accessible only by foot or carabao cart. It takes three hours to Poonbato, five hours to Burgos, eight hours to Maguisguis and Villar, and ten hours to Moraza and Maguisguis during the dry season. The proposed road would make shorter the access time to two-thirds through Route-A1, and one-third through Routes A1 and A2.

The community road is designed as a gravel road 4 m wide, and additional shoulder width on the mountain slope of 2 m to provide passage way in the event of small scale slope failures.

(2) Route-B

A community road is proposed from the town proper of Barangay Santa Fe on the right bank of the middle reach of Sto. Tomas River to Sitio Buag in the Aeta community. The total length of the proposed community road is 14.9 km along the Santa Fe River, which is a tributary of the Sto Tomas River.

There are four pure Aeta communities along the proposed route-B with a total population of about 1,000. There is no vehicle passable road from the town proper of Santa Fe to the Aeta communities, and the Aeta people usually gain access by walking to the town proper for marketing their mountain products. The following are the features of four communities along the proposed road, Route-B:

Features of Four Communities along the Proposed Road, Route-B

No.	Name of Aeta community	Nos. of HH	Travel time to town proper
1	Sitio Baluwet	52	90 min.
2	Sitio Banaba	32	120 min.
3	Sitio Buag	20	270 min.
4	Sitio Bacsil	18	180 min.
	TOTAL	132	

The proposed community road can make the travel time drastically shorter by means of jeepney. From the town proper of Santa Fe to Sitio Buag, it takes 4.5 hours by foot for 15 km, which can be less

than one hour by jeepney or normal truck. Upgrading social services, such as establishment of elementary school, periodical medical care, provision of agricultural technology and guidance in the remote Aeta communities is expected through construction of the community road Route-B.

The community road is designed as gravel road 4 m wide. In addition, a 2 m shoulder on the mountain slope side is provided to avoid disconnection by small slope failures. The maximum gradient was set at 10% so that the use of public vehicles such as jeepney and normal trucks is possible.

(3) Route-C

Community road, Route-C, is proposed from Sitio Palayan of Barangay San Rafael to Sitio Kahapa of Barangay Aglao in San Marcelino municipality. The total length of community road on Route-C is 45 km along the Sto. Tomas River and Mapanuepe Lake. There are three barangays, San Rafael, Aglao and Buhawen and 11 Aeta communities (Sitio) along Route-C.

The followings are the features of the four communities along the proposed road, Route-C:

Features of Four Communities along the Proposed Road, Route-C

No.	Barangay	Population	No.	Aeta Community	Nos. of HH
1	San Rafael	1,523			
			1	Sitio Lawin	78
			2	Sitio Itanglew	42
2	Aglao	2,365			
			3	Sitio Dalanawan	69
			4	Sitio Ibad	33
			5	Sitio Cuartel	36
			6	Sitio Kahapa	20
			7	Sitio Pawen	32
3	Buhawen	2,424			
			8	Sitio Silbang	52
			9	Sitio Lumibao	32
			10	Sitio Camalca	44
			11	Sitio Sayasay	21
	TOTAL	6,312			459

Of the whole section of community road, Route-C, the section of 22 km from San Rafael to the Dizon mine tailing dam is trafficable by vehicle. School teachers commute to the center of Barangay Buhawen by chartered jeepney from the town proper of San Marcelino. The remaining section from the Dizon Dam to Sitio Kahapa of 23 km is the proposed new route, which passes through Sitio Camalca, Lumibao, Ibad, Cuartel and Kahapa for 165 Aeta families. The present transportation there is generally by means of banca to cross the Mapanuepe Lake, or by foot crossing the Marella River to Barangay Santa Fe.

The community road is designed as a gravel road 4 m wide. In addition, a 2 m shoulder on the mountain slope side is provided to avoid disconnection by small slope failures. The maximum gradient was set at 10% so that public vehicles such as jeepney and normal trucks can travel on it.

15.9.2 Feasibility Design for Community Road Development

(1) Design Condition

Preliminary design for community road development was conducted under the following assumptions:

1) Road Width: Travel way width: 4 m
Total width: 8 m

2) Bridge Width: Travel way width: 4 m
Total width: 5 m
(Baquilan Bridge on Route-A1: 9.54 m: DPWH Standard)
3) Maximum vertical gradient: 10%
4) Road surfacing: 200 mm thick gravel surfacing.
5) River crossing structures:
Design flood < 500 m^3/s: Causeway
Design flood > 500 m^3/s: Bridge
6) Retaining wall: To be provided on mountain slopes steeper than 1:1.

(2) Cost Estimate

A cost estimate for community road development was carried out under the following assumptions:

1) Items for cost estimation were as follows:
a) Gravel surfacing including earth works,
b) Structural works including bridge and spillway
c) Structural works for retaining wall
2) The unit rates were set for the three items with consideration of adjustment factors based on the existing condition of the road.
3) Cost for Item 1: Gravel surfacing including earth works,
a) Unit Rate (Pesos/km) = Basic Unit Rate (Pesos/km) x Road Factor x Topo. Factor
b) Basic Unit Rate = P434,782 /km (JPY1,000,000 / km)
c) Road Factor:
i) New road: 1.0
ii) Improvement to a vehicle passable road from footpath: 1.0
iii) Improvement of vehicle passable road (W<3.0 m) 0.9
iv) Improvement of vehicle passable road (W>3.0 m) 0.8
d) Topo. Factor: based on the cross sectional slope.
4) Unit Cost for Item 2: Bridge and Spillway
a) Unit Rate (Pesos/m) = Basic Unit Rate (Pesos/km) x Type Factor x Width factor x Span factor x Road Width
b) Basic Unit Rate = P43,478 /m (JPY 100,000 / m) for unit rate of 30m span, 9.54 m width of bridge)
c) Type Factor:
i) Bridge: 1.0
ii) Causeway: 0.5
5) Unit Cost for Item 3: Retaining Wall
a) Unit Rate (Pesos/m) = Basic Unit Rate (Pesos/km) x Topo. Factor
b) Basic Unit Rate = P21,739 /m (JPY 10,000 / m) for 5 m height of wall

The project cost for each route was estimated based on the above assumptions. The results are summarized as follows:

Summary of Cost Estimate for Community Road Development

(Unit: Million Pesos)

No.	Work Item	Route-A1	Route-A2	Route-B	Route-C	Total
	Length	16.0 km	32.0 km	14.9 km	44.9 km	107.8 km
1	Road Improvement	64.9	131.7	56.0	183.0	435.8
2	Bridge	53.4	331.3	23.9	131.5	540.2
3	Causeway	0.0	57.7	6.5	14.1	78.4
4	Retaining Wall	0.0	0.0	0.0	94.5	94.5
5	Total of Civil works	118.3	520.9	86.5	423.2	1,149.0
6	Engineering Services	35.5	156.2	25.9	126.9	344.7
7	Contingency (10%)	15.3	67.7	11.2	55.0	149.3
8	Sub-Total (5+6+7)	169.2	744.9	123.7	605.2	1,643.1
9	Price Escalation (4%)	19.9	87.8	13.9	56.3	178.0
10	Project Cost	189.1	832.7	137.7	661.5	1,821.1

Total project cost for community road development is estimated at 1,821 million Pesos, considering the civil work cost, engineering services, physical contingency, and price escalation.

15.9.3 Priority Route for Community Road Development

Among the three routes of proposed community road development, it is proposed that the following routes shall be given priority for development:

1) Route-A1: Sitio Baquilan – Poonbato Bridge site (Bucao River): L=16.0 km

2) Route-B : Santa Fe town proper – Sitio Buag (Santa Fe River): L=14.9 km

For Route-A-1 and A-2, the beneficial barangays are the basically same, which would be all barangays in the upstream of the Bucao River basin. Route-A1 is to extend from the end of the existing road for 16 km upstream, by which the access time from the target barangays to the town proper of Botolan municipalities would be much decreased by more or less 3 hours. As the construction cost of Poonbato Bridge, which shares about 50% of the civil work cost of Route-A, is rather expensive it is recommended that the downstream section from the Poonbato Bridge be developed as the first step.

For Route-B, there will be no big structures required to develop a vehicle passable community road. It is highly expected that the area will be used for the development of community-based forest management, and improvement of the accessibility to the forest site would enhance the effects of the project. Accordingly, it is proposed that Route-B shall be implemented after construction of Route-A.

For Route-C, the section from San Rafael to Dizon Dam of 22 km is currently passable by vehicle, and no remarkable benefit is expected for the communities between San Rafael and Buhawen. In the communities between Dizon dam and Sitio Kahapa, the people generally take a shortcut access across the Marella River to Santa Fe when they visit the town proper of San Marcelino, which would be a much shorter distance than a proposed Route-C. Also, the people living around the Mapanuepe Lake usually use banca to travel to the town proper. Considering the current way the people are travelling, Route-C would be less effective for them. Therefore, route-C is not recommended for inclusion in the priority route for development.

15.10 Establishment of Aeta Assistance Station (AETAS)

15.10.1 Project Formation

For the implementation of assistance activities for the Aeta Tribe, a discussion with the related NGOs, as well as NCIP (National Commission on Indigenous People) was conducted. The Foundation of Cultural Survival Inc. (FOCUS), an NGO in the Philippines particularly established to support indigenous people, is a partner of the study team to assess the matters concerning the Aeta Tribe affected by the disasters related to the eruption of Mount Pinatubo.

It is recommended that the implementation of AETAS be under the leadership of the NGOs, and the government and donor agencies should support the activities of the NGOs in terms of technical and financial aspects, for the following reasons:

1) Various activities for supporting Aeta People in the study area were found which are basically operated by NGOs. Many of them, however, are limited activities because of insufficiency of available funds as well as lack of technical know-how,
2) In the Aeta communities in the remote mountain areas, some NGO volunteers stay for the long-term and their activities are effective in supporting the Aeta community. Because of the long-term relationship between the Aeta community and the NGOs, the Aeta people highly respect / appreciate the volunteers from the NGOs. Based on the existing relationship between the Aeta community and the NGOs, they are the right people to act, based on their own program.

In the course of the study, a proposal from FOCUS was submitted to the study team for assisting their program, which is quite similar to the AETAS proposed by the study team. As a result of the frequent discussions with FOCUS, it is recommended that the FOCUS AETAS Project be defined as the first step for establishment of AETAS (AETAS, Phase-1) to recover and preserve the cultural heritage of the Aeta Tribe in Mount Pinatubo.

15.10.2 Details of the Project

The components of AETAS Phase-1 are as follows:

1) Improvement of Upland Entrepreneurship School of Aeta
2) Assistance in Ancestral Land Protection, Development and Management Activities
3) Detail Study for establishment of Aeta Cultural Heritage (AETAS)
4) Assistance in Aeta Health, Nutrition and Livelihood Program.

The details are described as follows:

1) Improvement of Upland Entrepreneurship School of Aeta

The proposed Upland Entrepreneurship School has been started as Aeta Farm School. This 5-month training course is a joint project with the Ramon Magsaysay Technological University (RMTU), Department of Agriculture (DA), Provincial and Municipal Offices, Agricultural Training Institute (ATI), Department of Science and Technology (DOST) and Bahay-Kubo. The main objective of the school is to transfer Slope Agriculture Land Technologies (SALT) to the Aeta Students, and to increase their farm income by 50% after 3 years.

Improvement and operation of the Upland Entrepreneurship School is estimated at about 2 million Pesos.

2) Ancestral Land Protection, Development and Management Activities

Security of habitat is a crucial factor in the life and cultural survival of the Aetas. As a land-based

people they derived their principal source of subsistence from their environment and its resources. As for the Pinatubo Aetas, they find security and a sense of belonging in the land of their ancestors.

However, the hold of Aetas on their land has always been tenuous. The ever-increasing pressure of lowland population on upland areas has resulted in considerable loss of Aeta land to outsiders. Now, with the passage of R.A.8371, otherwise known as the Indigenous People's Right Act, which recognizes the rights of indigenous people to their ancestral land, the prospect of ensuring secure habitat has gained a new momentum, but the full implementation of the law is painstakingly slow and in many cases obstructed.

However, the acquisition of ancestral land title by itself is not enough. Equally important is the need to set up sustainable development and management plans and to undertake training in management and leadership skills to ensure that the resources of their domain are fully utilized for their benefit and that they are protected for future generations. This is where NGO's such as FOCUS can play significant roles in bringing their experience, resources, and commitment to complement government efforts, or in many cases, to initiate the necessary action to get the process going.

Activities under this program are then as follows:

a) To obtain a CADT for the 5,000 ha, Negrito Reservation in San Marcelino by year 2005 in cooperation with NCIP,
b) To develop a 200 ha reforestation in order to prevent further erosion of reservation land and to restore its ecological balance,
c) To establish a 2 ha herbal plantation in Baluwet in partnership with ACTION (Japanese NGO),
d) To develop a 1 ha expansion of the mango plantation in Kanaynayan.

The cost for this activity is estimated at 10 million Pesos for 5 years.

3) Detailed Study for establishment of Aeta Cultural Heritage (AETAS)

The culture of the Aetas constitutes part of the rich and colorful mosaic of Philippine culture. It is a product of hundreds and thousand of years of adaptation and thus represents a unique living record of the human experience. The loss of such a culture due to the impact of modernizing changes constitutes a loss in cultural heritage of the Philippines.

As the original inhabitants of the Philippine Archipelago, the Aetas deserve a better understanding and appreciation of their unique culture. That they have managed to live well in relative isolation in a difficult environment for thousand of years must say something about their strategy for survival from which something can be learnt. It is for this purpose that the promotion of Aeta cultural heritage takes on relevance.

The objective of the program is to spark the revival of Aeta cultural heritage by establishing an "AETAS" in Zambales over the next 5 years to showcase Aeta life and culture, through cultural performances, festivals, and a library of living tradition.

A detailed study and investigation will be included in this program. The estimated cost for the study is 1 million Pesos.

4) Aeta Health, Nutrition and Livelihood Program.

The issue of health and sickness is a paramount concern among Aetas given their geographical isolation and distance from the government health facilities. The infant mortality rate is high and so is malnutrition among Aeta children. This is due in large part to food inadequacy and a shift in diet from traditional root crop-based staple food to rice which they cannot raise in sufficient quantities. Rice is always in short supply. They sell their farm produce to buy rice in the town market.

At the Kanaynayan Aeta Resettlement in Castillejos, Zambales, the HOPE Foundation International have established the first Aeta Hospital in the country. This has become the base of operation of their yearly HOPE medical mission covering nearly all Aeta communities in Zambales. The Kanyanayan Health Center is the base of operation of the FOCUS Health, Nutrition, and Livelihood Project. Its program will focus on health education among nursing mothers and school children. It seeks to promote the use of herbal medicines which is an integral part of their indigenous knowledge. A livelihood program is integrated into the project to provide opportunities for income generation among the resettlement Aetas. The cost estimate to implement this program is about 1.5 million Pesos.

CHAPTER 16 CONSTRUCTION PLAN AND COST ESTIMATE OF PRIORITY PROJECTS

16.1 Construction Plan and Schedule of the Bucao River Dike Heightening/Strengthening

The dike locations, types, length, and estimated embankment volumes for construction are summarized below. No rock excavation will be required in the work.

Dike Locations, Types, Length, and Estimated Embankment Volumes

Location	Type	Length (m)	Embankment Volume (m^3)
Bucao Bridge abutment, left bank	New Dike	170	37,300
Downstream of Bucao Bridge, right bank	New Dike	2,350	351,700
Downstream of Bucao Bridge, left bank	New Dike	1,910	217,100
Upstream of Bucao Bridge, right bank	Dike Heightening	5,800	1,096,000
Upstream of Bucao Bridge, Baquilan area	Dike Heightening	1,650	93,200
	Dike Strengthening	200	8,000
Total		12,080	1,803,300

Staged implementation in order from the river mouth toward upstream is normally proposed for river improvement works. However, the need for river improvement depends on local factors, such as the height of the existing dikes with different degrees of overtopping risk, the number of residents and value of properties to be protected from inundation. Therefore, the following sequence of construction is provided as one of choice.

1) The Bucao Bridge abutment, left bank, and this part will be constructed at the time of bridge construction so that the abutment and approach road of the new bridge will be protected
2) Upstream of the Bucao Bridge, right bank
3) Downstream of the Bucao Bridge, right bank
4) Downstream of the Bucao Bridge, left bank
5) Upstream of the Bucao Bridge, Baquilan area, right bank

(1) Production Rate

Using conventional equipment available for the project, the monthly production rate of each group has been determined as follows:

Monthly Production Rate

Group	Name	Capacity	nos.	Monthly Production (m^3)
A	Tractor Shovel	2.1 m^3	1	19,100
	Dump Truck	12 t	4	
B	Backhoe Shovel	1.0 m^3	1	13,100
	Dump Truck	10 t	4	

(2) Construction Time Schedule

The construction time schedule for the Bucao River dikes is shown in Figure 16.1.1.

In the rainy seasons, more precisely from middle May to middle October, it is considered not practical to carry out any work, even dike protection work, because maintenance of the temporary roads for transporting construction materials as well as finishing the slopes of the embankment would be difficult. A construction period of four years (three dry seasons) will be appropriate for this type of construction, based on the required average monthly production of 100,000 m^3 in the embankments and this equates to 670 m in length. In order to relax site congestion, about three different dikes should

be constructed simultaneously with monthly production from 30,000 to 60,000 m^3 of embankment at each dike and this corresponds to 200 m to 300 m in length.

Therefore, depending on the required monthly embankment volume for each dike, a combination of Group A and Group B, with the necessary number of sets each, need to be employed for the work.

(3) Construction plant and equipment

Major construction plant and equipment with its approximate size and numbers to be used for this project are listed in the following table. Exact numbers of fleet vehicles will be determined with the required individual work volume.

Major Construction Plant and Equipment

No.	Name	Size	Nos.	Remarks
Embankment				
1	Wheel loader	2.1 m^3 class	4	Excavation / loading
2	Backhoe shovel	1.0 m^3 class	2	Excavation / loading / trimming
3	Dump truck	10 - 12 ton class	20 - 30	Hauling / embankment
4	Bulldozer	28 ton class	3	Bulldozing / grading
5	Bulldozer	21 ton, swamp	2	Bulldozing / grading
6	Vibration roller	10 ton class	3	Compaction
7	Motor grader	3.1 m class	2	Grading
8	Water sprinkler	10 m^3 class	1	Watering
Other works: Borrow soil, minor excavation, etc.				
9	Backhoe shovel	0.7 m^3 class	2	Excavation / loading
10	Bulldozer	21 ton class	3	General purpose
11	Trailer	20 ton class	1	Transportation of Equipment
12	Dump truck	10 ton	20 - 30	Hauling
13	Motor grader	2.7 m	1	Grading
14	Backhoe shovel	0.3 m^3 class	3	Miscellaneous

16.2 Construction Plan and Schedule of the Sto. Tomas River Dike Construction/ Heightening /Strengthening

The dike locations, types, lengths, and estimated embankment volumes for construction are summarized below. No rock excavation will be required with the work.

Dike Locations, Types, Length, and Estimated Embankment Volumes

Location	Type	Length (m)	Embankment Volume (m3)
D/s of Maculcol Bridge, right bank	New Dike	1,950	77,100
D/s & U/s of Maculcol Bridge, left bank	Strengthening	2,800	257,900 (excavation)
U/s of Maculcol Bridge, right bank	Dike Strengthening	3,100	35,800
	Dike Heightening	4,300	393,200
U/s of Maculcol Bridge, left bank	Dike Heightening	9,000	498,800
	Dike Strengthening	8,000	569,100
Total		29,150	1,831,900

Staged implementation in order from the river mouth toward upstream is normally proposed for river improvement work. However, the need for river improvement depends on local factors, such as height of existing dikes with different degrees of overtopping risk, number of residents and value of properties to be protected from inundation. Therefore, the following sequence of construction is

proposed as one of choice.

1) Upstream of the Maculcol Bridge, right bank, up to Paete Hill, dike heightening of 4,300 m
2) Upstream of the Maculcol Bridge, left bank, up to Vega Hill, dike heightening of 9,000 m
3) Upstream of Vega Hill, left bank, dike strengthening of 8,000 m
4) Downstream of the Maculcol Bridge, right bank, new dike of 1,950 m together with a diversion channel in the Gabor River, 1,700 m
5) Upstream of the Maculcol Bridge, right bank, dike strengthening of 3,100 m
6) Downstream and upstream of the Maculcol Bridge, left bank, dike strengthening of 2,800 m

Three types of dike construction have been designed for the improvement of the Sto. Tomas River banks. One is construction of a new dike and the remainder are heightening and strengthening of the existing dikes. In addition, a diversion channel in the Gabor River has also been designed.

The new dike is designed for the section where there is no existing dike at present. The dike heightening is applied to the section where the height of the existing dikes is insufficient and the dike strengthening is designed for the section where strengthening of the existing dikes is needed.

The works include embankment with lahar deposits to shape the dike, base concrete at the toe, gabion mattresses with filter cloth, grouted riprap for the riverside slope protection, sodding on borrow soil for the land side slope protection, and gravel pavement on the top of the dike. Removal of the existing grouted riprap is required before commencement of the embankment in the case of dike heightening where applicable.

An abundant supply of lahar deposits near the construction site will be utilized as much as possible for the embankment.

In general, the construction works will be carried out by a combination of earthmoving equipment such as wheel loaders, backhoe shovels, dump trucks, bulldozers, and vibration rollers. Considering the size of the project and hauling distances, motor scrapers can be used if their mobilization and maintenance are reasonably secured.

(1) Production Rate Study

Using conventional equipment available for the project, the monthly production rate of each group was determined as follows:

Monthly Production Rate

Group	Name	Capacity	nos.	Monthly Production (m^3)
A	Tractor Shovel	2.1 m^3	1	19,100
	Dump Truck	12 t	4	
B	Backhoe Shovel	1.0 m^3	1	13,100
	Dump Truck	10 t	4	

(2) Construction Time Schedule

The construction time schedule for the Sto. Tomas River dike is shown in Figure 16.2.1.

In the rainy seasons, more precisely from middle May to middle October, it is considered not practical to carry out any work, even dike protection work, because maintenance of the temporary roads for transporting construction materials, as well as finishing the slope of the embankments, would be difficult. A construction period of four years (three dry seasons) would be appropriate for this type of construction, based on the required average monthly production of 102,000 m^3 in the embankments and this equates to 1,620 m in length. In order to relax the site congestion , about 3 to 6 different dikes

should be constructed simultaneously with monthly production of 6,000 m^3 to 36,000 m^3 of embankment at each dike, and this corresponds to 360 m to 520 m in length.

Therefore, depending on the required monthly embankment volume for each dike, a combination of Group A and Group B, with the necessary number of sets each, should be employed for the work.

(3) Construction plant and equipment

The major construction plant and equipment, with its approx. size and numbers to be used for this project, are listed in the following table. Exact numbers of fleet vehicles will be determined from the required individual work volume.

Major Construction Plant and Equipment

No.	Name	Size	Nos.	Remarks
Embankment				
1	Wheel loader	2.1 m^3 class	4	Excavation / loading
2	Backhoe shovel	1.0 m^3 class	2	Excavation / loading / trimming
3	Dump truck	10 - 12 ton class	20 - 30	Hauling / embankment
4	Bulldozer	28 ton class	3	Bulldozing / grading
5	Bulldozer	21 ton, swamp	2	Bulldozing / grading
6	Vibration roller	10 ton class	3	Compaction
7	Motor grader	3.1 m class	2	Grading
8	Water sprinkler	10 m^3 class	1	Watering
Other works: Borrow soil, minor excavation, etc.				
9	Backhoe shovel	0.7 m^3 class	2	Excavation / loading
10	Bulldozer	21 ton class	3	General purpose
11	Trailer	20 ton class	1	Transportation of Equipment
12	Dump truck	10 ton	20 - 30	Hauling
13	Motor grader	2.7 m	1	Grading
14	Backhoe shovel	0.3 m^3 class	3	Miscellaneous

16.3 Construction Plan and Schedule for the Bucao Bridge

16.3.1 Construction Plan

The general view of the designed Bucao Bridge is shown in Figure 15.2.8. Taking the site conditions into consideration, general construction procedures will be:-

- Major works will be carried out only in the dry seasons.
- Since the new bridge is designed to be located 15 m downstream and parallel to the existing bridge, no detour of National Road No. 7 will be provided.
- Avoiding disturbance of public transportation on the existing bridge, temporary roads will be built on the riverbed for construction purposes.

(1) Substructure

Abutments and piers are numbered from the left bank to the right bank as shown in Figure 15.2.8.

(a) Pile Foundation

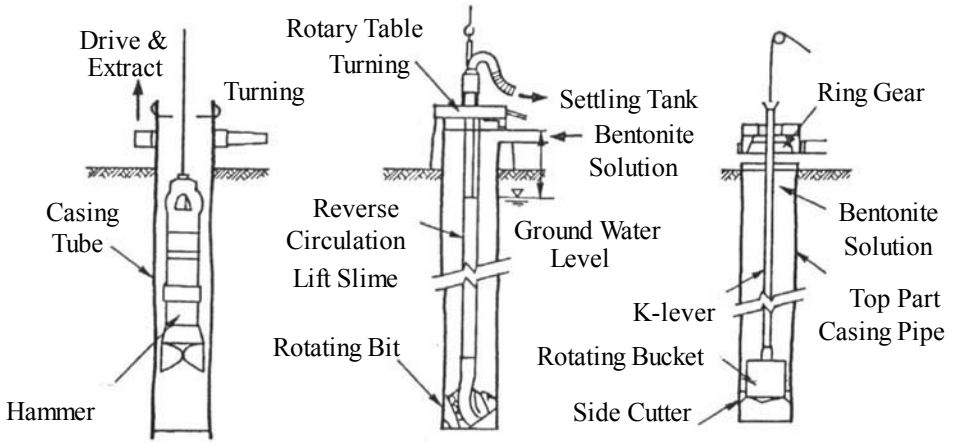
Bored, cast-in-place, concrete piles, with a diameter of 1.2 m, is the design for the foundation piers and abutments. The following table shows the length and number of piles for each foundation.

Length and Number of Piles for Each Foundation

Name of Foundation		Length (m)	Nos.	Total length (m)
Abutment	A 1	18	6	108
	A 2	28	6	168
Pier	P 1	22	6	132
	P 2	22	6	132
	P 3	22	6	132
	P 4	22	6	132
	P 5	22	6	132
Total			42	936

There are three different drilling methods for cast-in-place concrete piles.

- Earth drill method
- Reverse circulation method
- All casing method (Bento pile method)



Considering the site conditions, availability of required equipment, speed and economy as well as the experience in the Philippines, the earth drill method will be employed for this project.

Since the construction site is in the riverbed, the water table is high and the dominant subsoil is lahar (sand), some underground water flow is expected. Maintaining stability of the sidewall of drilled holes is a key issue. The following measures will be taken:

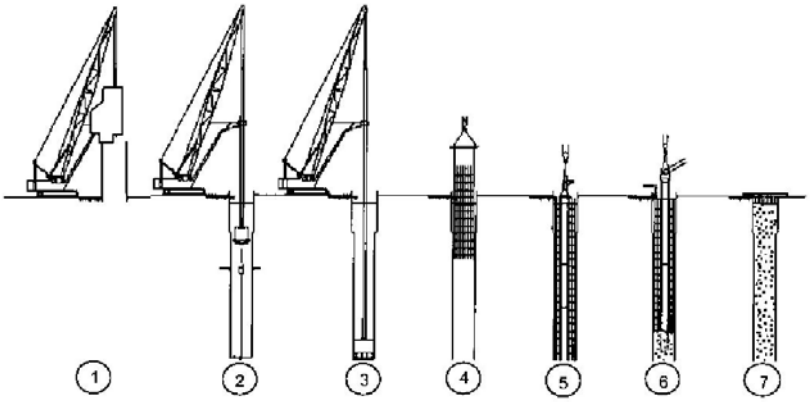
- Use steel pipe casing (a standpipe), approximately 10 m length.
- Keep water head in the casing 1.5 to 2.0 m higher than the ground water level.
- Use stabilization fluid with controlled specific gravity and viscosity. The mud fluid will make thin mud films on the surface of the sidewall and protect the surface from water seeping in or out.

The most common stabilization agent is bentonite.

The general procedure with the Earth drill method, and its illustrations, are as follows:

①. Installation of standpipe by a vibrator
②. Excavation by earth drilling bucket
③. Removal of slime by bucket (1st treatment)

④. Installation of reinforcing steel bar cages
⑤. Removal of slime by air-lift or suction method (2nd treatment)
⑥. Placing concrete by tremie pipe
⑦. Curing



Two working groups will be set up for efficient work through a day and night shift, a 24-hour working system. One group operates the earth drilling equipment for drilling work and the other group with a crane undertakes the installation of a standpipe, installation of reinforcement steel cages and placing the concrete. The earth drilling machine should be used without idling since this is the most critical work item to complete the project in time. It is estimated that the excavation of one pile will take approximately 36 hours, one and a half days, on average and 9 to 12 days per foundation in calendar days. Once excavation is commenced, operation should be continued until completion of placing concrete to avoid a risk of failures in bored holes.

To optimise the use of bentonite and to care for the environment, bentonite treatment plant will be provided on site.

For quality assurance, it is important to carry out proper supervision of the work and also to conduct bearing tests for the cast-in-place piles. The latter is because, for some activities, it is difficult to check if the work is carried out properly during construction, in particular the treatment of slime at the bottom of piles.

(b) Footing

This will generally become mass concrete so steady and proper concrete placement will be required to avoid forming “cold joints”.

(c) Piers and Abutments

Piers have been designed with two columns and abutments are to use the reversed T type cross section. Careful concrete placement will be required, in particular because some anchors for the superstructure will be embedded in the beam support.

(2) Superstructure

Since the height from the ground to the soffit of the steel plate girder is approximately 10 m and the erection site is accessible by mobile crane via a temporary road in dry seasons, the erection by truck crane using a bent method will be the most economical choice.

The extruder method can be used in the rainy seasons but this will normally require more time and

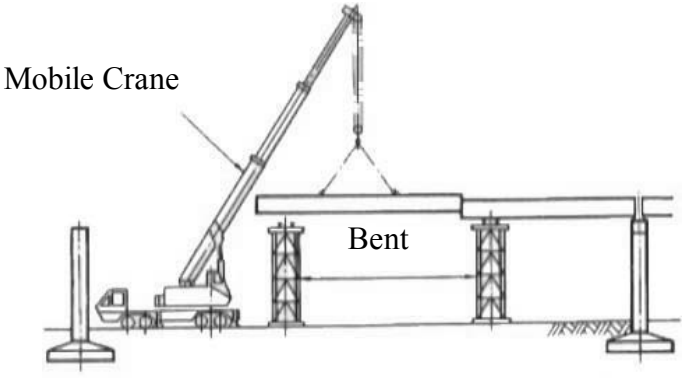
space.

(a) Prefabrication

Steel plate girders will be transported to the site by trailers in about 10 m long pieces. These will be prefabricated to about 20 m in length before erection.

(b) Erection

The prefabricated steel plate girders will be lifted on to the top of bent by a hydraulic truck crane or crawler crane of 120 t capacity on the temporary road. The lifting capacity is determined on the assumption of: 12 ton block weight and 10 m working radius. The bent will be a steel support structure. An image of the erection method is as illustrated as below.



Steel material is designed with non-paint type finish and, therefore, no painting is required on site.

(c) Slab and Pavement

The sequence of placing concrete for the deck slab should be arranged to avoid making cracks over the piers due to change of moment and stress during construction.

(3) Approach Road

The construction of an approach road will be carried out simultaneously with the construction of the bridge. Because an embankment approx. 10 m high is required, an earlier start on the embankment work is preferable so there is less settlement after completion of the project.

(4) Safety Control

The safety management code on site should be established and safety ropes, hats and life belts should be provided and issued to everyone who will go to higher positions so as to protect their lives.

(5) Removal of Existing Bridge

The existing bridge will be removed, only after completion of the Bucao Bridge and after it has been used for a period. Therefore, this work will be carried out separately in the following dry season.

16.3.2 Construction Schedule

The proposed construction time schedule for the Bucao Bridge is shown in Figure 16.3.1.

Right after the rainy season, construction of abutment A1, left bank - Manila side of the bridge - should be commenced because this foundation is located at the highest place and the designed pile

length is the shortest.

A construction period of two years is considered appropriate for this type of bridge construction. However, full use of two dry seasons is the key for completing the project on time. Therefore, some preparatory works have to be carried out in the rainy season to get ready to commence the foundation pile drilling in full force from the beginning of dry season.

16.4 Cost Estimate

16.4.1 Constitution of Project Cost

The project cost is estimated for three major sectors, i.e. (1) Structural measures for Sabo and Flood Control (2) Non-structural measures and (3) Community-Based Disaster Prevention measures, which are subdivided as follows:

(1) Structural measures for Sabo and Flood Control
   i) Bucao River Basin
   ii) Sto. Tomas River Basin

(2) Non-structural measures
   i) Flood / Mudflow Warning System
   ii) Evacuation System

(3) Community-Based Disaster Prevention measures
   i) Community-Based Forest Management
   ii) Agricultural Development on the Lahar area
   iii) Community Road Rehabilitation
   iv) Establishment of the Aeta Assistance Station

The project cost of each sub item consists of the following components:

(1) Construction Cost
(2) Land Acquisition and Compensation
(3) Administration and Engineering Services Cost
(4) Contingency
   i) Physical Contingency
   ii) Price Contingency

16.4.2 Conditions and Method of Cost Estimate

(1) Construction Cost

The construction cost is basically estimated on a unit price basis by multiplying the work quantity by the unit price.

The unit prices of construction work on the sabo and flood control structure have been determined with reference to prevailing unit prices which were collected from ongoing similar projects in Pampanga and Pangasinan provinces. The unit prices of five contract packages of the Pinatubo Hazard Urgent Mitigation Project, Phase II and two contract packages of the Agno River Flood Control Project, Phase II were referred to. As the price level of the ongoing similar projects was in the

year of 2001 mostly and that of this study is September 2002, the unit prices obtained from those projects were adjusted by price inflation rates for one year. Annual inflation rates of 2% for the foreign currency portion and 4% for the local currency portion were applied, considering the recent inflation trend (for details refer to Appendix I). Taxes and duties are included in the local currency portion of the unit prices. Table 16.4.1.shows applied unit prices, which are expressed in Philippine Peso and divided into a local currency portion and a foreign currency portion according to the following composition presented by NEDA.

	Local portion	Foreign portion
(i) Material		
a. Cement, Fuel& Lubricant	30%	70%
b. Aggregate & Lumber	60%	40%
c. Steel	20%	80%
d. Others	50%	50%
(ii) Machinery & Equipment Rental	30%	70%
(iii) Labor	100%	0%
(iv) Indirect costs	100%	0%

The cost of general items, including miscellaneous items, is estimated on a lump sum basis, which is assumed to be 10% of the sum of the construction costs estimated on the unit price basis. Data obtained from ongoing similar projects show 8% on average for the general items as presented in Table 16.4.2.

(2) Land Acquisition and Compensation Cost

The cost estimate for land acquisition and compensation is based on the cost data obtained from the Bureau of Internal Revenue for the zonal valuation of land and village information gathered in the field. Data obtained from the field was applied for this study as shown in Table 16.4.3.

(3) Administration and Engineering Cost

The administration and engineering costs required for project implementation were estimated on a lump sum basis. These were assumed to be 3% of the construction cost for government administration, 6% of the construction cost for the detail design and 10% for construction supervision as the engineering services cost, which are based on the DPWH standard.

(4) Contingency

Price contingency until the completion of the project was estimated using annual inflation rates of 4% for local currency and 2% for foreign currency. For physical contingency, 10% of construction cost for each item is applied.

16.4.3 Project Cost for Sabo and Flood Control Structure

The construction cost based on the feasibility design is estimated at P1,035 million for the Bucao River basin including P341 million for the cost of Bucao bridge replacement and P1,192 million for the Sto.Tomas River basin, of which detail breakdowns are shown in Table 16.4.4 for the Bucao River basin and Table 16.4.5 for the Sto. Tomas River basin, respectively. From tables the construction cost of each structure is summarized as follows:

Construction Cost for Each Structure

No.	Description	Amount (xP1,000)
1	Bucao River Basin	
(1)	Dike construction	690,624
(2)	Maintenance road	2,790
(3)	Bucao bridge replacement	341,086
	Total (1)	1,034, 500
2	Sto. Tomas River Basin	
(1)	Dike construction	1,125,598
(2)	Diversion channel	63,539
(3)	Maintenance road	2,991
	Total (2)	1,192,128
	Grand Total (1 to 2)	2,226,628

Based on the field investigation and the unit price given in Table 16.4.3, the cost of land acquisition and compensation is estimated at P82.9 million in totals of which summary is given in Table 16.4.6.

Detail calculation for the cost of land acquisition and compensation is presented in the report of Resettlement Plan prepared for this study.

Based on the construction cost, the government administration cost, engineering services cost and contingency are calculated as a lump sum basis. Thus, the project cost is estimated at P1,678 million for the Bucao River basin and at P1,960 million for the Sto. Tomas River basin, as shown in Tables 16.4.7 and 16.4.8, respectively, which are summarized as follows:

Project Cost

(Unit: 1,000 Pesos)

No.	Description	LC	FC	Total
1.	Construction cost of civil works			
	Bucao River basin	551,281	483,219	1,034,500
	Sto. Tomas River basin	687,044	505,085	1,192,128
2.	Land acquisition & compensation			
	Bucao River basin	44,878	0	44,878
	Sto. Tomas River basin	37,988	0	37,988
3.	Administration			
	Bucao River basin	31,035	0	31,035
	Sto. Tomas River basin	35,764	0	35,764
4	Engineering service cost			
	Bucao River basin	88,205	77,315	165,520
	Sto. Tomas River basin	109,927	80,814	190,741
5	**Sub Total**			
	Bucao River basin	**715,399**	**560,534**	**1,275,933**
	Sto. Tomas River basin	**870,723**	**585,899**	**1,456,621**
6	Price contingency			
	Bucao River basin	182,428	67,101	249,529
	Sto. Tomas River basin	245,391	79,459	324,850
7	Physical contingency			
	Bucao River basin	89,783	62,763	152,546
	Sto. Tomas River basin	111,611	66,536	178,147
8	**Total**			
	Bucao River basin	**987,609**	**690,399**	**1,678,008**
	Sto. Tomas River basin	**1,227,726**	**731,894**	**1,959,619**
9	**Grand Total**	**2,215,335**	**1,422,293**	**3,637,627**

Assuming an annual progress of construction works from the construction schedule, disbursement schedule of project cost is produced as shown in Table 16.4.9 for the Bucao river basin and Table 16.4.10 for the Sto. Tomas River basin. The tables show that if the replacement of the Bucao Bridge is expected to commence in the year of 2005 and the construction works of both river basins are expected to commence in the year of 2007, the annual disbursement is indicated as follows:

Annual Disbursement

(Unit: Million Pesos)

Project	Currency	2004	2005	2006	2007	2008	2009	2010
Bucao	LC	0	65	136	230	191	198	167
	FC	0	45	99	189	124	127	105
	Total	0	110	235	419	315	325	272
Sto. Tomas	LC	0	0	62	258	327	340	240
	FC	0	0	19	147	208	212	146
	Total	0	0	81	405	535	552	386
Total	LC	0	65	198	488	518	538	407
	FC	0	45	118	336	332	339	251
	Total	0	110	316	824	850	877	658

16.4.4 Project Cost for Non-Structural Measures

(1) Flood/Mudflow Monitoring & Warning System

The flood/mudflow monitoring & warning system consists of (i) 11 stations of observatory system, (ii) four sites of monitoring system and (iii) 35 warning posts, of which cost is estimated for the purchase cost and installation cost of equipment. Major equipment to be required for the system includes the following equipment:

Observatory system:	Rainfall gauge
	Water level gauge
	Cellular phone system
	Power supply unit
Monitoring system:	Computer with soft ware
	Cellular phone system
	UPS
Warning post:	Panzer mast
	Siren
	Power supply unit

Based on the prevailing market price of the above equipment, supply and installation cost is estimated at P33,559 thousand in total, for which a breakdown is listed in Table 16.4.11.

For implementation of the project, the government administration cost and engineering services cost is estimated at P1,007 thousand and P40,035 thousand, respectively. Thus, as shown in Table 16.4.12, the total project cost is estimated at P82,061 thousand including 10% of contingency. The detailed calculation of the estimate is presented in the supporting report: Appendix VIII. The project cost is summarized as follows:

Project Cost

(Unit: 1,000 Pesos)

No.	Description	Amount
1	Supply and installation cost	33,559
2	Administration cost	1,007
3	Engineering services cost	40,035
	Sub total	74,601
4	Contingency	7,460
Total		82,061

In the course of the feasibility study, however, it was recommended that the existing warning system be improved prior to establishment of the above GSM warning system. The initial investment cost for improvement of the existing warning system will be Zero, and it will require about 2 million pesos for annual operation cost.

(2) Evacuation Center

As discussed in Chapter 9, 36 existing schools need to be renovated and sixty evacuation centers have been selected for the priority development scheme.

Referring to the prevailing price of building construction and land acquisition collected from the district office and similar projects as shown in Table 16.4.13, the construction (initial stage) and renovation cost is estimated at P322.4 million. Table 16.4.14 shows the construction cost summary for the evacuation center.

Based on the construction cost, the project cost is estimated at P422 million including the government administration cost, engineering services cost and contingency as shown as follows:

Project Cost for Evacuation Center

(Unit: 1000 Pesos)

No.	Description	Amount
1	Construction (initial stage) and renovation cost	322,400
2	Administration cost	9,672
3	Engineering services cost	51,584
	Sub total	383,656
4	Contingency	38,365
Total		422,021

The detailed calculation of the estimate is described in the supporting report: Appendix VIII.

On the other hand, it was pointed out that the existing public or private buildings could also be used as evacuation centers, and it was recommended that appropriate buildings be selected from the 10 priority areas and assigned as evacuation centers prior to construction of new buildings. For the renovation of the 60 existing evacuation centers, it is recommended that a budget be allocated from the Department of Education, Culture and Sports (DECS) as all the existing evacuation centers are elementary schools and renovation should be implemented under the improvement of education facilities.

Taking into account the above, the development cost for a priority evacuation system is considered as zero under the category of disaster prevention, though an operational cost for provision of urgent activities of more or less 2 million pesos per year will be required.

16.4.5 Project Cost for Community-Based Disaster Prevention

(1) Community-Based Forest Management

For the cost estimate of community-based forest management, the unit prices per hectare of forest development were collected from the Forest Sector Project and provincial office. Table 16.4.15 shows the eleven kinds of collected unit prices.

The unit prices obtained from the Forest Sector Project were based on the MC2000-19, which is the guideline governing the updating of cost estimates and intensification of plantation maintenance and protection activities for the project in the forest sector. The unit price of a provincial office was obtained from the ongoing project. Nursery facilities cost with a density of one nursery per 400 ha of forest is included in the unit price.

Referring to the collected unit prices, the plantation cost is estimated at P460 million for forest trees on about 18,000 ha and at P116 million for agro-forestry on about 4,000 ha as shown in Table 16.4.16.

The project cost is given as follows:

Project Cost for CBFM

(Unit: 1,000 Pesos)

No.	Description	Amount
1	Plantation cost	576,895
2	Administration cost	17,307
3	Engineering services cost	92,303
	Sub total	686,505
4	Contingency	68,651
Total		755,156

In the feasibility study, however, it is recommended that 10% of the above shall be initially developed as a pilot scheme prior to conducting full development. The development cost for the pilot scheme with 2,200 ha is, therefore, considered as the priority development scheme. The project cost is therefore estimated at 75.5 million pesos.

(2) Agricultural Development

The unit prices of land development in the Lahar areas, production cost per hectare for seasonal and perennials crops and production cost of mango per hectare are summarized in Table 16.4.17, Table 16.4.18 and Table 16.4.19, respectively.

Estimated construction cost for full development of 1,726 hectares in the seven areas is shown in Table 16.4.20.

The project cost is estimated at P701 million as follows:

Project Cost for Agricultural Development

(Unit: 1,000 Pesos)

No.	Description	Amount
1	Development cost	535,257
2	Administration cost	16,058
3	Engineering services cost	85,641
	Sub total	636,956
4	Contingency	63,696
Total		700,652

Four areas were selected for priority development in the feasibility study totalling 1,170 ha. The project cost was estimated at P457 million pesos. A pilot project of 20 ha, (10 ha for the Bucao, and 10 ha for the Sto. Tomas Rivers) should be conducted prior to the priority development as well as full development of monitoring and review of purpose. The project cost for the pilot project was estimated at 19 million pesos.

(3) Community Road Rehabilitation

As described in chapter 10, the community road network has been planned to establish three routes as follows:

A-line: Along the Bucao River with a length of 48.1 km

B-line: Along the Santa Fe River with a length of 14.9 km

C-line: Along the Sto. Tomas River, Mapanuepe Lake and Marella River with a length of 44.9 km

Construction works for the above road lines are as follows:

	A line	B line	C line
i) New road construction (km)	26.06	4.64	23.49
ii) Improvement of existing road (km)	22.04	10.26	21.41
iii) Related structures construction			
- Bridge (No.)	5	2	2
- Spillway (No.)	9	5	10
- Retaining wall (m)	0	0	2,900

To estimate the construction cost of the above, referring to the prevailing unit prices of DPWH, the unit prices to be applied were set as follows:

	Applied	Collected
i) New road construction	: P4,200 /m	3,640 (DPWH)
		5,777 (Agno II)
ii) Improvement of existing road,		
- Road width, less than 3 m	: P3,800 (90% of (i))	
- Road width, more than 3 m	: P3,400 (80% of (i))	
iii) Bridge	: P232,000 /m	190,000~280,000 (DPWH)

The construction cost of community road is estimated at P1,149 million for which the breakdown is given in Table 16.4.21.

Based on the estimated construction cost, the project cost including government administration cost, engineering services cost and contingency is estimated at P1,821 million for the full development scheme as follows:

Construction Cost for Community Road Rehabilitation

(Unit: 1,000 Pesos)

No.	Description	Amount
1	Construction cost	1,149,038
2	Administration and engineering service cost	344,711
3	Physical contingency	149,374
	Sub total	1,643,124
4	Price Escalation	178,036
Total		1,821,160

As the priority scheme, the downstream of A-route with 16 km of road (Route-A1) was selected as mentioned in Chapter 10. The project cost for the priority scheme is estimated at P189 million.

(4) Establishment of the Aeta Assistance Station

The unit prices shown in Table 16.4.13 can be applied for the cost estimate of building construction, land preparation, land acquisition and so on for the Aeta Assistance Station as well as the evacuation center construction.

The detailed estimated cost is calculated in Appendix IX and a cost summary is shown as follows:

Cost for Aeta Assistance Station

(Unit: Pesos)

No.	Description	Amount
1	Construction cost	
	(1) School of upland entrepreneurship	1,135,000.00
	(2) Ancestral land protection development and management	4,941,606.40
	(3) Aeta cultural heritage	200,000.00
	(4) Aeta health nutrition and livelihood program	983,200.50
	Sub total (1)	7,259,806.90
2	Administration cost	1,074,905.60
3	Engineering services cost	362,990.35
	Sub total (1 to 3)	8,697,702.85
4	Contingency	6,000,000.00
Total (1 to 4)		14,697,702.85

16.4.6 Overall Project Cost

Based on the project plan discussed in the foregoing chapters, the overall project cost is estimated at P7,433 million for full development and P4,019 million for the priority development scheme for which a breakdown is given as follows:

Overall Project Cost

(Unit: Million Pesos)

No.	Project / Program	Full Development	Priority Development
1	Bucao River Flood Control w/Bucao Bridge	1,678	1,678
2	Sto.Tomas River Flood Control	1,960	1,960
3	GSM Warning & Evacuation System	504	82
4	Community Based Forest Management	755	76
5	Agricultural Development on Lahar Area	700	19
6	Community Road Rehabilitation	1,821	189
7	Aeta Assistance Station	15	15
Overall Project Cost		7,433	4,019

CHAPTER 17 IMPLEMENTATION PLAN OF PRIORITY PROJECTS

17.1 General

The projects selected for the feasibility study are multi-sectoral. Project components and the proposed responsible agencies (the lead agency is stated first in each case) are:

1) Structural measures which comprise:

- For the Bucao River:
  - (i) Dike heightening / revetment (Cost P1,678 million) : DPWH,
  - (ii) Bridge reconstruction (cost included above): DPWH,
- For the Sto Tomas River:
  - (ii) Dike heightening / revetment (Cost P1,960 million): DPWH

2) Non-structural measures and Community Based Disaster Prevention measures, which comprise:

- Improvements to provincial / municipal level flood monitoring / warning and evacuation system (Cost P82 million): Zambales Province (PDCC)
- Community based forest management (Cost P76 million for pilot scheme): Zambales Province / DENR
- Agricultural development on lahar high water channel area on the Bucao and Sto. Tomas Rivers (cost P19 million for pilot scheme): Zambales Province/DA,
- Community road rehabilitation (Cost P189 million): Zambales Province/DPWH,
- Establishment of Aeta Assistance Station (AETAS) (Cost P15 million for pilot scheme and studies): NGOs/NCIP/Zambales Province

17.2 Implementation Organization

17.2.1 Overview

As shown in the previous section, the recommended project components are in three distinct categories: structural and non-structural / CDPP. Structural components are an order of magnitude more costly than the non-structural / CDPP components and, moreover, clearly belong under DPWH as the lead agency. Non-structural / CDPP components are multi-sectoral and local, with a heavy community bias, and this feature is reinforced by the two components added during the feasibility study. It is therefore considered appropriate that these components should be managed together at the provincial level under the Department of Interior and Local Government (DILG) as lead agency.

The National Government based MPE-PMO[1] would manage the structural components for DPWH, while a specially established PMO within Zambales Provincial Government would manage the non-structural and CDPP components under the overall responsibility of DILG.

The two lead agencies, DPWH and DILG, would each (among other things) receive and transfer funds, according to project budgets and procedures, to the project management office responsible for

[1] Mount Pinatubo Emergency – Project Management Office, based in San Fernando, Pamapanga Province.

implementing the respective components.

This proposed arrangement would be in accordance with:

- broad GOP policy on decentralization to regional and local government,
- the intentions of the Local Government Code on increased involvement of, and devolvement to, LGUs, and
- the directive of the Department of Budget and Management (DBM) on unified PMOs under a lead implementing agency.

In line with the intentions of the Local Government Code, LGUs should be involved as far as possible, and, if funds permit, should contribute a modest amount to project costs. They should participate particularly in the lahar agricultural development, forest management, community road rehabilitation and the AETAS projects. They should undertake land acquisition for ROW purposes where this is needed.

Both structural and non-structural / CDPP components of the projects should be coordinated by a Project Coordination Committee (PCC) (with members from the two lead agencies, the project executing agencies[2] and other important bodies involved in the project). This provides an arrangement that can accommodate sub-projects in different sectors, with different funding sources and implementation periods. This model is widely used in the Philippines. (The formation of a commission or an authority is more appropriate for major complex, long term projects needing much interaction between the components.)

17.2.2 Proposed Project Implementation Structure

Figure 17.2.1 outlines a proposed project implementation structure based on the main features in the former sub-section 17.2.1 above.

Project Coordination Committee

As already mentioned, DPWH and DILG would have joint responsibility for the project, the PCC reporting to the DPWH and DILG Secretaries in Manila. The DPWH Secretary and an Undersecretary from DILG (or their delegates) could act as the PCC Chair and Vice Chair respectively.

The PCC would perform a high level coordinating role, helping to ensure that the project is implemented as an integrated whole according to approved cost budgets, schedules, and quality standards. To achieve these objectives, the PCC would review plans, budgets and progress against these, suggesting and authorizing change where this is justified. It would not interfere in the day-to-day running of project components by PMOs unless clear instances of incompetence were revealed by reports of substandard performance. Secretariat support to the PCC would be provided, as the more experienced and better resourced body.

Members of the PCC would consist of either national directors or senior Region 3 representatives of the main agencies concerned – in this case DPWH for structural projects, and DILG, DENR, NWRB, PAGASA, DSWD, DA, PHIVOLCS, OCD and the relevant LGUs for the remaining five non-structural components. National and Region III Disaster Coordinating Councils should also be

[2] Project executing agencies are agencies that lead each of the non-structural components: PAGASA, DENR, DA, NCIP, Zambales Provincial Engineering Office, Zambales Provincial Social Welfare and Development Office.

represented. Members should be selected by the respective agencies.

To assist the PCC's senior and busy members, a small Working Group attached to the PCC could be established. The WG would contain, *as needed by the PCC*, additional staff from each agency to undertake any more detailed analysis and support required by the PCC for each project sector. In particular, the WG should contain representatives from LGUs and the communities affected at project locations, to help plan and execute a community consultation program.

Project Management Offices

Detailed technical, financial and administrative management would be provided by two PMOs, one for structural components and the other for non-structural / CDPP components, assisted as considered necessary by consultants, as follows:

1) The foreign-funded structural components in the Bucao and Sto. Tomas Rivers would be managed by the existing unified[3] MPE-PMO. A new "sub-PMO" for this project could, the MPE-PMO directorate estimates, be staffed from MPE-PMO's own substantial staff resources under an additional expense code.
2) The MPE-PMO could also manage the locally funded structural components in the Maloma River (if implemented as part of the feasibility study project)[4]. This component would be too large (at about P1.3 billion), for the Region 3 PMO (until recently the Mount Pinatubo Rehabilitation PMO) to implement[5].
3) The five non-structural / CDPP components[6], would be project managed by a multi-sectoral provincial PMO. Five small sub-PMOs would be established by the five project executing agencies (PEAs) concerned, which are, respectively, PAGASA, PHIVOLCS, DENR, DA, NCIP, DSWG and the appropriate branch of provincial government for community road rehabilitation (Provincial Engineering Department or DPWH district office) and establishment of AETAS (National Commission of Indigenous People). Each sub-PMO would include representatives from the other agencies contributing to each component. Thus, the PAGASA sub-PMO would also contain members from DSWD and the Provincial Disaster Coordinating Council. The DENR sub-PMO would also contain members from the relevant LGUs, and the DA sub-PMO would also contain members from DENR and relevant LGUs, and the two LGU-managed components would also contain members from NCIP[7] and DENR. Suitably experienced and qualified members would be selected by the parent agency and should come from provincial government if available, or from Region 3.

Functions of the multi-sectoral provincial PMO would include[8]:

- Project planning (detailed specification, planning and scheduling of objectives, tasks, outputs, resource needs, performance measures),
- Monitoring and evaluation (physical and financial progress tracking and assessment, identification of problem areas and remedial measures),

[3] A unified PMO, according to the latest Department of Budget and Management (DBM) definition, has a consolidated structure and the necessary resources to oversee, operate and ensure efficient and effective implementation of all development projects in an implementing agency. This instruction is intended to reduce the number of independent PMOs in each agency.

[4] This was suggested by the OIC-Project Director from MPE-PMO, who also proposed national (as opposed to regional) agency representation on the PCC.

[5] The implementation authority of the Region III Director is currently limited to P30 million.

[6] Flood monitoring & evacuation system, community-based forest management, pilot agricultural development on lahar, community road rehabilitation, establishment of AETAS.

[7] National Council for Indigenous People.

[8] Based on the DBM National Budget Circular No. 485 dated 13 March 2003.

- Project coordination (assisting the PCC with overall project supervision and inter-agency and inter-component harmonization and coordination,
- Project operation (implementation of project components, including decision-making in technical, financial and administrative matters,
- Financial management (budgeting, accounting, cash management and internal audit),
- Coordination with the various stakeholders.

Funds flow

Foreign funds for the project would be channeled through DPWH and DILG to MPE-PMO and the provincial PMO respectively. Each PMO would exercise the necessary financial control over the funds disbursed according to plans and budgets, and distribute the necessary reports. Local funds would be sourced from national, regional and provincial levels as arranged by each participating agency. Again, PMOs would manage the receipt, disbursement and reporting of these funds.

Assessment of structure

The main advantages of this structure are thought to be:

1) Project management by an existing experienced PMO according to the DPWH's current practice. Therefore little institutional or procedural change would be needed for the management of the structural components;
2) Compliance with some of the latest instructions from DBM on unified PMOs;
3) Establishment or expansion of multi-sectoral project management capability at provincial level, in pursuance of GOP's decentralization policy.

The disadvantages of the structure include:

1) Because of the present official allocation of only foreign currency projects to MPE-PMO, large local currency projects or project components have no official location within DPWH unless Region 3's existing implementation authority is greatly increased from current levels, or the MPE-PMO is officially authorized to manage major local currency projects;
2) There seem to be anomalies in the DPWH management of MPE-PMO and Region 3 projects at Assistant Secretary level. Specifically, the Assistant Secretary responsible administratively for MPE-PMO appears only to deal with project study and not MPE-PMO's project implementation activities. Another Assistant Secretary with other line responsibilities is in charge of all project implementation;
3) The structure does not fully comply with the DBM's latest instruction on unified PMOs.
4) Inability of the MPE-PMO to manage an integrated multi-sectoral project with one PMO, although this does not affect implementation of this project as currently structured.

17.3 Implementation Schedule

Figure 17.3.1 shows the proposed implementation schedule for the priority projects, for which a feasibility study was conducted at this time. The implementation period for these priority projects is set for 10 years, taking into account the required funding arrangement, detailed design, tendering and other preparatory activities.

The details are as follows:

1) Monitoring Activities for Review of Feasibility Study

Monitoring of the basin hydrology and riverbed movement should be commenced as early as possible.

The accumulation of the data is essential to calibrate the flood run-off model and sediment transport model developed in the feasibility study. The calibration of the simulation models would greatly affect the review of the structural design at the time of the detailed design stage. The commencement of monitoring work is therefore set to start from year 2003, immediately after completion of the feasibility study, and to continue at least up to the completion of the construction work of the structural measures, which is scheduled for 2010. The cost for monitoring activities is estimated at 13 million pesos, which should be arranged by DPWH for development planning funding.

2) Structural Measures

Priority structural measures for the Bucao and Sto. Tomas Rivers are scheduled to commence from 2007 for the construction work, which is set taking into consideration the lead time for pre-construction activities such as funding arrangements, detailed design and tendering. Funding for implementation is expected from foreign assistance such as ADB, WB and JBIC. Among them, a JBIC loan as the financial arrangement is the most likely for this project, as all the major structural rehabilitation work for the Mount Pinatubo basins in the eastern part have been undertaken by the JBIC for financial assistance. The project cost for the structural measures is estimated at P3,638 million.

3) Non-Structural Measures

The pilot scheme for warning and evacuation systems would not require a bulk of initial investment. The improvement of warning and evacuation is defined as an urgent matter, for which the objective is to secure human life and to minimize the damage to human life in the event of any further disasters. The operational cost for 10 years is estimated at 30 million pesos, for which it is recommended the money be allocated from the provincial calamity fund of 18 million pesos/ year as of the year 2003.

Full development of a GSM warning system and monitoring of the Maraunot Notch are scheduled for the year 2007, which is the same as the structural measures. The initial investment cost is estimated at 82 million pesos, which might be included in the foreign loan for structural measures.

4) Community-Based Disaster Prevention Measures

The community road rehabilitation project is the one to be commenced earlier, so that other programs such as the Community based forest management and Aeta support project are easier to implement. The funding arrangement for the community road should, therefore, be hurried up in the year 2004. The construction activities would then be completed in 2007. After that, community based forest management should be commenced.

For agricultural development in the lahar area, it is recommended that it be implemented in parallel with the structural measures. The treatment of the high water channel would be expected in the course of construction of the structural measures. The results of monitoring riverbed movement will be able to be used for confirmation of any further hazard condition occurring in the river area.

A pilot scheme for AETAS needs to be implemented as early as possible. The FOCUS NGO, which would be the leading NGO for the implementation, is ready to commence work except for a funding arrangement. The project cost for the pilot scheme is estimated at about 15 million pesos, the NGO support for which is expected to be financed by a foreign donor, the Government of the Philippines, or other donors.

17.4 Capacity Building

From the experience of the study team, a wide ranging program of capacity building measures will be necessary to help ensure the success of both project implementation and post-construction operation and maintenance.

These measures should include:

1) Revision of the arrangements for river basin management, as outlined in section 2.2 of Appendix-XIII, as soon as possible. This will require a major change to current practice and will probably need extended assistance from suitably experienced national or international advisors;
2) Revision of the Water Code and its IRR as outlined in section 2.2 of Appendix-XIII;
3) A comprehensive program of personnel training and development for all agencies involved in the project, and in particular DPWH Region 3 technical divisions and the engineering units in the Zambales provincial office and Iba district office. This should start with a review of all staff and management capabilities and an assessment of their training needs during and after project implementation. The program would therefore need to be spread over the life of the project and beyond.

   Training should be a combination of (i) formal classroom training programs administered by either regional, national or international institutions as considered appropriate, and (ii) on-the-job training for specific tasks, groups of tasks or whole jobs. All training, with rare exceptions, should be located in the study area or in Region 3. External trainers, with equipment and facilities if necessary, should be imported for the purpose.

   PMO staff should be especially targeted for training on technical, project management and community relations matters;
4) To speed project approvals, specific delegation for particular types of approval should be implemented accompanied by the necessary procedural changes, training and development, and monitoring. Specific delegations (strictly, assignment of authority) to assist the project should be extended over time to a wider range of decisions and approvals.
5) Local counterpart funding for foreign-funded projects should be realistically budgeted, so that the funds are available when needed. As noted in Section 1.4.3 of Appendix-XIII, the absence of timely local funds is a major cause of delays in foreign-funded projects.
6) Standard criteria should be employed for the pre-qualification of contractors, and should include:

- Suitable past experience of similar projects – not less than two;
- Sufficiency of financial, engineering, construction and management resources;
- Proof of the above by certificates or other reliable documentation.

Decisions on pre-qualification should be taken strictly according to the results of applying the criteria.

17.5 Relations with the Community and NGOs

An issue common to most projects is opposition by one or more groups of powerful stakeholders. In the case of water resources development and specifically flood control projects of which there have been many in the Philippines, opposition by the community has been a main cause of delays and frustration for project managements. In this connection, the SAPI Study (refer to Section 1.3.4 of Appendix-XIII) found that public opposition was caused by:

1) Insufficient knowledge of the project and its objectives, methods, etc.,
2) Inadequate attempts by LGUs and National Government to inform communities of planned changes,
3) Poor arrangements for relocation.

To remedy these weaknesses, the following actions are required to build community awareness and ensure participation. The community will include commercial and other private interests as well as residents.

As soon as can be arranged, community representatives, from municipality, barangay and the grassroots level, should be involved in the planning, design, construction and operation of the project and its components. A comprehensive program of actions to inform and consult with the community should be prepared with the above participants as part of the project. These actions would include:

1) Open public consultation meetings where all main project features would be presented and discussed. These would be led jointly by LGUs and PMO personnel;
2) Interviews with key members of communities;
3) Surveys and questionnaires to obtain the widest range of opinion
4) If the project or any components are likely to generate opposition, focus groups of community representatives should be formed in each basin where problems might exist. The job of these groups would be to consider objections, discuss these in depth with project leaders via workshops, and thereby generate solutions to problems raised.

This program should be led by the government agencies leading the various project components, assisted by LGUs and advisors as appropriate. Relevant NGOs should also be brought into the consultation process, especially those enjoying good relations with the targeted communities. It is suggested that the three river basins should be targeted separately, the major effort going to the Bucao and Sto. Tomas River areas where most structural work is to be undertaken.

CHAPTER 18 ENVIRONMENTAL IMPACT ASSESSMENT OF PRIORITY PROJECTS

18.1 General

18.1.1 Brief Description of the Proposed Project

Under the master plan study on Sabo and Flood Control for Western River Basins of Mount Pinatubo, several priority projects were selected including their alternatives. These projects are divided into three categories: structural measures, non-structural measures, and community disaster prevention plans. The proposed priority structural measures are summarized in Table 18.1.1 with the estimated value of construction costs for each project. An Environmental Impact Assessment (EIA) was carried out for the whole of the proposed priority projects, while reporting provided here is mainly for the priority structural measures.

18.1.2 Brief Description of Methodology of the EIA

The EIA was carried out 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 has covered the environmental components: physico-chemical, biological and socio-economic. Consultations were also held with the stakeholders through the barangay and municipal officials. The EIA work covered the following aspects: (a) conduct of consultations, (b) information / data gathering, (c) description of environmental effects / impacts, and (d) the formulation of an environmental management plan.

The primary data gathered for this EIA was used to supplement the primary data gathered from the previous Initial Environmental Examination (IEE) Study conducted last year, 2002. The findings of the IEE are supplemented for the EIA especially for the Baseline Environmental Conditions and Resettlement Plan for the study areas. The ways of obtaining primary and secondary data were summarized and reported in the IEE Report. For details, refer to the IEE Report.

18.1.3 Scoping Meetings

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

The First Level Scoping Meeting for the EIA was held on January 31, 2003, with DENR-EMB Region 3 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 of most of the concerned stakeholders participated and discussions were held, mainly on potential resettlement issues and on the contents of structural measures. It should be noted that the First and Second Level Scoping Meetings are both indispensable for an EIA and its EIS for a project proponent for assuring an ECC from DENR. The project proponent will have to prepare a detailed scoping report in order to secure the ECC.

18.1.4 Consultation Workshop and Household/Perception Surveys

In addition to the First Level and Second Level Scoping Meetings as described above, several activities were also conducted for the EIA to supplement the socio-economic surveys conducted in the previous IEE study. Table 18.1.2 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.

18.2 Environmental Impact Assessment

18.2.1 Impact Zones and Environmental Factors

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, increased tax payments, improvement in basic services, etc. will spill over to the other towns and their neighboring municipalities.

As a first step of carrying out the EIA, various environmental factors have been listed and assessed to identify the degree of potential impact of each factor. This is called environmental screening. For this EIA, the environmental screening was carried out under the master plan study of this project and reported in its IEE report. For details, refer to the IEE report.

18.2.2 Potential Impacts on Physical Environment

(1) Geology, Topography and Soils

Table 18.2.1 summarizes the possible impacts of the project on the geological environment.

1) General Assessment

The various phases of the project will have a 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 geological 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 can be achieved.

Implementation of the project will affect the geological 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 lahar and flooding may remain at the same level as if without the project or in the extreme, risks may become greatly increased.

2) Pre-Construction and Construction Phase

Environmental baseline sampling, inventory surveys, and geodetic surveys, and possibly bore holes along the possible sites where the structures are to be located are the principal activities related to the pre-construction phase. These activities will have little or no impact on the environment.

The construction phase of the project may have significant impact on the physical environment, as it would involve significant earth moving and 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.

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.

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.

(2) Climate and Air Quality

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

A minor change in microclimate will be experienced during the construction phase due to further loss of the marginal vegetation in the surrounding areas. No significant air pollution is expected during the operational phase.

(3) Hydrology and Water Quality

The development plans proposed by the project are largely putting in place infrastructures to enhance the capacity of the river channels. These infrastructures are actually enhancement measures that will shorten the time to reach environmental stability for the rivers. The proposed project will actually mitigate the negative impacts of lahar.

(4) Noise

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

18.2.3 Potential Impacts on Biological/Ecological Environment

(1) Terrestrial Flora and Fauna

Tables 18.2.2 and 18.2.3 summarize the potential impacts on the terrestrial flora and fauna habitat in and around the priority project site areas. The major potential impacts include the following:

- Reduction of standing bio-mass during construction phase
- Reduction in plant bio-diversity and forest genetic resources during construction phase
- Disturbance of terrestrial fauna due to general construction work
- Reduction of wildlife population due to destruction of habitat and loss of food sources

(2) Aquatic flora and fauna

As a result of the massive lahar deposit accumulated along the concerned river beds, most of the aquatic flora and fauna have been destroyed since the eruption of Mount Pinatubo. The priority structural measures should be able to stabilize the river water flow and contribute to recovery of the aquatic flora and fauna.

18.2.4 Socio-Economic Impact

(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 also be a corresponding demand for social services and other basic necessities of life.

(2) Labor and Employment

As regards to employment and source of income, temporary employment during the construction project phase is possible. A more acceptable scenario would happen if well-planned and workable livelihood projects are incorporated in the social, institutional, and resettlement 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.

The increase in number of vehicles and heavy equipment machinery in construction activities and movement of people in building activities will potentially affect traffic flow.

(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 may occur due to the expected revenue that they temporarily gain from leasing their houses or part of their houses.

(4) Infrastructure and Public Utilities

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

(5) Health and Education

Additional health services and provision of education are also needed due to the increase in population.

The wages paid to workers will have positive impacts on health through increased affordability of health services. Higher income will enable the population to afford better food and medical care.

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

(6) Culture and Lifestyle

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

(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 LGUs in the form of taxes.

If unemployed people within the nearest Barangay are 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. An 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 rebound to food producers such as fishermen, farmers and small scale food industry operators, sari-sari stores and small canteens.

(8) Archeological/Anthropological/Historical Sites

A preliminary assessment indicates that no historical sites will be affected.

(9) Resettlement Issues

Various resettlement issues, such as loss of land and other properties, resettlement of the affected households and related compensation, etc. are discussed in the Resettlement Plan, as shown in section 10.4. Resettlement, and a separate document (Appendix XI). For details, refer to the document.

18.3 Environmental Impact Mitigation

18.3.1 Physical Impact

(1) Topography and Soil

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

(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 may be expected. Upon the completion of the project, when the land surface is 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/machinery is to be carried out to minimize noise generation. For particular activities where workers will be exposed to significant noise levels, these workers are to be provided with appropriate personal protective equipment – ear plugs.

(3) Hydrology and Water Quality

An increase in sediment load due to land clearing and other earth moving activities during the construction phase will increase the turbidity of the water. A better water quality may be expected after a few years of operation.

18.3.2 Biological Impact

The following summarizes the mitigation measures for the potential biological impacts:

- Minimization/alleviation of adverse disruption to the behavior of birds and other terrestrial fauna due to removal of trees and other plants
- Preservation of plant and genetic resources
- Minimization of noise and disturbance to wildlife
- Minimization of standing flora biomass loss from rehabilitation activities
- Aquatic ecology loss that has occurred to date would be recovered again by the structural measures.

18.3.3 Socio-Economic and Cultural Impact

The impact of the project on the socio-economic environment is 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 LGUs. There will also be significant purchases of supplies and materials during the construction phase.

18.3.4 Resettlement and Compensation Plan

For the directly affected households a resettlement and compensation plan has been formulated to address the impact of the loss of their land and other assets.

It has been identified that 89 potential PAPs (number of households) in total will have to have been resettled at the end of January 2003 and 106 potential PAPs at the end of May 2003. It should be noted that the number of PAPs would be changed at the time of project implementation. Therefore, the Resettlement Plan will have to be re-evaluated and renewed as needed.

18.4 Environmental Management Plan

18.4.1 Environmental Management Program during Construction

(1) General

Contractors to be hired by the proponent to carry out the construction must demonstrate the capacity to

carry out the requirements of the environmental management plan for construction described herein. A list of the general responsibilities of the contractor is presented below:

- Disposals of excavation spoils
- Watering of all exposed areas during windy days
- Covering of delivery trucks
- Proper waste disposal in workers' camp site
- Demobilization activities
- Other ECC Conditions

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.

(2) Employment and Manpower Capability Building

Priority for 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 a vulnerable group for unemployment, will maximize the positive impact of the project.

(3) Workers Quarters

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

(4) Workers and Public Safety

Various safety measures are needed for the workers and the public during construction. Project Management must ensure that if such provisions are not incorporated in the contract document, it must be amended to adequately address the problems.

(5) Traffic Management Plan

The presence of hauling trucks during the construction stage may change the present traffic situation. To mitigate the anticipated traffic related problems, various effective measures must be implemented.

18.4.2 Environmental Monitoring Program during Construction and Operation

Table 18.4.1 shows the summary matrix of the Environmental Monitoring Plan for the proposed project.

18.4.3 Risk Management Program

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

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

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

The risk to health from these hazards may be reduced to as low as reasonably practicable. This can be

achieved through the establishment of a comprehensive occupational health program.

18.4.4 Emergency/Contingency Response Plan

The contractor and its sub-contractors will be required to have an emergency response plan in place and to form an emergency response team during the construction phase. 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.

18.4.5 Social Development Plan

(1) General Plan

A Social Development Program shall be prepared and be applied to the Aeta and Non-Aeta communities and shall include the following:

- Skills development training and among others, handicraft production
- Adult literacy training
- Agriculture and aquaculture development program for both Aeta and non-Aeta that have returned to their original settlement and resumed their agricultural activity
- Establishment and improvement of a community health center for the delivery of basic health services
- Strengthening of the organizations and their mutual cooperation to support the future agro-industrial and agro-forestry endeavors
- Strengthening of the people's knowledge and preparedness for disaster prevention, especially the community leaders

(2) Compensation for Resettlement

It was identified that there are 89 households that were affected by the structural measures of the project at the end of January 2003 and a further 106 households at the end of May 2003.

The estimated total compensation cost for the resettlement is as below.

- The estimated total compensation cost for 89 households is P69,576,310.
- The estimated total compensation cost for 106 households is P82,866,200.

It is suggested that the Resettlement Plan of Action follow the perceptions expressed by the PAPs.

There is a Resettlement Plan that includes the compensation packages. Details of the concept of the Resettlement Plan of Action for the directly affected households has been formulated and prepared as a separate document (Appendix XI).

(3) Mango Production

Mango production is a great livelihood opportunity for the communities in the area affected by lahar. Using a good program and good selection of planting materials, mango will provide a promising future for the area. Good livelihood programs that are well funded and have alternative programs to support the communities' daily needs should be provided. While waiting for the mangoes to bear fruit and reach their productive stage, the residents should engage in cash crop production, small ruminant's production and/or native chicken production. This livelihood prospect can be used for the lowlanders and the Aetas and can be implemented by the concerned Local Government or the Department of Agriculture and Social Development section of DPWH and the National Commission for Indigenous People.

18.5 Resettlement Plan for Affected People

Land acquisition and displacement of people along the proposed dike and bridge construction areas will take place. As a result, an initial resettlement plan has been prepared to ensure that the project is committed to avoid or minimize the resettlement effects brought about by the project. All Project Affected Persons (PAPs) will be compensated at replacement cost/market values and assisted for their losses (physical and non-physical assets) in order for them to improve or maintain their pre-project standard of living. The vulnerable groups (i.e., poor, women-headed households, children, indigenous cultural communities, disabled and elderly) will also be given special attention as their needs may by different from the rest of the affected population. Participation of various stakeholders has been incorporated during the Resettlement Planning and will continue throughout the duration of the project implementation.

The proposed project, which is the construction of dikes in Zambales (Sto. Tomas and Bucao) will cover the municipalities of San Marcelino, San Narciso, San Felipe, and Botolan. An estimated 19.5 ha of land will be potentially affected. The area was based on the 100 m width from the centerline. In addition, 106 households (451 people being the households' population) will be affected by the proposed project. These PAPs will be required to relocate due to the dike construction. A compensation, rehabilitation assistance and income restoration program will be provided as per project policy to meet the resettlement and social safeguards requirements of the funding agencies such as the Asian Development Bank, World Bank and Japan Bank for International Cooperation.

This resettlement plan will be revised and finalized after the completion of the detailed design. An official census and detailed measurement survey will be carried out to determine the actual number of PAPs. A replacement cost study will also be conducted to reflect current market rates for all types of losses. Extensive consultation and participation programs will also take place to identify the needs of the PAPs, relocation options, rehabilitation measures and income restoration programs in order to achieve the project objectives.

The cost of resettlement for losses of physical assets and provision of disturbance compensation is estimated at 82.8 million pesos.

CHAPTER 19 EVALUATION OF PRIORITY PROJECTS

19.1 Economic Evaluation for Flood/Mudflow Control Measures

19.1.1 Definition of Project Benefits

The benefit to be obtained by implementing the project is defined as the reduction of direct and indirect damage resulting from flood and mudflow. The probable direct damage has been estimated under "without project" conditions at the end of 2001. Probable indirect damage has also been described and estimated under "without project" conditions in 2002.

The damage expected to occur under with-project conditions is assumed to be zero under a design flood of a 20-year return period or less. Therefore, the project benefit is equivalent to the probable damage to be caused by flood and mudflow of a 20-year return period or less.

Project benefits and costs, estimated in financial terms, have been converted to economic values by applying conversion factors.

19.1.2 Direct Damage

In estimating the value of damageable properties in the probable inundation area, a barangay database was established in the GIS (Geophysical Information System). All the data needed for estimating damage including the area, farmland, population, number of households, number of buildings and infrastructure such as roads and bridges, and irrigation canals of each barangay were input into this database.

The probable inundation areas were specified for the three river basins from a hydrological simulation study for return periods of 2, 5, 10, 20, 50, and 100 years as estimated in chapter 7. The probable damage quantity is shown in Table 12.1.7.

The unit value of each type of damageable property was either derived from information obtained during the study or taken from the East Pinatubo Study[1] and then adjusted by the actual or projected changes in market prices. The choice was made by assessing the relative reliability of the two sets of data.

The method of identifying and estimating damageable unit values is just the same as described in Chapter 12, subsection 12.1.2.

The following table summarizes the unit value of direct damage for the base year of 2002:

[1] The Study on Flood and Mudflow Control for Sacobia-Bamban/Abacan River Draining from Mt. Pinatubo – funded by JICA and undertaken by Nippon Koei Co., Ltd. in association with CTI Engineering Co., Ltd.

Summary of Direct Damage Values (Pesos)

Direct Damage	Value	
1 Buildings		
1.1 Residential	244,971	/ house
1.2 Non-residential	676,352	/ building
1.3 Household effects	40,652	/ house
1.4 Inventory and equipment (non-residential)	437,580	/ building
2 Agricultural crops and livestock		
2.1 Paddy	34,817	/ ha
2.2 Livestock	14,600	/ household
3 Infrastructure		
3.1 National roads	2,940	/ l.m.
3.2 Other roads	2,353	/ l.m.
3.3 National bridges	100,800	/ l.m.
3.4 Other bridges	84,000	/ l.m.
3.5 Irrigation facilities	979	/ l.m.

The direct damage amount for the respective probable flood values was calculated as shown in Table 19.1.1, and the annual damage calculation is described in Table 19.1.2.

19.1.3 Indirect Damage

In this study, indirect damage refers to secondary damage and cost resulting from flood and mudflow, such as:

- additional transport cost incurred because of long detours due to closures of existing bridges and roads,
- loss of product (output) due to the interruption of economic activity,
- the cost of evacuating people, and
- cleaning up buildings after the event.

(1) Additional Transportation Cost

The probable additional cost of transportation due to forced detours caused by flooding of roads and bridges was computed for bridges and roads separately. This was done using the distance, duration and frequency of the detour, and from vehicle operating cost. The following information was needed for the computation of this cost:

i) Alternative routes which would be used for the closure of each major bridge and road, for each origin-destination journey. This calculation did not include the probability of certain routes being impassable (or preferable) during particular times of the year. The distance, average duration and frequency[2] of each detour were also needed;

ii) The average number of each major type of vehicle making each origin-destination journey during the base year of 2002[3];

[2] The number of days per year when the detour is needed.

[3] No specific increase of vehicles has been included in the projection of indirect benefits to 2033, although the study team has forecasted traffic volumes to increase by an average of more than 5% per annum until 2017. However, a real increase (+2%) of R3 GRDP has been applied to all damageable assets and indirect benefits.

iii) The operating cost of each major type of vehicle;

The value of drivers' and passengers' time was not considered in this computation.

For this study, two main detours were proposed to bypass flooding between San Marcelino and Iba, causing either bridge failure or road closure. For traffic traveling from Olongapo to Iba, the detour would have to pass through San Fernando, Tarlac and Lingayen and would involve an additional distance of 279 km. For travel between San Fernando and Iba, the detour would also pass through Tarlac and Lingayen, the additional distance being 145 km.

Traffic volumes for four types of vehicle were measured at five locations between San Marcelino and Iba. The AADT[4] was projected (at about 5.4% per annum for all vehicles) for each vehicle type to 2017 at each of the three bridges.

Two sets of additional transportation costs were calculated: 1) for failure of each of the three bridges over the Sto. Tomas, Maloma and Bucao Rivers, and 2) for additional inundation by flood and mudflow from the three rivers, rendering the road between San Marcelino and Iba impassable to traffic.

Other assumptions were made in the computation, including:

- 70% of traffic travels from Olongapo to Iba, the rest from San Fernando to Iba;
- Vehicle operating costs in pesos/km were obtained from the DPWH feasibility study undertaken in 2002 as follows: car/pickup = 6.262, jeepney = 5.804, bus = 19.036, and truck = 14.921;
- Bucao and Maloma Bridges would break under floods of more than a 20-year return period and Maculcol Bridge over the Sto. Tomas River under floods of more than a 10-year return period magnitude;
- In the case of bridge failure, a temporary steel bridge would be constructed over a period of 10.5 months including 4 months for material procurement.
- Some cancellation of journeys, especially on the longer detour from Olongapo to Iba.

From the calculations shown in Tables 19.1.3 and 19.1.6, the most probable additional annual transportation costs due to failure of bridges over the three rivers are:

- P176.8 million (Bucao); P41.6 million (Maloma); P218.3 million (Sto. Tomas); totaling some P436.7 million.

From the calculations shown in Tables 19.1.7 and 19.1.10, the most probable additional annual transportation costs due to road inundation by flood/mudflow from the three rivers (occurring before or after the above damaged bridges are repaired) are:

- P10.6 million (Bucao); P5.1 million (Maloma); P9.5 million (Sto. Tomas); totaling some P25.2 million.

(2) Loss of Non-agricultural Production

The loss of production through interruption of economic activity caused by flood and mudflow was estimated from the per capita non-agricultural Region 3 GRDP multiplied by the number of people affected in urban areas. The information needed for this purpose includes:

- Non-agricultural GRDP for Region 3 at constant price for base year 2002;
- Total and urban population for Zambales Province and Region 3 for base year 2004;

[4] Annual Average Daily Traffic.

- Duration of interruption of economic activities for each of the three rivers in the study area;
- Most probable number of households affected at different levels of inundation for a 20-year return period or less.

Loss of production in the agricultural sector was not considered as this was already included in the loss of agricultural crops calculation.

Tables 19.1.11 and 19.1.12 show, respectively, the calculations used to derive the non-agricultural GRDP loss for the three rivers, and the base data used. The resulting non-agricultural GRDP losses, projected for the base year 2004, are:

- P2.60 million (Sto. Tomas); P0.10 million (Maloma); P0.93 million (Bucao); totaling some P3.63 million.

(3) Evacuation Cost

The evacuation cost to be incurred through flood and mudflow depends on the number of households, the period of evacuation and the unit evacuation cost. The information used included:

- Unit cost for evacuation of one household, assumed to be P330 per week[5];
- The number of households from a count of heavily damaged buildings. This information was assumed to be the most probable number of buildings inundated under a 20-year return flood;
- The evacuation period was assumed to be one week. The East Pinatubo Study used 10 weeks for a lahar event, and one week for a flood event.

The calculation of most probable annual cost is shown in Table 19.1.13 with results as follows:

- P106,500 (Sto. Tomas); P31,500 (Bucao); P2,500 (Maloma); totaling P140,500.

(4) Emergency Cleaning Cost

The emergency cleaning cost is the cost needed to clean up damage from flood and lahar. This cost is estimated from the product of the period expended, unit cost and the number of buildings cleaned. The expended periods for various levels of inundation are taken from Japanese Government data[6] and are shown in Table 19.1.14 along with other assumptions and calculations. The unit cleaning cost is assumed to be 230 pesos per day[7]. The number of buildings cleaned is equal to the number inundated to a depth of 50 cm or more multiplied by the estimated probability of inundation.

The most probable annual costs from Table 19.1.14 are:

- P1.43 million (Sto. Tomas); P0.12 million (Maloma); P1.06 million (Bucao); totaling P2.60 million.

(5) Development Benefit and Value of Damageable Assets

In this study, the specific computation of development benefit arising from the increased value of land and other assets and the use of such land for investment projects has not been undertaken. Instead, a broader and probably more conservative approach has been adopted.

Socio-economic conditions in the study area and even the flood prone areas will be improved in line

[5] Based on a similar cost of P216 per week in 1995 from the East Pinatubo Mud & Flood Control Study, plus 53% from the increase in CPI to 2002.
[6] Manual for Economic Study on Flood Control, 1999, Ministry of Land, Infrastructure and Transport, Japan
[7] Derived from 150 pesos per day used in the East Pinatubo Study in 1995 plus 53% from the increase in CPI to 2002.

with the real growth of the regional economy. In this case, damageable assets would increase in real value along with the growth of socio-economic conditions. Therefore, the flood mitigation benefit would increase, and could be estimated using a regional socio-economic projection. Such a projection would be based on population increase, improvement of people's living standard, and real growth of economic activity in the various sectors.

It is proposed that real growth of regional GDP projected to 2020[8] should be used in the computation of direct and indirect benefits to be used in the economic evaluation of the project and specifically for deriving the EIRR. A conservative increase of +2.0% has been adopted, based on an extension of the NEDA Medium Term Development Plan 2001 to 2004.

However, the "Manual on Economic Evaluation for Flood Control and Sabo Project", published by JICA in March 2002, advised that further development benefit is not to count for economic evaluation though some development benefit is expected because of the implementation of the project. The reason why JICA does not recommend counting the benefit is that the development benefit is difficult to quantify into monetary value and is rather difficult to estimate with appropriate accuracy. Based on the instruction by JICA, the development benefit is not considered in the study.

(6) Indirect Benefit in Aggregate

The following table summarizes the most probable annual indirect benefits for the base year 2002 discussed above.

Summary of Annual Indirect Benefits (Unit: Million Pesos)

Benefit	Bucao	Maloma	Sto Tomas	Total
Additional transportation cost	176.8 (bridge) 10.6 (road flood)	41.6 (bridge) 5.1 (road flood)	218.3 (bridge) 9.5 (road flood)	436.7 (bridge) 25.2 (road flood)
Non-agricultural production loss	0.9	0.1	2.6	3.63
Evacuation cost	0.0	0.0	0.1	0.1
Cleaning cost	1.1	0.1	1.4	2.6

19.1.4 Conversion Factors for Real Economic Values

(1) Transfer Payments

Market values are usually distorted by transfer payments such as taxes and subsidies. These payments are transferred to the government which acts on behalf of society. Therefore, they should not be treated as costs and should be eliminated from the market values of both costs and benefits. In the Philippines, the taxes applied to construction work are as follows: value added tax (VAT), excise tax, income tax, customs duties, tax on sand, gravel and quarry resources, various local taxes, etc. The overall tax rates on major materials and services are shown in Appendix-XII.

(2) Shadow Wage Rates

Wages of skilled workers are considered to reflect an opportunity cost of labor, because these workers are not generally in surplus. Therefore, the shadow wage rate of skilled workers is assumed to be equal to the actual wage rate. On the other hand, unskilled workers are generally in excess. For this reason the shadow wage rate of unskilled workers is assumed to be 0.6 of actual wage rates.

[8] As adopted in the Lower Cagayan Flood Control Study Final Report dated February 2002.

(3) Shadow Foreign Exchange Rates

It is understood that there are some distortions in the present foreign exchange rate due to balance of payments imbalance and protection structures in the country. In this study, the shadow exchange rate is assumed at 1.2 of the prevailing exchange rate, as recommended in "ICC Project Evaluation Procedures and Guidelines" by NEDA. This rate is applied to imported materials and services. The import portions of major construction materials are enumerated in Appendix-XII.

(4) Conversion factors

The material costs were nominally segregated into the following proportion of foreign and local portions, using the NEDA information.

Foreign and Local Proportion

Item	Local Portion	Foreign Portion
1. Materials		
Cement	0.3	0.7
Aggregate (Coarse and Fine)	0.6	0.4
Steel	0.2	0.8
Fuel and Lubricant	0.3	0.7
Lumber	0.6	0.4
2. Machinery and Equipment Rental	0.3	0.7
3. Labor	1.0	0.0
4 Administration Cost	1.0	0.0
5. Engineering Cost	0.1	0.9

To convert financial market value to real economic value, conversion factors are set up in respect of the elements discussed in paragraphs (1) to (3) above. Taking account of the foreign and local composition, the conversion factors corresponding to the above cost categories are summarized as follows.

Conversion Factors

Item	Local/Foreign Separate Estimate		Local/Foreign Combined Estimate
	Local Portion*1	Foreign Portion	
1. Materials			
Cement	0.51	1.06	0.89
Aggregate (Coarse and Fine)	0.68	1.04	0.83
Steel	0.23	1.06	0.90
Fuel and Lubricant	0.38	1.06	0.85
Lumber	0.79	1.01	0.88
Others	0.72	1.05	0.88
2. Machinery and Equipment Rental	0.27	1.13	0.87
3. Labor			
Skilled	0.93	-	0.93
Unskilled	0.60	-	0.60
4. Indirect Costs			
Overhead, contingencies and miscellaneous (OCM)	0.86	-	0.86
Profit	0.65	-	0.65
Value Added Tax*2	0.00	-	0.00
5. Government Expenditure*3	0.95	-	0.95
6. Engineering Service*4	-	1.22	1.10
7. Standard Conversion Factor	-	-	0.85

Note: *1 Including all taxes national and local in the Philippines
*2 Imposed on item numbers (2) and (3) only in this form.
*3. For engineering and administrative overhead
*4 Detailed design and supervising services by foreign consultants

All market values not included in the above table are converted to economic costs by applying a standard conversion factor (SCF) of 0.85. Thus these economic values are assumed to be 85% of the financial values.

19.1.5 Economic Costs

The construction costs estimated in Chapter 16 were based on market prices, those are financial costs. For the derivation of economic rates of return these costs must be converted to economic costs. For the conversion of financial costs, direct construction costs have been divided into machinery and equipment rental, materials (with some subdivision of materials), labor (skilled and unskilled), and indirect costs (VAT, overheads). Conversion factors for deriving economic costs were discussed in Sections 19.1.4 above.

The results of the conversion are given in detail in the table below:

Project Economic and Financial Costs

(Unit: Million Pesos)

Sub-project	Equipment	Labor	Material	Overhead*[1]	Total*[2]
Financial Cost					
Dike Construction	189.97	66.65	296.57	137.45	690.62
Diversion Channel	5.76	4.35	29.58	8.99	48.68
Maintenance Road	0.93	0.22	1.08	0.56	2.79
Bucao Bridge	71.80	61.13	136.56	71.60	341.09
TOTAL	268.46	132.34	463.78	218.59	1,083.18
Economic Cost					
Dike Construction	165.28	50.69	258.00	95.60	569.56
Diversion Channel	5.01	3.27	25.77	6.81	40.86
Maintenance Road	0.81	0.16	0.94	0.38	2.30
Bucao Bridge	62.47	50.68	120.58	50.62	284.34
TOTAL	233.56	104.80	405.29	153.40	897.00

Notes: *[1] Including VAT. *[2] Totals may not equal sum of constituent figures due to rounding.

The overall economic cost is calculated at 82.8% of the financial cost for the structural measures on the Bucao River. Accordingly, 82.8% of economic conversion factor was applied for the economic evaluation for the structural measures.

Based on the above, the economic costs for the structural measures are estimated as follows:

Estimated Economic Cost for Structural Measures

(Unit: 1,000 Pesos)

No.	Item	Bucao River	Sto.Tomas River	Remarks
1	Civil Work	1,034,500	1,192,128	
2	Land Acquisition & Compensation	44,878	37,988	
3	Administration	31,035	35,764	
4	Engineering Services	165,520	190,741	
5	Sub Total (1 to 4)	1,275,933	1,456,622	
6	Physical contingency	152,546	178,147	
7	Base Cost (5+6)	1,428,479	1,634,750	
8	Economic Conversion Factor	82.8%	82.8%	
9	Economic Cost (8 x 0.828)	1,182,780	1,353,573 (1,624,229)*1	*1) Including economic cost for Maculcol Bridge

Notes: Land acquisition and compensation cost were included in economic cost based on the comments from NEDA.

19.1.6 Economic Benefits

In accordance with the discussion in subsection 19.1.4 above, direct and indirect financial benefits are converted to economic benefits by applying the standard conversion factor of 85%; that is, economic benefits are 85% of financial benefits.

19.1.7 Economic Evaluation

The proposed flood/mudflow control measures for the Bucao and Sto. Tomas Rivers are to be implemented to prevent flooding and mudflow spreading to the flood/mudflow prone areas and also to improve the safety conditions along National Highway No.7. All the bridges across the rivers need to be re-constructed, together with the proposed dike heightening or river widening. Accordingly, the cost of re-construction of the Bucao and Maculcol Bridges was included in the cost of structural measures for flood and mudflow control. It is noted that the re-construction of the Maculcol Bridge across the Sto. Tomas River was not selected as a priority project, because that project has been committed by the Government of the Philippines for implementation. Its inclusion is only for economic evaluation.

The calculation sheets of economic internal rate of return are shown in Tables 19.1.15 and 19.1.16 and are given as follows:

Summary of the Results of the Economic Evaluation for Structural Measures

River	Structural Measure	Project Cost (Million Pesos)	EIRR
Bucao	Dike Heightening / Strengthening including re-construction of Bucao Bridge	1,678 (Equivalent to US$ 33.2 million)	15.7%
Sto. Tomas	Dike Heightening / Strengthening	1,960 (Equivalent to US$ 38.8 million)	26.3%

For the Bucao River, it is evaluated that the proposed flood/mudflow control work including re-construction of the Bucao Bridge is feasible from the economic viewpoint. The IRR is estimated at 15.7%, which is beyond the NEDA's criteria of 15%. In this case, the bridge component is the most beneficial aspect, which provides high value of indirect benefit for the project. If the bridge component is removed from the project, the IRR for the Bucao River Flood/Mudflow Control drops to 11.1%.

For the Sto. Tomas River, the proposed flood/mudflow control measure is highly feasible with 26.3% of economic internal rate of return. The damage prone area was reasonably wide and more than 5,000 HH will be protected against further mudflow damages.

19.2 Economic Evaluation for Non-Structural Measures and Community Disaster Prevention Plans

19.2.1 Economic Benefits

(1) GSM Telemetry Warning and Evacuation System

For the GSM telemetry warning and evacuation system, the objective of the project is to secure human life against further disasters. Since the project objective is to mitigate the damage to human life, it is rather difficult to quantify the benefit as monetary values. According to the JICA's Manual for Economic Evaluation for Flood Control and Sabo Project, it is suggested that the effect of mitigating damage to human life should not be counted as a benefit for the following reasons:

1) To protect human life from disaster is one of the important objectives of the flood control and sabo project. However, evaluation of the mitigation effect on human life as a monetary value is generally not an acceptable approach,
2) The number of deaths due to disaster is very dependent on natural and social factors, and it is difficult to estimate the number of deaths of people with /without the project.

Considering the above, the economic benefit for the warning and evacuation system is not included in the feasibility study, and the warning and evacuation system is defined as a basic human need, particularly for such areas where severe disasters have been experienced.

(2) Community-Based Forest Management

For the community-based forest management project, the following three kinds of economic benefit are taken into account:

1) Stumpage value for controlled tree cutting

Under the CBFM program, harvesting of trees in forest plantation is partially allowed to PO members in some extent under appropriate plan approved by DENR. In this study, Gmelina is assumed to plant in the re-forestation area, and the stumpage value of Gmelina is counted as the productive benefit. The unit value of Gmelina is estimated at P119,144 /ha according to on-going Forest Sector Project under the DENR. Harvesting is considered on 9 years after planting, and 20% of the plantation area will be harvested for five years. At the same time, re-plantation of Gmelina with the same area as harvested is considered.

2) Sales of agro-forestry product

According to the DENR, the 20% of CBFM area can be developed as Agro-Forestry area. Sales of agro-forestry products are considered as the economic benefit of CBFM program. This is the main benefit of the project as CBFM is highly expected as livelihood development program for the people in the mountain area. Three kinds of agro-forestry plantation, Mango, Cashew and Corn by SALT are considered. Annual net income for respective products is as follows:

Assumed Net Income by Agro-forestry Products under CBFM

Harvesting year	Mango	Cashew	Corn (SALT)
Rate of Plantation	40%	30%	30%
5 year after plant	-P2,718 / ha	-P1,273 / ha	P7,858 / ha
10 year after plant	P1,044 / ha	P10,663 / ha	P7,858 / ha
20 year after plant	P200,687 / ha	P22,642 / ha	P7,858 / ha
30 year after plant	P194,463 / ha	P22,642 / ha	P7,858 / ha
Annual Value (Discount: 15%)	P188,721 / ha	P31,793 / ha	P36,226 / ha

Source: Estimated by study team based on the data from Forest Sector Project (DENR / JBIC)

3) Reduction of sediment yield in the watershed

Reduction of sediment yield in the watershed by promoting CBFM is considered as the benefit. According to the Japanese authorized textbook for forest management, the sediment yield in a forest mountain is assumed to be only 1% of a bare mountain. In the study area, it is estimated that the sediment yield in 2010 is 4.43mm /year in the Bucao River basin and 5.49mm /year in the Sto. Tomas River basin, respectively. Assuming that the 50% of the sediment yield is mitigated by implementation of the CBFM instead of 99%, the volume reduction of sediment yield by CBFM is estimated as follows:

Sediment Yield Reduction Effect by CBFM Program

Watershed	Sediment Yield	Mitigation Rate	CBFM Area	Sediment Reduction Volume
Bucao	4.43 mm / year	50%	14,934 ha	661,576 m^3 / yr
Sto. Tomas	5.49 mm / year	50%	7,110 ha	390,339 m^3 / yr
TOTAL			22,044 ha	1,051,915 m^3 / yr

The value of reduction of sediment yield is considered by the alternative sediment reduction method by excavation of river channel. The unit price of channel excavation is estimated at P54.66 /m^3 in this study, which includes overhead of 20%. The economic value is therefore considered as 80% of the unit rate as P43.73/m^3. The annual economic value on the sediment reduction is then calculated as follows:

P43.73 / m^3x 1,051,915m^3 / yr = P46,000,243/year = P2,086/ ha/ year

The above effect on sediment reduction is considered from 10 years after commencement of the project. The detailed procedures for the benefit estimation are described in Appendix-IX in this report.

(3) Agricultural Development on Lahar Area

For the lahar agricultural development as a livelihood program, the sales of agriculture product are considered as the project benefit. The soil analysis indicates that while the fertility level is very low to support crops, they can be managed and brought back to crop production with the application of technologies that will improve the soil conditions, physically and chemically, and provision of basic needs like water and fertilizer and with properly fitted cropping patterns.

The following crops are accordingly listed up as appropriate crops for production on the lahar area.

Appropriate crops for production on the lahar area

Categories	Seasons	Crops	Expenses (Peso/ha)	Revenue (Peso/ha)	Net Income (Peso/ha)	Remarks
Cereals	Wet Season	Rice	21,972	58,800	36,828	
	Dry Season	Corn	26,973	40,670	13,697	
Vegetable	Dry Season	Onion	79,056	375,000	295,944	*1)
	Dry Season	Garlic	102,640	300,000	197,360	
	Dry Season	Tomato	49,429	405,000	355,571	*1)
	Dry Season	Squash	31,056	72,000	40,944	*1)
Fruits	Dry Season	Watermelon	28,042	225,000	196,958	*1)
Legumes	Dry Season	Mungbean	17,566	30,000	12,434	
	Dry Season	Peanut	22,615	50,000	27,385	
Rootcrops	Annual	Sweet Potato	33,741	223,200	189,459	*2)
	Annual	Cassava	48,966	180,000	131,034	*2)
	Annual	Gabi	45,371	225,000	179,629	*2)

Notes: *1) Crops is not appropriate in areas with poor access to market, such as middle stream of Bucao, and upstream of Sto.Tomas area.
*2) Crops are not appropriate in the areas where share tenancy is dominant land tenure.

The labor and material requirements for different production activities and yield data for various annual crops were taken from Aganon et.al. (1995: Crop Production Technologies in Ash and Lahar Laden Areas). The prevailing market prices in Iba, Zambales for seeds, fertilizers, chemicals, diesel and oil were used to determine the material costs while existing wage rates for hired labor were taken from direct interviews and were used to determine labor cost of production operations. The market prices of crops were taken from the Municipal Agriculture Office of Iba, Zambales and were applied in determining the value of total crop yield.

Forage grasses, pasture legumes and possibly fodder trees are not included in the appropriate list above, but they also should be selected as appropriate crops in the area where livestock, particularly cattle and goat, is common. These plants thrive with minimum of water. The leguminous crops will provide basic nitrogen into the soil, which would highly contribute to improve the soil condition. The forage crops will be continued for 7 to 10 years, and they will raise livestock by grazing. The livestock waste will be naturally distributed to the lahar pasture land and it will enhance fertility of the lahar pasture land. This way for lahar agriculture development was also recommended in the eastern Pinatubo area (refer to “Agricultural Development Planning for Sabocia-Bamban River Basin”, DPWH / Nippon Koei / PHILKOEI International, March 1998).

Since the pilot project areas are defined as the downstream area of the Bucao and the Sto. Tomas Rivers, cash crops such as onion and sweet potato are assumed to be planted.

(4) Community Road Rehabilitation Project

As the community road network is proposed on the mountain area to connect remote communities, where the population is quite limited and no remarkable economic activities are observed, economic viability of the community road development is not expected. On the other hand, it will yield a great benefit for the target communities from the sociological viewpoints. Followings are the expected benefit of the proposed project:

1) Elementary schools can be established and operated, as the teachers from the town proper can commute by public service vehicles. Based on this, school-age children may have opportunities to go to elementary school,
2) Periodical medical care service can be provided by the government because of the accessibility by vehicles. Health condition of Aeta people would be improved.
3) Commodity flow between the remote communities and the town proper will be strengthened. Based on this, the volume of the mountain products for marketing will increase and the income

level of Aeta people would be improved,

4) Community development activities, such as community-based forest management and slope agriculture land technology development will be encouraged. By this, the livelihood development on the remote Aeta communities might be realized.
5) Peace and Order in the mountain remote community would be improved. The periodical police patrol would be possible through the community road network.
6) Basin management activities would be strengthened through frequent site visit and technical advise by the government staff, which would encourage future basin conservation as well as sediment control activities in the mountain area. As the results, sediment yield in the basin would be mitigated and the downstream maintenance of river facilities would be lessen.

It is quite difficult, however, to quantify the above benefit.

For community road development on the Bucao River basin, the time saving for traveling is considered as the benefit. In the Upper Bucao River basin, the estimated population is about 11,000 people, which is considered to receive the direct benefits. The average time saving from community road development is assumed to be 3 hours, as they currently have no access road and they usually travel by carabao cart or by foot along the lahar buried river channel.

The saving of the accumulated travel time was estimated to be 792,000 hours/year. GRDP per capita is P10.54/hour. The annual benefit amounts to 8.35 million pesos.

(5) Establishment of Aeta Assistance Station

No economic return has been considered as the project aims to preserve the tradition and culture of Aeta People, originated in the Mount Pinatubo area.

19.2.2 Economic Evaluation

The results of the economic evaluation of the proposed non-structural measures and community disaster prevention plans are summarized as follows:

Economic Evaluation for Non-Structural Measures and Community Disaster Prevention Plans

Proposed Projects	Project Cost (Million Pesos)	EIRR
GSM telemetry warning and improvement of evacuation system (including monitoring system of Maraunot Notch)	82 (Equivalent to US$1.6 million)	N.A.
Community-Based Forest Management (for Pilot Scheme of 2,200 ha)	76 (Equivalent to US$1.5 million)	21.5%
Agricultural Development on Lahar Area (for Pilot Scheme of 20 ha)	19 (Equivalent to US$0.38 million)	9.8%
Community Road Rehabilitation Project (Priority Scheme for Route-A1:16km)	189 (Equivalent to US$3.7 million)	2.1%
Establishment of Aeta Assistance Station (Pilot Scheme for FOCUS Project)	15 (Equivalent to US$0.30 million)	N.A.

Table 19.2.1 shows the calculation sheet of EIRR for the CBFM program, in which the EIRR is estimated at 21.5%. Accordingly, the Community-Based Forest Management Program is judged as feasible in terms of the economic aspect.

The EIRR is estimated at 14.3% for combined agricultural development on lahar area in the Bucao (120 ha) and Sto. Tomas (250 ha), and 9.8% for the pilot scheme (20 ha) as summarized below and shown in Table 19.2.2.

Summary of Cost / Benefit, Economic Evaluation

No.	Location	Barangay	Area (ha)	Project Cost (million Pesos)	Annual Benefit (million Pesos)	EIRR	Cropping Pattern (Assumed)
1	Bucao-d/s-2 (R)	San Juan	120	105.8	81.3	11.6%	Sweet potato
2	Sto. Tomas, middle (L)	San Rafael	250	220.5	253.9	16.9%	Onion
3	Pilot Scheme of 1&2		20	19	2.6	9.8%	

The EIRR of the community road rehabilitation project was calculated at 2.1% as shown in Table 19.2.3, which was evaluated as non-feasible in terms of the economic viewpoint.

19.3 Poverty Assessment through Barangay Comparative Study

19.3.1 Objective of the Comparative Study

In this section, the effects on poverty reduction in the study area from the proposed Flood/Mudflow control measures were assessed. This was for the purpose of searching out the best arrangement for the projects, which is to aim at equitable recovery and development in the study area. Generally, the target area for Flood/Mudflow control is focused on the area in which more buildings, productive land, public facilities and population are concentrated. It seems that the proposed structural control measures could not cover the other area in the study area, in which there are less productivity, assets, development potential, buildings and population. Generally, there would be a limitation that it is difficult to justify protecting the poor communities, with less assets, by structural measures for economic reasons.

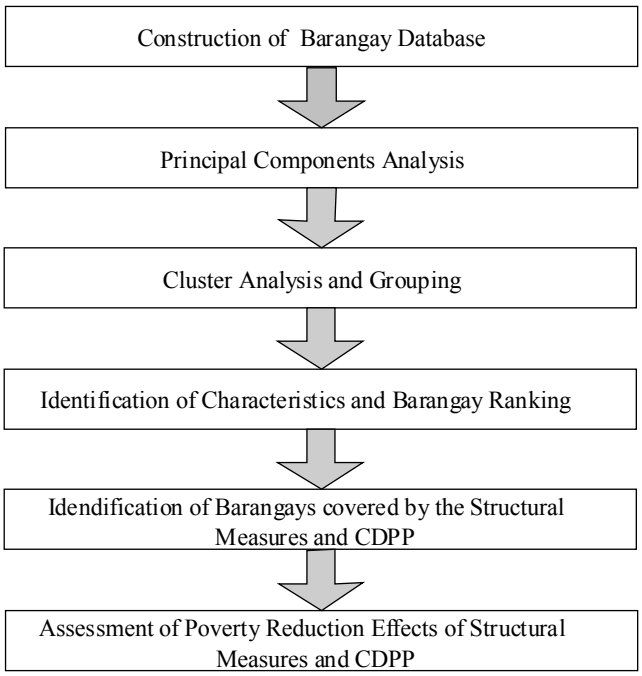
The proposed CDPP in this study, has not been formulated for direct linkage to the disaster prevention activities, but to mitigate poverty on the severely affected barangays. That must be the best defense against further disasters.

The objective of the Barangay comparative study is, therefore, as follows:

1) To identify the characteristics of the barangays in both the areas which are within the area protected by structural measures and out of the protected area,
2) To select the location of a CDPP site, by focusing on poverty reduction for communities severely affected by the events of the eruption of Mount Pinatubo and the subsequent series of lahar flows.

19.3.2 Approach and Methodology

The following figure is the flow chart of the Barangay comparative study, for which the multivariate statistical analysis was applied:



First of all, the barangay database was constructed based on the GIS database of the study team and the barangay information. For the barangay comparison, 15 kinds of data were used for multivariate statistical analysis.

After that, the Principal Component analysis (PC analysis) was conducted. PC analysis is to assess the correlation between the respective data and to determine the principal components, which is the group of data with relatively high correlation. In this study, six principal components were extracted from the 15 kinds of data.

Cluster analysis was then conducted to classify the barangays. Based on the score of respective principal components, the barangays which had been marked with a similar scoring pattern of respective principal components were grouped, and the characteristics of each group were assessed.

The barangay ranking was determined based on the accumulated score of PC analysis, by which the characteristics of the respective cluster and the poverty degree were identified.

Based on the results of Cluster analysis, the assessment of the beneficial barangays against the proposed structural measures was then carried out. By this, the expected effects of the structural measure for poverty reduction were assessed. At the same time, the CDPP plan formulation was assessed based on the cluster analysis. For this, the CDPP projects would be proposed for the areas that were identified with a relatively low score from PC analysis and a certain cluster was then characterized as the poverty area. Then, poverty reduction was focused as one of the main objectives of the proposed CDPP.

The detailed procedures are mentioned in Appendix-XV GIS in the supporting report.

19.3.3 Conclusions on Poverty Assessment

Based on the cluster analysis, poverty assessment was carried out in the study area. In this study, the principal components for the assessment were 1) accessibility for development, 2) suitability for agriculture, 3) degree of urbanization, 4) degree of education opportunity, 5) degree of infrastructure, and 6) per capita input from the government. Therefore, the poverty assessment was limited to only the six principal components mentioned above. In fact, the poverty structure is quite complex and not

easy to quantify.

Based on the assessment in this study, the degree of poverty was assessed in the following order:

Degree of Poverty

Order	Cluster	Characters	Nos. of Barangay	Poverty degree
1	Cluster-6	High Potential Barangay	4	Low
2	Cluster-2	Urbanized Agriculture Barangay	18	Relatively Low
3	Cluster-5	Urban Barangay	7	Medium
4	Cluster-4	Potential Development Barangay	11	Medium
3	Cluster-1	Agriculture Based Barangay	66	Medium-High
6	Cluster-3	Less Potential Barangay	16	High

The overall barangay ranking and scoring are shown in Table 19.3.1. The location of barangay classification is shown in Figure 19.3.1.

Based on the assessment above, the barangays which were identified as having a high or relatively high degree of poverty were generally not suitable for agricultural development. Income source should be studied well, taking into account the location and topography. Basically, the 16 barangays belonging to cluster-3 are located in the mountain area a long way from the center of their municipalities.

The slope agriculture method and/or agro-forestry would, therefore, be a high priority requirement for poverty reduction in this area. This would directly contribute to improving the situation of barangays classified into cluster-3.

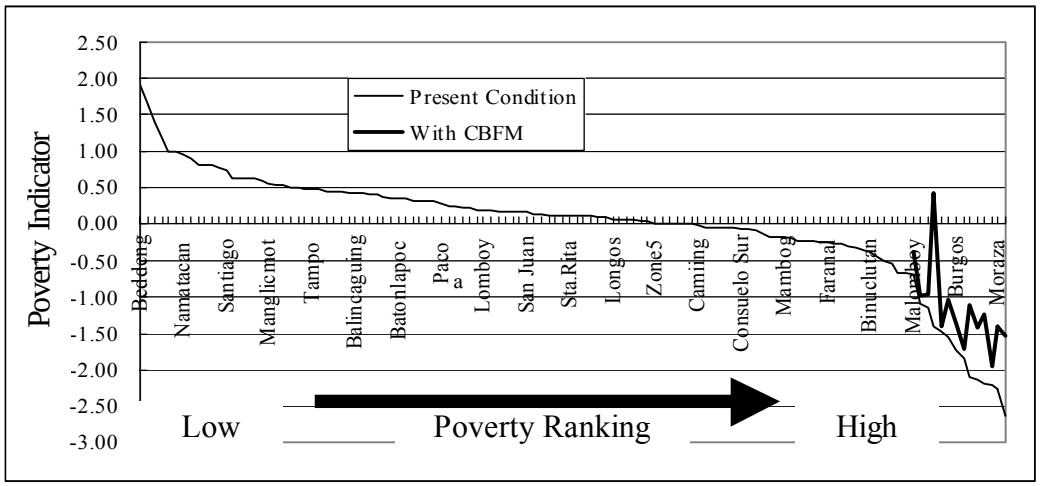
In addition, community road improvement to mountain areas would be another key factor to focus the poverty reduction in this area. The improvement of accessibility would be quite effective in improving the conditions for marketing and education access as well as the opportunity to use various services provided by the government.

19.3.4 Effective Projects for Poverty Reduction

Based on the above analysis, the poverty mitigation effect was assessed for the community-based forest management project and the community road rehabilitation project. This was because it is assumed that the barangays located in the mountain area were generally marked as having a high degree of poverty.

For the community-based forest management project, the priority area is located in the upstream of the Bucao and Sto Tomas River basins, which generally belong to cluster-3. That is favorable from the viewpoint of watershed management for disaster prevention, such as improvement of water retention capability, flood peak mitigation and mitigation of sediment yield in the basin, though the priority area was selected from the viewpoint of poverty reduction in the severely affected areas.

Poverty Reduction Effect by CBFM Program for the Priority Area



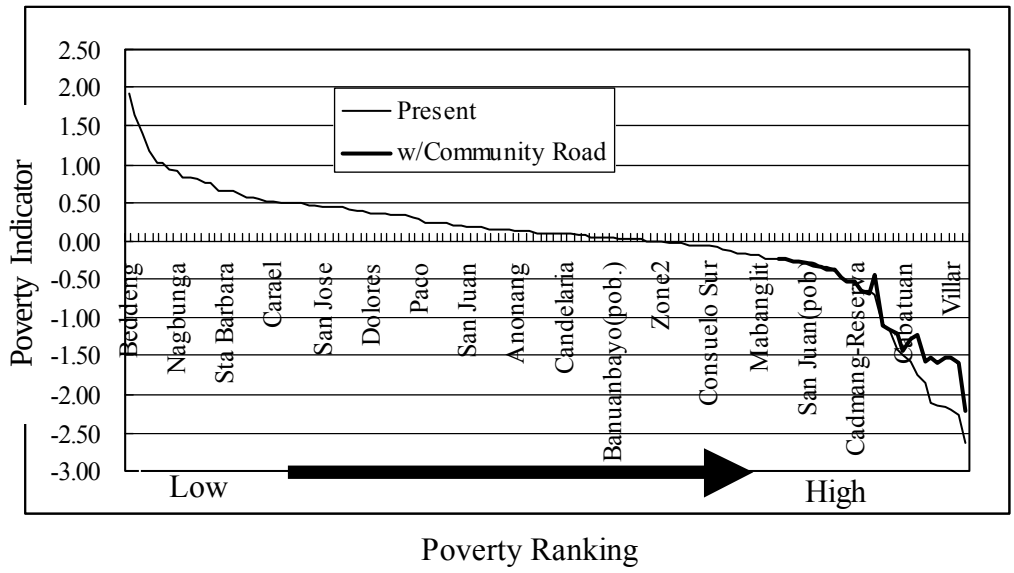
The above figure illustrates the effects of poverty reduction in the study area by introducing CBFM in the proposed area. The last 14 barangays were selected as the priority area for livelihood development. With agro-forestry development in the proposed area, the productive land is increased in each barangay and this is added to the poverty analysis to quantify the effect on poverty reduction by applying CBFM.

Also, for the Community Road Rehabilitation Project, all the target barangays were generally low ranked based on the barangay comparative study. The community road development would contribute to improving some principal factors such as degree of urbanization (PC4) and degree of social infrastructures (PC5). Mitigation of poverty values would, therefore, be reviewed for the target barangays if the community road network was realized. The results would be as follows:

Effects on Poverty Reduction through Community Road Development

No.	Municipality	Barangay	Barangay Ranking	Poverty Value w/o Project	Ranking after Community Road	Poverty Value after Community Road
1	Botolan	Maguisguis	122	-2.62	121	-2.23
2	Botolan	Moraza	121	-2.27	115	-1.59
3	Botolan	Villar	120	-2.20	114	-1.51
4	Botolan	Poonbato	119	-2.18	114	-1.51
5	Botolan	Palis	118	-2.14	115	-1.60
6	Botolan	Nacolcol	117	-2.11	114	-1.52
7	Botolan	Belbel	116	-1.84	114	-1.55
8	Botolan	Burgos	115	-1.74	112	-1.23
9	Botolan	Owaog-Nebloc	114	-1.55	113	-1.27
10	Botolan	Cabatuan	113	-1.49	112	-1.44
11	S-Marcelino	Santa Fe	112	-1.41	112	-1.21
12	S-Marcelino	Aglao	111	-1.15	112	-1.15
13	S-Marcelino	Buhawen	110	-1.10	114	-1.11
14	Botolan	Malomboy	109	-0.70	104	-0.46
15	S-Marcelino	San Rafael	95	-0.23	95	-0.23
	TOTAL					

Poverty Reduction Effect by Community Road Development



The result is almost the same as the one for Community-Based Forest Management, in that the proposed community road development would contribute to the improvement in the relatively poor barangays in the study area. That would improve the balance of the development in the study area from the viewpoint of equitable benefit to the whole area.

19.4 Overall Project Evaluation

Based on the economic evaluation and poverty reduction analysis, it is understood that, even though the economic viability is rather low, some projects, such as community road rehabilitation, and establishment of the Aeta Assistance Station, are quite important from the comprehensive development viewpoint. In addition, since the economically viable projects are generally located in the downstream reach of the river basin, projects might be realized only in the downstream area if only the respective economic evaluations were focused on to judge the projects. This might result in selective investment only for the areas where a relatively high level of economy is observed, and then the economic gap would be expanded within the same river basin.

From natural basin-wide viewpoints also, the river basin activities should cover the whole basin, from the upstream to downstream, watershed and flood plane, mountain and fan formed area, and so on. All the areas in one river basin are strongly linked in various natural and social aspects, and the particular activities in the upstream area might seriously affect the downstream area.

From the viewpoint of basin-wide, regional equity and poverty reduction, it is important to conduct a comprehensive approach to project evaluation.

Table 19.4.1 shows the results of overall economic evaluation of the selected priority projects. It was revealed that even some priority projects are not economically feasible, such as the Warning and Evacuation System, the Monitoring System for Maraunot Notch, Agricultural Development in the Lahar Area, the Community Road Rehabilitation Project, and the Aeta Assistance Station. The overall EIRR for the integrated projects is revealed as economically feasible with an EIRR of 20.0%, and integrated project implementation can be justified also from the economic viewpoint as well as in the view of basin-wide, natural and social importance.

CHAPTER 20 CONCLUSIONS AND RECOMMENDATIONS

20.1 Proposed Projects for Urgent Implementation

The following structural, non-structural and community-based disaster prevention measures have been proven to meet the national and local governments' policies for the regional development and the local people's desires, and have been found to be feasible technically, economically and/or environmentally. Therefore, urgent implementation of these measures is recommended.

Structural Measures

1) Bucao River dike heightening / strengthening with new dike construction including reconstruction of the Bucao Bridge,
2) Sto. Tomas River dike construction / heightening / strengthening, and drainage channel construction for Gabor River,

Non-structural Measures

3) Upgrading of the existing warning and evacuation system including dissemination of hazard maps, assignment of 10 evacuation centers to existing buildings, and training of the staff of disaster management agencies,

Community-based Disaster Prevention Measures

4) Pilot development for community-based forest management in an area of 2,200 ha,
5) Pilot development for agricultural development with an area of 10ha for each of the Bucao and Sto.Tomas River basins,
6) Rehabilitation of a 16km length of community road along the Bucao River, and,
7) Implementation of a pilot scheme for the FOCUS Aeta project including study on establishment of AETAS.

It is reiterated that the above mentioned structural, non-structural and community-based disaster prevention measures should be implemented in view of combined development of the whole basin including the flood prone lowland area and highland. The high EIRR of 20.0% for the overall projects proves viability of the said combined development. The goal, that is the regional economic development and poverty alleviation of the region, can be attained only by these basin-wide combined measures.

20.2 Preparatory Actions for Proposed Projects

Prior to implementation of the proposed projects mentioned above, the following actions are required to be taken by the agency concerned:

1) Monitoring activities should be conducted by DPWH, PHIVOLCS and DENR for review of the feasibility study including continuous observation of rainfall, river water level and discharge measurement in the study area, observation of rainfall, lake water level and groundwater at the Maraunot Notch, river cross section surveys for sediment balance analysis in the study area, water quality analysis for the Mapanuepe Lake, and so forth.
2) The implementation programs of the priority projects should be prepared by DPWH in detail for obtaining necessary agreements and concurrence, arranging necessary finance and expediting urgent implementation of the priority projects.
3) Agreements with local governments should be prepared and obtained for the project implementation including the RDC resolution and signing of necessary Memorandum of Agreements (MOAs) among the national government agencies concerned and LGUs. Important

agreement items with the LGUs include involvement and cost sharing of LGUs for land acquisition and compensation, and arrangement of operation, maintenance and management system for the projects.

4) Arrangements for receiving approval for the project implementation are also required to be taken by DPWH, which include ECC from DENR and ICC clearance from NEDA.
5) Survey of land owners should be conducted by DPWH in the areas affected by the project implementation, and land acquisition, compensation and relocation programs should be prepared. Obtaining of concurrence of the local people is essential on the implementation of the projects and programs of land acquisition, compensation and relocation.
6) The project coordination committee and PMO in Zambales Province should be established and MPE-PMO should be ready for inclusion of management of western structural projects to their mandate.
7) Some measures to restrict legally the settlement in the affected area should be made by LGUs concerned in order to minimize the number of the affected families to be relocated before the project construction.
8) Arrangement of financial support by donor countries and/or lending institutions should be prepared, if necessary.

20.3 Actions for Other Recommended Projects

Taking the long-term view, the following actions are recommended to implement the other projects and studies proposed in the master plan:

1) Based on results of continuous observation on rainfall and water level and monitoring of riverbed fluctuation and sediment movement in the western river basins, effectiveness and applicability of the structural measures such as consolidation dam, sand pocket and training channel are recommended to re-evaluate for their implementation in the Bucao and Sto. Tomas Rivers. Review of the improvement plan for the Maloma River is also recommended several years later when further socio-economic development is realized in and around the river basin.

2) For the following two community-based disaster prevention measures, further study will be needed to resolve the present issues and to develop:

   - Community infrastructure development at Tektek resettlement center: Further discussion by people in the centers and LGUs and studies are needed on the integration of the three NGO resettlement centers and effective development of community infrastructure in the integrated center to resolve the present worse condition of the infrastructure.
   - Community development in the Mapanuepe Lake basin: Future study is recommended for the community development using land and water potential of the lake after solving two major issues of lake water quality and Dizon tailings dam.

3) It is recommended that any socio-economic and technical/ engineering data is collected by DPWH for the effective development of the western river basins.

4) A wide ranging program of capacity building measures are recommended to help ensure the success of the projects and reviews proposed in the master plan and post-construction operation and maintenance. The measures should include revision of the Water Code and its IRR, a comprehensive program of personnel training and development for all the agencies involved in the projects, and so forth.

Tables

Table 1.3.1 Achievements on Transfer of Technology

Meeting		Date	Venue	Details
Workshop	1st-1	September 19, 2002	Iba	• Explanation and Discussion on Master Plan and Priority Projects
	1st-2	September 24 2002	Manila	• Explanation and Discussion on Master Plan and Priority Projects
	2nd-1	June 11, 2003	Iba	• Explanation and Discussion on The Results of Feasibility Studies
	2nd-2	June 16 2003	Manila	• Explanation and Discussion on The Results of Feasibility Studies
Meeting with Technical Working Group	1st	April 3, 2002	Manila	• Explanation and Discussion on Overall Study Plan
	2nd	May 17, 2002	Iba	• Presentation by Counterparts on Progress of the Study
	3rd	June 11, 2002	Manila	• Presentation by Counterparts on Progress of the Study, Explanation and Discussion on Flood Control and Sabo Measures
	4th	August 16, 2002	Iba	• Presentation by Counterparts on Hydrological Survey, Geological Survey and Sabo Plan
	5th	September 23, 2002	Manila	• Presentation by Counterparts on Master Plan and Priority Projects
	6th	December 10, 2002	Manila	• Presentation of Interim Report and Discussion
	7th	March 12, 2003	Manila	• Presentation by Counterparts on The Progress of Feasibility Studies
	8th	June 17, 2003	Manila	• Presentation by Counterparts on the Results of Feasibility Studies
	9th	August 6, 2003	Manila	• Presentation by Study Team on Draft Final Report
Joint Meeting	1st	May 28, 2002	Iba	• Explanation by Study Team on Overall Study, Collection of Hydrological Data, Geological Investigation and Traffic Volume Survey
	2nd	June 7, 2002	Iba	• Explanation of Flow and Outline of Framework Plan Formulation in Sto. Tomas River Basin by Study Team
	3rd	August 27, 2002	Iba	• Presentation by the Study Team on Hydrological Analysis, Mudflow Control Plan, and Initial Environmental Examination (IEE)
	4th	February 20, 2003	Iba	• Presentation of the Outline of the Feasibility Study, Explanation and Discussion on Geology (including Maraunot Notch), Structural Measures, Bucao and Maculcol Bridge & Community Disaster Prevention Plans
Technology Transfer Seminar	1st-1	December 16, 2002	Iba	• Presentation and Discussion on the Formulation of Master Plan, Introduction of HEC-HMS for Flood Run-off, Importance of Mudflow Analysis and the Purpose and Design Criteria of Sabo Structures
	1st-2	December 17, 2002	Manila	• Presentation and Discussion on the Formulation of Master Plan, Introduction of HEC-HMS for Flood Run-off, Importance of Mudflow Analysis and the Purpose and Design Criteria of Sabo Structures
	2nd-1	August 05, 2003	Iba	• Presentation and Discussion on Formulation of Overall Plan in the Study, Sabo and Flood Control Structural Measures, Sabo and Flood Control Non-structural Measures, Community Disaster Prevention System, and Environmental Assessment
	2nd-2	August 08, 2003	Manila	• Presentation and Discussion on Formulation of Overall Plan in the Study, Sabo and Flood Control Structural Measures, Sabo and Flood Control Non-structural Measures, Community Disaster Prevention System, and Environmental Assessment
GIS Seminar	1st	February 20 - 22, 2003	Iba	• The purpose of the seminar is designed to dramatically change the way geographic data can be viewed and shared for the planning purpose
On-the-Job Training	April - September, 2002, December, 2002 - March 2003, April - June 2003		Iba	• Face to face, day by day Training

Table 2.2.1 Estimated Cost Damages on Public Infrastructure in Region III, 1991

(As of 23 August 1991) (in thousand pesos)

Infrastructure Sub-Sector: Facility	Western Areas				Eastern Areas				Other Areas			Grand Total	Percent Dist.
	Zambales	Bataan	Olongapo	Total	Pampanga	Tarlac	Angeles	Total	Bulacan	N.Ecija	Total		
TRANSPORTATION	185,320	69,660	67,546	322,526	208,676	36,502	509,650	754,828	32,309	40,245	72,554	1,149,908	30.0%
Roads and Bridges	170,320	69,660	67,546	307,526	183,676	25,502	475,650	684,828	32,309	40,245	72,554	1,064,908	27.8%
1.National System	98,893	63,164	9,300	171,357	111,526	10,375	475,650	597,551	13,460	15,220	28,680	797,588	20.8%
- Roads	33,093	63,000	9,300	105,393	31,666	6,725	14,000	52,391	9,160	13,120	22,280	180,064	4.7%
- Bridges	65,800	164	0	65,964	79,860	3,650	461,650	545,160	4,300	2,100	6,400	617,524	16.1%
2.Local Roads and Bridges	71,427	6,496	58,246	136,169	72,150	15,127	0	87,277	18,849	25,025	43,874	267,320	7.0%
- Provincial City	8,653	1,769	58,246	68,668	50	1,895	0	1,945	3,701	5,600	9,301	79,914	2.1%
- Municipal	27,500	270	0	27,770	16,100	255	0	16,355	0	555	555	44,680	1.2%
- Barangay	35,274	4,457	0	39,731	56,000	12,977	0	68,977	15,148	18,870	34,018	142,726	3.7%
Railway Facilities	0	0	0	0	25,000	11,000	34,000	70,000	0	0	0	70,000	1.8%
Airport Facilities	15,000	0	0	15,000	0	0	0	0	0	0	0	15,000	0.4%
COMMUNICATION	6,992	0	4,012	11,004	1,707	344	160	2,211	0	0	0	13,215	0.3%
Telecommunications Facilities	6,702	0	2,712	9,414	1,707	344	160	2,211	0	0	0	11,625	0.3%
Postal Communication Facilities	290	0	1,300	1,590	0	0	0	0	0	0	0	1,590	0.0%
POWER AND ELECTRIFICATION	22,571	2,938	3,244	28,753	14,771	11,095	298	26,164	0	0	0	54,918	1.4%
NPC Facilities	860	1,199	3,244	5,303	0	2,025	298	2,323	0	0	0	7,627	0.2%
Electric Cooperatives	21,711	1,739	0	23,450	14,771	9,070	0	23,841	0	0	0	47,291	1.2%
WATER RESOURCES	732,973	41,400	119,250	893,623	342,738	229,960	81,222	653,920	11,050	10,050	21,100	1,568,642	40.9%
Water Supply Facilities	17,306	2,000	65,000	84,306	25,205	3,447	10,000	38,652	0	0	0	122,957	3.2%
1.Water District Facilities	15,641	2,000	65,000	82,641	20,840	3,447	10,000	34,287	0	0	0	116,927	3.1%
2.Level 1 Systems	1,665	0	0	1,665	4,365	0	0	4,365	0	0	0	6,030	0.2%
Irrigation Facilities	57,895	12,982	0	70,877	79,990	31,547	1,897	113,434	0	0	0	184,311	4.8%
1.National Irrigation Systems	25,017	2,275	0	27,292	17,828	21,089	0	38,917	0	0	0	66,209	1.7%
2.Communal Irrgation Systems	32,878	10,707	0	43,585	62,162	10,458	1,897	74,517	0	0	0	118,102	3.1%
Flood Control Drainage	657,772	26,418	54,250	738,440	237,543	194,966	69,325	501,834	11,050	10,050	21,100	1,261,374	32.9%
SOCIAL INFRASTRUCTURE	499,476	39,105	236,080	774,661	168,187	51,842	41,212	261,241	5,150	4,655	9,805	1,045,708	27.3%
School Buildings	409,690	33,475	141,930	585,095	129,811	13,050	11,940	154,801	5,050	3,155	8,205	748,102	19.5%
Health Facilities	16,200	3,120	14,650	33,970	7,730	4,810	24,150	36,690	0	0	0	70,660	1.8%
LTO Buildings	186	700	200	1,086	96	92	122	310	0	0	0	1,396	0.0%
Other Public Buildings: Structure	73,400	1,810	79,300	154,510	30,550	33,890	5,000	69,440	100	1,500	1,600	225,550	5.9%
Grand Total	1,447,332	153,103	430,132	2,030,567	736,079	329,742	632,542	1,698,364	48,510	54,950	103,460	3,832,390	100.0%
Percent Distribution	37.8%	4.0%	11.2%	53.0%	19.2%	8.6%	16.5%	41.3%	1.3%	1.4%	2.7%	100.0%	

Source: The Regional Task Force Secretariat : NEDA Regional Office III

Table 2.3.1 List of Major NGOs' Activities in the Study Area

No.	Name of NGO	Country	Sector	Area	Address
1	Aeta Development Association Inc.	Philippines	Livelihood for Aeta / Lahar Agriculture	San Felipe (Kakilingan) / Castillejos	http://isweb27.infoseek.co.jp/area/jyta/aeta1.html
2	Pinatto	Japan	Provision of 2nd hand goods etc.	Whole Pinatubo Area	
3	The Institute of Cultural Affairs, Japan	Japan	Agricultural/Forest Technology Transfer	Whole Pinatubo Area	
4	Pinatubo Aeta Education Foster Parent Program	Japan	Education / Scholarship	for Aeta People	http://www.sun-inet.or.jp/~ngo-net/aeta.html
5	Action	Japan	Livelihood for Aeta / Lahar Agriculture/Education / Scholarship	Baluwet Balaybay Castillejos	http://www.sam.hi-ho.ne.jp/action-hajime/index.html
6	Save the Children	Japan	Livelihood for Aeta	for Aeta People	http://www.savechildren.or.jp/works/0503.html
7	CCWA	Japan	Lahar Agriculture	Botolan	
8	Philippine Red Cross	Philippines	Livelihood for Aeta	Cabangan	
9	BUDHI	Philippines	Livelihood for Aeta	Whole Pinatubo Area	http://www.nuffic.nl/ciran/ikdm/2-1/communications/networks.html
10	Fundación Santiago	Philippines	Strengthening of the economic fabric	Zambales	http://www.aeci.org.ph/ngo-1997-2.htm

Table 3.2.1 Municipality Population of the Study Area in 1980, 1990 and 2000

National / Regional / Province / Municipality	Area (km²)	Census Population									Annual Growth Rate (%p.a)	
		1980		1990		2000						
		Number of Households	Population	Number of Household	Population	Number of Household	Population	Household Population	Average Size of Household	Density (per km²)	80-90	90-00
Philippines	294,554.00		48,098,460		60,703,206	15,274,579	76,503,333	76,286,062	4.99	260	2.35	2.34
Region III	18,231.00		4,802,793		6,199,017	1,632,047	8,030,945	8,015,807	4.91	445	2.57	2.62
Zambales (whole province)	3,611.10		287,607		369,665	91,613	433,542	432,729	4.72	120	2.54	1.61
Zambales Province (Study Area)												
Botolan	613.70		27,125	6,844	35,604	9,629	46,602	46,550	4.83	76	2.76	2.78
Cabangan	239.40		11,636	3,192	15,337	4,032	18,848	18,842	4.67	79	2.80	2.73
Castillejos	86.50		19,154	5,453	26,753	7,238	33,108	33,038	4.56	383	3.40	2.15
Iba	153.40		22,791	5,621	29,221	7,260	34,678	34,487	4.75	226	2.52	1.73
San Antonio	205.00		22,382	5,836	26,944	6,483	28,248	28,152	4.34	138	1.87	0.47
San Felipe	103.70		13,834	3,321	15,624	4,094	17,702	17,534	4.28	171	1.22	1.26
San Marcelino	440.90		24,964	7,598	36,589	5,866	25,440	25,401	4.33	58	3.90	-3.57
San Narciso	71.60		19,119	4,868	22,891	5,319	23,522	23,499	4.42	329	1.82	0.27
Grand Total	1,914.20		161,005	42,733	208,963	49,921	228,148	227,503	4.56	119	2.39	1.13
Region III												
Pampanga (East Pinatubo)												
Angeles City	83.35	33,137	188,834	46,421	236,685						2.28	
Arayat	119.42		56,692	12,100	73,189						2.59	
Mabalacat	153.53	13,244	80,966	22,750	121,115						4.11	
Magalang	138.35	5,278	34,840	7,389	43,940						2.35	
Mexico	98.97	9,155	53,491	11,234	69,441						2.64	
Sta. Ana	44.34	4,407	25,361	5,250	32,540						2.52	
Grand Total	637.96	65,221	440,184	105,144	576,910						2.74	
Total Pampanga	2,120.40		992,756		1,295,929	308,445	1,618,759	1,617,040	5.24	763	2.70	2.25
Tarlac (East Pinatubo)												
Bamban	143.14	3,972	26,072	6,209	35,639						3.18	
Capas	61.00	3,053	18,883	4,539	25,795						3.17	
Concepcion	193.35	12,296	76,446	16,162	97,776						2.49	
Grand Total	397.49	19,321	123,401	26,910	159,210						2.75	
Total Tarlac	3,053.40		688,457		859,708	215,395	1,068,783	1,067,484	4.96	350	2.25	2.20

Source : 1980,1990,2000 Census of Population and Housing, NSO
Study on Flood and Mudflow Control for Sacobia-Bamban/Abacan River Draining from Mt. Pinatubo, May 1996

Table 3.2.2 Labor Force, Employment Status and Employed Persons by Major Industry Group (1990, 1995, 2000)

(Unit: 1,000)

Item	Philippines		Region 3	
Employment Status				
Household Population, 15 Years Old & Over				
1990	37,999		3,856	
1995	42,770		3,365	
2000	48,076		4,965	
Participation Rate to Labor Force (%)				
1990	64.5		62.2	
1995	65.6		62.8	
2000	64.1		61.3	
Percentage of Labor Force				
Employment Rate (%)				
1990	91.9		90.1	
1995	91.6		91	
2000	89.9		90.1	
Unemployment Rate (%)				
1990	8.1		9.9	
1995	8.4		9	
2000	10.1		9.9	
Underemployment Rate in Percent of Employed (%)				
1990	22.1		15.9	
1995	19.8		13.3	
2000	19.9		8	
Employed Persons by Major Industry Group in 2000				
Agriculture	**10,401**	(37.4)	**683**	(25.0)
Agriculture, Fishery & Forestry	10,401		683	
Industry	**4,444**	(16.0)	**634**	(23.2)
Mining and Quarrying	106		6.0	
Manufacturing	2,792		377	
Electricity Gas and Water	116		19.0	
Construction	1,430		232	
Services	**12,929**	(46.5)	**1,413**	(51.7)
Wholesale and Retail Trade	4,587		497	
Transportation, Storage and Communication	2,024		278	
Financing, Real Estate & Business Service	678		74	
Community, Social & Personal Services	5,636		564	
Industry Not Adequately Defined or Reported	4			
Total	**27,775**	(100.0)	**2,731.0**	(100)

Source: 2001 Philippine Statistical Yearbook, October 2001, NSCB
Note: Percentage of total figures are shown in brackets

Table 3.2.3 Labor Force and Employment: 2000 Census Year

(Unit:1,000)

Area	Household Population 15 years old & over	Labor Force			Not in Labor Force
		Total	Employed	Un-employed	
Population Distribution					
I. Philippines	48,075	30,908	27,775	3,133	17,167
Male	23,944	19,236	17,258	1,978	4,708
Female	24,131	11,672	10,516	1,156	12,459
II. Region III	4,945	3,033	2,731	302	1,912
Male	2,460	1,972	1,786	186	487
Female	2,485	1,060	945	115	1,425

Source: Integrated Survey of Household Bulletin Series, NSO, October 2000

Table 3.2.4 GRDP and Per Capita GRDP by Region: 1990～2000

	Area	GDP/GRDP at Current Prices (Million Pesos)	Population	Per Capita GRDP (Pesos)	Ratio to National Per Capita GDP (%)	Order of Per Capita GRDP in Regions
1990						
	Philippines	1,077,237	60,703,216	17,522	100	-
1	NCR	347,609	7,948,402	43,593	249	1
2	CAR	20,267	1,146,191	17,608	100	3
3	Region 1	32,501	3,550,642	9,246	53	12
4	Region 2	23,724	2,340,545	9,601	55	11
5	Region 3	91,922	6,199,017	14,966	85	7
6	Region 4	155,817	8,263,099	19,255	110	2
7	Region 5	31,927	3,910,001	7,276	42	14
8	Region 6	75,649	5,393,333	13,337	76	8
9	Region 7	70,766	4,594,124	15,331	87	5
10	Region 8	28,269	3,054,490	8,413	48	13
11	Region 9	31,182	2,459,690	9,760	56	10
12	Region 10	55,120	2,197,544	15,248	87	6
13	Region 11	74,670	4,006,731	17,229	98	4
14	Region 12	37,813	2,032,958	12,853	73	9
15	Region 13	-	4,764,297	-	-	-
16	ARMM	-	1,836,930	-	-	-
1995						
	Philippines	1,905,951	68,616,536	27,124	100	-
1	NCR	623,939	9,454,040	68,429	252	1
2	CAR	38,453	1,254,838	28,912	107	2
3	Region 1	58,810	3,803,890	14,589	54	12
4	Region 2	40,374	2,536,035	14,882	55	11
5	Region 3	159,939	6,932,570	22,316	82	8
6	Region 4	273,578	9,943,096	28,210	104	3
7	Region 5	55,885	4,325,307	12,447	46	14
8	Region 6	132,112	5,776,938	21,464	79	9
9	Region 7	121,438	5,014,588	23,008	85	6
10	Region 8	47,854	3,366,917	13,568	50	13
11	Region 9	52,904	2,794,659	18,306	67	10
12	Region 10	97,682	2,483,272	23,761	88	5
13	Region 11	129,205	4,604,158	24,508	90	4
14	Region 12	54,788	2,359,808	22,943	85	7
15	Region 13	-	1,942,687	-	-	-
16	ARMM	18,991	2,020,903	9,047	33	15
2000						
	Philippines	3,302,588	76,498,735	42,117	100	-
1	NCR	1,178,249	9,932,560	117,391	279	1
2	CAR	75,813	1,365,220	50,881	121	2
3	Region 1	101,191	4,200,478	22,935	54	12
4	Region 2	70,975	2,813,159	23,494	56	11
5	Region 3	245,069	8,030,945	30,784	73	9
6	Region 4	459,733	11,793,655	41,786	99	3
7	Region 5	89,717	4,674,855	18,095	43	15
8	Region 6	215,665	6,208,733	31,767	75	8
9	Region 7	224,872	5,701,064	38,446	91	5
10	Region 8	81,662	3,610,355	20,732	49	13
11	Region 9	82,874	3,091,208	25,290	60	10
12	Region 10	116,867	2,747,585	40,133	95	4
13	Region 11	193,292	5,189,335	35,815	85	6
14	Region 12	86,438	2,598,210	31,978	76	7
15	Region 13	48,127	2,095,367	20,488	49	14
16	ARMM	32,044	2,412,159	13,818	33	16

Source: 2001 Philippine Statistical Yearbook

Notes:
1. The GRDP estimates for the CAR and the ARMM started only in 1987 and 1993 respectively. Before this the contributions to the economy of the province comprising the CAR were accounted for in Region 1 and 2 while those of the ARMM province were accounted for in Regions 9 and 12.
2. Data are as of July 2001.
3. Details may not add up to totals due to rounding.

Table 3.2.5 Gross Regional Domestic Product at Current Prices: 1990, 1995, and 2000

(Unit: Million Pesos)

Economic Sector	1990	1995	2000
Gross Domestic Product in the Philippines			
1. Agriculture	**235,956**	**412,197**	**526,087**
1) Crop Production	130,290	244,600	307,746
Palay	36,416	64,598	87,987
Corn	16,469	21,750	24,856
Coconut	12,515	25,084	19,216
Sugarcane	6,962	11,971	14,472
Others	57,928	121,197	161,215
2) Fishery	40,833	65,338	76,382
3) Livestock & Poultry	46,025	78,883	114,548
4) Agricultural Activities	9,901	19,243	24,028
5) Forestry	8,907	4,133	3,383
2. Industry	**371,347**	**611,097**	**1,028,181**
1) Mining & Quarrying	16,659	16,801	21,239
2) Manufacturing	267,485	438,247	745,857
3) Construction	64,903	106,639	163,574
4) Electricity, Gas & Water	22,300	49,410	97,511
3. Services	**469,934**	**882,657**	**1,748,321**
1) Transportation & Communication	53,191	88,929	198,956
2) Trade	154,592	261,862	473,004
3) Others	262,151	531,866	1,076,361
4. Total	**1,077,237**	**1,905,951**	**3,302,589**
Gross Regional Domestic Product in Region 3			
1. Agriculture	**22,360**	**38,532**	**46,043**
1) Crop Production			
Palay	-	-	-
Corn	-	-	-
Cocunut	-	-	-
Sugarcane	-	-	-
Others	-	-	-
2) Fishery	-	-	-
3) Livestock & Poultry	-	-	-
4) Agricultural Activities	-	-	-
5) Forestry	-	-	15,621
2. Industry	**34,750**	**59,398**	**80,633**
1) Mining & Quarrying	2,252	1,248	233
2) Manufacturing	24,445	39,226	59,230
3) Construction	5,939	14,002	10,406
4) Electricity, Gas & Water	2,114	4,922	10,764
3. Services	**34,813**	**62,009**	**118,392**
1) Transportation & Communication		1,436	
2) Trade			
3) Others		9,400	
4. Total	**91,922**	**159,939**	**245,069**

Source: 2001 Philippine Statistical Yearbook, NSCB

Table 3.2.6 Percentage Distribution of GRDP by Economic Sector: 1990, 1995, and 2000

(Percentage)

Economic Sector	1990	1995	2000
Philippines			
1. Agriculture	21.9	21.6	15.9
2. Industry	34.5	32.1	31.1
- Manufacturing	24.8	23.0	22.6
3. Services	43.6	46.3	52.9
- Trade	14.4	13.7	14.3
4. Total	100.0	100.0	100.0
Region 3			
1. Agriculture	24.3	24.1	18.8
2. Industry	37.8	37.1	32.9
- Manufacturing	26.6	24.5	24.2
3. Services	37.9	38.8	48.3
- Trade			
4. Total	100.0	100.0	100.0

Source : 2001 Philippine Statistical Year Book, NSCB

Table 3.2.7 Percentage Distribution of GRDP per Capita: 1990, 1995, and 2000

Item	1990	1995	2000
In Pesos			
Philippines	17,522	27,124	42,117
Region 3	14,966	22,316	30,784
Percentage (%)	85	82	73
In US$ Equivalent			
Philippines	716	1,051	942
Region 3	612	865	688

Source : 2001 Philippine Statistical Year Book, NSCB

Table 3.2.8 Gross Regional Domestic Product at 1985 Constant Prices: 1990, 1995, and 2000

(Unit: Million Pesos)

Economic Sector	1990	1995	2000
Gross Domestic Product in the Philippines			
1. Agriculture	**160,734**	**172,848**	**190,627**
1) Crop Production	85,870	92,999	100,202
Palay	24,873	28,189	33,134
Corn	10,950	9,837	10,750
Coconut	7,084	7,380	6,619
Sugarcane	3,652	3,694	4,908
Others	39,311	43,899	44,791
2) Fishery	30,783	34,453	35,760
3) Livestock & Poultry	29,069	38,890	45,287
4) Agricultural Activities	7,692	7,457	8,006
5) Forestry	7,320	1,779	1,372
2. Industry	**255,548**	**283,858**	**328,990**
1) Mining & Quarrying	11,091	10,035	10,708
2) Manufacturing	183,925	203,271	237,271
3) Construction	41,858	44,492	48,451
4) Electricity, Gas & Water	18,674	26,060	32,560
3. Services	**304,409**	**345,518**	**435,345**
1) Transport & Communication	41,108	47,366	68,174
2) Trade	107,428	123,430	152,904
3) Others	155,872	174,722	214,267
4. Total	**720,691**	**802,224**	**954,962**
Gross Regional Domestic Product in Region 3			
1. Agriculture	**15,849**	**17,258**	**19,346**
1) Crop Production	-	-	-
Palay	-	-	-
Corn	-	-	-
Coconut	-	-	-
Sugarcane	-	-	-
Others	-	-	-
2) Fishery	-	-	-
3) Livestock & Poultry	-	-	-
4) Agricultural Activities	-	-	-
5) Forestry			
2. Industry	**28,378**	**34,589**	**33,813**
1) Mining & Quarrying	1,282	592	104
2) Manufacturing	21,370	25,510	27,223
3) Construction	3,911	5,892	3,060
4) Electricity, Gas & Water	1,815	2,595	3,426
3. Services	**24,022**	**26,639**	**31,811**
1) Transport & Communication	-	-	5,704
2) Trade	-	-	12,488
3) Others	-	-	13,619
4. Total	**68,250**	**78,487**	**84,970**

Source : 2001 Philippine Statistical Year Book, NSCB

Table 3.2.9 Real Annual Growth of GRDP by Economic Sector: 1990-2000

(Percentage)

Economic Sector	1990-1995	1995-2000	1990-2000
Philippines			
1. Agriculture	1.46	1.98	1.72
2. Industry	2.12	3.00	2.56
- Manufacturing	2.02	3.14	2.58
3. Services	2.57	4.73	3.64
- Commerce	2.82	4.38	3.59
4. Total	2.17	3.55	2.85
Region 3			
1. Agriculture	1.71	2.31	2.01
2. Industry	4.04	(0.45)	1.77
- Manufacturing	3.61	1.31	2.45
3. Services	2.09	3.61	2.85
- Commerce	-	-	-
4. Total	2.83	1.60	2.22

Source : 2001 Philippine Statistical Year Book, NSCB

Table 3.2.10 Real Growth of GRDP per Capita: 1990-2000

Economic Sector	1990	1995	2000
GRDP per Capita at 1985 Constant Prices (Pesos)			
Philippines	11,872	11,691	12,483
Region 3	11,010	11,321	10,580
Percentage (%)	93	97	85
Annual Growth Rate (%)	**90-95**	**95-00**	**90-00**
Philippines	-0.31	1.32	0.50
Region 3	0.56	-1.34	0.40

Source : 2001 Philippine Statistical Year Book, NSCB

Table 3.2.11 Production of Major Crops: 1990, 1995, and 2000

Crop	1990					1995					2000				
	Area (1000ha)	Quantity (1000ton)	Yield (ton/ha)	Value (Mil. Pesos)	% Share	Area (1000ha)	Quantity (1000ton)	Yield (ton/ha)	Value (Mil. Pesos)	% Share	Area (1000ha)	Quantity (1000ton)	Yield (ton/ha)	Value (Mil. Pesos)	% Share
Philippines															
1 Cereals	7,139	14,173	1.99	64,699	26.3	6,451	14,669	2.27	103,694	44.9	6,548	16,901	2.6	135,331	46.4
- Palay	3,319	9,319	1.99	45,672	18.5	3,759	10,541	2.80	77,684	33.7	4,038	12,389	3.1	105,558	36.2
- Corn	3,820	4,854	1.27	19,027	7.7	2,692	4,129	1.53	26,010	11.3	2,510	4,511	1.8	29,773	10.2
2 Major Crops	4,054	37,960	9.36	64,760	26.3	4,771	39,204	8.22	87,880	38.1	5,854	46,008	7.9	116,076	39.8
- Coconut	3,112	11,943	3.84	18,745	7.6	3,065	12,183	3.98	20,955	9.1	4,090	12,499	3.1	26,123	8.9
- Banana	312	3,540	11.35	7,254	2.9	339	3,449	10.17	12,457	5.4	348	4,156	11.9	19,365	6.6
- Mango	77	453	5.88	4,325	1.8	108	697	6.45	9,876	4.3	132	848	6.4	16,037	5.5
- Sugar Cane	235	18,667	79.43	11,387	4.6	302	17,774	58.86	13,153	5.7	372	23,519	63.2	16,463	5.6
- Pineapple	41	1,422	34.68	4,774	1.9	44	1,443	32.79	5,079	2.2	43	1,524	35.1	10,392	3.6
- Cassava	214	1853	8.66	3,467	1.4	226	1,906	8.44	4,936	2.1	211	1,771	8.4	6,765	2.3
- Tobacco	63	82	1.30	2,132	0.9	56	64	1.13	1,567	0.7	41	50	1.2	2,419	0.8
- Onion						9	88	10.16	1,002	0.4	10	84	8.8	1,319	0.5
Total Agricultural Crops				**246,242**					**230,396**					**291,956**	
Region 3															
1 Cereals	533.0	1,928	3.62	9,433	83.3	565.0	1,794	3.17	13,200	87.2	554.0	1,965	3.55	16,594	85.4
- Palay	521.0	1,911	3.67	9,366	82.7	548.0	1,757	3.21	12,949	85.5	530.0	1,888	3.56	16,086	82.8
- Corn	12.0	17	1.42	67	0.6	17.0	37	2.12	251	1.7	24.0	77	3.21	508	2.6
2 Major Crops	44.9	2,277	50.68	1882	16.6	45.0	1,228	27.29	1,953	12.8	59.7	1440		2,832	14.6
- Coconut	2.3	11.2	4.87	18	0.2	2.0	8	4.00	14	0.1	1.8	6	3.33	13	0.1
- Banana	3.1	35	11.22	74	0.7	4.0	38	9.50	137	0.9	4.0	40	10.00	186	1.0
- Mango	11.0	44	4.00	420	3.7	18.0	66	3.67	935	6.2	27.5	88	3.20	1,662	8.6
- Sugar Cane	26.6	2,178	81.88	1,329	11.7	19.0	1,109	58.37	821	5.4	24.8	1305	52.62	914	4.7
- Pineapple	0.01	0.025	2.50	0.1	0	0.1	1	7.76	4	0.0	0.1	0.8	8.00	6	-
- Cassava	1.0	8	8.00	15	0.1	1.0	7	6.80	18	0.1	1.1	7	6.36	27	0.1
- Tobacco	0.9	1	1.11	26	0.2	1.0	1	0.66	24	0.2	0.4	0.5	1.25	24	0.1
- Onion															
Table Total				**11,315**	**100.0**				**15,153**	**100.0**				**19,426**	**100.0**

Source: (1) 2001 Philippine Statistical Yearbook, NSCB
(2) Data presented by BAS in Manila

Note: 1. Region III values estimated on the basis of regional production applying unit prices calculated from the national average in the above table
2. % share of value for Philippines is derived from value of all agricultural crop poduction. For Region III, % share of value is derived from totals of cereals and major crops which appear in this table.

Table 3.2.12 Production, Harvested Area and Yield of Paddy in Zambales Province: 1990, 1995, and 2000

	Item	Jan-June			July -Dec.			Annual Total		
		Production (tons)	Area Harvested (ha)	Yield (ton/ha)	Production (tons)	Area Harvested (ha)	Yield (ton/ha)	Production (tons)	Area Harvested (ha)	Yield (ton/ha)
1990	Zambales Province	-	-	-	-	-	-	75,226	28,060	2.68
	Irrigated	-	-	-	-	-	-	47,254	16,870	2.80
	Rainfed	-	-	-	-	-	-	27,972	11,190	2.50
1995	Zambales Province	14,001	5,320	2.63	42,531	14,920	2.85	56,536	20,240	2.79
	Irrigated	14,001	5,320	2.63	22,323	6,840	3.26	36,328	12,160	2.99
	Rainfed	-	-		20,208	8,080	2.50	20,208	8,080	2.50
2000	Zambales Province	27,394	8,011	3.42	50,633	17,277	2.93	78,027	25,288	3.09
	Irrigated	27,394	8,011	3.42	30,528	9,055	3.37	57,922	18,066	3.21
	Rainfed	-	-	-	20,105	8,222	2.45	20,105	8,222	2.45

Source: Bureau of Agricultural Statistics, Iba, Zambales

Table 3.2.13 Production, Harvested Area and Yield of Corn in Zambales Province : 1990, 1995, and 2000

	Item	Jan-June			July -Dec.			Annual Total		
		Production (1,000 tons)	Area Harvested (1,000ha)	Yield (ton/ha)	Production (1,000 tons)	Area Harvested (1,000ha)	Yield (ton/ha)	Production (1,000 tons)	Area Harvested (1,000ha)	Yield (ton/ha)
1990	Zambales Province	No data available			No data available					
	White	-	-	-	-	-	-	4	10	0.4
	Yellow	-	-	-	-	-	-	4	10	0.4
1995	Zambales Province	18	50	0.36	31	60	0.52	49	110	0.45
	White	6	20	0.30	20	40	0.50	26	60	0.43
	Yellow	12	30	0.40	11	20	0.55	23	50	0.46
2000	Zambales Province	53	56	0.95	18	18	1.00	71	76	0.93
	White	30	37	0.81	18	18	1.00	48	57	0.84
	Yellow	23	19	1.21	0	0	0.00	23.0	19.0	1.21

Source: BAS, Iba, Zambales
BAS, Manila

Table 3.2.14 Farm-gate Price of Paddy and Corn for Region 3: 1996-2000

(Unit: Pesos/kg)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
Paddy													
1996	8.78	9.05	8.84	9.03	9.02	8.87	8.71	8.11	6.99	7.06	6.91	7.15	8.20
1997	7.58	8.09	8.12	8.04	8.14	8.23	8.58	8.54	7.88	7.48	7.30	7.72	7.92
1998	8.23	8.33	8.39	8.53	8.92	8.84	9.12	9.15	8.24	7.56	7.42	7.96	8.11
1999	8.20	8.64	8.66	8.52	8.32	8.52	8.24	7.90	7.41	7.40	7.48	7.62	7.87
2000	8.08	8.61	8.66	8.84	8.87	8.93	9.28	8.93	8.23	7.96	7.78	7.97	8.48
Corn,Yellow													
1996	6.87	6.48	6.87	6.62	6.42	5.64	5.51	5.51	5.69	5.30	5.38	5.59	6.16
1997	6.64	6.65	6.62	6.75	6.39	6.16	5.69	5.59	5.59	5.40	5.29	5.60	5.97
1998	5.90	5.92	5.87	5.84	6.28	6.95	7.52	5.98	5.32	4.85	4.91	4.43	5.65
1999	5.23	5.80	5.70	5.84	5.55	5.40	4.60	4.71	4.81	5.34	5.96	6.81	5.39
2000	7.49	8.19	6.88	6.81	6.94	5.57	5.49	5.42	5.76	6.09	6.07	6.27	6.42
Corn,White													
1996	8.23	8.44	8.14	8.75	8.36	7.08	5.99	6.02	5.76	5.77	5.35	5.59	6.78
1997	6.72	6.63	7.26	7.51	6.66	6.26	6.25	5.95	5.75	5.88	5.57	5.47	6.17
1998	5.93	6.02	6.63	7.56	7.65	7.38	7.85	6.15	4.96	4.45	4.49	4.58	6.62
1999	5.16	5.66	6.99	6.55	6.34	6.70	6.22	6.30	6.22	6.65	6.69	7.00	6.32
2000	6.75	7.78	7.45	7.74	7.80	7.03	5.98	6.30	6.65	6.74	6.87	6.72	6.98

Source: Bureau of Agricultural Statistics, Ben-Lor Bldg, Quezon City

Table 3.2.15 Inventory of Freshwater Fishponds by Municipality in Study Area: 2000

Region/ Province/Municipality	Freshwater Fishpond (ha)			
	Total	Backyard	Medium	Commercial
1. Region 3	25,513.0	2,281.0	9,357.0	13,875.0
2. Zambales Province	98.1	50.8	47.3	0.0
3. Study Area				
Zambales Province	90.1	46.8	43.2	0.0
1 Botolan	4.9	0.0	4.8	0.0
2 Iba	9.2	8.2	1.0	0.0
3 Cabangan	0.0	0.0	0.0	0.0
4 San Felipe	10.9	6.7	4.2	0.0
5 Castillejos	37.6	4.4	33.2	0.0
6 San Antonio	5.2	5.2	0.0	0.0
7 San Marcelino	10.8	10.8	0.0	0.0
8 San Narciso	11.6	11.6	0.0	0.0

Source : BAS, Iba, Zambales
Note : Fishpond size is classified as follows:
Backyard: 500 sq.m. and below
Medium scale: More than 500 sq.m. up to 10 ha.
Commercial scale : More than 10 ha.

Table 3.2.16 Production and Farm-gate Price of Fish Species in Freshwater Fishpond for Zambales Province: 1996-2001

Year	Tilapia	Carp	Catfish	Mudfish	Gourami	Others
Production (tons)						
Zambales Province						
1996	43	-	-	<1	-	-
1997	31	-	-	<1	-	-
1998	23	-	-	<1	-	-
1999	47	-	-	<1	-	-
2000	58					
2001	59					
Farmgate, Wholesale and Retail Price in Aug. 2000 (Pesos/kg)						
1) Farmgate	45.50	-	-	55.60	-	-
2) Wholesale	50.55	-	-	60.00	-	-
3) Retail	60.65	-	-	65.70	-	-

Source: BFAR Region 3
BAS, Zambales
Note: Farmgate price (pesos/kg) depends on the size of tilapia. The bigger the more expensive.

Table 3.2.17 Inventory and Farm-gate Price of Livestock and Poultry: 1996-2000

Item	Cattle	Carabao	Swine	Goat	Duck	Chicken
Inventory (Unit: Heads)						
Zambales Province						
1996	-	-	-	-	-	-
1997	-	-	-	-	-	-
1998	30,197	29,099	162,060	31,438	860,328*	
1999	33,255	29,849	96,770	35,014	909,688*	
2000	32,290	27,779	107,010	43,280	829,448*	
Farm-gate Price						
Unit	Pesos/kg	Pesos/kg	Pesos/kg	Pesos/kg	Pesos/kg	Pesos/kg
Annual Average Price						
1996	-	-	-	55.65	-	50.83
1997	-	-	-	54.23	-	-
1998	-	-	-	76.43	-	53.05
1999	-	-	-	69.20	-	54.14
2000	86.33	77.96	-	65.58	-	62.63

Source: Statistical Yearbook 2001, NEDA region 3
BAS, Iba, Zambales
Note: Prices shown are unit prices of live animals
* Totals also include chicken

Table 3.2.18 Inventory of Establishments Registered to DTI by Municipality in Zambales and Study Area: From January 1, 1997 to April 23, 2002

(Unit: nos)

Province/ Municipality \ Type of Industry	Manufacturing	Wholesale & Retail Trading	Services	Others	Total
1. Zambales Province	507	4,297	3,658	125	8,587
2. Study Area (in Zambales Province)	102	856	466	54	1,478
1 Botolan	22	124	45	10	201
2 Iba	25	265	185	15	490
3 Cabangan	6	67	29	6	108
4 San Felipe	9	132	56	17	214
5 Castillejos	-	-	-	-	-
6 San Antonio	18	89	59	4	170
7 San Marcelino	13	94	49	-	156
8 San Narciso	9	85	43	2	139

Sour Statistical Report dated April 23, 2002, DTI Region 3
Note This table includes the 8 municipalities that account for about 94% of the Study Area.

Table 3.2.19 Assets of Manufacturing Industry: 1997

(Value Units: Million pesos)

Item	Philippines	Region III
I. Large and Medium Scale Manufacturer with Average Total Employment of 10 and More		
1. Number of Establishments (nos)	14,734	1,413
2. Employment (Average for the year)		
1) Total (Persons)	1,109,676	102,727
2) Paid Employees (persons)	1,097,175	101,007
3) Compensation (Million Pesos)	101,009	7,331
3. Production and Value Added		
1) Value of Output *1	1,353,842	151,225
2) Total Cost*2	989,169	106,134
3) Value Added	558,644	61,176
4. Fixed Assets		
1) Land	29,903	1,903
2) Building	97,763	8,071
3) Transport Equipment	15,402	1,262
4) Machinery	257,985	28,415
5) Other Fixed Assets	18,668	1,028
Total	419,722	40,678
5. Inventory		
Finished Products	80,763	10,803
Work -in- Process	29,851	5,786
Material Fuel & Supplies	109,617	9,546
Goods for Resale	8,925	76
Total	229,156	26,212
II Smale Scale and Cottage Manufacturer with Average Total Employment of less than 10		
1. Number of Establishments (nos)	101,052	
2. Employment (Average for the year)		
1) Total (Persons)	382,610	
2) Paid Employees (persons)	235,489	
3) Compensation (Million Pesos)	8,567	
3. Production and Value Added		
1) Value of Output *1	47,485	
2) Total Cost *2	33,880	
3) Value Added	17,527	
4. Fixed Assets	-	
1) Land	-	
2) Building	-	
3) Transport Equipment	-	
4) Machinery	-	
5) Other Fixed Assets	-	
Total	18,072	
5. Inventory		
1) Finished Products and Work in Process	6,063	
2) Material Fuel & Supplies	1,783	
3) Goods for Resale	633	
Total	8,479	

Source: 1997 Annual Survey of Establishments, Vol. III Manufacturing NSO

Note: *1 In producer prices

*2 Detail figures may not add up to totals due to rounding .

*3 Following selected costs only: (1) Materials and Supplies purchased, (2) Fuels purchased, (3) Electricity purchased, (4) Contract work and Industrial services done by others, (5) Merchandise purchased for resale and (6) indirect tax. Indirect taxes and Subsidies received are not included in the total cost.

Table 3.2.20 Family Annual Income and Expenditure at Current Prices: 2000

Item	Philippines		Region 3		Zambales Province	
I. Average Annual Income (Pesos)	144,039		151,449		123,667	
II. Average Annual Expenditure (Pesos)	118,002		120,003		95,054	
III. Details of Expenditure (%)	100.0		100.0		100.0	
1 Food	43.6	(35.7)	47.0	(37.2)	50.8	(39.0)
- Consumed at home	38.7		40.9		46.9	
- Consumed Outside the Home	5.0		6.2		3.9	
2 Tobacco and Alcohol	1.8		2.2		2.0	
3 Clothing, Other Wear	2.5		2.9		1.8	
4 Housing Expenses	25.3	(20.7)	23.4	(18.5)	22.0	(16.9)
- Fuel, Light & Water	6.3		7.1		6.7	
- Non-Durable Furnishing	2.5		0.2		0.1	
- Furniture and Equipment			1.7		1.0	
- Rental Value of Dwelling Unit	14.2		11.7		11.7	
- Maintenance and Repairs	2.3		2.7		2.5	
5 Taxes Paid	2.1		1.3		2.1	
6 Other Expenses	24.7	(20.2)	23.2	(18.4)	21.3	(16.4)
- Education	4.2		4.1		4.3	
- Medical Care	1.9		2.0		1.1	
- Others	18.6		17.1		15.9	
IV. Annual Savings (Balance)	26,037		31,446		28,613	

Source: 2000 Family Income and Expenditure Survey, Integrated Survey of Households Bulletin Series No. 98, Volume II, February 2002, NSO

Note: Figures in brackets show the ratio of food expenditure to total income.

Table 3.2.21 Consumer Price Index and Inflation Rate: 1985-2001

Year	Month	Philippines		Metro Manila		Outside Metro Manila		Region 3	
		CPI	IR (%)	CPI	IR (%)	CPI	IR (%)	CPI	IR (%)
1985		46.1	23.1	39.8	20.7	48.2	23.6		
1986		46.4	0.8	41.9	5.3	48.2	0.0		
1987		48.2	3.8	44.8	6.9	49.7	3.2		
1988		52.4	8.8	49.3	10.0	53.0	6.7		
1989		58.8	12.2	54.0	9.6	60.0	13.1		
1990		67.1	14.2	62.7	16.1	68.8	14.7	67.8	11.0
1991		79.5	18.5	75.6	20.6	81.0	17.7	81.2	19.8
1992		86.3	8.6	83.8	10.8	87.4	7.9	87.3	7.5
1993		92.3	7.0	91.6	9.3	92.5	5.8	91.6	4.9
1994		100.0	8.3	100.0	9.2	100.0	8.1	100.0	9.2
1995		108.0	8.0	108.2	8.2	108.0	8.0	107.1	7.1
1996		117.8	9.1	117.3	8.4	118.0	9.3	117.3	9.5
1997		124.8	5.9	125.1	6.6	124.6	5.6	124.5	6.1
1998		136.9	9.7	137.9	10.2	136.5	9.6	137.2	10.2
1999		146.0	6.6	145.2	5.3	146.3	7.2	146.1	6.5
2000									
	Jan.	148.8	0.5	147.9	0.7	149.2	0.5	148.8	1.6
	Feb.	149.3	0.3	148.3	0.3	149.7	0.3	149.0	0.1
	Mar.	149.4	0.1	148.6	0.2	149.7	0.0	148.9	-0.1
	Apr.	149.7	0.2	148.9	0.2	150.1	0.3	149.5	0.4
	May	150.4	0.5	150.4	1.0	150.3	0.1	149.9	0.3
	June	151.4	0.7	150.4	0.0	151.8	1.0	151.3	0.9
	Jul.	152.1	0.5	151.3	0.6	152.4	0.4	151.8	0.3
	Aug.	153.1	0.7	152.2	0.6	153.5	0.7	153.1	0.9
	Sep.	153.8	0.5	153.6	0.9	153.8	0.2	152.9	-0.1
	Oct.	154.8	0.7	154.2	0.4	155.0	0.8	154.7	1.2
	Nov.	156.7	1.2	157.5	2.1	156.4	0.9	156.2	1.0
	Dec.	157.8	0.7	157.7	0.1	157.9	1.0	157.4	0.8
2001									
	Jan.	159.0	6.9	159.1	7.6	158.9	6.5	158.3	6.4
	Feb.	159.3	6.7	159.5	7.6	159.2	6.3	157.9	6.0
	Mar.	159.4	6.7	159.9	7.6	159.2	6.3	157.2	5.5
	Apr.	159.8	6.7	160.7	7.9	159.4	6.2	157.1	5.0
	May	160.0	6.4	160.9	7.0	159.7	6.3	157.6	5.1
	June	161.6	6.7	162.5	8.0	161.2	6.2	159.5	5.4
	Jul.	162.5	6.8	163.8	8.3	162.0	6.3	159.7	5.2
2002									
	Jan.	165.0	3.8	167.7	5.4	164.0	3.2	161.5	2.0
	Aug.	167.6	~3.1	168.8	~3.1	167.2	~3.2	163.6	~2.4

Source: 2001 Philippine Statistical Yearbook, NSCB

Note: CPI stands for Consumer Price Index (1994=100)
IR stands for Inflation Rate, an annual inflation rate in percent, in each year and month except 2000, when IR is a monthly inflation rate.

Table 3.2.22 Wholesale Price Index of all Items and Construction Materials in Metro Manila: 1985-2000

Year	Month	Wholesale Price Index									
		General Index (1985=100)			Construction Materials in Metro Manila (1985=100)						
		All Items	Crude Materials Ex. Fuel	Manufac-tured Goods	All Items	Cement	Sand, Stone & Gravel	Rein-Forced Steel	Lumber Products	Fuel & Lubricant	Machinery & Equipment Rental
1985		100.0	100.0	100.0	-	-	-	-	-	-	-
1986		97.5	96.3	103.7	-	-	-	-	-	-	-
1987		105.4	115.3	109.6	-	-	-	-	-	-	-
1988		118.5	143.2	119.6	-	-	-	-	-	-	-
1989		129.9	157.0	130.1	-	-	-	-	-	-	-
1990		141.8	154.3	144.8	157.5	157.9	221.9	171.3	176.2	104.8	182.8
1991		166.1	181.9	165.4	182.6	193.0	258.3	182.7	208.5	152.1	182.8
1992		172.2	192.5	172.6	189.3	200.7	265.4	187.6	221.2	131.6	182.8
1993		172.0	180.2	174.1	191.4	176.1	281.7	189.3	236.0	127.5	254.8
1994		186.9	223.4	179.8	200.6	179.8	300.9	188.5	264.9	126.7	254.8
1995		197.1	217.8	181.6	208.2	196.0	312.0	198.5	268.0	124.5	254.8
1996		214.7	249.8	186.2	214.5	214.7	330.5	207.0	270.4	133.0	254.8
1997		215.8	238.4	190.4	219.5	198.3	343.5	208.6	277.7	140.8	254.8
1998		240.9	285.9	196.6	227.1	182.9	365.9	224.8	284.9	145.4	254.8
1999		254.8	315.9	198.8	229.0	174.7	380.1	224.4	284.3	153.7	296.9
2000											
	Jan.	259.8	300.7	201.6	231.4	190.4	386.5	221.9	286.6	170.0	296.9
	Feb.	258.0	273.2	201.5	231.5	190.9	386.6	221.9	286.6	175.7	296.9
	Mar.	257.7	267.6	201.3	232.4	199.1	389.5	221.9	286.6	180.9	296.9
	Apr.	254.2	259.0	201.3	232.6	199.6	389.5	221.9	286.6	183.3	296.9
	May	256.0	257.8	201.7	232.9	198.6	389.5	221.9	286.6	182.9	296.9
	June	254.0	236.9	201.5	233.1	199.7	389.5	221.9	286.4	188.5	296.9
	Jul.	258.3	222.5	201.3	233.4	199.7	359.5	221.9	286.4	195.9	296.9
	Aug.	257.5	220.4	201.3	233.5	199.5	389.5	221.9	286.4	200.6	296.9
	Sep.	260.4	207.1	201.4	234.0	201.1	391.8	224.0	286.4	204.3	296.9
	Oct.	261.4	212.3	201.8	235.8	201.9	391.8	224.0	288.2	217.8	296.9
	Nov.	270.9	219.9	202.4	237.2	203.8	391.8	232.7	288.2	218.0	296.9
	Dec.	265.5	206.8	203.2	238.0	207.4	392.9	232.7	288.2	230.0	296.9
2001											
	Jan.	265.5	209.1	204.3	240.6	209.7	395.8	237.5	292.9	226.3	296.9
	Feb.	262.3	201.5	204.6	241.3	215.3	395.8	237.5	292.9	223.6	296.9
	Mar.	260.1	200.2	204.9	242.5	215.4	402.0	237.5	296.5	223.6	296.9
	Apr.	260.4	203.8	205.0	242.9	217.5	402.0	237.5	295.9	223.6	296.9
	May	263.2	208.1	205.4	243.1	219.8	403.8	237.5	295.9	222.8	296.9
	June	264.3	215.9	205.9	243.7	227.6	403.8	237.5	295.9	225.2	296.9
	Jul.				244.0	229.6	403.8	237.5	295.9	225.1	296.9
2002											
	Jan.	266.7	244.4	204.2	243.2	228.0	403.1	239.8	296.2	200.9	296.9
	July	n.a.	n.a.	n.a.	251.4	229.7	432.6	239.1	315.6	220.7	296.9

Source: 2001 Philippine Statistical Yearbook, October 2001,NSCB

Table 3.2.23 Foreign Exchange Rate of the Peso versus the US Dollar: 1987-2001

Month	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Jan.	20.478	20.870	21.350	22.543	28.000	26.527	25.348	27.676	24.573	26.185	26.344	42.410	38.717	40.390	50.969
Feb.	20.528	21.010	21.350	22.761	28.000	26.045	25.280	27.701	25.732	26.177	26.333	30.364	39.098	40.845	48.290
Mar.	20.550	21.016	21.330	22.750	28.000	25.383	25.513	27.565	25.987	26.197	26.367	37.081	38.766	41.063	48.467
Apr.	20.484	21.018	21.564	22.805	27.842	25.804	26.385	27.277	26.021	26.173	26.369	39.979	38.018	41.278	50.185
May	20.466	20.905	21.608	22.977	27.806	26.250	27.094	26.874	25.797	26.222	26.374	38.898	38.095	42.829	50.539
June	20.456	21.062	21.807	23.270	27.750	25.584	27.272	26.910	25.575	26.203	26.384	42.091	38.019	43.154	51.488
Jul.	20.440	21.038	21.880	23.860	27.750	24.910	27.695	26.829	25.585	26.228	28.968	42.016	38.245	44.941	*53.562*
Aug.	20.453	21.079	21.880	25.000	27.000	23.924	28.043	26.484	25.875	26.202	30.165	43.874	39.671	45.077	*51.210*
Sep.	20.600	21.336	21.945	25.750	27.000	25.120	29.813	26.000	26.065	26.257	33.873	43.809	41.112	46.283	*51.355*
Oct.	20.725	21.392	22.100	25.750	27.000	24.636	28.831	24.928	25.992	26.285	34.938	40.831	40.158	51.427	*51.935*
Nov.	20.877	21.379	22.234	28.000	26.700	25.492	27.958	23.879	26.183	26.287	34.655	39.462	40.787	49.393	*52.024*
Dec.	20.800	21.335	22.440	28.000	26.650	25.096	27.699	24.418	26.214	26.288	39.975	39.059	40.313	49.896	*51.404*
Average	20.571	21.120	21.791	24.456	27.458	25.398	27.244	26.378	25.800	26.225	29.471	40.893	40.313	44.715	50.936

Source: Data presented by Central Bank
International Financial Statistics, IMF
NSO Monthly Bulletin of Statistics, May 2001, NSO

Note: Italic figures were obtained from "NSO Monthly Bulletin of Statistics, May 2001, NSO".

Table 3.2.24 Inventory of Educational Facilities: 2000-2001 School Year

Item	Philippines	Region 3	Zambales Province
Number of Schools			
Pre-School	11,643	1,573	87
Government	6,450	953	80
Private	4,593	620	7
Elementary School	40,284	3,214	220
Government	36,013	2,609	217
Private	4,271	605	3
Secondary School	7,509	688	41
Government	4,336	311	23
Private	3,173	357	18
Tertiary School	1,603	153	7
Government	389	20	4
Private	1,214	133	3
Numbers of Enrolled			
Pre -School	592,227	*	661
Government	308,667	*	389
Private	283,560	*	272
Elementary School	12,759,900	1,316,719	70,020
Government	11,832,611	1,154,576	67,853
Private	927,289	162,143	2,167
Secondary School	5,378,735	564,729	36,448
Government	4,157,889	393,293	22,574
Private	1,220,846	171,436	13,874
Tertiary School	2,067,965	167,567	7,652
Government	-	65,523	4,063
Private	-	102,044	3,589

Source: 2001 Philippine Statistical Yearbook,NSCB
Data from DECS (Department of Education Culture and Sports), Provincial Division & Region 3
Note: In general, the periods of school attendance for respective schools are as follows:
2 years for pre-school; 6 years for primary school;4 years for secondary school;
and 4 years for tertiary school. The period of tertiary school depends on the field of the study.
* Unreliable data

Table 3.2.25 Inventory of Hospitals, Barangay Health Stations and Rural Health Units: 2000

	Item	Philippines	Region 3	Zambales Province
1.	Hospital	1,712	155	13
	Public	623	43	6
	Private	1,089	112	7
	Bed Capacity	81,016	-	549
	Bed Capacity per 10,000 population	10.6	-	12.6
2.	Barangay Health Station	14,416*1	1,464*1	80
3.	Rural Health Unit	2,405*2	252*2	35

Source: 2001 Statistical Yearbook, NSCB
Statistical Yearbook, 2001, NEDA Region 3
Department of Health (DOH), Regional Division
Note: *1 1999 data
*2 1997 data

Table 3.2.26 Inventory of Roads and Bridges: December 2001

Item	Philippines	Region 3	Zambales
1. Road by System Classification (km)			
a. National	29,844	1,738.22	188.00
b. Provincial	27,076	13,481.74*[1]	1,789.78*[1]
c. Municipal and City	22,856		
d. Barangay	121,989		
Total	201,765	15,219.96	1,977.78
2. Road by Surface Type (km)			
a. Concrete	30,024	3,908.42	204.13
b. Asphalt	13,462	1,435.12	351.02
c. Gravel	101,542	7,269.44	970.65
d. Earth	56,737	2,606.99	451.97
Total	201,765	15,219.97	1,977.77
National Roads			
a. Concrete	11,971	879.50	27.27
b. Asphalt	6,868	711.45	160.72
c. Gravel	10,571	130.44	-
d. Earth	434	16.83	-
Total	29,844	1,738.22	188.00
Provincial Roads			
a. Concrete	3,564	3,028.92*[1]	176.86*[1]
b. Asphalt	2,164	723.67*[1]	190.30*[1]
c. Gravel	18,108	7,139.00*[1]	970.65*[1]
d. Earth	3,240	2,590.16*[1]	451.97*[1]
Total	27,076	13,481.74*[1]	1789.78*[1]
Municipal and City Roads			
a. Concrete	7,632		
b. Asphalt	3,266		
c. Gravel	8,494		
d. Earth	3,463		
Total	22,856		
Barangay Roads			
a. Concrete	6,858		
b. Asphalt	1,163		
c. Gravel	64,368		
d. Earth	49,600		
Total	121,989		
3. Road Density (m./sq.km)			
Land Area (Sq.km.)	300,000	18,231	3,714
a. National	99	95	51
b. Provincial	90	740*[1]	482*[1]
c. Municipal and City	76		
d. Barangay	407		
Total	673	835	533
4. Bridge			
Length of Bridges (m)	286,784	24,060	3,898
- Permanent *2	262,298	24,038	3,898
- Temporary *3	24,485	22	-

Source: (1) Data presented by DPWH, Region 3
(2) Data presented by DPWH, Head Office (Planning Service)

Note: *1 All local roads
*2 Concrete, steel, and similar materials
*3 Bailey, timber, coconut, and similar materials
Due to rounding, totals may not exactly equal the sum of individual figures

Table 3.2.27 Number of Households by Type of Water Supply System: 1990 and 1997

Item	Philippines 1990	Region 3 1997	Zambales Province** 1990
1. Number of Households by Main Source of Potable Water in 1990 census Year (Unit: 1000)			
a. Own Use, Faucet, Community Water System	2,572.4	277.4*	36.7
b. Shared, Faucet, Community Water System	2,169.7	174.6*	18.5
c. Own Use, Tubed/Piped, Deep Well	967.4	221.8*	19.6
d. Shared,Tubed/Piped, Deep Well	1,696.1	244.2*	13.4
e. Tubed/Piped, Shallow Well	920.2	184.8*	16.3
f. Dug Well	1,566.2	29.4*	6.3
g. Spring, Lake, River, Rain, etc.	1,314.0	16.3*	4.3
h. Peddler	201.2	14.7*	0.4
Total	11,407.3	1,163.2*	115.6
2. Household Served by Potable Water Systems (Unit: 1000)			
Level I *1	3,395.2		
Level II *2	28.0		
Level III *3	634.2		
Total	4,057.4		
3. Coverage of Household Served (%)			
Population (1000)	60,559.1	7,371.9*4	563.0
Households (1000)	11,407.3	1,163.2*	115.6
Coverage by Level I, II, & III (%)	35.6		
Coverage by Level III	5.6	2.4*	3.2

Source: (1) 1990 Census of Population and Housing, NSO

Notes: * 1997 data

** Figures are estimates on a 10% sample and include Olongapo City

*1 Level I is a point source, consisting of shalllow wells, deep wells and dug wells, developed springs, river/ponds/undeveloped springs and rain collectors.

*2 Level II is communal faucet system, generelly suitable for rural areas.

*3 Level III is a piped system with individual house connections, suitable for densely inhabited urban areas.

*4 Estimated by interpolation to give 1997 figure

Table 3.2.28 Electrification Program: Coverage, Number and Percentage Served : December 2000

Item	Philippines	Region 3
1. Municipality Level		
Program Coverage (nos)	1,454	92
Number Energized (nos)	1,454	92
Percent Served (%)	100%	100%
2. Barangay Level		
Program Coverage (nos)	36,075	2,097
Number Energized (nos)	27,879	2,021
Percent Served (%)	77%	96%
3. Total Connection		
Program Coverage (nos)	7,784,000	700,000
Number Energized (nos)	5,300,056	662,151
Percent Served (%)	68%	95%

Source: 2001 Philippine Statistical Yearbook,NSCB

Table 3.2.29 Telephone Service Penetration by Operation by Operator Category : 2000

Item	Philippines	Region 3
Telephone Distribution		
- Telephone		
Lines	6,905,962	513,626
Exchanges	992*[1]	110
- Subscribers	3,061,387	222,915
- Population (1000)	76,503	8,031
- Telephone Density per 100 Persons		
Lines	9.0	6.4
Subscribers	4.0	2.8

Source: '(1) 2001 Statistical Yearbook, NSCB
'(2) 2000 Census of National, Regional and Provincial Population

Note *1 For 1999
*2 As a reference, the telephone density in NCR, was 29.6 of lines and 14.5 of subscribers.
*3 Telephone lines were managed by PLDT and DIGITEL in Region 3

Table 3.3.1 Results of Soil Analysis

	Station					Dutch Intervention Values	Environmental Standard of Japan (soil)
River	**Bucao**		**Maloma**		**Sto. Tomas**		
Parameters	Downstream	Upstream	Downstream	Upstream	Downstream		
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	0.05
Cadmium, Cd (ppm)	BDL	BDL	BDL	BDL	BDL	12	0.01
Lead, Pb (ppm)	BDL	BDL	BDL	BDL	BDL	530	0.01
Copper, Cu (ppm)	0.22	0.50	0.14	0.32	3.5	190	125
Mercury, Hg (ppb)	BDL	108	60	BDL	85	10,000	0.5
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
*There are no Philippines environmental standards for soil. DIV values are the limits over which soil remediation will be required.
*The values of the parameters in connection with soil fertility shall be evaluated based on the critical levels for each different crop.
*The environmental quality standards of Japan are those required for keeping human health.

Table 3.3.2 Results of Sediment Analysis, January 2003

	Station							Dutch Intervention Values	Environmental standard of Japan (soil)
River	**Bucao**		**Maloma**		**Sto. Tomas**				
Parameters	Down-stream	Upstream	Down-stream	Upstream	Down-stream	Upstream	Mapanuepe Lake		
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	0.05
Cadmium, Cd (ppm)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	12	0.01
Lead, Pb (ppm)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	530	0.01
Copper, Cu (ppm)	0.06	0.09	0.15	0.25	0.40	0.83	**7.6**	190	125
Mercury, Hg (ppb)	**115**	**75**	**80**	BDL	**215**	BDL	BDL	10,000	0.5
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.

*There are no Philippines environmental standards for soil for any element. DIV values are the limits over which soil remediation would be required. The values of the parameters in connection with soil fertility shall be evaluated by the critical levels for different crops.

*The environmental quality standards of Japan are those required for keeping human health

Table 3.4.1 Water Quality of Surface Waters within Mt. Pinatubo Western Watershed Area, May 2002

Parameters	Unit	Standard		Bucao River @ Malumboy	Bucao River @ H-Way Bridge	Maloma River	Mapanuepe Lake	Marella River	Pinatubo Crater Lake
		DENR Class C (Fishery Water/ Manufacturing)	DENR Class D (Agriculture/ Irrigation)						
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
COD	mg/L	ns	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 3.4.2 Water Quality of Surface Waters within Mt. Pinatubo Western Watershed Area, August 2002

Parameters	Unit	Standard		Bucao River @ Malumboy	Bucao River @ H-Way Bridge	Maloma River	Mapanuepe Lake	Marella River	Pinatubo Crater Lake
		DENR Class C (Fishery Water/ Manufacturing)	DENR Class D (Agriculture/ Irrigation)						
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	^{o}C	3^{o}C max rise	-	27	30	29	25	28.5	27.6
BOD_5	mg/L	7	10	5	10	6	10	8	6
COD	mg/L	ns	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 3.4.3 Laboratory Results of the Groundwater Survey of Water Wells

	Parameter	Unit	Stn 3	Stn 4A	Stn 6A	Stn 15A	Stn 18A	Stn 20a
1	Arsenic	mg/L	ND	0.57	ND	ND	ND	ND
2	Cadmium	mg/L	ND	ND	ND	ND	ND	ND
3	Calcium	mg/L	ND	ND	ND	18	35	41
4	Chloride	mg/L	9.4	15	5.8	12	16	16
5	Chromium VI	mg/L	ND	ND	ND	ND	ND	ND
6	Copper	mg/L	ND	ND	ND	ND	ND	ND
7	Cyanide	mg/L	ND	ND	ND	ND	ND	ND
8	Fluoride	mg/L	ND	ND	ND	ND	ND	ND
9	Iron	mg/L	0.33	0.34	0.39	0.33	0.43	0.51
10	Lead	mg/L	ND	ND	ND	ND	ND	ND
11	Magnesium	mg/L	10	63	29	216	86	60
12	Manganese	mg/L	ND	ND	ND	ND	0.66	0.08
13	Mercury	mg/L	0.00024	0.00014	0.00145	0.00043	0.00063	0.00154
14	Nitrate	mg/L	0.17	0.22	0.08	0.09	0.07	0.06
15	Nitrite	mg/L	ND	ND	ND	ND	ND	ND
16	Nitrogen	mg/L	<0.09	64	47	41	37	57
17	Phosphorus	mg/L	0.52	0.15	0.09	ND	0.06	0.18
18	Sulfate	mg/L	34	180	33	252	428	315
19	Zinc	mg/L	ND	0.05	0.29	0.1	1.4	0.11
20	Phenols	mg/L	ND	ND	ND	ND	ND	ND
21	Conductivity	uS/cm	210	700	330	760	1,120	990
22	pH		7.7	7.1	7.2	6.5	6.4	7.2
23	Temperature	mg/L	27.8	27.6	27.5	27.9	28	27.8
24	COD	mg/L	1080	345	887	641	1080	887
25	DO	mg/L	3.3	1.8	3	5	2	2
26	Color	PCU	5	5	6	6	5	5

Table 3.5.1 Changes in River Channel before and after Eruption of Mount Pinatubo

River System	Stretch	River Length (m)		Gradient		Average Bed Elevation (Lower End) El.m		Average Bed Elevation (Upper End) El.m		River Area (ha)		Lahar Deposit Volume (mil.m3)	
		1977	2002	1977	2002	1977	2002	1977	2002	1977	2002	1977	2002
Bucao	Mouth ~ Bucao Bridge	3,000	2,600	1/470	1/500	0.0	0.4	4.9	5.0	91	217	-	1
	Bucao Bridge ~ Baquilan	7,600	7,300	1/330	1/260	4.9	5.0	24.7	30.0	860	1,454	-	65
	Baquilan ~ Malomboy	3,500	3,400	1/340	1/190	24.7	30.0	35.4	49.2	300	710	-	53
	Upper Bucao	23,100	22,700	1/90	1/90	39.3	49.8	271.7	285.9	1,160	3,288	-	400
	Balin Baquero	24,200	21,300	1/80	1/100	31.5	48.6	300.0	260.6	699	2,975	-	324
	TOTAL									3,110	8,644		843
Maloma	Mouth ~ Maloma Bridge	2,600	2,400	-	1/800	0	0.8	-	3.8	29	44	-	1
	Maloma Bridge ~ Maloma / Gorongoro Confluence	4,800	4,600		1/800	-	3.8	-	8.9	58	173	-	2
	TOTAL									87	217		3
Sto. Tomas	Mouth ~ Maculcol Bridge	1,600	1,400	1/400	1/580	0	2.2	3.6	4.7	61	151	-	1
	Maculcol Bridge ~ Umaya	7,700	7,800	1/580	1/340	3.6	4.7	16.1	26.2	305	449	-	30
	Umaya ~ Vega Hill	4,100	4,500	1/300	1/240	16.1	26.2	29.7	43.1	184	510	-	68
	Vega Hill ~ Mt.Bagang	13,300	12,300	1/130	1/130	29.7	43.1	110.5	129.6	303	2,610	-	390
	Marella River	7,100	6,800	1/50	1/60	110.5	129.6	233.5	232.8	56	794	-	260
	Mapanuepe River	13,700	11,500	1/320	1/1,800	110.5	129.6	129.6	132.9	113	305	-	69
	TOTAL									1,022	4,819		818

Source: JICA Study Team

Table 3.8.1 Land Use Trends in the Study Area

(1) Forest Area

(Unit:km^2)

	1990	1992	1993	2001
Botolan	206.2	137.4	169.1	199.9
Cabangan	22.1	45.1	67.8	53.2
Castillejos	30.0	28.7	35.7	31.0
Iba	28.8	68.2	67.3	32.9
San Antonio	0.4	9.6	17.9	22.8
San Felipe	2.7	10.4	22.3	29.3
San Marcelino	154.4	128.0	152.6	166.1
San Narciso	0.8	4.1	8.6	9.6
Subic	70.8	58.9	75.6	97.1
Total	**516.2**	**490.4**	**616.8**	**641.9**

(2) Grass

(Unit:km^2)

	1990	1992	1993	2001
Botolan	223.0	112.1	105.2	40.6
Cabangan	67.1	20.4	40.8	15.3
Castillejos	22.0	4.1	11.3	4.2
Iba	57.5	70.9	26.3	9.9
San Antonio	46.2	8.1	23.6	15.7
San Felipe	45.1	4.8	14.4	7.7
San Marcelino	112.9	17.0	48.5	23.5
San Narciso	17.8	0.8	7.4	4.2
Subic	13.1	3.6	15.4	7.6
Total	**604.7**	**241.8**	**293.0**	**128.7**

(3) Bare Land

(Unit:km^2)

	1990	1992	1993	2001
Botolan	191.0	116.3	103.5	134.4
Cabangan	50.0	82.5	39.4	50.9
Castillejos	21.8	41.7	23.5	19.4
Iba	48.8	27.9	42.6	25.1
San Antonio	33.3	59.0	28.3	11.9
San Felipe	52.4	77.0	52.3	31.7
San Marcelino	68.6	83.3	55.3	34.2
San Narciso	27.1	43.4	22.0	11.6
Subic	2.5	8.7	7.5	6.9
Total	**495.5**	**539.8**	**374.3**	**326.2**

(4) Cultivated Area

(Unit:km^2)

	1990	1992	1993	2001
Botolan	69.4	43.9	63.2	105.6
Cabangan	32.6	24.0	22.0	32.8
Castillejos	3.1	13.1	23.7	34.5
Iba	28.6	3.3	16.9	59.0
San Antonio	15.4	20.0	26.0	33.0
San Felipe	19.0	16.4	24.5	31.9
San Marcelino	24.9	50.7	48.2	57.6
San Narciso	28.4	15.6	30.0	34.0
Subic	1.0	9.1	7.1	32.6
Total	**222.4**	**196.0**	**261.6**	**420.9**

Table 3.8.2 Existing Agricultural Land Use Condition in the Study Area

(Unit: ha)

Municipality	Irrigated Rice	Rainfed Rice	Irrigation Ratio (%)	Sugarcane	Cassava	Rootcrops	Corn	Legume	Fishpond	Orchard	Total
Botolan	871.51	543.08	61.61%	4.38	65.65	180.98	35.20	62.00	4.90	741.81	2,510.13
Iba	678.80	416.25	61.99%	4.00	17.34	22.50	8.75	5.00	9.20	368.23	1,530.69
Cabangan	350.01	851.17	29.14%	12.54	39.48	166.33	7.38	6.33	0.00	189.63	1,623.16
San Felipe	493.00	432.50	53.27%	2.00	33.78	42.50	0.60	3.50	10.90	110.36	1,129.67
Castillejos	296.75	660.75	30.99%	0.00	55.85	209.00	5.25	14.00	37.60	316.45	1,595.96
San Antonio	415.50	918.68	31.14%	0.00	14.25	120.75	43.25	42.50	5.20	148.05	1,708.49
San Marcelino	971.15	226.50	81.09%	0.00	24.13	160.00	32.38	26.35	10.80	333.58	1,785.70
San Narciso	1,140.88	977.13	53.87%	0.00	3.84	27.05	3.53	6.10	11.60	167.38	2,338.05
Total	5,217.60	5,026.06	50.93%	22.92	254.32	929.11	136.34	165.78	90.20	2,375.49	14,221.85

Source: Data presented by Provincial Office of Zambales

Table 3.9.1 Measurement of Road and Bridge in the Study Area

	Existing				Planned				Proposed			
	Road		Bridge		Road		Bridge		Road		Bridge	
	Section	Total Length(km)	Number of Bridge	Total Length(m)	Section	Total Length(km)	Number of Bridge	Total Length(m)	Section	Total Length(km)	Number of Bridge	Total Length(m)
National Road	4	91.4	37	2,162.0	2	65.0	0	0.0	2	35.0	3	1,025.0
mean		22.9		58.4		32.5		0.0		17.5		341.7
Provincial Road	33	94.5	30	943.0	0	0.0	0	0.0	4	60.0	0	0.0
mean		2.9		31.4		0.0		0.0		15.0		0.0
Total	37	185.9	67	3,105.0	2	65.0	0	0.0	6	95.0	3	1,025.0
mean		5.0		46.3		32.5		0.0		15.8		341.7

Source: Data presented by DPWH

Table 3.10.1 Common Wildlife Species in Terrestrial Landscapes of 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

Source: Bureau of Forest Development, 2-12-81

Table 3.10.2 Rare and Threatened Philippine Wildlife

I. Birds

	English name	Scientific name
1	Philippine Eagle	*Pithecophaga jefferyi*
2	Giant Scops Qwl	*Mimizuku gurneyi*
3	Mindoro Imperial Pigeon	*Ducula mindorensis*
4	Palawan Peacock Pheassant	*Polyplectron emphanum*
5	Cebu Black Shama	*Copsychus cebuensis*
6	Ashy Ground Thrush	*Zoothera cinerea*
7	Eastern Sarus Crane	*Grus antigone sharpii*
8	Koch's Pitta	*Pitta kochi*
9	Rufous Hornbill	*Buceros hydrocorax*
10	Blue-naped Parrot	*Tanygnathus lucionensis*
11	Bleeding-heart Pigeon	*Gallicolumba luzonica*

II. Mammals

	English name	Scientific name
1	Tamaraw	*Anoa mindorensis*
2	Philippine Deer	*Cervus (Rusa) sp.*
3	Mouse Deer	*Tragulus nigricans*
4	Philippine Tarsier	*Tarsius philippinensis*
5	Dugong	*Dugong dugon*
6	Calamian Deer	*Axis calamianensis*
7	Water Buffalo	*Bubalus meollendorfi*
8	Mindanao Gymnure	*Podogymnura truei*

III. Reptiles

	English name	Scientific name
1	Hawksbill Turtle	*Eretmochelys imbricata*
2	Olive-backed Loggerhead	*Lepidochelys olivacea*
3	Philippine Crocodile	*Crocodylus mindorensis*
4	Monitor Lizard	*Varanus sp.*

Source: Bureau of Forest Development, 2-12-81

Table 3.10.3 Estimated Population of IPs and their Locations (as of March 2001) (1/2)

Municipality/settlement	Tribe	# of families	# of individuals
1. Castillejos		175	828
Kanaynayan	Aeta	105	528
San Isidro		50	300
2. Subic		309	1,548
Gala	Aeta	74	372
Alibang	Aeta	55	276
Cawag R. A.	Aeta	149	744
Cabangaan	Aeta	31	156
3. Olongapo City		642	3,036
Iram R. A.	Aeta	566	2,652
Mapweng	Aeta	50	252
Maliwakat	Aeta	26	132
4. San Marcelino		1,775	9,744
San Rafael:	Aeta		
Itanglew		118	588
Palayan		23	144
Sta. Fe:	Aeta		
Baliwet		118	588
Buag		30	150
Banaba		35	174
Bacsil		18	90
Kakilingan		300	1,800
Lomboy		110	660
Maaguegue		90	540
Payodpod		360	2,160
Aglao:	Aeta		
Paw-en		84	420
Ibad		56	282
Cuartel		52	258
Kahapa		41	204
Buhawen:	Aeta		
Bayarong		22	90
Silbang		35	174
Kutis Village		38	192
Sr. Faustina, Village		42	210
Lumibao	Aeta	68	342
Navan		56	282
Sayasay		44	222
Labuan		35	174
5. San Antonio			90
Nagsaza	Aeta	18	90
6. San Narciso			392
Omaya	Mixed Tribe	98	392
7. San Felipe		509	2,593
Lalec	Aeta	94	468
Tektek	Aeta	35	174
Sagpat	Aeta	168	883
Banawen	Aeta	90	450
Cabaruan	Aeta	56	288
Balincaguing	Aeta	66	330
8. Cabangan		924	4,620
Maligaya	Aeta	188	942
Cadmang	Aeta	124	618
Reserva	Aeta	295	1,476
Baculi	Aeta	71	354
Tangos	Aeta	32	162
Maporac	Aeta	118	588
Casabaan	Aeta	96	480
9. Botolan		4,289	25,162
A. Settlements			
Bucao	Aeta	245	1,570
Cabatuan	Aeta	102	510
Masikap Village	Aeta	91	456
Villar Bihawo	Aeta	204	1,020

Table 3.10.3 Estimated Population of IPs and their Locations (as of March 2001) (2/2)

Municipality/settlement	Tribe	# of families	# of individuals
Yamot (Lakas)	Aeta	252	1,260
Bubulon	Aeta	16	76
Tipli-Villar	Aeta	60	360
Kasoy	Aeta	70	420
Kalawangan	Aeta	13	78
Ogik	Aeta	80	480
Dangla	Aeta	87	522
Mantabag	Aeta	180	1,080
Bituen	Aeta	75	450
Quitombok	Aeta	100	600
Tinimubo	Aeta	35	210
Pera	Aeta	25	150
B. Resettlement Areas			
Loob -Bunga:			
Owaog	Aeta	107	642
Biangue	Aeta	86 (combined)	516
Malomboy	Aeta		
Moraza	Aeta	210	1,260
Nacolcol	Aeta	157	942
Maguisguis	Aeta	288	1,728
Palis	Aeta	122	732
Belbel	Aeta	80	480
Poonbato	Aeta	368	2,208
Villar	Aeta	216	1,296
Barreto	Aeta	47	282
Baquilan:			
Tumangan	Aeta	151	906
Owaog	Aeta	24	144
Villar	Aeta	48	288
Burgos	Aeta	110	660
Poonbato	Aeta	61	366
Nacolcol	Aeta	67	402
Maguisguis	Aeta	49	294
Malomboy	Aeta	91	542
Baquilan	Aeta	142	852
Quintomboc	Aeta	72	432
Cabatuan	Aeta	18	108
Patal Anawo	Aeta	17	102
Bituen	Aeta	53	318
Biangue	Aeta	26	156
Maligaya	Aeta	44	264
10. Iba		287	1,434
Jessmag	Aeta	95	474
Lupang Pangako	Aeta	192	960
11. Palauig		247	1,236
Sibol	Aeta	17	84
	Bontok	4	24
Dapla	Various tribes	28	138
	from Cordillera		
Sta. Martha	Aeta	60	300
Dampay	Aeta	138	690
12. Masinloc		1,563	825
Mandaloy	Bontok & Applai	46	228
	Kankanaey	1	3
	Kalinga/Apayao	11	54
Balonganon	Bontok	19	116
	Kankanaey	32	162
	Ifugao	1	4
Benguet Road	Kalinga	43	258
13. Sta. Cruz		92	532
Acoje	Bontok	73	438
	Benguet	17	84
	Ifugao	2	10
Grand Total		9,518	52,040

Sources: Barangay Officials & Tribal Chieftains Records

Table 5.1.1 Annual Maximum Daily Rainfall in the Study Area

(mm/day)

Year	Station		
	Iba	Sta. Rita	San Marcelino
1976	543	610	363
1977	291	326	439
1978	196	341	222
1979	398	471	472
1980	281	249	131
1981	183	162	163
1982	321	258	188
1983	190	157	214
1984	263	137	156
1985	285	314	281
1986	218	334	217
1987	172	211	143
1988	191	197	135
1989	184	194	135
1990	175	207	200
1991	183	281	220
1992	325	109	190
1993	242	250	281
1994	168	212	112
1995	176	163	100

Source:PAGASA

Table 5.1.2 Basin Mean Rainfall

	Weights		
	Bucao	**Maloma**	**Sto. Tomas**
Iba	0.082	0.000	0.000
Santa Rita	0.232	0.222	0.000
San Marcelino	0.000	0.468	0.612
204 (PHIVOLCS)	0.686	0.310	0.388

	2 year	5 year	10 year	20 year	30 year	50 year	100 year
Bucao River Basin							
1 -day	256.7	377.9	473.4	576.9	642.2	730.1	860.8
2 -day	420.1	587.5	707.7	829.9	903.4	998.8	1,134.2
3 -day	512.4	704.3	840.9	979.1	1,061.9	1,169.1	1,320.6
4 -day	609.8	830.6	985.4	1,140.3	1,232.4	1,351.0	1,517.5
5 -day	699.9	937.7	1,095.2	1,246.3	1,333.7	1,443.5	1,593.1
Maloma River Basin							
1 -day	203.2	308.9	399.0	502.4	570.2	664.7	810.8
2 -day	341.3	486.6	597.5	715.1	788.0	885.1	1,027.0
3 -day	430.7	596.1	720.5	851.2	931.6	1,038.1	1,192.6
4 -day	488.4	663.6	797.6	939.9	1,028.2	1,145.8	1,317.7
5 -day	579.7	783.0	925.4	1,067.6	1,152.2	1,261.0	1,413.6
Sto. Tomas River Basin							
1 -day	200.1	305.0	395.3	499.6	568.4	664.5	813.9
2 -day	339.7	484.6	593.2	707.0	777.0	869.3	1,003.2
3 -day	430.3	598.0	723.9	855.9	937.1	1,044.5	1,200.3
4 -day	492.4	680.0	822.8	974.1	1,067.8	1,192.4	1,374.4
5 -day	564.2	768.8	917.2	1,069.2	1,161.2	1,281.2	1,452.4

Table 5.2.1 Water Balance Analysis in the Bucao River Basin

Year	Annual Run-off			Annual Rainfall			Annual Loss	Remarks
	Observed Days N	Mean Discharge (1) m3/s	Runoff Height (2) mm	Iba (3) mm	Santa Rita (4) mm	Basin (5) mm	(6) = (5)-(2) (6) mm	
1963	365	70.29	3,604	3,784		4,654	**1,050**	**Reasonable Balance**
1964	366	34.30	1,764	3,385		4,164	2,400	Unreasonable
1965	365	30.87	1,583	3,739		4,599	3,016	Unreasonable
1969	365	29.87	1,532	3,585		4,410	2,878	Unreasonable
1970	365	46.53	2,386	4,272		5,255	2,869	Unreasonable
1975	365	65.80	3,374	2,528		3,109	-265	Unreasonable
1976	366	58.86	3,026	4,374	4,888	5,516	2,490	Unreasonable
1978	365	31.57	1,619	5,227		6,429	4,810	Unreasonable
1984	366	67.58	3,303	4,107	4,276	4,848	**1,545**	**Reasonable Balance**
1986	365	40.95	1,996	4,024	4,930	5,531	3,535	Unreasonable
1989	365	143.00	6,970		4,133	4,670	-2,300	Unreasonable

Table 5.2.2 Water Balance Analysis in the Sto.Tomas River Basin

Year	Annual Run-off			Annual Rainfall			Annual Loss	Remarks
	Observed Days N	Mean Discharge (1) m3/s	Runoff Height (2) mm	Iba (3) mm	Santa Rita (4) mm	Basin (5) mm	(6) = (5)-(2) (6) mm	
1963	365	20.38	3,631	3,784		4,011	380	Suspicious Balance
1964	366	10.08	1,801	3,385		3,588	1,787	Unreasonable
1965	365	7.11	1,267	3,739		3,963	2,696	Unreasonable
Average								

Note : Catchment Area at Gauge Station A= 177 km^2

Runoff Height (2) = (1) * N * 86.4 / (177 km^2)

Basin Rainfall (5) = 1.06 * (3)

Pan-Evaporation = 1,736 mm/year (at Floridablanca in Pampanga, 1985-1987)

Reasonable Annual Loss = (Pan-Evaporation) * (Ratio) = 1,736 * (0.5 to 0.9) = 900 to 1,600 mm/year

Negative value for annual loss (6) is unreasonale in view of hydrological balance.

Larger value for annual loss (6) than pan-evaporation is also unreasonable in view of hydrological balance.

Table 5.2.3 Daily Flow Duration Data for the Bucao River

Days	%	Discharge (m3/s)				Normalization
	Year	1963	1984		(1) = Average	Rate
		A= 615 km^2	A= 647 km^2	(A=615 km^2)	A= 615 km^2	(2) = (1) / Mean Q
1	0.3	782.0	875.2	831.9	807.0	11.99
10	2.7	372.2	598.0	568.4	470.3	6.99
20	5.5	263.3	332.5	316.1	289.7	4.31
30	8.2	180.4	205.9	195.7	188.1	2.80
40	11.0	144.0	125.5	119.3	131.6	1.96
50	13.7	122.0	107.5	102.2	112.1	1.67
60	16.4	118.0	89.5	85.1	101.5	1.51
70	19.2	108.0	59.9	56.9	82.5	1.23
80	21.9	98.0	52.5	49.9	74.0	1.10
90	24.7	86.0	50.2	47.7	66.9	0.99
100	27.4	82.0	50.2	47.7	64.9	0.96
110	30.1	82.0	47.9	45.5	63.8	0.95
120	32.9	71.2	47.9	45.5	58.4	0.87
130	35.6	67.6	45.6	43.3	55.5	0.82
140	38.4	59.2	41.0	39.0	49.1	0.73
150	41.1	56.0	34.1	32.4	44.2	0.66
160	43.8	52.5	29.5	28.0	40.3	0.60
170	46.6	46.6	28.5	27.1	36.8	0.55
180	49.3	34.0	22.5	21.4	27.7	0.41
190	52.1	28.0	19.5	18.5	23.3	0.35
200	54.8	23.0	11.3	10.7	16.9	0.25
210	57.5	20.0	11.1	10.6	15.3	0.23
220	60.3	15.6	11.1	10.6	13.1	0.19
230	63.0	15.6	11.1	10.6	13.1	0.19
240	65.8	14.8	10.9	10.4	12.6	0.19
250	68.5	14.0	9.5	9.0	11.5	0.17
260	71.2	14.0	9.5	9.0	11.5	0.17
270	74.0	13.4	9.3	8.8	11.1	0.17
280	76.7	13.4	9.1	8.6	11.0	0.16
290	79.5	12.8	9.1	8.6	10.7	0.16
300	82.2	12.8	9.1	8.6	10.7	0.16
310	84.9	12.8	9.1	8.6	10.7	0.16
320	87.7	11.0	9.1	8.6	9.8	0.15
330	90.4	11.0	9.1	8.6	9.8	0.15
340	93.2	11.0	9.1	8.6	9.8	0.15
350	95.9	10.5	9.1	8.6	9.6	0.14
360	98.6	10.5	8.5	8.1	9.3	0.14
365	100.0	10.0	8.5	8.1	9.0	0.13
Mean Q		70.3	67.6	64.3	67.3	1.00

Table 5.4.1 Summary of Discharge Measurements during Flood in July 2002

Bucao River

Date	Approximate Time	Gauge Height (m)	Measured Discharge (m^3/s)
7/4	12:55	1.7	94
7/5	15:00	1.8	155
7/6	17:45	1.7	123
7/7	09:20	2.8	1,366
7/7	16:45	2.2	723
7/8	11:45	1.6	

Maloma River

Date	Approximate Time	Gauge Height (m)	Measured Discharge (m^3/s)
7/4	13:30	0.9	25
7/5	12:30	1.1	33
7/5	14:20	1.2	47
7/6	15:10	1.6	93
7/6	16:45	1.6	91
7/7	10:20	2.2	231
7/7	15:45	2.5	302
7/8	11:50	1.4	61

Sto. Tomas River

Date	Approximate Time	Gauge Height (m)	Measured Discharge (m^3/s)
7/5	14:00	2.5	21
7/6	16:20	3.0	172
7/7	12:10	top girder	-
7/8	12:50	bottom girder	-

Table 6.2.1 Ratio of New Collapse on Each Geology (Watershed Under 100 km^2)

Geology		Average (Collapsed area/Watershed area)	Geology		Average (Collapsed area/Watershed area)
Igneous Rocks	Granite	0.50 %	Sedimentary Rocks	Sediment	1.70 %
	Diorite	0.06		Pyrocrastic deposit	0.22
	Gabblo,Serpentinite	0.04		Tuff	0.23
	Quartz porphyly	0.10		Tuff breccia	0.19
	Porphyrite	1.08		Volcanic lithosol	0.39
	Diorite	0.46		Conglomerate	0.10
	Qaurtz trachyte	0.26		Breccia	0.45
	Quartz ansesite	0.53		Sandstone	0.21
	Andesite	0.22		Quartzite	2.04
	Andesitic lava	0.29		Mudstone	0.36
	Basalt	0.11		Shale	0.10
	Porphyry diorite	0.13		Slate	0.07
Metamorphic Rocks	Schist	0.34		Sandy shale	0.14
	Hornfeis	0.07		Sandy slate	0.09
Sedimentary Rocks	Paleozoic Formation	0.50		Siliceous sandstone	0.25
	Mesozoic Formation	0.05		Tufferceous shale	1.01
	Tertiary Formation	0.25		Limestone	0.27
	Diluvium Deposit	0.19		Chert	0.16
	Aluvium Deposit	0.04		Siliceous tuff	0.73

Unstable	10.00

Source: Pocketbook for field engineer on sabo works and works to prevention landslip, landslide and snowslip, Sankaido, Japan

Table 6.2.2 Depth of Collapse on Each Geology

Geology		Depth of collapse (m)	Geology		Depth of collapse (m)
Igneous Rocks	Granite	2～3	Sedimentary Rocks	Sediment	1～2
	Diorite	5		Pyrocrastic deposit	2～3
	Gabblo,Serpentinite	2～3		Tuff	2～3
	Quartz porphyly	3～4		Tuff breccia	2～3
	Porphyrite	5		Volcanic lithosol	5
	Diorite	2～3		Conglomerate	1～2
	Qaurtz trachyte	5			
	Quartz ansesite	0～1		Sandstone	1～2
	Andesite	4～5		Quartzite	5
	Andesitic lava	3～4		Mudstone	2～3
				Shale	1～2
	Porphyry diorite	0～1		Slate	2～3
Metamorphic Rocks	Schist	2～3		Sandy shale	2～3
	Hornfeis	1～2		Sandy slate	1～2
Sedimentary Rocks	Paleozoic Formation	2～3		Siliceous sandstone	2～3
	Mesozoic Formation	2～3		Tufferceous shale	1～2
	Tertiary Formation	3～4		Limestone	2～3
	Diluvium Deposit	3～4		Chert	2～3
	Aluvium Deposit	4～5			

Unstable	4

Source: Pocketbook for field engineer on sabo works and works to prevention landslip, landslide and snowslip, Sankaido, Japan

Table 6.2.3 Average Depth of Erosion of Each Geology

Geology		Average depth (m)	Geology		Average depth (m)
Igneous Rocks	Granite	0.013	Sedimentary Rocks	Sediment	0.026
	Diorite	0.003		Pyrocrastic deposit	0.006
	Gabblo,Serpentinite	0.001		Tuff	0.006
	Quartz porphyly	0.004		Tuff breccia	0.005
	Porphyrite	0.054		Volcanic lithosol	0.020
	Diorite	0.012		Conglomerate	0.002
	Qaurtz trachyte	0.013			
	Quartz ansesite	0.003		Sandstone	0.003
	Andesite	0.010		Quartzite	0.102
	Andesitic lava	0.010		Mudstone	0.009
	Basalt			Shale	0.002
	Porphyry diorite	0.001		Slate	0.003
Metamorphic Rocks	Schist	0.003		Sandy shale	0.002
	Hornfeis	0.005		Sandy slate	0.002
Sedimentary Rocks	Paleozoic Formation	0.002		Siliceous sandstone	0.002
	Mesozoic Formation	0.013		Tufferceous shale	0.004
	Tertiary Formation	0.002		Limestone	0.025
	Diluvium Deposit	0.009		Chert	0.007
	Aluvium Deposit	0.009			
				Unstable	0.400

Source: Pocketbook for field engineer on sabo works and works to prevention landslip, landslide and snowslip, Sankaido, Japan

Table 6.2.4 Estimation of Annual Sediment Yield in 2001

River	Watershed	Area				Sediment Yield			
		Catchment Area : A (km^2)	Normal Slope Area : A1 (km^2)	Unstable Slope Area : A2 (km^2)	River Bank Erosion Area : A3 (km^2)	Yield from A1 : V1 (10^6 m^3/yr)	Yield from A2 : V2 (10^6 m^3/yr)	Yield from A3 : V3 (10^6 m^3/yr)	Total Sediment : V (10^6 m^3/yr)
Bucao River	B1	68.4	58.9	9.2	0.3	0.35	2.26	0.60	3.22
	B2	20.0	20.0	0.0	0.0	0.12	0.00	0.00	0.12
	B3	50.5	37.1	13.0	0.4	0.22	3.20	0.80	4.22
	B4	12.0	6.6	5.1	0.3	0.04	1.25	0.60	1.90
	B5	142.1	114.7	26.6	0.8	0.69	6.54	1.60	8.84
	B6	154.0	154.0	0.0	0.0	0.92	0.00	0.00	0.92
	B7	64.9	64.9	0.0	0.0	0.39	0.00	0.00	0.39
	B8	13.0	13.0	0.0	0.0	0.08	0.00	0.00	0.08
	B9	35.1	35.1	0.0	0.0	0.21	0.00	0.00	0.21
	B10	60.9	60.9	0.0	0.0	0.37	0.00	0.00	0.37
	B11	33.9	33.9	0.0	0.0	0.20	0.00	0.00	0.20
	Total	654.8	599.1	53.9	1.8	3.59	13.26	3.61	20.46
	%	100.0%	91.5%	8.2%	0.3%	17.6%	64.8%	17.6%	100.0%
Maloma River	M1	42.6	41.4	1.2	0.0	0.25	0.30	0.00	0.54
	M2	39.4	39.4	0.0	0.0	0.24	0.00	0.00	0.24
	M3	17.4	17.4	0.0	0.0	0.10	0.00	0.00	0.10
	M4	42.0	42.0	0.0	0.0	0.25	0.00	0.00	0.25
	M5	10.4	10.4	0.0	0.0	0.06	0.00	0.00	0.06
	Total	151.8	150.6	1.2	0.0	0.90	0.30	0.00	1.20
	%	100.0%	99.2%	0.8%	0.0%	75.4%	24.6%	0.0%	100.0%
Sto. Tomas River	S1	54.4	43.7	10.0	0.7	0.26	2.46	1.40	4.13
	S2	22.2	22.2	0.0	0.0	0.13	0.00	0.00	0.13
	S3	13.9	13.7	0.2	0.0	0.08	0.05	0.00	0.13
	S4	18.8	18.8	0.0	0.0	0.11	0.00	0.00	0.11
	S5	39.0	39	0.0	0.0	0.23	0.00	0.00	0.23
	S6	42.1	41.2	0.9	0.0	0.25	0.22	0.00	0.47
	S7	29.1	29.1	0.0	0.0	0.17	0.00	0.00	0.17
	S8	6.8	6.8	0.0	0.0	0.04	0.00	0.00	0.04
	S9	6.1	6.1	0.0	0.0	0.04	0.00	0.00	0.04
	S10	9.3	9.3	0.0	0.0	0.06	0.00	0.00	0.06
	S11	20.7	20.7	0.0	0.0	0.12	0.00	0.00	0.12
	Total	262.4	250.6	11.1	0.7	1.50	2.73	1.40	5.64
	%	100.0%	95.5%	4.2%	0.3%	26.7%	48.4%	24.9%	100.0%

Table 6.3.1 Grain Size and Specific Gravity of Riverbed Material

Sampling Location	Sample Number	River System	Distance from River-mouth	Portion in Riverbed	Specific Gravity (t/m^3)	Grain Size (mm)			Ratio
						D_{60}	D_{84}	D_{16}	D_{84} / D_{16}
No.1	No.1-R	Bucao	4 km	Right Side	2.56	0.50	0.90	0.18	5.0
	No.1-M			Middle Side	2.44	0.28	0.70	0.15	4.7
	No.1-L			Left Side	2.58	0.27	0.60	0.13	4.6
	Average				2.53	0.35			4.8
No.2	No.2-R	Bucao	12 km	Right Side	2.51	0.48	0.90	0.10	9.0
	No.2-M			Middle Side	2.65	0.28	0.70	0.16	4.4
	No.2-L			Left Side	2.77	0.29	0.40	0.18	2.2
	Average				2.64	0.35			5.2
No.3	No.3-R	Bucao	19 km	Right Side	2.67	0.55	1.30	0.19	6.8
	No.3-M			Middle Side	2.39	0.60	0.90	0.24	3.8
	No.3-L			Left Side	2.63	0.85	2.10	0.30	7.0
	Average				2.56	0.67			5.9
No.4	No.4-R	Maloma	3 km	Right Side	2.65	0.54	0.85	0.27	3.1
	No.4-M			Middle Side	2.48	0.67	1.30	0.34	3.8
	No.4-L			Left Side	2.58	0.59	1.00	0.28	3.6
	Average				2.57	0.60			3.5
No.5	No.5-R	Maloma	13 km	Right Side	2.53	0.54	0.85	0.27	3.1
	No.5-M			Middle Side	2.64	0.66	1.30	0.34	3.8
	No.5-L			Left Side	2.58	0.58	1.00	0.28	3.6
	Average				2.58	0.59			3.5
No.6	No.6-R	Sto.Tomas	3 km	Right Side	2.73	0.23	0.30	0.13	2.3
	No.6-M			Middle Side	2.36	0.55	2.60	0.18	14.4
	No.6-L			Left Side	2.52	0.28	0.60	0.14	4.3
	Average				2.54	0.35			7.0
No.7	No.7-R	Sto.Tomas	13 km	Right Side	2.31	1.60	4.00	0.35	11.4
	No.7-M			Middle Side	2.70	0.26	0.39	0.14	2.8
	No.7-L			Left Side	2.68	0.28	0.43	0.16	2.7
	Average				2.56	0.71			5.6
No.8	No.8-R	Sto.Tomas	23 km	Right Side	2.65	0.90	2.10	0.30	7.0
	No.8-M			Middle Side	2.72	0.70	1.40	0.30	4.7
	No.8-L			Left Side	2.65	0.55	0.80	0.20	4.0
	Average				2.67	0.72			5.2
Average of All Data					**2.58**	**0.54**			**5.1**

Note : D_{60} expresses the particle size with 60 % passing by weight

D_{60} = representative particle size = mean value of particle size (approximately)

D_{84}/D_{16} expresses mix degree of particle size

A riverbed material with $D_{84}/D_{16} \leq 5$ can be assumed a uniform material in sediment hydraulics.

Table 6.3.2 Grain Size Distribution of Riverbed Material

River	Location	Site	Cumulative Passing (%) for Grain Size									
			19.0 mm	12.5 mm	9.5 mm	4.75 mm	2.06 mm	0.85 mm	0.425 mm	0.3 mm	0.15 mm	0.075mm
Bucao	No.1	Right		100.0	99.4	98.8	96.2	82.5	52.3	37.2	9.4	1.7
		Middle	100.0	99.6	99.0	96.9	93.3	86.9	76.4	64.8	17.4	1.8
		Left	100.0	99.3	98.9	97.1	94.2	89.2	79.6	69.2	21.4	4.6
	No.2	Right		100.0	99.0	98.6	96.5	83.7	55.7	41.1	35.6	1.5
		Middle	100.0	99.6	99.0	96.9	93.3	86.9	76.4	64.8	17.4	1.8
		Left				100.0	99.9	97.9	87.3	62.8	9.4	1.6
	No.3	Right		100.0	99.1	95.5	89.8	77.0	47.7	30.2	9.6	3.3
		Middle		100.0	99.2	98.1	94.6	83.8	27.8	20.0	8.0	1.8
		Left			100.0	97.9	84.7	60.2	30.6	15.7	3.0	1.2
Maloma	No.4	Right		100.0	99.5	98.4	95.7	84.5	44.3	19.4	3.5	1.2
		Middle	100.0	98.9	97.9	96.5	91.9	73.8	29.3	11.5	1.3	0.5
		Left	100.0	99.4	98.9	97.8	95.5	81.1	38.5	16.9	1.5	0.6
	No.5	Right		100.0	99.5	98.4	95.7	84.5	44.3	19.4	3.5	1.2
		Middle	100.0	98.9	97.9	96.5	91.9	73.8	29.3	11.5	1.3	0.5
		Left	100.0	99.4	98.9	97.8	95.5	81.1	38.5	16.9	1.5	0.6
Sto.Tomas	No.6	Right		100.0	99.7	99.7	99.3	98.8	88.6	85.4	20.4	3.0
		Middle	100.0	99.1	98.5	94.8	80.4	66.7	54.8	38.8	8.9	1.3
		Left			100.0	98.7	96.4	89.4	77.7	63.8	18.3	4.1
	No.7	Right	100.0	99.7	97.9	88.5	67.2	42.7	29.0	7.1	1.4	0.0
		Middle				100.0	99.9	98.2	87.8	72.0	19.2	3.6
		Left			100.0	99.9	99.1	95.2	84.7	65.8	13.8	1.4
	No.8	Right	100.0	98.6	98.0	94.3	84.1	53.7	26.2	17.5	6.3	3.0
		Middle			100.0	99.8	96.7	73.6	33.7	17.2	3.1	0.5
		Left				100.0	99.3	82.0	45.0	29.6	12.1	6.6
Average			100.0	99.6	99.1	97.5	93.0	80.3	53.6	37.5	10.3	2.0

Table 6.4.1 Conditions for Two-Dimensional Mudflow Analysis

Conditions	Bucao River	Sto. Tomas River	Remarks
River Conditions			
Simulated Area	6.08 km x 14.08 km (76 mesh x 176 mesh)	10.08 km x 28.08 km (126 mesh x 351 mesh)	
Unit Scale of Mesh (m)	80	80	Created from Digital Elevation Data (Scale 1:10,000)
Maximum Erosion Depth (m)	5.0	5.0	
Erosion Depth at Site of Structure (m)	0.0	0.0	
n: Roughness Coefficient	0.030	0.030	At All Meshes
Hydrograph			
Scale of Flood	20-Year Probable Flood	20-Year Probable Flood	
Duration of Hydrograph (Hour)	48	48	
Peak Discharge (m^3/s)	Bucao: 2,930 Baquilan: 920	Marella: 680 Mapanuepe Alt-1: 1,020 Mapanuepe Alt-2&3: 220	
Total Discharge (10^6 m^3)	Bucao: 245 Baquilan: 76	Marella: 43 Mapanuepe Alt-1: 43 Mapanuepe Alt-2&3: 27	
Density of Water (g/cm^3)	1.4	1.4	
Sediment Characteristics			
Specific Gravity of Sediment (g/cm^3)	2.60	2.60	
Mean Grain Size: D_{60} (mm)	0.30	0.50	
Sediment in Model	Uniform Sediment	Uniform Sediment	
Porosity of Deposited Sediment (%)	40	40	
Boundary Conditions			
Inflowing Sediment Volume (x 10^6 m^3)	Bucao: 60 Baquilan: 4	Marella: 12 Mapanuepe: 0	
Sediment Transport Formula	Brown's Formula	Brown's Formula	Total Load

Table 6.4.2 Conditions for One-Dimensional Riverbed Movement Analysis

Conditions	Bucao River	Sto. Tomas River	Remarks
River Conditions			
n: Roughness Coefficient	0.035	0.035	At All Sections
Cross Sections	Survey Result in 2002	Survey Result in 2002	
Length of Reach in Model	25.4 km (Sta. -2.4 km to 23.0 km)	31.5 km (Sta. -1.5 km to 30.0 km)	
Maximum Erosion Depth (m)	30.0	30.0	
Sediment Characteristics			
Specific Gravity of Sediment (g/cm^3)	2.58	2.59	Laboratory Test (2002)
Mean Grain Size: D_{60} (mm)	0.35	0.35	Near Sta. 0.0 km
Sediment in Model	Mixed Gradation	Mixed Gradation	
Porosity of Deposited Sediment (%)	40	40	Laboratory Test (1994)
Hydrograph			
Annual Mean Discharge (m^3/s)	62.0	22.0	
Annual Runoff Coefficient (%)	68	67	
Peak Discharge in Normal Year (m^3/s)	743 (at Bucao Bridge)	264 (at Maculcol Bridge)	
Peak Discharge in Flood Year (m^3/s)	3,800 (at Bucao Bridge)	1,200 (at Maculcol Bridge)	20-Year Probable Flood
Flow Distribution for Tributaries	Balin Baquero: 0.47 Upper Bucao: 0.15 Balintawak: 0.25 Baquilan: 0.13	Marella: 0.66 Mapanuepe: 0.21 Santa Fe: 0.13	Total=1.00
Density of Water (g/cm^3)	1.0	1.0	
Boundary Conditions			
Upstream End			
Annual Inflowing Sediment Volume ($\times 10^6$ m^3/year)	Balin Baquero: 4.0 Upper Bucao: 1.6	Marella: 2.8	Same as Estimated Sediment Yeild in 2007
Inflowing Sediment Volume during a Flood ($\times 10^6$ m^3/day)	Balin Baquero: 17.0 Upper Bucao: 5.4	Marella: 4.7	10% of Sediment Concentration
Downstream End			
Water Depth	Critical Water Depth	Critical Water Depth	
Riverbed Elevation	Fixed at Original in 2002	Fixed at Original in 2002	
Sediment Transport Formula	Yang's Formula (1973)	Yang's Formula (1973)	Based on Unit Stream Power Theory, Total Load

Table 6.4.3 Lowest Riverbed Profile for 20 Years in the Bucao River under Present Condition (Alternative-1)

(Unit: El.m)

Station	Riverbed	Case 1				Case 2				Case 3			
km	in 2002	after 1 year	5 years	10 years	20 years	after 1 year	5 years	10 years	20 years	after 1 year	5 years	10 years	20 years
23.00	180.21	180.10	179.72	179.59	179.18	180.58	183.98	179.37	178.16	180.10	179.72	179.59	178.35
22.00	165.81	165.90	165.96	165.73	165.56	166.20	165.99	166.20	166.06	165.90	165.96	165.73	165.91
21.00	151.26	151.00	151.16	151.16	151.04	151.38	152.92	153.44	152.45	151.00	151.16	151.16	152.53
20.00	138.20	138.29	138.59	138.49	138.57	138.79	139.56	139.57	140.34	138.29	138.59	138.49	139.92
19.00	127.20	126.70	126.87	127.32	127.39	126.95	126.89	127.72	128.81	126.70	126.87	127.32	128.59
18.00	116.60	116.64	117.12	117.68	117.05	116.92	118.02	118.01	118.71	116.64	117.12	117.68	118.39
17.00	107.22	107.05	107.24	107.35	108.24	107.37	107.16	107.21	107.67	107.05	107.24	107.35	108.89
16.00	97.49	97.29	97.26	97.30	98.45	98.02	97.22	97.12	97.55	97.29	97.26	97.30	98.59
15.00	88.75	87.65	88.08	88.68	89.52	87.98	88.09	88.09	88.98	87.65	88.08	88.68	89.64
14.00	78.49	78.45	78.64	78.66	80.95	78.78	78.54	78.54	79.50	78.45	78.64	78.66	80.46
13.00	68.87	66.61	66.88	67.25	70.60	67.85	66.91	67.18	68.57	66.61	66.88	67.25	69.56
12.00	62.93	62.85	64.12	65.76	67.56	63.18	64.57	65.98	67.30	62.85	64.12	65.76	67.35
11.50	58.59	58.34	60.65	61.84	63.33	58.93	60.78	61.19	63.02	58.34	60.65	61.84	63.36
11.00	55.54	54.40	56.75	57.55	58.79	55.59	56.56	57.35	59.35	54.40	56.75	57.55	59.50
10.75	53.50	52.40	53.24	55.25	56.15	54.23	53.75	54.86	57.31	52.40	53.24	55.25	57.05
10.50	51.97	50.48	50.73	53.01	53.96	52.33	51.66	53.10	55.10	50.48	50.73	53.01	54.95
10.25	50.45	48.58	48.99	50.07	51.70	50.67	49.07	50.49	52.46	48.58	48.99	50.07	52.74
10.00	48.93	46.74	46.89	47.12	48.65	48.82	47.94	48.49	49.24	46.74	46.89	47.12	49.73
9.75	47.16	47.15	47.25	47.24	49.04	47.83	48.89	48.61	49.98	47.15	47.25	47.24	49.02
9.50	45.64	46.17	46.24	46.24	47.55	46.50	47.11	46.88	47.89	46.17	46.24	46.24	47.36
9.25	44.42	44.63	44.49	44.72	45.60	45.04	44.89	44.75	45.96	44.63	44.49	44.72	45.63
9.00	43.50	43.30	42.71	42.69	44.03	43.89	42.95	43.03	44.24	43.30	42.71	42.69	43.87
8.75	42.28	41.94	41.49	42.09	42.92	42.33	42.18	42.27	43.17	41.94	41.49	42.09	43.17
8.50	40.75	40.43	40.18	40.58	41.61	40.90	40.79	41.06	41.55	40.43	40.18	40.58	41.61
8.25	39.54	38.96	38.79	39.41	40.21	39.35	39.61	39.99	40.34	38.96	38.79	39.41	40.39
8.00	38.62	37.56	37.49	37.97	38.81	38.03	38.03	38.62	38.73	37.56	37.49	37.97	38.73
7.50	35.23	34.98	34.77	35.43	35.73	35.99	35.79	35.52	35.73	34.98	34.77	35.43	35.89
7.00	32.18	33.67	33.41	33.58	33.68	33.82	33.69	33.05	33.52	33.67	33.41	33.58	33.51
6.50	30.18	29.98	29.82	30.01	29.98	30.99	29.82	29.64	30.05	29.98	29.82	30.01	30.03
6.00	28.04	28.03	26.28	26.30	26.62	28.89	26.49	26.29	27.15	28.03	26.28	26.30	26.79
5.00	24.14	22.77	22.70	22.86	24.27	23.39	24.05	23.33	26.22	22.77	22.70	22.86	25.97
4.00	17.70	19.31	18.87	19.70	20.89	20.55	19.20	19.65	21.56	19.31	18.87	19.70	21.79
3.00	15.73	17.17	16.75	17.94	18.54	17.71	17.68	18.24	19.34	17.17	16.75	17.94	19.77
2.00	12.78	12.90	14.10	14.99	15.86	13.47	14.32	15.16	15.85	12.90	14.10	14.99	16.58
1.50	11.23	11.16	12.98	14.15	14.53	11.52	13.09	14.16	14.24	11.16	12.98	14.15	14.97
1.00	9.71	9.82	10.57	11.40	12.82	9.93	10.82	12.03	12.46	9.82	10.57	11.40	12.27
0.60	7.65	7.50	9.06	10.25	11.29	9.18	9.59	11.09	11.27	7.50	9.06	10.25	11.62
0.40	7.15	8.55	8.86	10.04	11.16	8.07	8.66	10.42	11.33	8.55	8.86	10.04	11.13
0.20	6.65	7.20	6.91	8.46	9.82	7.76	6.31	9.28	10.16	7.20	6.91	8.46	9.71
0.00	6.30	6.83	8.08	8.66	9.68	7.26	9.15	9.71	10.31	6.83	8.08	8.66	10.02
-0.20	5.97	6.42	7.00	8.48	8.89	6.86	7.11	8.43	8.84	6.42	7.00	8.48	8.95
-0.40	5.44	5.72	6.54	7.66	8.21	6.42	6.61	7.89	8.31	5.72	6.54	7.66	8.44
-0.70	4.91	4.93	5.75	6.92	7.24	5.45	5.81	6.89	7.20	4.93	5.75	6.92	7.37
-1.00	4.11	4.50	5.23	6.00	6.26	4.78	5.20	6.03	6.54	4.50	5.23	6.00	6.30
-1.50	2.77	3.15	3.79	4.09	4.69	3.38	3.64	4.38	4.54	3.15	3.79	4.09	4.51
-2.00	1.35	2.09	2.38	2.58	2.96	2.30	2.38	2.75	2.99	2.09	2.38	2.58	3.07
-2.40	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01

Table 6.4.4 Lowest Riverbed Profile for 20 Years in the Sto. Tomas River under Present Condition (Alternative-1)

(Unit: El.m)

Station	Riverbed	Case 1				Case 2				Case 3			
km	in 2002	after 1 year	5 years	10 years	20 years	after 1 year	5 years	10 years	20 years	after 1 year	5 years	10 years	20 years
30.00	292.00	286.33	280.36	275.82	273.97	286.33	279.36	276.50	273.20	286.33	280.36	275.82	273.08
29.50	278.00	275.54	270.49	267.22	266.04	275.54	269.48	269.14	265.50	275.54	270.49	267.22	266.03
29.00	262.00	261.71	259.11	255.79	255.66	261.71	259.35	258.81	254.13	261.71	259.11	255.79	255.64
28.50	248.00	247.88	244.53	244.21	243.94	247.88	247.05	244.71	244.46	247.88	244.53	244.21	243.94
28.00	235.00	234.98	233.11	232.82	232.35	234.98	233.17	232.82	232.35	234.98	233.11	232.82	232.36
27.50	226.00	224.90	223.66	222.56	221.93	224.90	223.81	222.62	221.88	224.90	223.66	222.56	221.91
27.00	214.00	213.58	213.50	213.47	213.44	213.58	213.56	213.51	213.46	213.58	213.50	213.47	213.45
26.50	206.00	206.33	206.33	206.10	205.95	206.33	206.30	206.02	205.90	206.33	206.33	206.10	205.98
26.00	200.07	199.11	198.95	198.61	198.14	199.11	198.99	198.30	197.99	199.11	198.95	198.61	198.29
25.50	191.23	191.20	191.19	191.08	190.98	191.20	191.20	191.12	190.94	191.20	191.19	191.08	190.94
25.00	185.29	185.03	184.70	184.71	184.62	185.03	184.87	184.78	184.71	185.03	184.70	184.71	184.65
24.50	178.83	177.98	177.48	177.40	177.24	177.98	177.39	177.35	177.24	177.98	177.48	177.40	177.23
24.00	172.12	170.02	170.00	169.97	169.44	170.02	170.08	170.02	169.48	170.02	170.00	169.97	169.05
23.50	162.09	161.66	161.13	160.86	160.50	161.66	161.09	161.08	160.48	161.66	161.13	160.86	160.34
23.00	152.92	152.24	152.23	152.16	152.01	152.24	152.22	152.15	152.02	152.24	152.23	152.16	152.05
22.50	144.02	142.91	142.66	142.64	142.55	142.91	142.66	142.64	142.55	142.91	142.66	142.64	142.54
22.00	134.39	132.66	132.65	132.58	132.44	132.66	132.66	132.56	132.45	132.66	132.65	132.58	132.43
21.50	124.96	124.21	124.18	124.07	123.94	124.21	124.17	124.05	123.96	124.21	124.18	124.07	123.98
21.00	113.53	113.01	113.15	113.20	113.11	113.01	113.21	113.20	113.24	113.01	113.15	113.20	113.77
20.50	107.75	108.30	108.17	108.29	108.27	108.30	108.19	108.40	108.40	108.30	108.17	108.29	108.66
20.00	104.14	103.77	103.92	103.96	103.88	103.77	103.96	104.17	104.06	103.77	103.92	103.96	103.79
19.50	100.89	100.45	99.74	99.75	99.72	100.45	99.77	99.69	99.71	100.45	99.74	99.75	99.34
19.00	97.20	97.32	96.45	96.51	96.53	97.32	96.48	96.52	96.54	97.32	96.45	96.51	96.54
18.50	93.84	91.74	91.70	91.77	91.80	91.74	91.71	91.83	91.88	91.74	91.70	91.77	91.88
18.00	87.68	87.52	87.53	87.77	87.57	87.52	87.54	87.65	87.62	87.52	87.53	87.77	87.49
17.50	84.28	84.39	84.38	84.41	84.55	84.39	84.37	84.44	84.52	84.39	84.38	84.41	84.51
17.00	79.71	79.35	78.95	79.04	79.05	79.35	78.96	79.01	79.05	79.35	78.95	79.04	79.00
16.50	75.04	74.69	74.90	74.98	75.34	74.69	74.84	75.09	75.41	74.69	74.90	74.98	75.23
16.00	71.38	71.91	71.69	71.87	71.96	71.91	71.71	72.00	71.94	71.91	71.69	71.87	72.09
15.50	68.33	69.48	68.63	68.57	69.03	69.48	68.60	68.64	68.95	69.48	68.63	68.57	69.02
15.00	65.81	66.01	65.06	65.09	65.15	66.01	65.17	65.16	65.05	66.01	65.06	65.09	65.12
14.50	62.42	62.29	61.93	61.90	62.08	62.29	61.90	61.91	62.08	62.29	61.93	61.90	62.00
14.00	59.13	59.78	58.43	58.68	58.63	59.78	58.49	58.59	58.44	59.78	58.43	58.68	58.52
13.50	56.11	55.80	55.26	55.14	54.85	55.80	55.23	54.91	54.92	55.80	55.26	55.14	54.91
13.00	52.93	52.61	52.53	52.18	52.14	52.61	52.67	52.08	52.04	52.61	52.53	52.18	52.05
12.50	50.23	50.62	49.55	49.41	49.52	50.62	49.63	49.20	49.54	50.62	49.55	49.41	49.72
12.00	47.63	47.09	46.56	46.69	46.93	47.09	46.67	46.61	46.83	47.09	46.56	46.69	46.73
11.50	44.62	44.36	43.85	43.97	44.10	44.36	43.81	44.14	44.59	44.36	43.85	43.97	44.34
11.00	42.00	42.06	41.61	41.76	41.69	42.06	41.76	41.64	41.52	42.06	41.61	41.76	41.66
10.50	40.34	39.92	39.72	39.67	39.76	39.92	39.88	39.63	39.83	39.92	39.72	39.67	40.01
10.00	37.54	37.77	37.66	37.64	37.60	37.77	37.78	37.49	37.90	37.77	37.66	37.64	37.80
9.50	35.54	34.90	35.09	35.21	35.66	34.90	35.11	35.07	35.34	34.90	35.09	35.21	35.57
9.00	33.41	33.88	33.42	33.17	33.59	33.88	33.30	32.89	33.57	33.88	33.42	33.17	33.72
8.50	31.56	31.56	31.96	31.65	31.86	31.56	31.97	31.64	31.98	31.56	31.96	31.65	32.27
8.00	30.10	29.95	30.82	30.47	30.75	29.95	30.78	30.22	30.83	29.95	30.82	30.47	31.18
7.70	28.41	28.51	29.20	29.19	29.40	28.51	29.07	29.38	29.40	28.51	29.20	29.19	29.86
7.50	27.58	28.39	28.38	27.96	28.37	28.39	28.15	28.52	28.64	28.39	28.38	27.96	28.86
7.25	26.90	27.05	27.03	26.97	28.12	27.05	27.16	27.57	28.07	27.05	27.03	26.97	27.78
7.00	26.06	25.96	25.81	25.87	26.89	25.96	26.01	26.34	26.74	25.96	25.81	25.87	26.81
6.80	25.26	25.49	25.46	25.41	26.16	25.49	25.57	25.99	26.38	25.49	25.46	25.41	26.18
6.50	24.17	24.34	24.15	24.38	24.88	24.34	24.23	24.47	24.95	24.34	24.15	24.38	24.94
6.25	23.71	23.86	23.25	23.22	24.15	23.86	23.42	23.94	24.16	23.86	23.25	23.22	24.12
6.00	22.85	22.01	22.90	22.75	23.30	22.01	22.73	23.03	23.25	22.01	22.90	22.75	23.43
5.75	22.13	22.85	20.66	21.04	21.97	22.85	21.03	21.44	22.12	22.85	20.66	21.04	22.01
5.50	21.45	20.76	21.32	20.85	21.85	20.76	21.02	21.28	21.62	20.76	21.32	20.85	21.89
5.25	20.96	20.47	20.24	20.63	21.34	20.47	20.50	20.39	20.73	20.47	20.24	20.63	21.09
5.00	19.55	19.67	19.70	19.55	20.55	19.67	19.82	19.90	19.89	19.67	19.70	19.55	20.56
4.50	18.05	18.01	18.17	18.38	19.01	18.01	18.18	18.73	19.00	18.01	18.17	18.38	19.00
4.00	16.71	16.40	16.86	17.31	17.60	16.40	16.94	17.70	17.68	16.40	16.86	17.31	17.63
3.50	15.15	15.94	15.75	16.01	16.46	15.94	15.81	16.04	16.49	15.94	15.75	16.01	16.57
3.00	14.20	13.80	13.88	14.28	14.47	13.80	14.00	14.55	14.36	13.80	13.88	14.28	14.40
2.50	12.58	12.31	12.69	12.81	12.92	12.31	12.81	12.94	12.79	12.31	12.69	12.81	12.88
2.00	11.30	10.83	11.37	11.91	11.45	10.83	11.60	11.97	11.44	10.83	11.37	11.91	11.57
1.50	9.86	9.95	10.52	10.48	10.53	9.95	10.63	10.42	10.87	9.95	10.52	10.48	10.66
1.00	8.46	8.88	9.33	9.79	9.25	8.88	9.57	9.81	9.49	8.88	9.33	9.79	9.34
0.50	7.23	7.94	8.16	8.00	8.18	7.94	8.37	8.03	8.70	7.94	8.16	8.00	8.22
0.33	6.85	7.44	7.70	8.35	7.81	7.44	7.69	8.50	8.10	7.44	7.70	8.35	7.85
0.13	6.45	6.36	6.72	7.15	7.15	6.36	6.64	7.07	7.54	6.36	6.72	7.15	7.25
0.00	6.27	6.52	7.03	7.09	6.89	6.52	6.98	6.50	7.11	6.52	7.03	7.09	6.96
-0.30	5.95	5.58	5.89	6.22	6.05	5.58	5.84	5.93	6.39	5.58	5.89	6.22	6.02
-0.50	5.50	5.02	5.34	5.52	5.36	5.02	5.30	5.67	5.61	5.02	5.34	5.52	5.39
-0.60	5.17	4.75	4.95	5.22	4.97	4.75	4.89	5.36	5.42	4.75	4.95	5.22	5.00
-0.85	4.02	3.86	3.95	4.12	4.01	3.86	3.96	4.16	4.33	3.86	3.95	4.12	4.04
-1.00	3.52	3.36	3.43	3.59	3.52	3.36	3.41	3.62	3.77	3.36	3.43	3.59	3.53
-1.25	2.89	2.73	2.79	2.91	2.93	2.73	2.78	2.92	3.01	2.73	2.79	2.91	2.94
-1.50	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19

Table 8.2.1 Possible Structural Measures in Western River Basins of Mount Pinatubo

ZONE	STRUCTURAL MEASURE	PURPOSE	BUCAO RIVER BASIN		MALOMA RIVER BASIN		STO. TOMAS RIVER BASIN	
			Dimension/Component	Evaluation	Dimension/Component	Evaluation	Dimension/Component	Evaluation
Sediment Source Zone	Strengthening of Notch	To protect from the further erosion at overflow section of the Maraunot Notch.	Three Alternatives for outlet work: (1) Gabion mattress, (2) Concrete weir, and (3) Discharge tunnel	The plans (1) and (2) are recommendable if the geological condition is rigid/stable.	N.A.	The river originates at the lower part of slope of Mt.Pinatubo.	N.A.	There is no collapse of crater at the uppermost stretch of the Marella River.
	Re-vegetation	To prevent gully erosion, To accelerate catchment conservation	N.A.	91% mountain slope has already become stable. Thus, not applicable.	N.A.	There is no unstable mountain slope in the upper catchment area.	N.A.	95% mountain slope has already become stable.
	Small-scale Sabo Dam	To trap sediment from small-scale tributaries.	N.A.	Sediment control effect is small.	N.A.	Sediment control effect is small.	N.A.	Sediment control effect is small.
	Large-scale Sabo Dam	To trap sediment from main tributaries, To stabilize unstable lahar deposits	Six large-scale sabo dam sites were identified. The priority for development was evaluated.	The construction cost for foundation underneath dam is remarkably high because of thick lahar deposits at dam site.	N.A.	The current problem is flood inundation in the lower stretch, rather than sedimentation.	N.A.	A sabo dam site was identified at the Marella River, which was recommended by the RAP in 1994. However, it is not economical.
Sediment Deposition/ Secondary Erosion Zone	Consolidation Dam	To stabilize in-channel deposition	Consolidation dam at the Malumboy is proposed to stabilize the unstable sediment.	The dam is able to stabilize the unstable sediment of more than 300 million m^3.	N.A.	Same as above.	Consolidation dam is proposed to stabilize the unstable lahar deposits in the Marella River.	It is important to stabilize the unstable lahar deposits and to fix a river channel.
	Sand Pocket	To trap remobilized lahar deposits	Sand pocket at down-stream of the Malumboy is effective in trapping re-mobilized sediment.	The sand pocket can trap the remarkable volume of remobilized sediment.	N.A.	Same as above.	Sand pocket is proposed in the vicinity of Mt.Bagang.	To avoid the collapse of the Mapanuepe Lake, this has large flood control effect.
	Groundsill	To regulate secondary erosion of in-channel deposition To fix riverbed elevation	Lateral dikes as part of sand pocket are provided to fix the river channel.	Lateral dike functions as groundsill.	N.A.	Same as above.	A series of groundsills are provided at training channel mentioned below.	To maintain the riverbed elevation of training channel. To avoid shifting a channel
	Channel Training Works	To fix river channel To reduce in-channel sediment deposition	Openings of lateral dike of sand pocket are provided at left bank.	The river channel should be fixed at left bank along mountain side to protect right bank.	River channel improve-ment works are provided for lower stretch.	Widening/Straightening of river channel is required for ensure enough flow capacity.	Training channel is proposed in the vicinity of Mt.Bagang to fix river channel.	To avoid the collapse of the Mapanuepe Lake, this has large flood control effect.
Sediment Conveyance Zone	Channel Excavation	To maintain flow capacity of river channel	Maintenance excavation is required, if necessary, until the new bridge is constructed.	No clogging of river channel is identified at river mouth.	N.A.	No clogging is identified at river mouth.	Maintenance excavation is required until the new bridge is constructed.	No clogging of river channel is identified at river mouth.
	Dike	To protect inland from flood/ mudflow.	Heightening/Strengthening of existing dike	Strengthening of existing dike is required to avoid the breach of the dike.	Dike is provided as part of river channel improvement.	Widening/Straightening of river channel is required for ensure enough flow capacity.	Heightening/Strengthening of existing dike	Strengthening of existing dike is required to avoid the breach of the dike.
	Spur Dike	To control flow direction To protect from local scouring.	Spur dikes were provided to fix a river channel at right bank.	The location of spur dike should be determined based on the monitoring of flood flow condition	Spur dikes were provided to protect the dike from local scouring.	The location of spur dike should be determined based on the monitoring of flood flow condition	Spur dikes were provided to fix a river channel apart from the left bank.	The location of spur dike should be determined based on the monitoring of flood flow condition

Table 8.7.1 Lowest Riverbed Profile after 20 Years in the Sto. Tomas River

(Unit: El.m)

Station	Alternative-1			Alternative-2			Alternative-3			Alternative-2*			Alternative-3*		
km	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
30.00	273.97	273.20	273.08	275.39	274.29	274.05	275.31	277.08	274.23	292.00	292.03	292.03			
29.50	266.04	265.50	266.03	266.82	267.70	266.81	266.68	270.22	266.68	278.00	278.00	278.00			
29.00	255.66	254.13	255.64	255.66	258.68	255.63	255.27	258.67	255.25	262.00	262.00	262.00			
28.50	243.94	244.46	243.94	244.42	244.41	244.41	243.60	244.66	243.60	248.00	248.00	248.00			
28.00	232.35	232.35	232.36	231.57	231.44	231.57	232.39	232.29	232.39	235.00	235.00	235.00			
27.50	221.93	221.88	221.91	222.49	222.00	222.26	221.69	222.42	222.17	226.00	226.00	226.00			
27.00	213.44	213.46	213.45	213.91	213.89	213.94	213.65	213.70	213.67	214.00	214.00	214.00			
26.50	205.95	205.90	205.98	205.93	205.90	205.89	205.90	205.92	205.89	206.00	206.02	206.01			
26.00	198.14	197.99	198.29	198.42	198.38	198.36	197.97	198.11	197.85	200.07	200.07	200.07			
25.50	190.98	190.94	190.94	191.26	191.26	191.26	190.96	190.93	191.01	191.24	191.24	191.24			
25.00	184.62	184.71	184.65	185.35	185.27	185.36	184.87	184.90	184.81	185.30	185.30	185.30			
24.50	177.24	177.24	177.23	178.83	178.84	178.83	177.38	177.37	177.41	178.83	178.83	178.83			
24.00	169.44	169.48	169.05	172.13	172.13	172.13	167.79	167.94	167.91	172.12	172.12	172.12			
23.50	160.50	160.48	160.34	162.10	162.10	162.10	159.48	159.72	159.85	162.09	162.10	162.09			
23.00	152.01	152.02	152.05	152.92	152.92	152.93	151.95	152.21	151.96	152.92	152.92	152.92			
22.50	142.55	142.55	142.54	144.02	144.02	144.02	142.78	143.02	142.66	144.02	144.02	144.02			
22.00	132.44	132.45	132.43	134.39	134.39	134.39	133.37	133.47	133.39	134.39	134.39	134.39			
21.50	123.94	123.96	123.98	124.96	124.96	124.96	124.96	124.96	124.96	124.96	124.96	124.96	124.96	124.96	124.96
21.00	113.11	113.24	113.77	112.39	112.29	112.34	113.00	113.09	112.99	109.62	109.23	109.26	113.53	113.53	113.53
20.50	108.27	108.40	108.66	107.92	107.89	108.01	108.19	108.19	108.28	106.01	105.98	106.08	92.91	92.86	92.93
20.00	103.88	104.06	103.79	103.67	103.99	103.86	104.14	104.04	104.23	102.67	102.54	102.66	89.13	89.13	89.13
19.50	99.72	99.71	99.34	100.17	100.10	100.13	100.16	100.40	100.23	98.96	99.01	99.03	86.92	87.36	86.56
19.00	96.53	96.54	96.54	96.72	96.72	96.74	96.66	96.57	96.63	95.26	95.18	95.28	86.19	86.93	85.79
18.50	91.80	91.88	91.88	91.90	91.85	91.95	91.36	91.25	91.45	91.85	91.92	91.85	84.69	84.16	84.34
18.00	87.57	87.62	87.49	87.72	87.73	87.93	86.70	86.67	86.64	87.25	87.61	87.31	81.70	80.47	81.61
17.50	84.55	84.52	84.51	83.64	83.48	83.50	83.03	82.93	83.24	82.45	82.87	82.43	78.78	78.71	78.36
17.00	79.05	79.05	79.00	79.69	79.73	79.59	78.76	78.58	79.45	78.39	78.36	78.41	75.89	76.84	75.36
16.50	75.34	75.41	75.23	75.81	75.69	75.78	75.20	75.27	75.85	74.30	74.26	74.31	72.90	73.17	72.54
16.00	71.96	71.94	72.09	72.71	72.46	72.70	72.51	72.32	72.26	71.25	71.04	71.15	70.03	69.95	70.04
15.50	69.03	68.95	69.02	68.76	68.83	68.96	69.22	69.15	68.84	67.85	67.82	67.86	67.39	66.99	67.38
15.00	65.15	65.05	65.12	64.69	65.18	64.89	65.80	65.65	65.53	64.90	64.83	64.74	64.31	64.29	64.31
14.50	62.08	62.08	62.00	61.58	61.83	61.55	62.27	62.25	62.24	61.94	62.17	62.04	62.32	62.34	62.34
14.00	58.63	58.44	58.52	58.25	58.27	58.20	58.95	58.91	58.80	58.12	58.58	58.31	58.49	58.48	58.49
13.50	54.85	54.92	54.91	54.78	54.68	54.87	55.22	55.21	55.17	54.73	55.10	54.75	55.12	55.09	55.11
13.00	52.14	52.04	52.05	52.18	52.00	52.21	52.58	52.49	52.60	52.05	52.42	52.11	52.54	52.53	52.53
12.50	49.52	49.54	49.72	49.43	49.55	49.41	49.76	49.88	49.70	49.48	49.84	49.55	49.93	49.93	49.94
12.00	46.93	46.83	46.73	47.02	47.09	46.87	47.11	47.25	47.16	47.13	47.17	47.02	46.82	46.81	46.82
11.50	44.10	44.59	44.34	44.27	44.33	44.32	44.25	44.40	44.28	44.42	44.33	44.74	43.88	43.85	43.89
11.00	41.69	41.52	41.66	41.77	41.93	41.62	41.57	41.71	41.51	41.89	41.90	41.78	41.65	41.64	41.64
10.50	39.76	39.83	40.01	39.61	39.70	39.50	39.50	39.49	39.42	39.97	39.96	40.12	39.67	39.68	39.67
10.00	37.60	37.90	37.80	37.86	37.97	37.67	37.50	37.60	37.70	37.85	37.82	37.84	37.24	37.33	37.24
9.50	35.66	35.34	35.57	35.70	35.64	35.80	35.62	36.10	35.62	36.00	35.76	35.84	35.13	35.13	35.16
9.00	33.59	33.57	33.72	33.82	33.97	33.79	34.22	34.02	34.18	33.78	33.86	33.87	33.21	33.37	33.25
8.50	31.86	31.98	32.27	32.00	31.96	32.36	32.76	32.90	32.77	32.28	32.07	32.31	31.73	31.93	31.81
8.00	30.75	30.83	31.18	30.95	31.18	31.12	30.75	30.98	30.78	31.21	30.85	31.20	29.82	29.84	29.85
7.70	29.40	29.40	29.86	29.84	29.93	30.08	29.88	29.68	29.92	29.79	29.77	29.71	28.43	28.44	28.44
7.50	28.37	28.64	28.86	29.32	29.33	29.14	28.78	28.74	29.04	28.97	28.89	28.61	27.64	27.64	27.66
7.25	28.12	28.07	27.78	27.99	28.11	28.22	27.79	27.86	27.93	27.95	27.83	27.62	26.49	26.47	26.54
7.00	26.89	26.74	26.81	27.22	27.18	27.37	26.79	26.95	26.67	26.75	26.93	26.83	25.75	25.73	25.77
6.80	26.16	26.38	26.18	26.14	26.27	26.45	26.34	26.20	26.41	25.85	25.89	25.91	24.98	24.85	25.00
6.50	24.88	24.95	24.94	25.29	25.14	25.21	25.16	24.96	25.14	24.44	24.61	24.50	23.84	23.63	23.85
6.25	24.15	24.16	24.12	23.85	24.02	24.27	24.19	24.17	24.19	23.52	23.15	23.68	23.08	22.96	23.09
6.00	23.30	23.25	23.43	23.24	23.31	23.01	22.87	23.09	22.99	22.99	22.89	22.93	22.08	22.12	22.11
5.75	21.97	22.12	22.01	22.87	22.03	22.72	22.49	22.34	22.20	22.41	22.63	22.32	21.41	21.48	21.46
5.50	21.85	21.62	21.89	21.46	21.81	21.90	21.24	21.95	21.65	22.17	21.46	22.15	20.83	20.85	20.84
5.25	21.34	20.73	21.09	20.79	20.42	20.88	21.06	20.65	20.64	21.15	21.11	21.11	19.82	19.82	19.83
5.00	20.55	19.89	20.56	20.14	20.11	19.94	19.94	20.64	20.03	20.19	20.20	20.23	19.27	19.25	19.26
4.50	19.01	19.00	19.00	18.45	18.36	18.48	18.78	18.76	18.44	18.47	18.65	18.52	17.75	17.77	17.77
4.00	17.60	17.68	17.63	17.57	17.62	17.38	17.42	17.43	17.49	17.29	17.40	17.34	16.54	16.63	16.54
3.50	16.46	16.49	16.57	16.35	16.41	16.24	16.17	16.15	16.24	16.34	16.34	16.36	15.22	15.15	15.24
3.00	14.47	14.36	14.40	14.40	14.67	13.92	14.02	14.40	14.59	14.40	14.37	14.33	13.36	13.22	13.36
2.50	12.92	12.79	12.88	12.98	13.41	12.89	13.26	13.19	13.18	13.12	13.16	13.13	12.04	12.04	12.08
2.00	11.45	11.44	11.57	11.88	11.84	11.60	11.45	12.02	11.78	11.76	11.79	11.67	10.34	10.72	10.84
1.50	10.53	10.87	10.66	10.63	10.70	10.55	10.92	10.51	10.68	10.40	10.47	10.44	9.35	9.67	9.61
1.00	9.25	9.49	9.34	9.32	9.37	9.29	9.43	9.42	9.26	9.00	9.00	9.23	8.31	8.31	7.97
0.50	8.18	8.70	8.22	8.07	8.06	8.28	8.28	8.21	8.20	7.89	8.06	7.87	6.94	6.93	6.46
0.33	7.81	8.10	7.85	7.58	7.46	7.76	7.80	7.92	7.94	7.36	7.35	7.41	6.36	6.43	5.89
0.13	7.15	7.54	7.25	6.94	7.04	7.09	7.10	7.15	7.00	6.73	6.90	6.78	5.91	5.99	5.46
0.00	6.89	7.11	6.96	6.58	6.49	6.73	6.75	6.77	6.88	6.43	6.44	6.47	5.61	5.71	5.17
-0.30	6.05	6.39	6.02	5.70	5.80	5.85	5.84	5.87	5.88	5.58	5.64	5.61	4.86	4.97	4.45
-0.50	5.36	5.61	5.39	5.12	5.10	5.22	5.19	5.21	5.25	5.05	5.04	5.07	4.43	4.51	4.05
-0.60	4.97	5.42	5.00	4.76	4.80	4.84	4.87	4.86	4.89	4.69	4.71	4.69	4.18	4.24	3.83
-0.85	4.01	4.33	4.04	3.88	3.88	3.90	3.90	3.91	3.90	3.78	3.83	3.81	3.49	3.52	3.23
-1.00	3.52	3.77	3.53	3.37	3.42	3.45	3.40	3.39	3.40	3.30	3.35	3.32	3.13	3.12	2.96
-1.25	2.93	3.01	2.94	2.85	2.84	2.84	2.86	2.84	2.87	2.80	2.80	2.79	2.62	2.63	2.60
-1.50	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19

Table 8.9.1 Measurement of Proposed Bridge against Existing Bridge

			Unit	Bucao Bridge	Maloma Bridge	Maculcol Bridge
Proposed Bridge	Bridge Length	①	m	321.000	240.000	430.000
	Finished Grade	②	m	19.968	9	12.9
	Soffit Girder Level	③	m	16.948	7.068	10.968
	Design Flood Level	④	m	13.50	5.42	9.12
	Under Clearance	⑤	m	3.448	1.648	1.848
	Bridge Site			down stream	same as existing bridge	upper stream
Existing Bridge	Bridge Length	⑥	m	300.000	90.000	381.000
	Finished Grade	⑦	m	10.680	6.600	6.200
Measurement of Proposed Bridge against Existing Bridge	Bridge Length	①−⑥	m	21.000	150.000	49.000
	Finished Grade	②−⑦	m	9.288	2.400	6.700

Table 9.3.1 List of Evacuation Center during Calamities (1/3)

(Department of Education, Region III Division of Zambales, Iba)

No.	Municipal/ City	River Basin	Name of School	Location				Conditions			Utilized in (month, year and No. of Evacuees)	Comments (Budget, etc.)
				Barangay	Coodination		Detail	Capacity	Elevation (El. m)	Storing against Emergency (Food, Water, etc. if any, quantities)		
					Longitude	Latitude						
1	Botolan	Bucao	Bancal Elementary School	Bancal	N 15 0 18' 28.0'	E 120 0 00' 08.6'	Along National Hi-way, Brgy. Bancal, Botolan, Zambales	14 Class Rooms 500 Persons	17	W: NO, EL:OK, CR: 4units CR is not enough. No water pump is avaiable. No potable water in School.	1991 All rooms are used from Brgy Nacolcol and Poonbato	To provide potable water CR to increase
2	Botolan	Bucao	Batonlapok Elementary School	Batonlapok	N 15 0 17' 16.8'	E 120 0 01' 58.0'	Along National Hi-way, Botolan, Zambales	10 Class Rooms 300 Persons	24	W:OK, EL:Partial, CR: 8 unit * 4 rooms are not electrified.CR is not enough.	4 times after 1991 July/2002 : 15 fam.from Carael School area is often flooding	To provide electricity To increase CR To elevate school area and to provide drainage.
3	Botolan	Bucao	Beneg Elementary School	Beneg	N 15 0 16' 52.2'	E 120 0 00' 27.7'	Along Rural Road, Brgy. Beneg, Botolan, Zambales	6 Class rooms 180 persons	21	W:NO, EL:OK, CR: 6 unit * Required to repair water sytem	Not used as evacuation center Every year flooded in school area	To elevate school area To provide drainage To repair water system
4	Botolan	Bucao	Binoclutan Elementary School	Binoclutan	N 15 0 14' 13.4'	E 120 0 00' 46.5'	Along Rural Rd.Coastal Area, Brgy. Binoclutan, Botolan, Zambales	6 Class rooms 180 Persons	16	W:NO, EL:OK, CR: 2 unit * CR is not enough	Sep.2001: 100fam. From Carael	High tide occurred in 1985. Every high tide season affects to the area. Not suitable as Evacuation Center.
5	Botolan	Bucao	Botolan North Central Elementary School	Tampo	N 15 0 17' 25.5'	E 120 0 01' 26.0'	Along National Hi-way, Center of Botolan, Zambales	19 Class room 1 big hall 670 Persons	6	W: OK, EL:OK, CR:19units	1991 All rooms are used Jul/2001: 1fam. From brgy.Carael	Building is rahter old. Some renovation will be needed. School area is about 5ha.
6	Botolan	Bucao	Botolan South Central School	Paco	N 15 0 17' 17.6'	E 120 0 01' 22.5'	South Central Brgy. Paco, Botolan, Zambales	16 Class room 1 Big hall 580 persons	13	W:OK, EL:OK, CR: 16 unit	1991 All rooms are used	Building is rahter old. Some renovation will be needed. School area is about 3ha.
7	Botolan	Bucao	New Taugtog Elementary School and High School	New Taugtog	N 15 0 18' 28.0'	E 120 0 02' 42.5'	Purok 3 New Taugtog, Botolan, Zambales	10 rooms in HS 5 rooms in EMS 800 Persons	17	W: OK, EL:OK, CR:7units CR is not enough in HS Class Room for Grade 5&6 is not enough	Newly established in 2000 for Elementary School, and 2001 for High school	More class rooms needed to accommodate students. School are is about 5 ha. Hostpital is located in adjacent.
8	Botolan	Bucao	Panan Elementary School	Panan	N 15 0 12' 59.2'	E 120 0 01' 30.4'	Along National Hi-way, Brgy. Panan, Botolan, Zambales	13 Class romms 390 Persons	23	W:NO, EL:OK, CR: 13 unit	Two times in 1991 All rooms are used. Sep.2001: 1fam.from Carael	Leakage of rainwater from roof are to be repaired School area is about 5 ha.
9	Botolan	Bucao	Ramon Magsaisai Technical University.	Porac	N 15 0 14' 51.4'	E 120 0 01' 08.5'	Along National Hi-way, Brgy. Porac, Botolan, Zambales	23 Class Rooms Several Halls 16 Domitiries More than 1000	52	W:OK, EL:OK, CR: Many	1991 : 2 times 1995 : due to flush flood Aug/2001 : from San Felipe Sep/2001 : Many from Carael	Best places. Enough capacity. Enough food in experimental farms.
10	Botolan	Bucao	San Isidro Elementary School	San Isidro	N 15 0 18' 49.3'	E 120 0 00' 58.5'	Rural Road, Brgy. San Isidro, Botolan, Zambales	6 Cross Room 150 persons	22	W: NO, EL:OK, CR:2units CR is not enough.No water pump is avaiable. No potable water in School.	1991 All rooms are used from Brgy Maguisguis, Poonbato and Villar.	To provide potable water CR and Class Room to increase No flood affected
11	Iba	Bucao	Amungan Elementary School	Amungan	N 15 0 21' 44.7'	E 119 0 57' 31.9'	Along National Hi-way, Brgy. Amungan, Iba, Zambales	30 classrooms 2-3 thousand persons Area: 2000 sq.m.	16	W= NO EL. NO CR= OK	1991 all classroom used Sept. 2001-all CR used	better water system Repair of classroom more toilets
12	Iba	Bucao	Bangan Talinga Elementary School	Bangan Talinga	N 15 0 20' 57.3'	E 119 0 57' 59.8'	Along National Hi-way, Brgy. Bangan Talinga, Iba, Zambales	12 classrooms 180 Families A= almost 2 ha.	17	W=NO EL: OK CR: all with CR	1991-all rooms 2001-all rooms occupied	water for drinking CR to be repaired
13	Iba	Bucao	Dampay Elementary School	Amungan	N 15 0 22' 18.0'	E 119 0 57' 28.7'	Along National Hi-way, Dampay, Brgy. Amungan, Iba, Zambales	9 classrooms 7/8 families/C/R Area: 2 hectares	25	W= OK EL. OK CR= OK	1991-all Classroom occupied 2001-(Sept.)all classroom occupied	repair of all classrooms
14	Iba	Bucao	Dirita- Balugan Elementary School	Dirita-Balugan	N 15 0 19' 56.2'	E 119 0 58' 45.5'	Along National Rd.near Iba Market, Brgy. Dirita, Balugan, Iba, Zambales	14 Classrooms 4-5 Families/c/r Area: 11,924 sq. m	26	W= YES EL: OK CR:6	1991-almost all classrooms are used	repair of classroom
15	Iba	Bucao	Iba Central School	Poblacion	N 15 0 19' 26.7'	E 119 0 58' 56.1'	Along National Road, Brgy. Poblacion, Iba, Zambales	20 classrooms 500 families Area: 20,400 sq.m	24	W= OK EL. NO CR= OK	1991-all Classroom occupied Sept. 2001-all class room	repair of electrical wiring
16	Iba	Bucao	Lawak Elementary School	Amungan	N 15 0 21' 24.2'	E 119 0 57' 43.9'	Along National Hi-way, Brgy. Amungan, Iba, Zambales	14 classrooms 2-3 thousand persons Area: 2000 sq.m.	26	W=OK EL. OK CR= 5	1991-14 classrooms occupied 2001- all classroom	repair of classroom roofing
17	Iba	Bucao	Palanginan Elem. Sch.	Palanginan	N 15 0 19' 07.9'	E 119 0 59' 24.5'	Along National Road, Brgy. Palanginan, Iba, Zambales	100 families 30 classrooms	28	EL.:OK ,W: OK,CR - 12 units only	1991-for less than 1 month 2001-anticipated flooding	needs repair/replacement upgrade water system needs more toilets
18	Cabangan	Maloma	Anonang Elementary School	Anonang	N 15 0 07' 34.7'	E 120 0 03' 25.5'	Brgy. Anonang, Cabangan, Zambales	10 families 6 classrooms	20	W: water system:OK, El. OK CR: not enough (2) units only needs repair	1991: once only 3 rooms were occupied	3 classrooms need repair H.E. Building deteriorated
19	Cabangan	Maloma	Cabangan Central Elementary School	Poblacion	N 15 0 09' 39.2'	E 120 0 03' 17.9'	Along National Hi-way, Cabangan, Zambales	17 ClassRooms 1 multi-purpose building More than 1000	25	W: not enough,El: Ok CR: not enough	1991: once only all rooms, buildings occupied	Water not sufficient some classrooms need repair (termites infected)

Table 9.3.1 List of Evacuation Center during Calamities (2/3)

(Department of Education, Region III Division of Zambales, Iba)

No.	Municipal/ City	River Basin	Name of School	Location				Conditions			Utilized in (month, year and No. of Evacuees)	Comments (Budget, etc.)
				Barangay	Coodination		Detail	Capacity	Elevation (El. m)	Storing against Emergency (Food, Water, etc. if any, quantities)		
					Longitude	Latitude						
20	Cabangan	Maloma	Mt. Cabangaan A Private Lot at the foot of the mountain	S Antonio	N 15 0 09' 46.9'	E 120 0 03' 02.9'	San Antonio & San Isidro Boundaries, Cabangan, Zambales	100 families from San Antonio Temporary Shelter	22	W:none, El: none, CR:temporary	1991 was used for 1 week only Evacuees returned to San Antonio	Temporary shelter is delapidated
21	Cabangan	Maloma	Pavillion Evacuation Center	Sto. Niño	N 15 0 08' 48.4'	E 120 0 03' 10.6'	Along National Hi-way, Brgy. Sto. Niño, Cabangan, Zambales		23		1991	abandoned building was used as temporary shelter for several days only
22	Cabangan	Maloma	San Isidro Plaza Temporary Shelter	Sn. Isidro	N 15 0 09' 57.8'	E 120 0 02' 52.3'	Brgy. San Isidro, Cabangan, Zambales	20 families 200 sq. m.		W:OK, El: None, CR: temporary	1991 used for 1 month only.	Temporary shelter was const. at the plaza since school bldgs. of the brgy. was constructed only in 1994.
23	Cabangan	Maloma	San Juan Elem. Sch.	San Juan	N 15 0 09' 21.6'	E 120 0 03' 38.5'	Brgy. San Juan, Cabangan, Zambales	100 families 15 classrooms 1 adm. Building	20	W: OK, El.:OK, CR: not adequate '3 units only	1991 Flashflood 1994	Flooded during heavy rain Needs more sch. buildings and toilets
24	Cabangan	Maloma	San Juan Plaza Concrete 4 Door Row House	San Juan	N 15 0 09' 21.3'	E 120 0 03' 40.5'	Brgy. San Juan, Cabangan, Zambales	20 families 2 hectares	21	W.:OK, El: OK, CR: 2 units only needs repair	1991 several months after eruption and construction of the building	Evacuees transferred from Mt. Mabiga
25	Cabangan	Maloma	Santa Rita Elementary School	Santa Rita	N 15 0 10' 43.7'	E 120 0 02' 50.1'	Along National Hi-way, Brgy. Sta. Rita, Cabangan, Zambales	20 families 14 rooms 1 Admin. Bldg. A=5,314 sq.m.	49	W: OK , El: OK CR: 3 units only	1991 for 3 weeks just stay overight daytime return to their brgys.	all classrooms need repair needs more toilets
26	Cabangan	Maloma	Tangos Evacuation Center	Tangos Dolores	N 15 0 09' 41.7'	E 120 0 07' 02.7'	Sitio Tangos Dolores, Cabangan, Zambales					
27	San Felipe	St. Tomas	Bantay Carmen	Maloma	N 15 0 05' 56.0'	E 120 0 03' 56.5'	Along National Hi-way, Maloma, San Felipe, Zambales	60 families fr. Maloma, Bunawen Muraza	45	W: Ok, El:Ok, CR: individually built	1991 to present	28 families became permanent settlers houses individually built
28	San Felipe	St. Tomas	San Rafael Elem. Sch.	San Rafael	N 15 0 03' 28.1'	E 120 0 03' 59.7'	Brgy. San Rafael, San Felipe, Zambales	100 persons 3 rms used existing 9 rms. 5,466 sq. m.	39	W: Ok, El:Ok, CR:OK, 1 unit/rm for evacuatuon: CR not available to the 3 rooms	1991 every flash flood almost yearly except this year	3 room building needs basic facilities and repair
29	San Felipe	St. Tomas	Sindol Elem. Sch.	Sindol	N 15 0 04' 36.2'	E 120 0 04' 00.4'	Along National Hi-way, Brgy. Sindol, San Felipe, Zambales	12 families 9 cl rms. 1 adm. Bldg. 3 hectares	47	W: Ok, El: Ok,CR: not adequate	1991 for 3 weeks only	Need repair wide playground needs more toilets
30	San Felipe	St. Tomas	Sitio Sagpat	Maloma	N 15 0 06' 05.1'	E 120 0 05' 56.7'	Sitio Sagpat Maloma, San Felipe, Zambales					
31	San Felipe	St. Tomas	Tektek Resettlement Area	Sindol	N 15 0 05' 45.5'	E 120 0 03' 45.3'	Sitio Tek-Tek, San Felipe, Zambales	47 families	41	W: not adequate E: none CR: 2 units only (public) per house	1995 when declared as an evacuation center house and lots were donated became permanent settlers	needs basic facilities needs livelihood for indigenous people
32	San Marcelino	St. Tomas	Laoag Elem. Sch.	Laoag	N 14 0 58' 32.8'	E 120 0 10' 03.6'			50			
33	San Marcelino	St. Tomas	Linasin Elem. Sch.	Linasin	N 14 0 58' 23.6'	E 120 0 08' 58.7'		4 buildings	37			
34	San Marcelino	St. Tomas	Linusungan Elem. Sch.	Linusungan	N 14 0 57' 05.4'	E 120 0 09' 45.7'		3 Bldgs. 7 Cls. Rooms App 1 hec.	43	existing water supply is not enough Electricity - ok toilet needs repair	1991 used for 2 mos. 50 families	
35	San Marcelino	St. Tomas	San Marcelino Elem. Sch.	Poblacion	N 14 0 58' 42.6'	E 120 0 09' 19.0'	Brgy. Burgos, San Marcelino, Zambales	>100 families A=3 hec. 23 existing clsrms 3 adm. Buildings		W: Ok, El:Ok,CR:Ok	1991 all classrooms were used but vacated after June 15 all bldgs collapsed	Needs repair Termite infested
36	San Marcelino	St. Tomas	Sn Guillermo N. H Sch.	Burgos	N 14 0 58' 23.6'	E 120 0 08' 58.7'		6 buildings	37			
37	San Marcelino	St. Tomas	St. William's Sch.	Central	N 14 0 58' 28.2'	E 120 0 09' 25.8'		3- two storey buildings	42			
38	San Marcelino	St. Tomas	Vega Hill	Consuelo Norte	N 14 0 59' 06.3'	E 120 0 09' 11.7'	Brgy. Consuelo Norte, San Marcelino, Zambales	1,500 families	64	W: Ok nat. spring potable El: none CR: temporary	1991 for almost 1 year tent were put up	Permenent Settlers built houses
39	San Narciso	St. Tomas	Alusiis elem. Sch.	Alusiis	N 15 0 01' 33.1'	E 120 0 04' 39.2'			36			
40	San Narciso	St. Tomas	Beddeng Elem. Sch.	Beddeng	N 14 0 59' 14.4'	E 120 0 05' 00.5'	Along National Hi-way, Brgy. Beddeng, San Narciso, Zambales	50 persons 3 rooms used 12 classrms existin	36	W: not sufficient El: Ok CR: not adequate	1991for several days only heavy ashfall one building was left others collapsed Needs water supply	Reconst. 1993 only Needs repair/ replacement
41	San Narciso	St. Tomas	Consuelo Elem. Sch.	Consuselo	N 14 0 59' 13.9'	E 120 0 08' 24.4'		3 sch buildings 6 classrms	38	electricity - none toilet - ok water - deepwell but defective	1991 for 20 families used for storage	
42	San Narciso	St. Tomas	Doce Martirez El. Sch.	Grullo	N 15 0 00' 48.3'	E 120 0 05' 39.1'		5 buildings	39			
43	San Narciso	St. Tomas	La Paz Elem. Sch.	La Paz	N 15 0 00' 50.5'	E 120 0 04' 06.1'		3 sch buildings 11 classrms.	31			

Table 9.3.1 List of Evacuation Center during Calamities (3/3)

(Department of Education, Region III Division of Zambales, Iba)

No.	Municipal/ City	River Basin	Name of School	Location				Conditions			Utilized in (month, year and No. of Evacuees)	Comments (Budget, etc.)
				Barangay	Coodination		Detail	Capacity	Elevation (El. m)	Storing against Emergency (Food, Water, etc. if any, quantities)		
					Longitude	Latitude						
44	San Narciso	St. Tomas	La Paz High Sch.	La Paz	N 15 0 00' 57.1'	E 120 0 04' 19.3'		4 buildings	35			
45	San Narciso	St. Tomas	Lalek	Sindol	N 15 0 05' 23.1'	E 120 0 04' 19.8'		100 families		W: not sufficient El: none CR: individual	1991 tent were put up, was used for more than 1 year 98 families became perma- nent settlers	Not declared as Evacuation Center
46	San Narciso	St. Tomas	Magsaysay Mem. Col	Libertad	N 15 0 00' 58.7'	E 120 0 04' 47.5'		3 buildings 10 elem. classrms 10 HS classrms.	34	electricity - ok water - ok toilet - ok	not used as an evacuation center	
47	San Narciso	St. Tomas	Namatacan Elem. Sch.	Namatacan	N 15 0 00' 24.0'	E 120 0 08' 03.2'			53			
48	San Narciso	St. Tomas	Phil Merchant Mar. Ac.	Aldea	N 14 0 59' 59.3'	E 120 0 04' 21.8'		15 buildings 20 clsrms. 1 dormitory 1 gymnasium app 1.5 hec.	18	electricity - ok water - ok toilet - ok	not used as an evacuation center	constructed only in 1998
49	San Narciso	St. Tomas	San Jose-Patrocinio Elem. Sch.	Poblacion East	N 15 0 00' 41.9'	E 120 0 04' 55.0'	Brgy. Patrocinio, San Narciso, Zambales	100 to 150 persons 15 class rooms 2 adm. Building Area= 1.4 hec.	44	W:not adequate E: needs to be upgraded CR: not adequate	1991 for 3 days only all buildings collapsed except for one	Almost all buildings need repair concrete fence for demolition
50	San Narciso	St. Tomas	San Juan-Candelaria Elem. Sch.	Candelaria	N 15 0 00' 49.0'	E 120 0 05' 05.6'	Brgy. Candelaria, San Narciso, Zambales	100 to 150 persons 11 class rooms 1 adm. Building	42	W: Ok, El.:Ok CR: not adequate	1991 for 2 weeks only	Buildings recons- tructed 1992 needs repair
51	San Narciso	St. Tomas	San Narciso Central Elementary School	Sn Rafael	N 15 0 01' 03.2'	E 120 0 04' 44.2'	Along National Hi-way, Brgy. San Rafael, San Narciso, Zambales	100 to 150 persons existing 17 cl rms 1 adm. bldg.	48	W: Ok, El: Ok,CR: not adequate/non-functional	1991 for 3 days 1992 flash flood	Need repair frequently flooded
52	San Narciso	St. Tomas	San Rafael-Natividad Elem. Sch.	Sn Rafael	N 15 0 00' 55.1'	E 120 0 04' 28.8'	Brgy. San Rafael, San Narciso, Zambales	10 families Area=1.2 hec.	44	W:Ok, El:Ok, CR: 2 units	1991 for one week only evacuees were transferred to other evacuation center	Classrooms need repair Termite infested Needs more toilets
53	San Narciso	St. Tomas	Simminublan Elem. Sch.	Simminublan	N 14 0 59' 20.5'	E 120 0 07' 06.1'		4 sch. Bldgs 1 adm. 1 H.E./Ind. Arts bldgs. 850 sq. m.	26	electricity - ok water - water system needs repair toilet - ok	1991 10 families used for 1 month 1993 and 1994 during flood	flooded during rainy season
54	San Narciso	St. Tomas	Umaya Elem .Sch.	Umaya	N 15 0 00' 01.3'	E 120 0 09' 38.9'			59			
55	San Narciso	St. Tomas	Zambales Academy	Alusiis	N 15 0 01' 14.1'	E 120 0 04' 41.5'		4 sch. buildgs 1 adm. 16 class rms.	33	electricity - ok water - ok toilet - ok	1991 1 bldg. used for 1 month 30 families	
56	Castillejos		Balaybay Resettlement Elementary School	Balaybay	N 14 0 53' 35.9'	E 120 0 12' 06.4'	Brgy. Balaybay Resettlement Area Castillejos, Zambales	1,600 families 20 classrooms	147	W: if deepwell be repaired water supply will be sufficient El: Ok, CR: Ok	May 1993 when the place was declared as Resettlement Area	Tents were put up within the school area. Sch buildings were const. in 1994 only
57	Castillejos		Ramon Magsayasay Elementary School	Brgy. Pob.	N 14 0 55' 57.2'	E 120 0 12' 02.5'	Along National Hi-way, Poblacion, Castillejos, Zambales	18 families 12 classrooms 2 multi purpose bldg.	64	W: jetmaticpump: not adequate El: Ok, CR: Ok	1991 for almost 1 month 1993 flashflood	Needs more sch.buildings 3 classrooms need repair
58	Castillejos		Santa Maria Elementary School	Sta. Maria	N 14 0 56' 12.2'	E 120 0 11' 52.3'	Along National Hi-way, Brgy. Sta. Maria, Castillejos, Zambales	40 families 28 class rooms 1 adm. Building	63	W:Ok, El.:OK, CR: 10 units only 2 units need repair	1991 once only for 1 month Evacuees from diff barangays near Mt. Pinatubo	Needs more toilets and class rooms
59	Castillejos		Villaflor Elementary School	Sn Roque	N 14 0 55' 44.4'	E 120 0 12' 20.1'	Along National Hi-way, Brgy. San Roque, Castillejos, Zambales	8 families 14 classrooms	61	W: waterpump not adequate El.: Ok, CR: not adequate	1991, was used only once evacuees from Brgy. Nagbunga near the river	all rooms were occupied some classroooms need repair affected by termites
60	Palauig		Tent City or Palauig Evac. Center		N 15 0 24' 39.7'	E 119 0 57' 06.9'		100 houses 76 families Area: 20,400 sq.m	59	W= NO EL. Ok CR= Needs repair	1991-all buildings occupied Sept. 2001-all buildings were occ.	better water system repair of CR
61	Sn Antonio		Angeles elem. Sch.	Angeles	N 14 0 56' 13.7'	E 120 0 08' 50.6'		3 sch. Buildings 12 classrms.	21			
62	Sn Antonio		San Esteban Elem. Sch.	Sn Esteban	N 14 0 56' 52.6'	E 120 0 09' 23.5'		5 sch. Buildings 8 classrms. 1 ind arts bldg 1- H.E. bldg. app. 750 sq. m.	43	electricity - ok water - ok toilet - ok	1992 - 15 families	sch. Buildings need repair
63	Sn Antonio		West Dirita Elem. Sch.	Dirita	N 14 0 57' 40.2'	E 120 0 04' 29.4'		3 sch. buildings 1 adm. Bldg. 12 classrms.	14	electricity - ok water - ok toilet - ok	1991 - 30 families	flooded when Dinumagat River overflows but easily subside

Table 9.3.2 Capacity and Condition of Evacuation Center

Location No.	River Basin	Municipal/ City	Capacity		Storing against Emergency (Food, Water, etc. if any, quantities)	Possibility of Inundation	Condition of Damage	Rate (%)
			Survey Result	Assumption (Person)				
1	Bucao	Botolan	14 Class Rooms 500 Persons	500	W: NO、EL:OK、CR: 4units CR is not enough. No water pump is avaiable. No potable water in School.	No	Midium	25
2	Bucao	Botolan	10 Class Rooms 300 Persons	300	W:OK, EL:Partial, CR: 8 unit * 4 rooms are not electrified.CR is not enough.	Yes	Serious	50
3	Bucao	Botolan	6 Class rooms 180 persons	180	W:NO, EL:OK, CR: 6 unit * Required to repair water sytem	No	Midium	25
5	Bucao	Botolan	19 Class room 1 big hall 670 Persons	670	W: OK、EL:OK、CR:19units	Yes	Serious	50
6	Bucao	Botolan	16 Class room 1 Big hall 580 persons	580	W:OK, EL:OK, CR: 16 unit	No	-	0
7	Bucao	Botolan	10 rooms in HS 5 rooms in EMS 800 Persons	800	W: OK、EL:OK、CR:7units CR is not enough in HS Class Room for Grade 5&6 is not enough	No	Minor	10
10	Bucao	Botolan	6 Cross Room 150 persons	150	W: NO、EL:OK、CR:2units CR is not enough.No water pump is avaiable. No potable water in School.	Yes	Serious	50
17	Bucao	Iba	100 families 30 classrooms	500	EL.:OK ,W: OK,CR - 12 units only	No	Minor	10
18	Maloma	Cabangan	10 families 6 classrooms	50	W: water system:OK, El. OK CR: not enough (2) units only needs repair	No	Minor	10
39	St.Tomas (L)	San Narciso	N.A.	450	N.A	No	Midium	25
43	St.Tomas (L)	San Narciso	3 sch buildings 11 classrms.	220	N.A	Yes	Serious	50
44	St.Tomas (L)	San Narciso	4 buildings	280	N.A	No	Midium	25
46	St.Tomas (L)	San Narciso	3 buildings 10 elem. classrms 10 HS classrms.	200	electricity - ok water - ok toilet - ok	No	-	0
48	St.Tomas (L)	San Narciso	15 buildings 20 clsrms. 1 dormitory 1 gymnasium app 1.5 hec.	400	electricity - ok water - ok toilet - ok	No	-	0
49	St.Tomas (L)	San Narciso	100 to 150 persons 15 class rooms 2 adm. Building Area= 1.4 hec.	125	W:not adequate E: needs to be upgraded CR: not adequate	No	Midium	25
50	St.Tomas (L)	San Narciso	100 to 150 persons 11 class rooms 1 adm. Building	150	W: Ok, El.:Ok CR: not adequate	No	Minor	10
51	St.Tomas (L)	San Narciso	100 to 150 persons existing 17 cl rms 1 adm. bldg.	150	W: Ok, El: Ok,CR: not adequate/non-functional	No	Minor	10
52	St.Tomas (L)	San Narciso	10 families Area=1.2 hec.	50	W:Ok, El:Ok, CR: 2 units	No	Minor	10
55	St.Tomas (L)	San Narciso	4 sch. buildgs 1 adm. 16 class rms.	320	electricity - ok water - ok toilet - ok	No	-	0
40	St.Tomas (L)	San Narciso	50 persons 3 rooms used 12 classrms existin	50	W: not sufficient El: Ok CR: not adequate	Yes	Serious	50
42	St.Tomas (L)	San Narciso	5 buildings	350	N.A	No	Midium	25
47	St.Tomas (L)	San Narciso	N.A.	450	N.A	No	Midium	25
53	St.Tomas (L)	San Narciso	4 sch. Bldgs 1 adm. 1 H.E./Ind. Arts bldgs. 850 sq. m.	280	electricity - ok water - water system needs repair toilet - ok	No	Minor	10
54	St.Tomas (L)	San Narciso	N.A.	450	N.A	No	Midium	25
32	St.Tomas (L)	San Marcelino	N.A.	450	N.A	Yes	Serious	50
33	St.Tomas (L)	San Marcelino	4 buildings	280	N.A	Yes	Serious	50
34	St.Tomas (L)	San Marcelino	3 Bldgs. 7 Cls. Rooms App 1 hec.	140	existing water supply is not enough Electricity - ok toilet needs repair	No	Midium	25
35	St.Tomas (L)	San Marcelino	>100 families A=3 hec. 23 existing clsrms 3 adm. Buildings	500	W: Ok, El:Ok,CR:Ok	Yes	Serious	50
36	St.Tomas (L)	San Marcelino	6 buildings	420	N.A	Yes	Serious	50
38	St.Tomas (L)	San Marcelino	1,500 families	7,500	W: Ok nat. spring potable El: none CR: temporary	Yes	Serious	50
41	St.Tomas (L)	San Narciso	3 sch buildings 6 classrms	120	electricity - none toilet - ok water - deepwell but defective	Yes	Serious	50
60	St.Tomas (L)	Palauig	100 houses 76 families Area: 20,400 sq.m	380	W= NO EL. Ok CR= Needs repair	No	Midium	25
61	St.Tomas (L)	Sn Antonio	3 sch. Buildings 12 classrms.	240	N.A	Yes	Serious	50
62	St.Tomas (L)	Sn Antonio	5 sch. Buildings 8 classrms. 1 ind arts bldg 1- H.E. bldg. app. 750 sq. m.	160	electricity - ok water - ok toilet - ok	Yes	Serious	50
28	St.Tomas (R)	San Felipe	100 persons 3 rms used existing 9 rms. 5,466 sq. m.	100	W: Ok, El:Ok, CR:OK, 1 unit/rm for evacuatuon: CR not available to the 3 rooms	No	Midium	25
29	St. Tomas (R)	San Felipe	12 families 9 cl rms. 1 adm. Bldg. 3 hectares	60	W: Ok, El: Ok,CR: not adequate	No	Midium	25

Table 9.3.3 Estimation Process of Number of Evacuees and Inundation Area

Area	Municipality	Barangay	Barangay Basic Data			(3) Inundation Area (km2)	(4) Rate (4)=(1)/(3)	(5) Evacuee (5)=(4)*(2)
			(1) Area (km^2)	(2) Population	Density (Pop/km^2)			
Bucao River Basin	Botolan	Bancal	1.21	910	752	0.02	0.02	17
		Bangan	1.70	1,586	934	0.73	0.43	685
		Batonlapoc	2.38	1,170	491	1.84	0.77	904
		Beneg	0.87	1,414	1,630	0.54	0.62	874
		Capayawan	0.70	820	1,173	0.69	0.98	804
		Carael	5.60	1,723	308	2.95	0.53	906
		Danacbunga	3.87	2,306	595	0.98	0.25	581
		Malomboy	31.09	3,598	116	2.60	0.08	301
		Paco	0.74	2,298	3,124	0.47	0.64	1,469
		Parel	1.27	816	643	0.44	0.34	280
		Paudpod	3.97	558	141	1.33	0.34	187
		San Juan	46.60	2,530	54	0.46	0.01	25
		San Miguel	1.10	997	905	0.83	0.75	748
		Santiago	3.08	1,666	541	0.24	0.08	129
		Tampo	1.28	1,173	918	0.17	0.13	154
	Iba	Palanginan	12.81	4,651	363	0.15	0.01	54
	Bucao Area Total		118.27	28,216	-	14.42	0.12	8,118
Maloma River Basin	Cabangan	Anonang	2.32	747	323	0.45	0.19	144
		Casabaan	0.28	635	2,276	0.00	0.00	0
		Laoag	1.66	891	537	0.99	0.59	200
		Tondo	0.53	1,022	1,922	0.14	0.26	50
	San Felipe	Maloma	23.45	3,977	170	4.21	0.18	714
	Maloma Area Total		28.24	7,272	-	5.78	0.20	1,108
Sto. Tomas River Basin	San Marcelino	La Paz	1.06	1,019	964	1.03	0.97	990
	San Narciso	Grullo	4.92	1,609	327	0.50	0.10	162
	San Narciso	Natividad	2.10	1,375	654	1.17	0.56	764
	San Narciso	Patro cinio	2.44	2,114	866	1.01	0.42	878
	San Narciso	San Juan	1.40	1,237	882	0.52	0.37	458
	San Narciso	San Rafael	0.63	1,387	2,213	0.00	0.00	5
	San Narciso	Beddeng	10.69	2,477	232	6.78	0.63	1,572
	San Narciso	Dallipawen	3.28	733	224	1.95	0.60	437
	San Narciso	Namatacan	5.53	1,448	262	0.70	0.13	184
	San Narciso	Simminublan	7.81	1,412	181	6.25	0.80	1,130
	San Marcelino	Burgos	2.01	1,903	945	0.76	0.38	717
	San Marcelino	Central(pob.)	0.23	681	2,950	0.17	0.73	497
	San Marcelino	Consuelo Norte	2.10	1,292	615	1.12	0.53	690
	San Marcelino	Consuelo Sur	0.60	1,247	2,067	0.36	0.60	750
	San Marcelino	Laoag	3.24	1,820	561	0.93	0.29	523
	San Marcelino	Linasin	1.92	2,011	1,047	0.70	0.36	730
	San Marcelino	Linusungan	3.69	1,247	338	3.10	0.84	1,047
	San Marcelino	Lucero	1.27	1,387	1,095	0.81	0.64	887
	San Marcelino	Rizal	1.83	807	441	1.75	0.95	771
	San Marcelino	San Guillermo	1.92	786	410	1.89	0.99	777
	San Marcelino	San Isidro	2.63	1,416	538	2.34	0.89	1,259
	San Marcelino	Sta.Fe	50.74	1,969	39	0.71	0.01	27
	San Narciso	La Paz	3.60	3,764	1,047	1.65	0.46	1,729
	Castellejos	Buenayista	3.76	615	163	0.74	0.20	121
	Castellejos	Nagbayan	7.65	1,689	221	0.35	0.05	77
	San Marcelino	Nagbunga	4.32	1,036	240	0.50	0.12	120
	San Marcelino	Rabanes	5.79	707	122	1.81	0.31	221
	-	San Antonio	-	-	-	18.24	-	4,232
	San Felipe	Amagna	2.20	1,285	584	0.62	0.28	365
	San Felipe	Apostol	8.68	1,594	184	4.73	0.54	250
	San Felipe	Balincaguing	1.89	720	381	1.15	0.61	440
	San Felipe	Faranal	3.14	1,690	537	0.36	0.11	192
	San Felipe	Feria	4.33	1,126	260	0.74	0.17	192
	San Felipe	Maloma (Aeta)	57.34	0	0	0.86	0.01	0
	San Felipe	Manglicmot	8.14	1,219	150	0.97	0.12	145
	San Felipe	Rosete	4.64	1,173	253	0.40	0.09	102
	San Felipe	San Rafael	1.66	935	563	0.50	0.30	281
	San Felipe	Sindol	7.81	1,507	193	0.00	0.00	0
	San Felipe	Sto.Nino	1.36	3,641	2,674	0.52	0.38	400
	San Narciso	Omaya	16.72	757	45	1.26	0.08	57
	San Narciso	Paite	4.59	367	80	1.13	0.25	90
	Sto. Tomas Area Total		259.69	55,202	-	71.09	0.27	29,151
Total			406	90,690	-	91.29	0	38,377

Table 10.3.1 Results of Household Interview

No.	Item	Botolan	Cabangan	Castillejos	Iba	San Antonio	San Felipe	San Marcelino	San Narciso
1	Total Population	46,602	18,848	33,108	34,678	28,248	17,702	25,440	23,522
2	Nos of HH in Municipality	9,629	4,032	7,238	7,260	6,483	4,094	5,866	5,319
3	Average nos of persons in HH	4.84	4.67	4.57	4.78	4.36	4.32	4.34	4.42
4	Sample No. of HH	40	40	34	30	40	40	40	40
5	Sampled Barangay	Nacolcol Porac Carael Poonbato Maguiguis Paudpod San Juan Malomboy	Sto Nino San Rafael Nue San Juan San Isidro Del Carmen Apo-apo Cadmang Arew	Buenavista Nagbunga Del Pilar Nagbayan Balaybay Looc San Pablo	Dirita Lipay-dingin Amungan Sta.barbara San Agustin Palanginan	San Nicolas San Gregorio Santiago San Miguel San Juan East Dirita West Dirita Antipolo	Rosete Feria Apostol Manglicmot Amagna Maloma Sto Nino San Rafael	Buhawen Laoag San Rafael Lucero Rabanes Sta.Fe Nagbunga Aglao	Grullo Alusiis La Paz San Rafael Dallipawen Namatacan Libertad San Pascual
6	Housing Condition								
	1) Type-1 Steel & Concrete	27	4	18	12	31	21	18	11
	2) Type-2 Bricks, stone & steel	2	3	3	0	3	0	0	8
	3) Type 3 Wood & asbestos	0	0	0	0	1	1	0	7
	4) Type 4 Cogon, nipa and bamboo	9	5	6	4	3	4	11	10
	5) Others Wood/concrete	2	28	2	14	2	10	11	3
	6) No Response	0	0	0	0	0	4	0	1
		40	40	29	30	40	40	40	40
7	Actual Monthly Income								
	1) 0-3,000 Pesos	31	30	18	19	20	27	27	6
	2) 3,000 - 6,000 Pesos	3	9	6	7	10	7	10	22
	3) 6,000 - 10,000 Pesos	3	1	9	1	3	1	1	9
	4) 10,000 Pesos above	2	0	0	3	3	1	2	3
	5) No Response	0	0	1	0	4	4	0	0
		39	40	34	30	40	40	40	40
8	Needed Monthly Income								
	1) 1,000 - 5,000 Pesos	16	13	2	13	10	14	8	3
	2) 5,000-10,000 Pesos	22	20	15	8	20	18	22	28
	3) 10,000 Pesos above	2	7	15	9	6	6	9	9
	4) No Repsonse	0	0	2	0	4	2	1	0
		40	40	34	30	40	40	40	40
9	Source of Income	Small business Farming Fishing Hired Labor Vending	Farming Vending Small business Livestock raising Honorarium	Honorarium Farming Hired Labor Pension Vending	Honorarium Hired Labor Pension Fishing Farming	Student Housewife Farming Vending Small business	Hired Labor Farming Small business Pension Fishing	Honorarium Hired Labor Vending Farming Livestock	Farming Vending Small business Livestock Honorarium
10	Total damage amount per HH after Eruption								
	1) 50,000 pesos below	47.5%	40.0%	52.9%	76.7%	25.0%	60.0%	55.0%	35.0%
	2) 50,000 - 100,000 Pesos	22.5%	5.0%	14.7%	6.7%	5.0%	7.5%	12.5%	22.5%
	3) 100,000 Pesos above	17.5%	0.0%	14.7%	6.7%	2.5%	12.5%	20.0%	42.5%
	4) No Response	12.5%	55.0%	17.6%	10.0%	67.5%	20.0%	12.5%	0.0%
11	Investment for Rehabilitation including self financing								
	1) 50,000 Pesos below	77.5%	90.0%	2.9%	76.7%	2.5%	40.0%	70.0%	62.5%
	2) 50,000 Pesos above	17.5%	2.5%	0.0%	3.3%	0.0%	2.5%	7.5%	35.0%
	3) No response	5.0%	7.5%	97.1%	20.0%	97.5%	57.5%	22.5%	2.5%
12	Major Changes in living conditions before /after Eruption								
	1) Relocation	17.5%	2.5%	2.9%	90.0%	30.0%	0.0%	20.0%	2.5%
	2) No accece to Bus Terminal	70.0%	95.0%	50.0%	76.7%	95.0%	77.5%	85.0%	40.0%
	3) No access to School	15.0%	5.0%	97.1%	23.3%	37.5%	15.0%	22.5%	7.5%
	4) More available PUVs	92.5%	75.0%	100.0%	36.7%	92.5%	87.5%	75.0%	97.5%
13	Current Condition of Evacuation Activities								
	1) Necessity of Evacuation System	100.0%	97.5%	100.0%	93.3%	90.0%	97.5%	92.5%	85.0%
	2) Presence of Organization for Evacuation	90.0%	82.5%	67.6%	26.7%	57.5%	40.0%	55.0%	100.0%
	3) Experiences in training	55.0%	62.5%	44.1%	20.0%	52.5%	27.5%	42.5%	92.5%
	4) Availability of places to evacuate	32.5% WLAC (Bucao) Taugtog RC Baquilan RC Mountains New Taugtog RC	62.5% Pavilion Evacuation Day-care center w/in barangay Mt.Mabiga New San Juan	32.4% Balaybay RC Manila Mountains	56.7% Libis school Tent city Palauig Evacuation Relatives	35.0%	35.0% Amagna Bantay Carmen School Tektek RC	32.5% San Narciso school plaza mountain "lanipan"	35.0% Lalek Sindol Manila Pangasinan Laguna
14	Priority issues to improve the living condition in the Community	①Livelihoon ②Drainage network ③Road network ④Irrigation network ⑤House renovation	①Dike constructuin ②Creek & river desilting ③Elevating road ④Livelihood ⑤Good leadership	①Widening / Ripraping River ②Livelihood ③Drainage ④Road Improvement ⑤Garbage Collection	①Livelihood ②Drainage ③School ④Water system ⑤Health Center	①Drainage ②Livelihood ③Irrigation ④Road ⑤riprap riverbank	①Drainage ②Livelihood ③Road improvement ④Health center ⑤House renovation	①Electricity ②Infrastructure ③Scholarship ④Livelihood ⑤Food	①Livelihood ②Irrigation ③Drainage ④Lending projects ⑤Scholarship
15	Priority Measures for Community Improvement	①Flood control ②River widening ③River dredging ④Dike improvement ⑤Road network	①Flood control ②Dike strenthen ③By-pass channel ④Water spillway ⑤Catch basin for river	①River dredging ②Ripapping ③By-pass channel ④River rehabilitation	①River widening ②Government aid ③Boat for emergency ④Drainage ⑤Elevate Road	①Drainage ②Irrigation ③Tree planting ④Resettlement center ⑤River dredging	①Drainage ②Livelihood ③Road improvement ④Health center ⑤House renovation	①Water channel ②Reforest watershed ③Road improvement ④Drainage ⑤River dredging	①Drainage ②Public consultation ③Clean & clear dikes, canal ④Locate areas greatly affected ⑤Cooperation
16	Priority measures for HH improvement	①Livelihood ②Coordination network ③Early warnings ④Elevate settlement ⑤Relocation	①Evacuation center ②Health Center ③Drainage	①Riprapping ②Maintain cleanliness ③Relocation ④River rehabilitation	①Warning system ②Seminars ③Relocate fishponds ④Relocate people ⑤Livelihood	①Backyard cleaning ②Sandbagging & filling ③Clean canals & road ④Livelihood ⑤Skill training	①Relocation ②Livelihood ③Housing ④Capital (money) ⑤Early warning	①Scholarship ②Drainage ③Resettlement ④Livelihood ⑤Communication	①Public awaredness ②Cooperation with Projects ③Public consultation ④Ensure safety & security
17	Willingness to relocate to the safer places	100.0%	100.0%	94.1%	93.3%	80.0%	95.0%	100.0%	100.0%
18	Desired destination of relocation	45.0% WLAC (Bucao) Taugtog RC New Taugtog RC Baquilan RC Original Barangay	45.0% Sindol Manila Pangasinan Lguna Olongapo	67.6% Subic Castillejos Balaybay Looc Lucena	16.7% within Barangay with relatives	22.5% Barangay hall Mountain School Church Manila	15.0% Amagna Cabaruan RC Lalek RC Bantay Carmen Tektek	27.5% San Narciso Plaza School Buhawen Vega hill	17.5% Sindol Manila Pangasinan Laguna Olongapo

Table 10.4.1 Priority Development / Improvement Needs for Resettlement Centers

No.	Resettlement Center	Owner	Location	Priority of development / improvement needs
1	Baquilan	MPC	Botolan	1) Lack of livelihood development program 2) Insufficient of food and drinking water 3) Lack of sewage facilities 4) Improvement of Clinic facilites 5) Provision of education goods / improvement of education programs 6) Transfer ownership of residential lot from Government to residents 7) Improvement of community road within the Resettlement Center 8) Improvement of garbage system
2	Taugtog	MPC	Botolan	1) Lack of livelihood development Program 2) Improvement of garbage system 3) Maintenance of public peace 4) Improvement of water supply system 5) Establishment of Clinic 6) Provision of education googs and scholarship programs 7) Improvement of drainage system within the resettlement center 8) Provision of communication system
3	Loob-Bunga	MPC	Botolan	1) Urgent implementation of livelihood development programs 2) Projects for improvement of BHN 3) Improvement of public health 4) Maintenance of Public Peace 5) Provision of education goods 6) Construction / improvement of community road 7) Construction of irrigation facilities
4	Balaybay	MPC	Castillejos	1) Livelihood development programs uner Government Initiative 2) Drinking water supply project 3) Improvement of medical facilites 4) Establishment of Public Market 5) Provision of communication system
5	Bantay Carmen	NGO	San Felipe	1) Construction of elementary school 2) Pavement of community road 3) Provision of electricity supply 4) Livelihood development programs 5) Contruction of clinic or medical facilities 6) House renovation 7) Improvement of water supply system 8) Transfer of land ownership from NGO to residents
6	Tektek	NGO	San Felipe	1) Construction of Elementary School 2) Pavement of community road 3) Electicity supply 4) Livelihood programs 5) Construction of public toilet 6) Construction of clinic / health center
7	Lalek	NGO	San Felipe	1) Improvement of water supply system 2) Construction of Elementary School 3) Pavement of community road 4) Electricity supply 5) Livelihood programs

Source: Direct Hearing Survey conducted by the JICA Study Team , 2002

Table 10.5.1 List of CBFM Projects in the Study Area

NAME OF PO	TYPE	LOCATION	NAME OF CHAIRMAN	AREA AWARDED (HA.)	DATE ISSUED	CBFMA #
01. Cabaruan Multi-Purpose Coop.	CBFMA	Cabaruan, Feria, San Felipe, Zambales	Charito Sebastian	335.0	January 27, 1999	30202015
02. Anak Maralita ng Pinatubo Uunlad ng Nagkakaisa, Inc.	CBFMA	Nilumbangan, Botolan, Zambales	Franklin Dequina	1,020.58	October 28, 1999	30202024
03. Sento sa Pamamahala ng Pamayanang Mambikap, Inc.	CSD to CBFMA	Mambog, Botolan, Zambales	Arturo Pacheco	289.0	January 27, 1999	30202017
04 Samahang Katutubo ng Palis Tungo sa Pag-unlad	CBFMA	Loob-bunga Ressetlement, Botolan Zambales	Warlito Cruzado	426.836	December 28, 1999	30202034
05. Balincaguing Upland Farmers Assn.	CSC to CBFMA	Balincaguing, San Felipe, Zambales	Igmedio de Dios	205.0	January 9, 1999	30202029
06. Mt. Mabanghil Hillside Developers Assn.	CSC to CBFMA	Owaog, Nibloc, Botolan, Zambales	Wilson Fronda	127.791	September 29, 2000	30202050
07. Bucao Tribal Council	CBFMA	Bucao, Botolan, Zambales	Rosita Cabalic	97.26	December 12, 1999	30202064
08. LALEC Upland Farmers Assn.	CSC to CBFMA	Sindol, San Felipe, Zambales	Reynaldo Pulido	200.644	Deember 1, 2000	30202066
09. Aglao Upland Farmers Assn.	CBFMA	Batiawan, Alpay, San Isidro, Subic Castillejos, San Marcelino, Zambales	Josephine Olda	4,998.85	February 27, 2000	30202045
10. Mt. Dutdut Upland Farmers Assn. Inc.	CBFMA	Aglao, San Marcelino, Zambales	Crisanta Cuevas	4,595.46	February 18, 2000	30202044
11. Malomboy-Biangue Upland Farmers Association	CSC to CBFMA	Malomboy-Biangue, Botolan, Zambales	Jose Manalan	517.83	December 31, 2001	30202088
12. Pagkakaisa ng Aeta ng Pinatubo	CBFMA	Bucao, Porac, Botolan, Zambales	Chito Balintag	54.24	December 2002	30202094
13 Anonang Upland Farmers Association inc. (AUFAI)	CBFMA	So. Dusoc and Dalig, Anonang, Cabangan, zambales	Mario Reyes	113.3		
14 Cabangan Kabataan Forest Developers Assocaiton	CBFMA	So. Apalit, longos, Cabangan, Zambales	Feliciano Catolico Jr.	73.745		
15 Bucao Tribal Council	CBFMA	So. Pamalasan, Porac, Botolan, Zambales	Rosita Cabalic	97.06		
16 Anak Maralita ng Pinatubo Uunlad na Nagkakaisa	CBFMA	So. Nilumbagan, Malomboy, Botolan, Zambales	Frank Dequina	1026.53		
17 Sentro sa Pamamahala ng Pamayanang Mambikap, Inc. (SPPMI)	CBFMA	So. Mamala, Mambog, Botolan, Zambales	Arturo Pacheco	289.0		
18. Zambales Cooperative Federation (ZACOFED)	CBFMA	So. Nabuje and Nibloc, Owaog, Botolan, Zambales	Gregorio Bolasco	164.0		
19. San Roque Community Management Center, Inc.	CBFMA	So. Baculi and Reserva, Cadmang, Cabangan, Zambales	Alberto Diago	222.5		
20. Samahang Katutubo ng Paliz Tungo sa Pag-unlad	CBFMA	So. Bihawo, Loob-bunga, Mambog, San Juan, Botolan, Zambales	Ferdinand Luzano	426.836		
21. Binuclotan Fisherfolk Association	CCFS	So. Pamalasan, Binoclutan Botolan, Zambales	Leonardo M. Valensula	20.80		
22. Lubos na Alyans ng katutubong Ayta ng San Lakas (LAKAS)	CCFS	So. Bihawo, Mambog,Botolan, Zambales	Carlito Domulot	48.00		
23. New San Juan Upland Farmers Association	CSC	So. Kasoy, New San Juan, Cabangan Zambales	Dionisio Areniego	38.00		
24. Longos Upland Farmers Assn.	CSC	So. Apnit, Longos, Cabangan, Zambales	Feliciano Catolico Sr.	87.36		
25. Cadmang Upland Farmers Assn.	CSC	So. Reserva, Cadmang Cabangan, Zambales	Santiago Manalan	120.0		
26 San Rafael Upland Farmers Association	CSC	San Rafael, Cadmang Cabangan, Zambales	Julito Castillo	93.23		
27. Mabanglit Upland Farmers Association	CSC	So. Maligaya, Mabanglit Cabangan, Zambales	Salvador Buratao	356.27		
28 Kagamutan Upland Farmers Assn.	CSC	So. Kagamutan, Panan, Botolan, Zambales	Santiago Mayo	57.60		
			Total Area	**16,380.69**		

Source: DENR

Table 10.5.2 Monitoring and Evaluation of CBFM Projects in the Study Area (Based from the PENRO Reports)

Name of PO	Tenurial Instrument	Areas Development and Management				Socio-economic Advancement		Remarks
		Area Planted/ Developed Maintenance	Species Planted	Forest Area	Existing Forest Product	Livelihood	Livelihood Training	
Cabaruan, Mulit-Purpose Cooperative	CBFMA	130.0	EU,A,AC	15.0	-	-	-	PO is active
Bukluran ng Ugnayan para sa Kalikasan at Likas Yaman	CBFMA	20	M,B	100	Dipterocarp Spp.	Upland Farming Mango Plantation	-	
Mabanglit Upland Farmers Association	CSC	200	M,C,J,D	-	-	Cogon Gathering	-	needs other source of income
Samahan ng tribong Dangla	CCFS	10	B,C, M	-	-	-	-	No sustainability of project
samahan ng Maliliit na Mag-sasaka	CCFS	5	AG,A,C	-	-	-	-	Program Lapsed
sa Mataas na Lupa			J,M					
Loob-bunga Tree Farmers Association	CCFS	-	-	-	-	-	-	Loose and no contuity
Binoclutan Small Fisherfolks Inc.	CCFS	-	-	-	-	-	-	No developmental activities
Loob-bunga Youth Development	CCFS	-	-	-	-	-	-	Discontinued development
Cooperative								
Lubos na Alyansa ng Katutubong Ayta	CCFS	48	AG,A,M	10	-	-	Value formation	Project still needed
			C,G,EU				Organization building	for sustainance
Bucao Tribal Council	CBFMA	29	MH,M,C,BN	2	LUAN, PALUSAPIS	-	-	PO is active
Longos Upland Farmers Association	CSC	87.6	AG,EU,M,C	7	NONE	-	Agro-forestry	PO is active
Anonang Upland Farmers Assn.	CSC	59	AG,N,EU,MN	-	-	-	-	PO is active
Bagong Buhay Upland Farmers Assn.	CSC	7	EU,MN,C	32	LUAN, SAKAT	-	-	PO is active
Binoclutan Fiherfolks Association	CSC	7	J,M,MH,G	-	-	-	-	Needs financial Assistance
San Roque Community Management	CBFMA	150	MH,MN,AG	-	-	goat raising	Sasso	PO is active
Center Inc.			EU,N					
Samahang Katutubo ng Palis	CBFMA	200	MH,M,C,	-	-	-	-	PO is active
			BN,COCO					
Cabangan Kabataan Forest Development		25	AG,MN,EU	-	-	-	-	PO is active

* EU-Eucalyptus
A-Acheute
AC-Acacia
J- jackfruit
D-Durian
G- Gemelina
M- Mango
B-Bamboo
C-Cashew
BN- Banana
AG- Agoho
MH- Mahogany
N- Narra
MN-Mangium

Table 11.1.1 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
Marine Ecology	☑	☑	Field survey and mapping
AIR			
Climate		☑	PAGASA, NWRB
Air Quality		☑	Data from monitoring of NPC Masinloc Power Plant
Noise		☑	Data from monitoring of NPC Masinloc Power Plant
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 11.3.1 Summary of Environmental Impacts

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

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

Table 11.4.1 Summary Matrix of the Environmental Management Plan (1/3)

Project Activities (Construction and Operation)	Impact Description per parameter (Physical, Biological, Visual)	Mitigation (if negative)/ Enhancement (if positive)	Cost of Mitigation or Enhancement	Institutional Plan	Schedule	Guarantees (MOAs, etc.) Contracts
Construction Phase						
Removal of vegetation/earth clearing	Generation of fugitive dust (TSP)	Dust suppression (i.e. sprinkling); Dust masks for workers (if necessary)	Included with the project cost	Contractors/ Environmental Officer	Daily, during construction	Contract/TOR with subcontractors
	Increase in noise levels	Buffering/Screening of site; Restrict activities to daytime; Noise suppression systems for equipment (if necessary)	Included with the project cost	Contractors/ Environmental Officer	During construction	Contract/TOR with subcontractors
	Generation of waste/debris from removal of vegetation	Burying of removed vegetation in the composting area	Included with the project cost	Contractors/ Environmental Officer	During construction	Contract/TOR with subcontractors
	Destruction of wildlife habitat	Reduce disturbance and loss; Replacement in other areas on project site.	Included with the project cost	Contractors/ Environmental Officer	During construction	Contract/TOR with subcontractors
	Disruption of growth of wildlife population	Reduce disturbance and loss	Included with the project cost	Contractors/ Environmental Officer	During construction	Contract/TOR with subcontractors
Construction of workers' barracks/field office	Generation of solid waste	Daily garbage collection; Disposal only in approved areas.	Included with the project cost	Contractors/ Environmental Officer	Daily, during construction	Contract/TOR with subcontractors
	Generation of sewage	Provide temporary septic tanks; Periodic cleaning of septic tanks.	Included with the project cost	Contractors/ Environmental Officer	Weekly, during construction	Contract/TOR with subcontractors

Table 11.4.1 Summary Matrix of the Environmental Management Plan (2/3)

Project Activities (Construction and Operation)	Impact Description per parameter (Physical, Biological, Visual)	Mitigation (if negative)/ Enhancement (if positive)	Cost of Mitigation or Enhancement	Institutional Plan	Schedule	Guarantees (MOAs, etc.) Contracts
	Influx of outside lbor and their household	Hire local labor	Included with the project cost	Contractors/ Environmental Officer	During pre-constructio n	Contract/TOR with subcontractors
	Slope stability	Use of slope protection works	Included with the project cost	Contractors/ Environmental Officer	During construction	
	Increase in noise levels	Buffering/Screening of site; Restrict activities to daytime; Noise suppression systems for equipment (if necessary)	Included with the project cost	Contractors/ Environmental Officer	During construction	Contract/TOR with subcontractors
	Increase in noise levels	Buffering/Screening of site; Restrict activities to daytime; Noise suppression systems for equipment (if necessary)	Included with the project cost	Contractors/ Environmental Officer	During construction	Contract/TOR with subcontractors
	Slope stability	Use of slope protection works	Included with the project cost	Contractors/ Environmental Officer	During construction	Contract/TOR with subcontractors
	Groundwater	Water quality monitoring	Included with the project cost	Contractors/ Environmental Officer	Weekly, during construction	Contract/TOR with subcontractors
Transportation of construction materials	Emissions from transportation	Emission testing for trucks/vessels Proper maintenance of vehicles	Included with the project cost	Contractors/ Environmental Officer	Weekly, during construction	Contract/TOR with subcontractors
	Increase in traffic congestion	Schedule trips to non-peak hours to minimize congestion	Included with the project cost	Contractors/ Environmental Officer	During construction	Contract/TOR with subcontractors

Table 11.4.1 Summary Matrix of the Environmental Management Plan (3/3)

Project Activities (Construction and Operation)	Impact Description per parameter (Physical, Biological, Visual)	Mitigation (if negative)/ Enhancement (if positive)	Cost of Mitigation or Enhancement	Institutional Plan	Schedule	Guarantees (MOAs, etc.) Contracts
Construction of sabo and, flood control facilities and other horizontal structures	Generation of solid wastes	Disposal only in approved areas	Included with the project cost	Contractors/ Environmental Officer		Contract/TOR with subcontractors
	Generation of fugitive dust/TSP	Dust suppression (i.e. sprinkling); Dust masks for workers (if necessary)	Included with the project cost	Contractors/ Environmental Officer	Daily, during construction	Contract/TOR with subcontractors
	Increase in noise levels	Buffering/Screening of site; Restrict activities to daytime; Noise suppression systems for equipment (if necessary)	Included with the project cost	Contractors/ Environmental Officer	During construction	Contract/TOR with subcontractors
	Generation of solid waste	Disposal in approved areas	Included with the project cost	Contractors/ Environmental Officer	During construction	Contract/TOR with subcontractors
	Generation of fugitive dust	Dust suppression	Included with the project cost	Contractors/ Environmental Officer	Daily, during construction	Contract/TOR with subcontractors
Landscaping and replanting (if any)	Aesthetic improvement		Included with the project cost	Contractors/ Environmental Officer	During construction	Contract/TOR with subcontractors

Table 11.4.2 Summary Matrix of the Environmental Monitoring Plan

Impacts	Parameter	Location	Frequency	Responsibility	Cost
Generation of fugitive dust	TSP	Construction sites	During construction	Environmental Officer	Ph.P 50,000/mo
Noise Pollution	Noise level	Construction sites	Daily during construction	Environmental Officer	Ph.P 1,000/day
Siltation/Sedimentation/ Erosion	TSS, turbidity	Rivers	Weekly, during construction	Environmental Officer	Included in project cost
Vegetation loss	Area of coverage of vegetated areas	Areas stripped of vegetation	During construction	Environmental Officer	Included in project cost

Table 12.1.1 Assessed Values of New Constructed Buildings and Taxable Improvements

Municipality	Total Assessed Value (P'000)				Number of buildings				TAV/building (P'000)			
	7-12/00 (1)	1-6/01 (2)	7-12/01 (3)	1-6/02 (4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Botolan	664.7	350.8	556.2	433.7	4	12	9	6	**166.2**	**29.2**	**61.8**	**72.3**
Cabangan	246.0	4,013.5	465.8	490.4	6	7	3	7	**41.0**	**573.4**	**155.3**	**70.1**
Castillejos	1,852.3	1,267.6	2,442.7	799.8	14	9	16	14	**132.3**	**140.8**	**152.7**	**57.1**
Iba	2,283.9	323.2	3,754.5	4,459.0	20	4	40	32	**114.2**	**80.8**	**93.9**	**202.7**
San Antonio	1,431.7	602.0	1,147.1	1,319.2	19	12	16	12	**75.4**	**50.2**	**71.7**	**109.9**
San Felipe	3,174.3	1,419.1	1,797.7	1,895.3	11	13	10	12	**288.6**	**109.2**	**179.8**	**157.9**
San Marcelino	54.8	184.7	1,120.2	1,447.4	3	3	9	5	**18.3**	**61.6**	**124.5**	**289.5**
San Narciso	1,384.1	1,006.7	749.3	1,798.4	18	8	6	5	**76.9**	**125.8**	**124.9**	**359.7**
TOTALS	**11,091.6**	**9,167.6**	**12,033.4**	**12,643.2**	**160**	**68**	**109**	**93**	**116.8**	**134.8**	**110.4**	**135.9**

Source: Zambales Provincial Assessor's Office, Iba

Table 12.1.2 Schedule of Unit Values for Buildings: 1999

(Pesos per square meter)

TYPE	(1) One family Dwelling	(2) Two-family Dwelling (3) Multiple Dwelling	(4) Accessories or Row house	(5) Apartment (6) Boarding House (7) Lodging House Hotel	(8) Accessory Building a. Garage b. Quarters c. Guard House d. Laundry House, etc.	(9) School Building	(10) Condominium/ Hotel/ Bank/ Hospital/ Office	(11) Theater Church Assembly House
IA	7,370	7,040	6,220	6,220	-	6,340	7,810	7,910
IB	6,530	6,430	5,780	5,780	-	5,940	6,530	6,450
IIA	5,040	4,970	4,560	4,560	4,800	4,960	5,600	5,160
IIB	4,570	4,340	3,870	3,870	3,010	4,500	5,040	4,730
IIC	4,370	4,240	3,790	3,790	2,630	4,240	4,610	4,440
IIIA	3,700	3,140	3,020	3,020	2,070	3,310	3,940	3,770
IIIB	3,160	2,810	2,680	2,680	1,820	3,030	3,390	3,250
IIIC	2,890	2,330	2,190	2,190	1,530	2,560	3,240	3,030
IIID	2,530	2,040	1,580	1,580	1,250	-	2,730	2,800
IV	1,700	-	-	-	-	-	-	-

TYPE	(12) Factory Warehouse Industrial Plant/Storage	(13) Market/ Shopping Center	(14) Gymnasium Coliseum	(15) Recreation a. Bowling lane b. Clubhouse	(16) Saw Hills and Lumber shed	(17) Gasoline Station	(18) Swimming Pool and Bath House	(19) Piggery and Poultry House
IS	7,280	-	-	-	-	-	4,640 : 6,980	-
IA	4,340	6,170	5,460	5,570	-	5,380	-	-
IB	4,000	5,430	4,850	5,100	-	4,740	-	-
IIA	2,770	3,690	3,470	4,000	-	3,290	-	-
IIB	2,520	3,280	3,090	3,710	-	2,790	-	-
IIC	2,160	3,040	2,790	3,010	2,040	2,410	-	-
IIIA	1,480	2,810	1,970	2,390	1,880	-	-	1,550
IIIB	1,300	2,520	1,660	2,150	1,610	-	-	1,420
IIIC	1,060	2,130	1,510	1,530	1,450	-	-	1,330
IIID	-	1,800	700	1,160	1,250	-	-	1,070

Source: Zambales Provincial Assessor's Office, Iba

Table 12.1.3 Results of Household Survey: Housing Condition (Responses & Weighted Values)

Type of Building	Botolan	Cabangan	Castillejos	San Antonio	San Felipe	San Marcelino	San Narciso	Totals	% Total Responding	Average Assessed Value* (Pesos/m^2)	Weighted Value/m^2 by Type
1) Type 1 – Steel and concrete	27	4	18	31	21	18	11	130	49	6,950	3,406
2) Type 2 – Bricks, stone and steel	2	3	3	3	-	-	8	19	7	4,660	326
3) Type 3 – Wood and asbestos	-	-	-	1	1	-	7	9	3	3,070	92
4) Type 4 - Cogon, nipa	9	5	6	3	4	11	10	48	18	1,700	306
5) Others – Wood and concrete	2	28	2	2	10	11	3	58	22	3,070	675
6) No response	-	-	5	-	4	-	1	10	-	-	-
TOTALS	40	40	34	40	40	40	40	274	99	-	4,805

Notes:

1. Average assessed value was obtained by grouping building types from the Schedule of Unit Values for Buildings (1999).
2. Survey data was extracted from IEE Report for Sabo and Flood Control Project in Major Three Western River Basins of Mount Pinatubo prepared by JBJ Consulting Inc. dated 31 July 2002.

Table 12.1.4 Results of Household Survey: Floor Areas (Responses and Weighted Averages)

Floor Area	Botolan	Cabangan	Castillejos	San Antonio	San Felipe	San Marcelino	San Narciso	Totals	% Total Responding	Weighted Average Floor Area
Below 50m^2 (45m^2)	27	24	18	11	33	35	32	180	68	30.6
50-100m^2 (75m^2)	12	14	14	20	2	3	6	71	27	20.3
More than 100m^2 (100m^2)	1	2	1	9	-	1	-	14	6	6.0
No reponse	-	-	1	-	5	1	2	9	-	-
TOTALS	40	40	34	40	40	40	40	274	101	56.9

Notes:

1. Assumed average floor areas are stated in brackets for each survey category.
2. Survey data was extracted from IEE Report for Sabo and Flood Control Project in Major Three Western River Basins of Mount Pinatubo prepared by JBJ Consulting Inc. dated 31 July 2002.

Table 12.1.5 Results of Household Survey: Ownership of Household Effects (Responses & Weighted Cost)

Household Effects	Botolan	Cabangan	Castillejos	San Antonio	San Felipe	San Marcelino	San Narciso	Totals	% Total Responding	Estimated Cost (Pesos)	Weighted Cost (Pesos)
Refrigerator	10	19	16	30	16	8	23	122	45	7,500	3,375
Electric Range	4	7	4	6	1	-	2	24	9	12,000	1,080
Stereo	15	19	13	24	5	7	28	111	41	11,000	4,510
TV set	31	27	27	39	30	22	32	208	76	8,000	6,080
Radio	34	33	25	34	28	24	34	212	77	5,000	3,850
Electric fan	12	19	7	20	12	13	17	100	36	1,500	540
Washing machine	3	4	10	5	1	1	-	24	9	6,000	540
Flat iron	1	-	-	5	2	1	-	9	3	650	20
Computer	-	1	1	-	2	-	-	4	1	40,000	400
VCD/VHS player	-	-	3	-	1	6	-	10	4	5,000	200
Rice cooker	1	2	-	-	-	-	-	3	1	1,300	13
Air conditioner	-	1	-	-	-	-	-	1	0.4	11,000	44
Carpets, curtains, fittings*										20,000	20,000
Total households owning items	111	132	106	163	98	82	136	828			
Total households in survey	40	40	34	40	40	40	40	274	-	-	40,652

Notes:

1. Average assessed value was obtained by grouping building types from the Schedule of Unit Values for Buildings (1999).
2. *Estimated outside the survey.
3. Survey data was extracted from IEE Report for Sabo and Flood Control Project in Major Three Western River Basins of Mount Pinatubo prepared by JBJ Consulting Inc. dated 31 July 2002.

Table 12.1.6 Damage Value for Economic Evaluation on Structural Measures

(Unit: Peso)

A.	Direct Damage	
A.1	Buildings	
	a) Residential	244,971 / house
	b) Non-Residential	676,352 / building
	c) Household Properties	40,652 / house
	d) Facilities/ Stocks	437,580 / building
A.2	Farm Land	
	a) Paddy Field	34,817 / ha
	b) Cash Crop	
	c) Sugarcane	
	d) Fruits	
	e) Livestock	14,600 / household
A.3	Infrastructures	
	a) Road	
	National Road	2,940 / l. m.
	Other Roads	2,353 / l. m.
	b) Bridges	
	National Road	100,800 / l. m.
	Other Roads	84,000 / l. m.
	c) Irrigation facilities	979 / l. m.

Source: Study on Flood and Mudflow Control for Sacobia-Bamban/Abacan River Drainage from Mt. Pinatubo, May 1996

B.	Indirect Damages (Assumed 100% of Direct Damage)
B.1	Detour Cost of Transportation
B.2	Suspension of Economic Activities
B.3	Cost for Rescue Activities / Relief Goods
B.4	Repair/Cleaning of Buildings

Table 12.1.7 Probable Damage Quantities

Bucao River Basin

Return Period (years)	Hazard Area (km^2)	Max. I.Depth (m)	House									Road		Paddy	Conversion House damaged by lahar
			Total	Inundation Depth (m)								National	Others	Field	
			(nos)	0.2	0.4	0.6	0.8	1.0	1.5	2.0	> 2.0	(m)	(m)	(ha)	(nos)
2	7.7		1,276	130	683	1,029	1,155	1,203	1,246	1,276	1,276	1,370	16,330	330	758
5	8.7		1,460	163	684	1,076	1,252	1,352	1,411	1,460	1,460	1,730	20,780	378	922
10	9.6		1,591	154	693	1,099	1,332	1,428	1,527	1,591	1,591	1,800	24,190	417	1,047
20	11.1		1,908	291	876	1,333	1,591	1,697	1,832	1,908	1,908	2,230	29,110	508	1,203
30	11.9		2,040	244	930	1,403	1,705	1,817	1,964	2,038	2,040	2,510	31,510	547	1,314
50	12.9		2,191	241	999	1,470	1,825	1,946	2,111	2,185	2,191	2,780	34,110	609	1,425
100	14.4		2,406	271	1,116	1,583	1,977	2,127	2,311	2,400	2,406	3,170	36,790	670	1,561

Maloma River Basin

Return Period (years)	Hazard Area (km^2)	Max. I.Depth (m)	House									Road		Paddy	House damaged by lahar
			Total	Inundation Depth (m)								National	Others	Field	
			(nos)	0.2	0.4	0.6	0.8	1.0	1.5	2.0	> 2.0	(m)	(m)	(ha)	(nos)
2	4.8		128	14	58	96	117	125	128	128	128	740	19,420	207	81
5	5.1		144	6	35	89	122	135	143	144	144	740	20,930	226	110
10	5.3		150	2	21	73	119	134	149	150	150	780	21,700	234	126
20	5.5		154	3	15	56	105	132	152	154	154	800	22,880	242	135
30	5.6		161	8	16	54	107	136	159	161	161	800	23,420	248	141
50	5.7		253	63	103	125	188	225	246	253	253	1,000	24,530	255	167
100	5.9		292	43	141	148	205	246	281	292	292	1,110	25,930	261	193

Sto. Tomas River Basin

Return Period (years)	Hazard Area (km^2)	Max. I.Depth (m)	House									Road		Paddy	House damaged by lahar
			Total	Inundation Depth (m)								National	Others	Field	
			(nos)	0.2	0.4	0.6	0.8	1.0	1.5	2.0	> 2.0	(m)	(m)	(ha)	(nos)
2	39.9		3,782	1,305	3,002	3,457	3,668	3,733	3,759	3,782	3,782	4,130	166,190	2,387	1,498
5	48.9		5,045	1,445	3,712	4,517	4,830	4,950	5,020	5,045	5,045	4,910	218,630	2,862	2,223
10	54.0		5,762	1,496	4,016	5,116	5,467	5,632	5,732	5,761	5,762	5,540	247,890	3,175	2,683
20	58.9		6,444	1,412	4,306	5,584	6,046	6,284	6,406	6,443	6,444	5,020	273,750	3,465	3,181
30	62.2		6,832	1,409	4,458	5,801	6,373	6,652	6,792	6,831	6,832	6,260	289,540	3,656	3,465
50	65.9		7,296	1,424	4,582	5,987	6,760	7,052	7,250	7,295	7,296	6,910	307,530	3,868	3,838
100	71.0		8,079	1,537	4,856	6,454	7,379	7,754	8,016	8,077	8,079	7,620	333,840	4,168	4,384

Table 12.1.8 Probable Damage Amount

Bucao River Basin (Unit : Peso)

Return Period (years)	Hazard Area (km^2)	House			Road		Paddy Field (ha)	Damage Cost						
		Resid.	Non-Res	Total (nos)	National (m)	Others (m)		House		Road		Paddy Field	Livestock	Total
								Resid.	Non-resi	National	Others			
2	9.4	751	7	758	2,082	16,649	442	214,502,873	7,797,524	6,121,080	39,175,097	15,389,114	10,964,600	293,950,288
5	10.2	913	9	922	2,155	19,302	475	260,773,799	10,025,388	6,335,700	45,417,606	16,538,075	13,329,800	352,420,368
10	11.3	1,037	10	1,047	2,445	22,091	538	296,191,051	11,139,320	7,188,300	51,980,123	18,731,546	15,140,200	400,370,540
20	13.6	1,191	12	1,203	2,947	26,634	652	340,176,993	13,367,184	8,664,180	62,669,802	22,700,684	17,388,600	464,967,443
30	14.5	1,301	13	1,314	3,243	28,918	700	371,595,523	14,481,116	9,534,420	68,044,054	24,371,900	18,994,600	507,021,613
50	15.7	1,411	14	1,425	3,517	30,218	767	403,014,053	15,595,048	10,339,980	71,102,954	26,704,639	20,600,600	547,357,274
100	17.0	1,546	15	1,561	3,831	31,494	812	441,573,158	16,708,980	11,263,140	74,105,382	28,271,404	22,571,600	594,493,664

Maloma River Basin (Unit : Peso)

Return Period (years)	Hazard Area (km^2)	House			Road		Paddy Field (ha)	Damage Cost						
		Resid.	Non-Res	Total (nos)	National (m)	Others (m)		House		Road		Paddy Field	Livestock	Total
								Resid.	Non-resi	National	Others			
2	4.8	81	0	81	701	7,425	187	23,135,463	0	2,060,940	17,471,025	6,510,779	1,182,600	50,360,807
5	5.2	109	1	110	727	7,780	203	31,132,907	1,113,932	2,137,380	18,306,340	7,067,851	1,591,400	61,349,810
10	5.3	125	1	126	789	8,008	209	35,702,875	1,113,932	2,319,660	18,842,824	7,276,753	1,825,000	67,081,044
20	5.5	134	1	135	818	8,362	218	38,273,482	1,113,932	2,404,920	19,675,786	7,590,106	1,956,400	71,014,626
30	5.5	140	1	141	818	8,644	223	39,987,220	1,113,932	2,404,920	20,339,332	7,764,191	2,044,000	73,653,595
50	5.7	166	1	167	1,022	9,441	227	47,413,418	1,113,932	3,004,680	22,214,673	7,903,459	2,423,600	84,073,762
100	5.9	192	1	193	1,128	9,974	233	54,839,616	1,113,932	3,316,320	23,468,822	8,112,361	2,803,200	93,654,251

Sto. Tomas River Basin (Unit : Peso)

Return Period (years)	Hazard Area (km^2)	House			Road		Paddy Field (ha)	Damage Cost						
		Resid.	Non-Res	Total (nos)	National (m)	Others (m)		House		Road		Paddy Field	Livestock	Total
								Resid.	Non-resi	National	Others			
2	69.6	1,484	14	1,498	21,483	145,379	3,777	423,864,532	15,595,048	63,160,020	342,076,787	131,503,809	21,666,400	997,866,596
5	75.3	2,201	22	2,223	22,621	155,099	4,035	628,656,223	24,506,504	66,505,740	364,947,947	140,486,595	32,134,600	1,257,237,609
10	78.4	2,657	26	2,683	23,551	163,416	4,179	758,900,311	28,962,232	69,239,940	384,517,848	145,500,243	38,792,200	1,425,912,774
20	81.6	3,150	31	3,181	24,311	172,615	4,338	899,712,450	34,531,892	71,474,340	406,163,095	151,036,146	45,990,000	1,608,907,923
30	83.7	3,431	34	3,465	24,889	176,876	4,445	979,972,513	37,873,688	73,173,660	416,189,228	154,761,565	50,092,600	1,712,063,254
50	85.6	3,800	38	3,838	25,356	181,016	4,528	1,085,367,400	42,329,416	74,546,640	425,930,648	157,651,376	55,480,000	1,841,305,480
100	88.1	4,341	43	4,384	26,012	188,280	4,629	1,239,889,443	47,899,076	76,475,280	443,022,840	161,167,893	63,378,600	2,031,833,132

Table 12.1.9 Annual Damage Calculation

Bucao River Basin

Return Period (years)	Average Annual Probability of Exceedance for Return Period	Average Annual Events within interval	Mudflow Damage up to Indicated Return Period (Million Peso)	Average Mudflow Damage (Million Peso)	Average Annual Mudflow Damage within Interval (Million Peso)	Avrage Annual Mudflow Damage up to Indicated R.P. (Million Peso)
2	0.50		294.0			0.0
		0.30		323.2	97.0	
5	0.20		352.4			97.0
		0.10		376.4	37.6	
10	0.10		400.4			134.6
		0.05		432.7	21.6	
20	0.05		465.0			156.2
		0.03		506.2	15.2	
50	0.02		547.4			171.4
		0.01		570.9	5.7	
100	0.01		594.5			177.1

Maloma River Basin

Return Period (years)	Average Annual Probability of Exceedance for Return Period	Average Annual Events within interval	Mudflow Damage up to Indicated Return Period (Million Peso)	Average Mudflow Damage (Million Peso)	Average Annual Mudflow Damage within Interval (Million Peso)	Avrage Annual Mudflow Damage up to Indicated R.P. (Million Peso)
2	0.50		50.4			0.0
		0.30		55.9	16.8	
5	0.20		61.3			16.8
		0.10		64.2	6.4	
10	0.10		67.1			23.2
		0.05		69.0	3.5	
20	0.05		71.0			26.6
		0.03		77.5	2.3	
50	0.02		84.1			29.0
		0.01		88.9	0.9	
100	0.01		93.7			29.8

Sto. Tomas River Basin

Return Period (years)	Average Annual Probability of Exceedance for Return Period	Average Annual Events within interval	Mudflow Damage up to Indicated Return Period (Million Peso)	Average Mudflow Damage (Million Peso)	Average Annual Mudflow Damage within Interval (Million Peso)	Avrage Annual Mudflow Damage up to Indicated R.P. (Million Peso)
2	0.50		997.9			0.0
		0.30		1,127.6	338.3	
5	0.20		1,257.2			338.3
		0.10		1,341.6	134.2	
10	0.10		1,425.9			472.4
		0.05		1,517.4	75.9	
20	0.05		1,608.9			548.3
		0.03		1,725.1	51.8	
50	0.02		1,841.3			600.0
		0.01		1,936.6	19.4	
100	0.01		2,031.8			619.4

Table 12.2.1 Summary of Economic Evaluation for Structural Measures

Structural Flood and Mudflow Control Measures		Bridge (million Peso)	Flood Control (million Peso)	Total (million Peso)	EIRR (%)	B-C* (million Peso)
BUCAO RIVER BASIN						
Alt-1	Dike Heightening	375.4	605.7	981.1	15.2	191
			605.7	605.7	24.3	528
Alt-2	Dike Heightening + Malomboy Consolidation Dam	375.4	1,335.2	1,710.6	6.7	-464
			1,335.2	1,335.2	10.3	-127
Alt-3	Dike Heightening + Malomboy Consolidation Dam + Sand Pocket	375.4	2,925.7	3,301.1	-	-1,893
			2,925.7	2,925.7	-	-1,556
MALOMA RIVER BASIN						
Alt-1	River Improvement	126.9	1,171.6	1,298.5	-	-889
STO.TOMAS RIVER BASIN						
Alt-1	Dike Heightening	227.4	1,277.9	1,505.3	48.2	5,314
			1,277.9	1,277.9	53.5	5,518
Alt-2	Dike Heightening + Training Channel	227.4	5,246.3	5,473.7	17.1	1,750
			5,246.3	5,246.3	17.8	1,954
Alt-3	Dike Heightening + Sand Pocket	227.4	3,329.0	3,556.4	25.5	3,472
			3,329.0	3,329.0	27.0	3,676

Note : (*) B-C was evaluated at a discount rate of 15%.

Cost of Bridge

	Unit Price (Yen)	Length (m)	Width (m)	L x W (m^2)	Cost (Peso)*	Miscellaneous (Peso)	Total Cost (Peso)
Bucao Bridge	200,000 / sq.m	355	9.52	3379.6	288,800,000	86640000	375,440,000
Maloma Bridge	100,000 / sq.m	240	9.52	2284.8	97,600,000	29280000	126,880,000
Maculcol Bridge	100,000 / sq.m	430	9.52	4093.6	174,900,000	52470000	227,370,000

Note : (*) 1 Peso = 2.34 Yen.