TABLES

Table J.1 Comparison Table for Alternative Routes of North Luzon Expressway

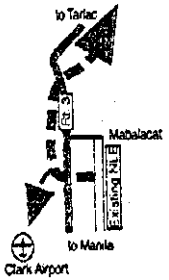
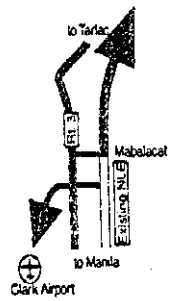
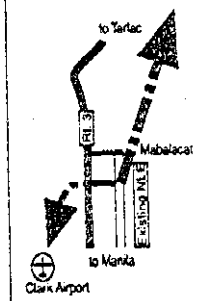
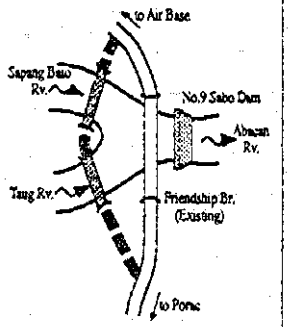
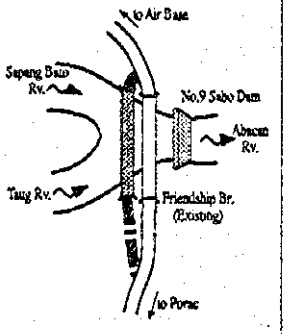
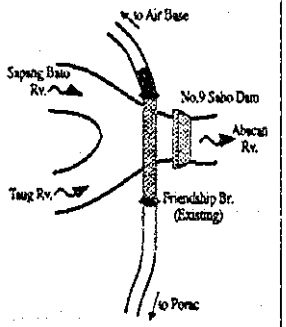
Route Name	Advantage	Disadvantage	Quantities / Cost
ALT-1 	1) The best accessibility from Clark Airport to the NLE 2) The minimum additional land acquisition for crossing the Clark Area. 3) No obstruction for urban expansion of Mabalacat City 4) Crossing the edge of future CIP area 5) No additional improvement work of Mabalacat Interchange	1) The highest construction cost 2) Crossing the Route 3 twice and the existing railway three(3) times 3) Unfavorable holizontal and vertical alignments of main route 4) The highest social enviroment impact	Main Road 16.0 km Access Road 2.0 km Interchange Single Trumpet 1 no. Semi-direct Y type 1 no. Toll Gate 1 no. Bridge(L>100m) 2 nos. (700 m) Viaduct Main Road 3 nos. (1,500 m) Access Road 0 no. (0 m) Flyover Bridge 3 nos. **Construction Cost P 2,287 million**
ALT-2 	1) Lowest construction cost 2) Smooth holizontal and vertical alignments of main route 3) Low social enviroment impact	1) Large additional land acquisition area 2) Obstruction for urban expansion of Mabalacat City 3) Crossing the center of future CIP area 4) Additional improvement work of Mabalacat Interchange	Main Road 10.0 km Access Road 3.0 km Interchange Semi-direct Y type 1 no. Diamond 1 no. Direct Y type 1 no. Toll Gate 1 no. Bridge(L>100m) 2 nos. (600 m) Viaduct Main Road 0 no. (0 m) Access Road 1 no. (500 m) Flyover Bridge 4 nos. **Construction Cost P 1,282 million**
ALT-3 	1) The best accessibility from Manila to Tarlac 2) Smooth holizontal and vertical alignments of main route 3) Low social enviroment impact 4) No additional improvement work of Mabalacat Interchange	1) Large additional land acquisition area 2) Obstruction for urban expansion of Mabalacat City 3) Crossing the center of future CIP area	Main Road 11.3 km Access Road 3.0 km Interchange Semi-direct Y type 1 no. Direct Y type 1 no. Toll Gate 1 no. Bridge(L>100m) 1 no. (800 m) Viaduct Main Road 0 no. (0 m) Access Road 1 no. (500 m) Flyover Bridge 4 nos. **Construction Cost P 1,440 million**

Table J.2 Comparison Table for Alternative Routes of Friendship Bridge

Route Name	Advantage	Disadvantage	Quantities / Cost
ALT-1 	1) Good accessibility from the Air Base to the area between the Sapang Bato River and the Taug River 2) Usable the existing bridge for detour route for construction period 3) Not disturbed the construction works of the new bridge by the existing bridge 4) Good location for avoiding the malinfluence by two direction turbulent flow from the Sapang Bato River and theTaug River	1) The highest construction cost 2) The largest additional land acquisition area 3) The highest social environment impact for access road section 4) Unfavorable holizontal alignment	Total Length 750.0 m Bridge 375.0 m (200+175) Access Road 375.0 m **Construction Cost ₱ 64,950,000**
ALT-2 	1) Usable the existing bridge for detour route for construction period 2) Not disturbed the construction works of the new bridge by the existing bridge	1) The location malinfluenced by two direction turbulent flow from the Sapang Bato River and the Taug River 2) Inaccessability from the Air Base to the area between the Sapang Bato River and the Taug River 3) Large additional land acquisition area	Total Length 470.0 m Bridge 250.0 m Access Road 220.0 m **Construction Cost ₱ 42,904,000**
ALT-3 	1) The lowest construction cost 2) No additional land acquisition area 3) The lowest social environment impact 4) Smooth holizontal alignment 5) The shortest bridge	1) The location malinfluenced by two direction turbulent flow from the Sapang Bato River and the Taug River 2) Inaccessability from the Air Base to the area between the Sapang Bato River and the Taug River 3) Unusable the existing bridge for detour route for construction period 4) Disturbed the construction works of the new bridge by the existing bridge	Total Length 240.0 m Bridge 210.0 m Access Road 30.0 m **Construction Cost ₱ 33,996,000**

FIGURES

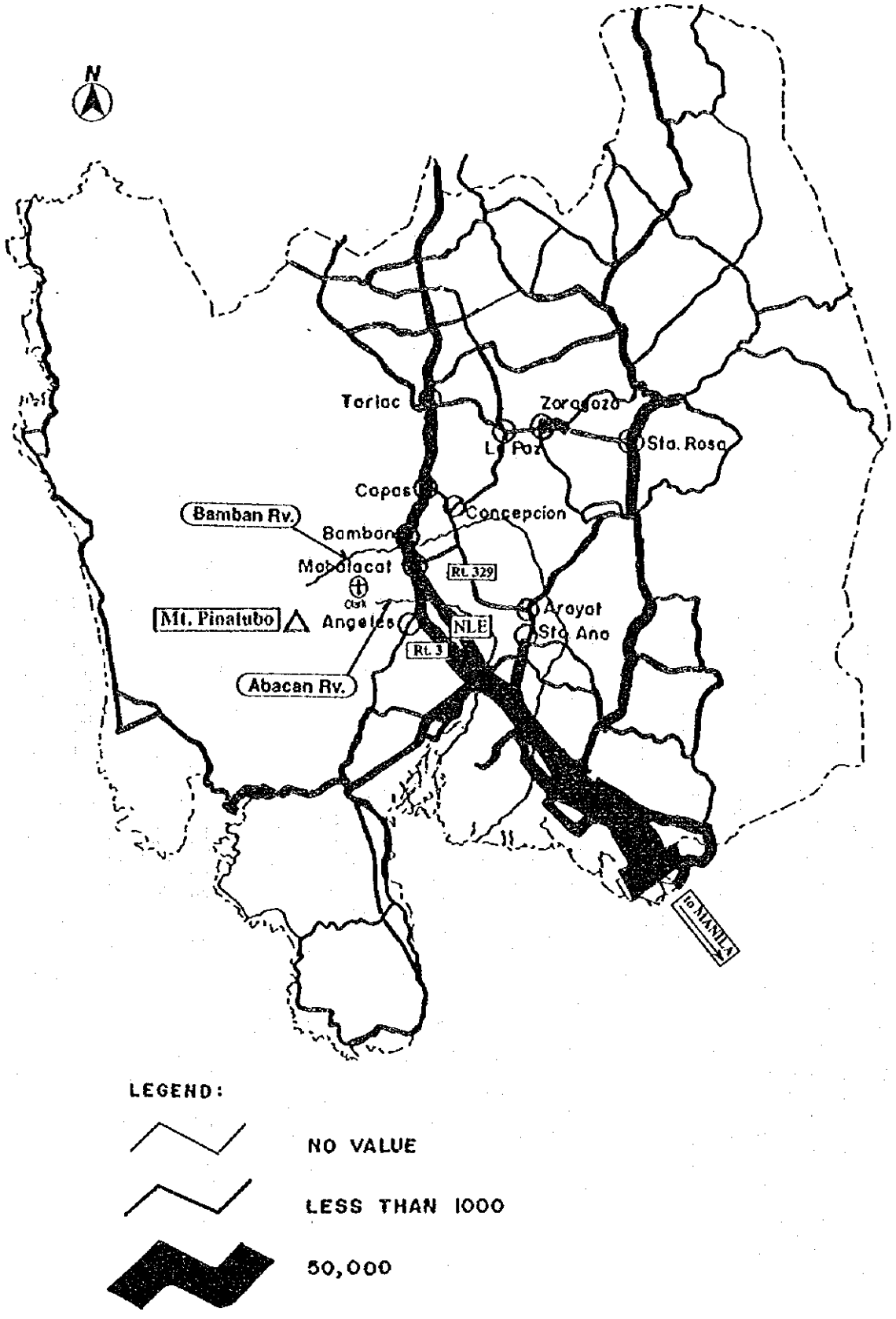


Figure J.1 Estimated Traffic in Region III in 1993

Source : CLDP

THE GOVERMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN ABACAN RIVER DRAINING FROM MT PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

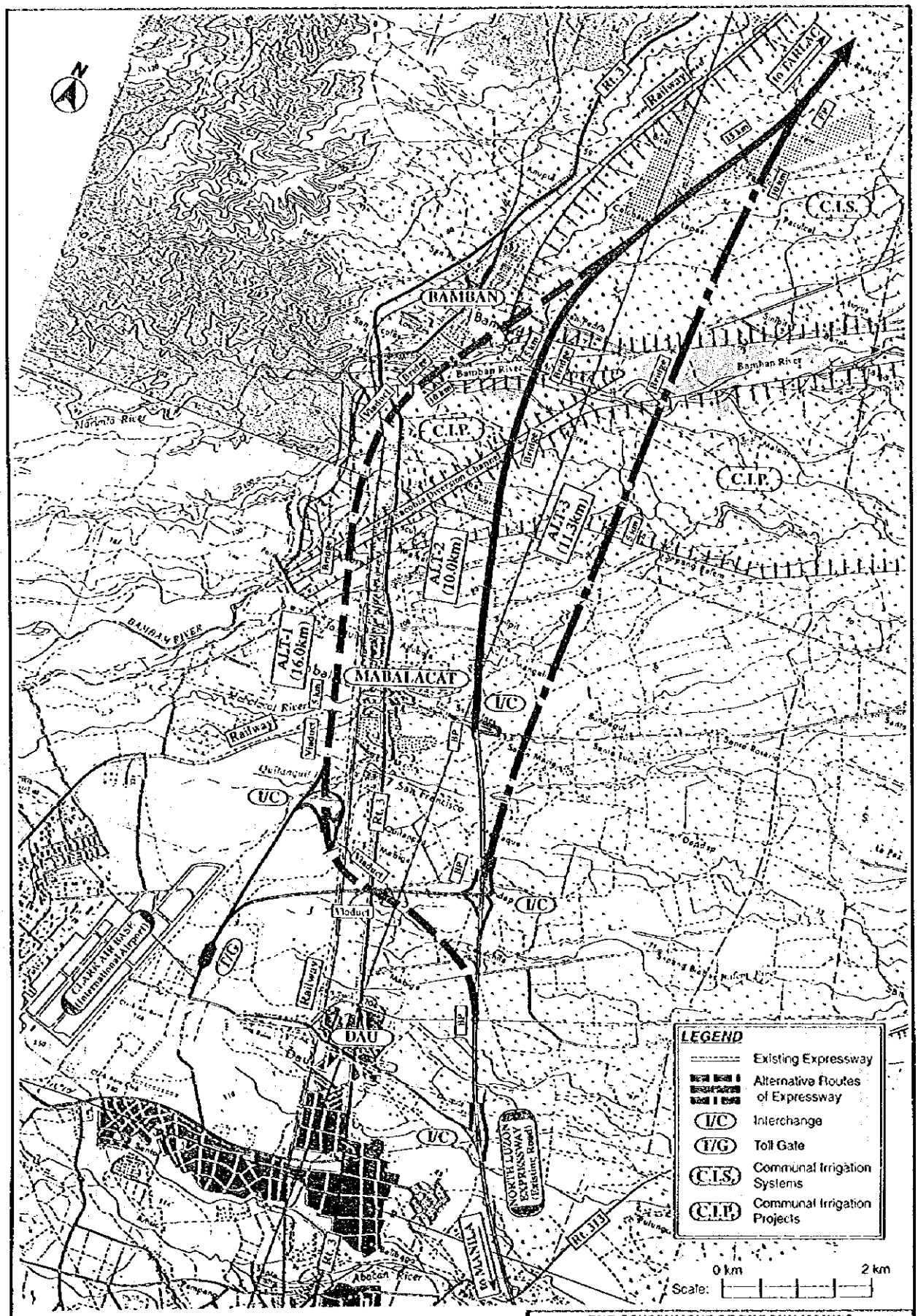


Figure J.2 Alternative Routes of North Luzon Expressway Extension

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

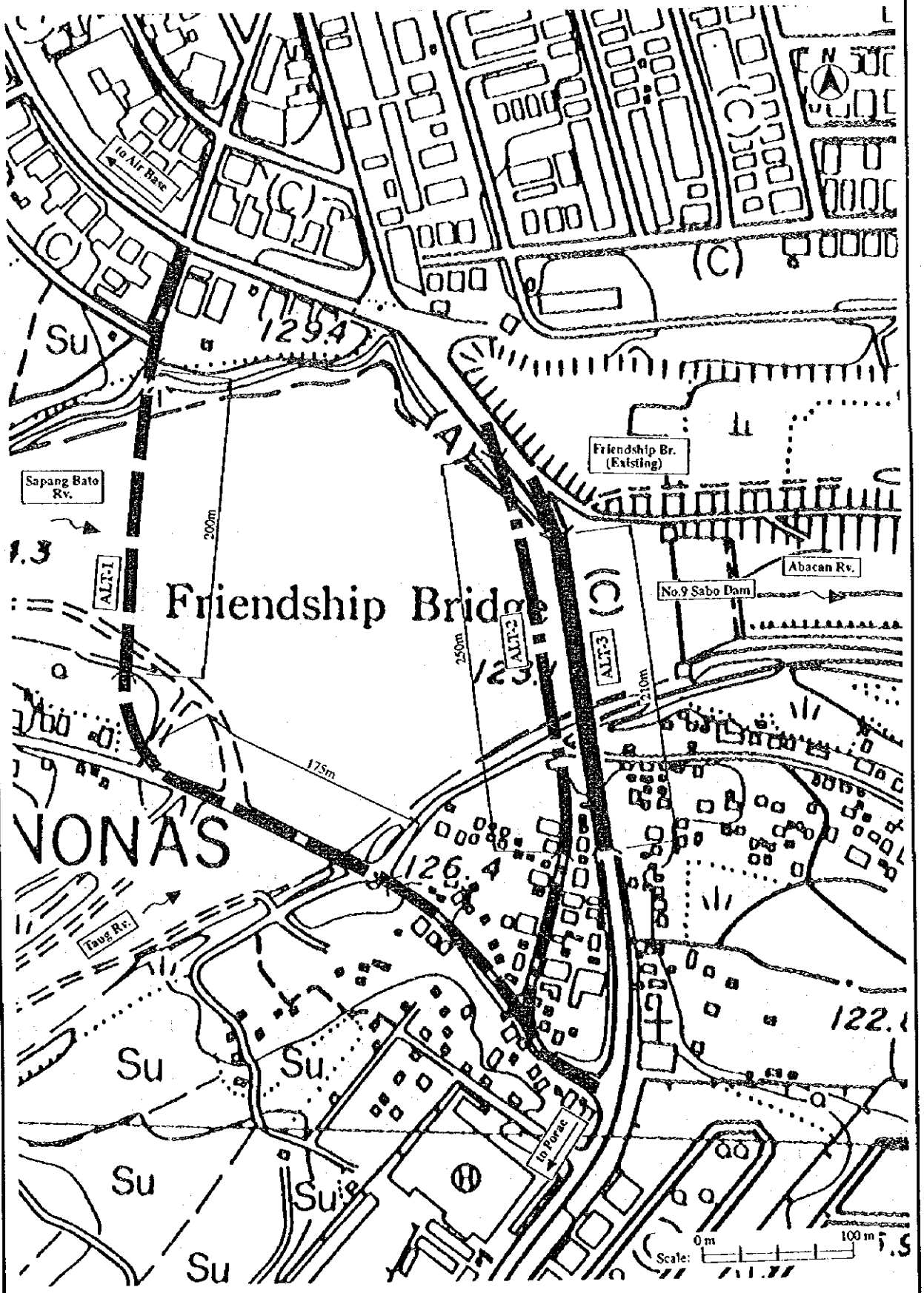


Figure J.3 Alternative Routes of Friendship Bridge

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

APPENDIX K

AGRICULTURAL DEVELOPMENT PLAN

APPENDIX K

AGRICULTURAL DEVELOPMENT PLAN

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K.1 INTRODUCTION

1.1 PROJECT BACKGROUND

The June 15, 1991 eruption of Mt. Pinatubo, one of the largest eruption of this century in the world, produced remarkable volumes of pyroclastic flow and fall deposits. The pyroclastic flow deposits covered thousands of square kilometers and the volume was estimated at 6.7 km^3 on the slopes of the Mount Pinatubo.

Lahar generated by heavy rain falling on erodible pyroclastic flow deposits pose continuing and grave danger to human lives and property in low-lying areas. Among the majors rivers surrounding Mt. Pinatubo, the Sacobia-Bamban river and the Abacan river (the Study Area) pose great danger to the outlying areas currently used for residential, agricultural and industrial purposes.

There exist a National Irrigation System (NIS) serving 4,300 ha and 100 Communal Irrigation System (CIS) serving 16,000 ha of paddy field in the Study area. This NIS is being operated and well maintained by NIA and farmers in the area are able to produce stable and relatively high yield of palay. However, most CISs are hardly operated and maintained by farmers themselves or irrigator's association and production in the area is usually insufficient extent due to improper water management and lack of facilities. Many CISs are required rehabilitation/restoration and improvement for proper water management and desirable production. Effective planning and implementation of rehabilitation / restoration of CISs will be carried out by farmers participation which shall require strengthening or establishment of farmers organizations. Through participation of such organizations, successful implementation of the said rehabilitation/restoration can be expected.

1.2 OBJECTIVES OF THE STUDY

The study contains the following activities and output:

(1) To collect the agricultural statistical data and information of present agriculture condition in and around Sacobia-Bamban and Abacan river basins.

(2) To review the existing agricultural development projects in the Study area.

(3) To identify the agricultural development projects affected by lahar in and around the Sacobia-Bamban and Abacan river basins.

(4) To select priority schemes to be proposed for future agricultural development.

1.3 THE STUDY AREA

The Study area is located in the southern part of the Tarlac province and the northern part of Pampanga province, lying in the western portion of the sedimentary basin with its long axis trending North - South. The Study area comprises lowlands and moderately a sloping area with a gentle relief. Number of Barangay and total area in the Study area are estimated as follow :

(1) Area covered under the Sacobia-Bamban river basin area :

Municipality	No. of Barangay	Total Area
Tarlac Province :		(ha)
Bamban	11	3,980
Capas	8	7,620
Concepcion	23	12,910
Pampanga Province :		
Mabalacat	25	22,570
Magalang	27	23,950
Total	94	71,030

(2) Area covered under the Abacan river basin area :

Municipality	No. of Barangay	Total Area
Pampanga Province :		(ha)
Angeles City	29	7,640
Arayat	29	13,050
Santa Ana	14	11,640
Mexico	43	22,130
Total	115	54,460

The Study area is shown in Figure K.1.

K.2 PRESENT AGRICULTURAL CONDITION IN THE STUDY AREA

2.1 GENERAL CONDITION

The Study area extends in the midst of the Central Luzon plain. At the northern side is the Tarlac town, the provincial capital of the Tarlac Province. The Study area is bounded on the southern side by San Fernando, the provincial capital of the Pampanga Province. At the western side is the Pinatubo mountain range. The eastern side includes the configuration of the Pampanga, Sacobia-Bamban and the Abacan rivers.

The Study area is composed of the provinces of Pampanga and Tarlac. The Study area of Pampanga Province includes the six (6) municipalities of Mabalacat, Magalang, Angeles City, Arayat, Santa Ana and Mexico. In the Study area of Tarlac Province, a part of Bamban, Capas and Concepcion municipalities are included.

Total population in the Study area is estimated at 601,950 in 1994. The population density is 480 persons per km^2. The number of households is 117,600 and the average family size is about 5.1 persons. The details are shown in Table K.1 and summarized as follows;

Municipality	No. of Barangay	Area	Total Household	Total Population	Population Density
Sacobia-Bamban River Basin Area		(km^2)	(nos.)	(person)	(person/km^2)
Tarlac Province :					
Bamban	11	39.8	2,080	10,120	254
Capas	8	76.2	4,040	19,990	262
Concepcion	23	129.1	10,860	58,000	449
Pampanga Province :					
Mabalacat	25	225.7	21,380	103,030	456
Magalang	27	239.5	8,090	44,590	186
Abacan River Basin Area					
Pampanga Province :					
Angeles City	29	76.4	39,120	186,290	2,438
Arayat	29	130.5	13,480	75,500	579
Santa Ana	14	116.4	5,950	33,660	289
Mexico	43	221.4	12,600	70,770	320
Total	209	1,255.0	117,600	601,950	480

Source : Population survey by JICA Study Team in August 1994, of which details is given in Appendix A "Socio Economy".

2.2 CLIMATE

The river basins around Mt. Pinatubo are affected by a southwest monsoon for the wet months from May to October, while a northeast monsoon dominates during the dry months from November to March. The distinctive wet and dry seasons are brought about by these reversal monsoons. The air mass of southwest monsoon is classified into equatorial maritime and is warm and very humid, having an average temperature of 27 °C. Among 16 tropical cyclones per annum which affects weather condition in the Luzon Island for the period from 1948 to 1991, 5 tropical cyclones on an annual average passed through in the Central Luzon.

In the Study area, the monthly rainfall of 1,278 mm was recorded from 1977 to 1991 at BAI, Magalang Station. The annual rainfall had receded gradually for the period from 1977 to 1983 and the drought in 1983 caused a serious problems in economic activities in Central Luzon, such as shortage of drinking water and reduction of hydropower generation and low agricultural productivity. Those after 1983 has been restored by the

level of annual average rainfall. After the eruption of Mt. Pinatubo for the period from 1991 to 1993, the annual rainfall was almost equivalent to the annual average rainfall.

The Study area receives no really driest month but wetter month in November/December. About 85 % annual rainfall occurs for the period from May to October in the Study area. An important feature that can describe the rainfall distribution is the number of rainy days.

The monthly average temperature in the Study area varies for the range from 25.7 °C in December to 29.2 °C in May. The maximum temperatures occur generally between 1:00 p.m. and 3:00 p.m. while the minimum temperatures occur between 5:00 a.m. and 7:00 a.m. The monthly relative humidity in the Study area is rather stable throughout a year at about 79 %. Open pan evaporation data in Floridablanca (1986-1987) varies for the range from 119.6 mm in November to 204.2 mm in March. The annual evaporation amount is recorded at 1,736 mm.

Month	Rainfall	Max. Temp.	Min. Temp.	Mean Temp.	Relative Humidity
	(mm)	(°C)	(°C)	(°C)	(%)
January	9.0	32.4	19.2	25.8	76
February	10.1	33.1	19.1	26.1	75
March	31.1	34.3	20.3	27.3	72
April	37.5	35.9	22.2	29.0	69
May	104.4	35.3	23.2	29.2	78
June	161.7	33.6	23.2	28.4	82
July	240.8	33.0	22.0	28.0	85
August	254.8	32.3	22.8	27.6	87
September	157.0	32.9	22.7	27.8	83
October	173.3	32.7	22.1	27.4	82
November	84.4	32.7	21.0	26.8	79
December	13.8	32.0	19.4	25.7	78
Annual/ Average	1,277.9	33.4	21.5	27.4	79

Sources :Annual rainfall ; average of 1977- 1991 at BAI, Magalang Station
Monthly temperature ; average of 1969-1990 at Hacienda Luisita Station
Monthly relative humidity ; average of 1969-1990 at Hacienda Luisita Station

2.3 SOIL

(1) Soil before the Eruption of Mt. Pinatubo

Soil map before the eruption in the Study area is shown in Figure K.2. Angeles series is the most extensive soil associated with land management units. This series occurs also in the infilled valley and residual terraces. On the hilly and mountainous land forms undifferentiated Angeles soils occur. The minor soils occurring on the plain are Quingua, La Paz, Bantog and Candaba series. The latter occurs only in the Candaba Swamp. The riverbed of Abacan and Sacobia-Bamban rivers is organized into Angeles coarse sand.

Sacobia-Bamban River Basin Area

The soils of the Sacobia-Bamban river basin are Angeles fine sand, Luisita fine sand, Angeles sand, Angeles sandy loam and Angeles coarse sand. Angeles fine sand is located on the upper stream of the watershed, Luisita fine sand on mid-northern side of the river, Angeles sand in the mid-southern side of the river, Angeles sandy loam at the downstream of the watershed and the Angeles coarse sand on the terraces along the Sacobia-Bamban River and on the flood plain.

Angeles fine sand is a deep, well drained soil with loose and structureless fine sand surface with a small amount of silt and clay. Soil reaction is slightly acidic

(pH 6.1). Subsoil is gravely sand (up to 80m or deeper). Sugarcane and rice were commonly being grown on this soil. Luisita fine sand is similar to Angeles fine sand although its soil reaction is very slightly acidic (pH 6.6) and the subsoil has no gravel. Landuse is the same as Angeles fine sand. Angeles sand is a deep, well drained soil. The surface soil consists of coarse and medium sands with little amount of clay and silt. Soil reaction is moderately acidic (pH5.8). Rice is the important crop of this soil with sugarcane, root crops and vegetables. Angeles coarse sand has uniform texture from the surface up to a depth of more than one meter. Soil reaction is moderately acidic (pH 5.6). Natural vegetation on this soil was talahib, bamboo and camachile.

In general, the soils of the alluvial plain of the Sacobia-Bamban River basin had the following chemical properties: slightly acidic (pH 6.70), low organic matter content (1.12%), high cation exchange capacity (24.12 meq/100 g soil), high base saturation (73.46%), moderately available Phosphorous (11.6 ppm) and low exchangeable potassium (0.16 meq/100 g soil). The general fertility of these soils is moderate. The moderate natural fertility of the soils in the Sacobia-Bamban river watershed agrees with the characterization of the buried soils in Barangay Culatingan and San Vicente, Concepcion, Tarlac.

Abacan River Basin Area

The soils of the Abacan river basin are Angeles fine sand, Angeles sand, La Paz fine sand and Angeles coarse sand. Angeles fine sand and Angeles sand are located in the upper stream of the watershed while La Paz fine sand is located in the downstream of the watershed. Angeles coarse sand is located at the terraces adjacent to the river flood plain. The physico-chemical properties and land uses of Angeles fine sand, Angeles sand and Angeles coarse sand are similar to the same soils in Sacobia-Bamban river basin. La Paz fine sand is a deep, well drained soil. Soil reaction is strongly acidic (pH 5.4). Sugarcane is the main crop of this soil. La Paz sand is similar to La Paz fine sand except the surface soil texture which is medium to coarse land. Soil reaction is moderately acidic (pH 5.6). Rice and sugarcane are the main crops of this soil.

In general, the soils of the alluvial plain of the Abacan river basin are acidic (pH5.08), low organic matter (0.12%), moderate cation exchange capacity (14.75 meq/100 g soil), moderate base saturation (45.00%), high available phosphorous (30.33 ppm, P), and low exchangeable potassium (0.11 meq/100g). These soils are moderately fertile. The characterization of the buried soil in Sapang Libutad, Angeles City and a soil profile in San Pablo, Mexico confirms that the moderate natural fertility of the former soils.

(2) Physical Characteristics and Fertility Status of Lahar

Lahar samples from Sacobia-Bamban and Abacan river basin areas consist largely of sand (80.4 - 95.4 %), silt (0.6 - 10.6 %) and small amount of clay (4.0 - 9.0 %). At the downstream of the Sacobia-Bamban river basin area, the mudflow deposits are finer and consist largely of silt (53.6 %) and a small amount of sand (20.4 %) and clay (26.0 %). The coarse to sandy upstream sediment deposits have a medium to very fast hydraulic conductivity which ranges from 1.2×10^{-4} to 6.5×10^{-2} cm/sec. Bulk density varies from 0.98 gm/cc for the loosely structured loamy sand to 1.83 gm/cc for compacted loamy sand due to heavy machinery (bulldozer). Available moisture is very low (1.89 %) to low (6.12 - 8.04 %), expect for the lahar in Dolores, Magalang which is high (23.7 %).

The sediment deposits in Culatingan, Concepcion in Tarlac province have poorly drained condition due to finer texture with high silt and clay content. The pozzolanic property of the volcanic materials may hamper agricultural productivity. This is being experienced

by farmers in Culatingan, the hardening or crusting of the sediment when dry. The physical properties of lahar are shown in Table K.2.

In Sacobia-Bamban rive basin area, the reaction (pH) of the lahar ranges from medium acid to slightly acid (pH 5.7 - 6.7). Concepcion which is moderate (1.46 %). Cation Exchange Capacity (CEC) is very low, except for the lahar in San Vicente, Concepcion which is moderate (9.37 meq/100g soil). Base saturation is moderate, except for the sediments in Culatingan which is adequate (63.35 %). Phosphorus is low, except for the sediments from Culatingan and San Vicente which are moderate (8.8 and 9.71 ppm). Available Potassium is low, except for the sediments in Culatingan and San Vicente which adequate (0.34 and 0.26 m/100g soil). Only soils from San Vicente and Dolores, Magalang have extractable sulfate (58 and 830 ppm SO_4). The lahar in Dolores is a recent deposit. Micro nutrient levels (Zinc, Copper, Iron and Manganese) in most of the sites are low to very low. The lahar deposits in Culatingan and San Vicente have adequate amount of copper and iron.

The reaction of the lahar in the Abacan river basin area ranges from medium acid to slightly acid (pH 5.9 - 6.6). Organic matter content (OM) of lahar is very low (less 1%). Cation exchange capacity is very low (less 4 meq/100g soil). Base saturation is moderate (20 - 60 %) to adequate. Phosphorus content of the lahar in Sapang Libutad, Angeles City is adequate to marginal. Available potassium is very low (less 0.15 meq/100g soil). Only lahar from Angeles City have extractable sulfate for these could be recent deposition. The available micro nutrient (Zinc, Copper, Iron and Manganese) are very low to low.

Lahar in the Sacobia-Bamban and Abacan river basin areas are low in natural fertility, except for the sediments in Culatingan and San Vicente, Concepcion in Tarlac province which are moderate. Thin layer of ash falls (less 10cm thick) when incorporated into the soil by plowing has a favorable influence on the rejuvenation of underlying older soils by supplying them with a source of plant nutrients. Ashfalls of Mt. Pinatubo contain large amount of feldspars. These are easily weatherable minerals and contribute to the formation of secondary minerals and a source of supply for Ca, Na, and K. The chemical properties of lahar are shown in Table K.3.

2.4 PRESENT LANDUSE

The present land use map in the Study area was prepared based on (a) the Landsat images taken in January 1991 and January 1993 with a scale of 1:50,000, and (b) topographic map taken in April 1994 with a scale of 1:10,000 in this JICA study. The Study area were identified in eleven land use categories as follows : Paddy (Rice), Sugarcane, Upland Crops, Fruit Trees, Grass Land, Primary Forest, Secondary Forest, Fishpond, Swamp, Build-up Area, and Miscellaneous.

Agricultural land uses in both the Tarlac and Pampanga provinces significantly decreased after the eruption of Mt. Pinatubo. Agricultural lands were seriously damaged by lahar and mudflow deposits and sedimentation from 1991 to 1993. In the Sacobia-Bamban river basin, total 14,010 ha were damaged from 1991 to 1993, 1,775 ha in Bamban from 1991 to 1993, 3,515 ha in Capas, 45,970 ha in Concepcion, 2,470 ha in Mabalacat, and 280 ha in Magalang. In the Abacan river basin, total 3,710 ha were damaged in 1991, 1,080 ha in Angeles city, 2,310 ha in Mexico and 320 ha in Santo Ana. These areas affected by lahar deposits and sedimentation were mostly still remained or changed to grass land, some farmer were growing watermelon or sugarcane at the sediment crop land on trial. Total affected area by lahar and mudflow deposits in the Study area are estimated as follows;

(Unit : ha)

Municipality	1991 PFD	1991 Lahar	1992 Lahar	1993 Lahar	Total Affected Area
Sacobia-Bamban River Basin Area					
Tarlac Province :					
Bamban	470	830	450	25	1,775
Capas	65	2,620	230	600	3,515
Concepcion	0	5,080	300	590	5,970
Pampanga Province :					
Mabalacat	50	1,260	830	330	2,470
Magalang	0	5	20	255	280
Sub-total	585	9,795	1,830	1,800	14,010
Abacan River Basin Area					
Pampanga Province :					
Angeles City	370	710	0	0	1,080
Santa Ana	0	320	0	0	320
Mexico	0	2,310	0	0	2,310
Sub-total	370	3,340	0	0	3,710
Total	955	13,135	1,830	1,800	17,720

Remarks : PFD ; Pyroclastic flow deposits, These figures are estimated based on May 5, 1994 Pinatubo Volcanic and Flood Hazards Map.

The 5,950 ha and 1,800 ha of paddy field in the Sacobia-Bamban and Abacan river basin areas were damaged by lahar and mudflow from 1991 to 1993. These field are changed to sugarcane, upland crops field or grass land. At present, paddy (rice) and sugarcane were the extensively grown crops. Cassava, sweet potato, legume, fruits and commercial crops were also planted. Muskmelon and watermelon were grown at the Candaba Swamp during dry season. Rainfed and irrigated paddy, sugarcane, root crops, vegetables and fruit trees are grown on the lower river terraces and broad alluvial plains. Rainfed lowland paddy was also grown on the foot of volcanic hills and moderately sloping pyroclastic hills. Other upland crops were grown on these land management units. Forest, shrubs and grassland are extensive on the pryroclastic hill, volcanic hills foot and pyroclastic mountain.

Land use condition in the Study area before and after the eruption of Mt. Pinatubo are shown in Table K.4 and land use maps (Figure K.3 and K.4), and summarized as follow ;

(Unit : ha)

Items	Sacobia-Bamban River Basin Area			Abacan River Basin Area		
	after	before	Difference	after	before	Difference
Paddy (Rice)	20,760	26,710	-5,950	19,620	21,420	-1,800
Sugarcane	11,070	12,540	-1470	10,840	11,150	-310
Upland Crops	140	140	0	900	910	-10
Fruit Tree	570	570	0	610	610	0
Grass Land	10,610	11,330	-720	4,300	4,360	-60
Primary Forest	630	630	0	990	990	0
Secondary Forest	9,650	10,260	-610	6,260	6,350	-90
Fish Pond	0	0	0	920	920	0
Swamp Area	0	0	0	220	220	0
Build-up Area	5,060	5,430	-370	6,450	6,510	-60
Miscellaneous	2,300	3,420	-1,120	720	1,030	-310
Lahar/Mudflow	10,240	0	10,240	2,640	0	2,640
Total	71,030	71,030	0	54,470	54,470	0

Source : These figures are estimated by GIS based on 1/10,000 (1994) and 1/50,000 of topographic maps.

Most built-up areas were located on the broad alluvial plains, residual terrace and pyroclastic hills. The build-up area in Sacobia-Bamban river system, at both sides of Bamban bridge were completely damaged by lahar in 1991 and 1992, and barangays of

Sta. Rita, Malupa, San Martin and Magao in Concepcion also damaged with thick of lahar deposits in 1991. On the other hand, stream bank erosion of Abacan river in Angeles City destroyed residential establishments in 1991, and in 1992 partially.

2.5 *PRESENT CROP YIELD AND PRODUCTION*

Paddy (rice) remained the major crop raised in the Study area even after the eruption of Mt. Pinatubo. Although paddy and sugarcane ranks as the main crop in the Study area, the area planted to paddy decreased from 15,7100 ha to 7,990 ha and sugarcane/corn increased from 1,790 ha to 2,010 ha. Other upland and cash crops were still planted despite the eruption such as corn, string beans, cassava and mixed fruit trees. According the 5-years statistical data (1991/92 - 1994/95) by Municipal agriculture offices, present cropped area in affected area by lahar and mudflow are estimated in Table K.5, and summarized as follows:

(Unit : ha)

Crops	1990/91	1991/92	1992/93	1993/94	1994/95
Sacobia-Bamban River Basin Area :					
Paddy (Rice), irrigated	9,740	5,010	4,450	4,520	4,170
Paddy (Rice), rainfed	2,050	910	860	1,350	1,310
Sugarcane/ Corn	2,070	1,010	900	1,140	1,360
Other Crops	150	90	130	100	290
Total	14,010	7,020	6,340	7,110	7,130
Abacan River Basin Area :					
Paddy (Rice), irrigated	2,090	1,650	1,480	1,460	1,510
Paddy (Rice), rainfed	1,280	780	800	910	980
Sugarcane/ Corn	270	540	530	580	650
Other Crops	80	70	110	160	180
Total	3,720	3,040	2,920	3,110	3,320

Remarks : These data are estimated based on 50 barangays in affected area by lahar/mudflow.
Bamban (9), Concepcion (18) / Tarlac province , Mabalacat (4), Magalang (4) / Pampanga province in Sacobia-Bamban river basin area.
Mexico (12) and Santa Ana (3) / Pampanga province in Abacan river basin area.

Most of crop yield and production in the Study area are decreased due to damage by lahar and mudflow from 1990/91 to 1993/94. In 1993/94 cropping season, crop yield and production of paddy (rice) are recovered 4.3 - 4.5 t/ha under irrigated field condition has same level before eruption of Mt. Pinatubo. Major crop yields are estimated in Tables K.6 and K.7 and summarized as follows:

(Unit : t/ha)

Crops	1990/91	1991/92	1992/93	1993/94	1994/95
Sacobia-Bamban River Basin :					
Paddy (Rice), irrigated	3.6	4.2	3.9	3.9	4.3
Paddy (Rice), rainfed	3.9	3.9	3.8	3.9	4.0
Sugarcane	47.9	44.6	44.3	47.9	47.9
Corn	6.6	6.5	5.3	6.0	5.1
Abacan River Basin :					
Paddy (Rice), irrigated	3.8	4.3	4.3	4.5	4.6
Paddy (Rice), rainfed	2.3	3.1	3.0	3.3	3.5
Corn	4.4	4.4	4.4	4.3	4.5

Remark : These data are estimated based on 50 barangays in affected area by lahar/mudflow.

Based on the statistical data of the Municipal agricultural offices, present crop production in the affected area by lahar and mudflow are estimated as follows:

(Unit : tons)

Crops	1990/91	1991/92	1992/93	1993/94	1994/95
Sacobia-Bamban River Basin :					
Paddy (Rice)	43,060	24,800	20,560	22,680	23,080
Sugarcane	81,860	28,050	27,510	39,910	39,920
Corn	640	860	250	890	2,040
Legume	10	30	90	50	70
Root Crops	70	140	70	70	140
Abacan River Basin :					
Paddy (Rice)	9,390	9,530	8,260	9,550	10,050
Sugarcane/Corn	1,190	2,360	2,310	2,470	2,930
Legume	80	70	90	120	140

Remark : These data are estimated based on 50 barangays in affected area by lahar/mudflow.

K.3 INVENTORY OF IRRIGATION SYSTEMS / PROJECTS IN THE STUDY AREA

3.1 GENERAL

The object of the inventory were

a. to review and collect the latest information (maps and reports) on existing irrigation systems/projects in and around Sacobia-Bamban and Abacan river basins including those on the downstream reaches of the rivers,

b. to identify the irrigation systems/projects affected by lahar in and around the Sacobia-Bamban and Abacan river basins, and

c. to selected priority schemes to be proposed for future irrigation development.

The Project covers all Irrigation Systems/Projects within the Study area which were adversely affected/damaged by the eruption of Mt. Pinatubo including lahar flow.

(1) National Irrigation

These are more than 1,000 ha areas, developed and/or maintained by the National Irrigation Administration (NIA) wherein the farmers/beneficiaries are required to pay the Irrigation Service Fee (ISF).

a. National Irrigation Systems (NIS) ; Existing National Irrigation Systems, either wholly or partly affected by the eruption of Mt. Pinatubo.

b. National Irrigation Projects (NIP) ; These are on-going or proposed projects in the area the implementation of which were postponed or stop indefinitely and are either wholly or partly affected by the eruption of Mt. Pinatubo.

(2) Communal Irrigation

These are less than 1,000 ha areas, developed by the National Irrigation Administration (NIA), but are owned/operated/maintained by Irrigators' Association without government assistance. The farmers/beneficiaries are required to pay across the board 10% of the chargeable construction cost during the construction stage and the remaining 90% is to be paid without interest for a period of 50 years.

a. Communal Irrigation Systems (CIS) ; Existing Communal Irrigation Systems, either wholly or partly affected by the eruption of Mt. Pinatubo.

b. Communal Irrigation Projects (CIP) ; These are on-going or proposed communal projects in the area the implementation of which were postpone or stop indefinitely and are either wholly or partly affected by the eruption of Mt. Pinatubo.

(3) Pump Irrigation

These are less than 500 ha areas, developed by the National Irrigation Administration (NIA), but are owned/operated/maintained by Irrigators' Association without government assistance. The farmers/beneficiaries are required to pay across the board 10% of the chargeable construction cost during the construction stage and the remaining 90% is to be paid without interest for a period of 50 years.

a. Pump Irrigation Systems (PIS) ; Existing Pump Irrigation Systems, either wholly or partly affected by the eruption of Mt. Pinatubo.

b. Pump Irrigation Projects (PIP) ; These are on-going or proposed pump irrigation projects in the area the implementation of which were postpone or stop indefinitely and are either wholly or partly affected by the eruption of Mt. Pinatubo.

3.2 INVENTORY OF IRRIGATION SYSTEMS / PROJECTS IN THE STUDY AREA

The result of the inventory of existing irrigation systems in the Study area indicate among others their location, service and irrigable area, depth of lahar covered with each system, proposed rehabilitation program, extend of damage by lahar and/or heavy siltation due to ashfall from Mt. Pinatubo and are summarized per river basin as follows:

(1) Sacobia-Bamban River Basin

Prior to eruption of Mt. Pinatubo, Balog-Balog Multipurpose Project (BBMP), which is supposed to be financed by the Italian Government was deferred indefinitely due to technical reasons. The extension areas of the said project covers the existing communal systems within the middle and lower reaches of the Sacobia-Bamban River.

A Master Plan Study was conducted by JICA in December 1989 for the Improvement of Communal Irrigation Systems through Physical and Institutional Development and Rural Development in Southern Tarlac Province. Most of the existing communal irrigation systems identified in the said Study are within the area of the Sacobia-Bamban River basin.

There are 28 existing CIS/CIP/PIS/PIPs within the Sacobia-Bamban river basin of which 25 CISs and one each under the CIP, PIS and PIP classification. They are within the province of Tarlac as follows:

Name of Municipality	No of CIS/CIP	Area (ha)
a. Bamban	5	1,532
b. Capas	7	2,172
c. Concepcion	16	7,349
Total	28	11,053

(2) Abacan River Basin

The Pampanga Delta Development Project - Irrigation component (PDDP-IC), a NIP in terms of coverage and scope and where some of its western service area are within the Abacan River was postponed due to lahar damaged. An Evaluation Study was requested by the NIA in order to determine if the project will be further affected by lahar flow including the recommendation of a possible alternative scheme of irrigation development.

A Master Plan Study was conducted by JICA in November 1992 for the Mapping and Agricultural Potential Study for the Integrated Rural Development Program in Pampanga Province. The existing communal irrigation systems identified in the said Study are the San Roque CIS and San Pablo Central CIS are within the basin area of the Abacan River.

There are 122 existing SRIP/CIS/CIP/PIS/PIPs within the Abacan river basin, all with the province of Pampanga as follows:

	Name of Municipality	No of CIS/CIP	Area (ha)
a.	Angeles	5	473
b.	Mabalacat	12	2,414
c	Magalang	11	2,175
d.	Florida Blanca	1	211
e.	Lubao	1	800
f.	Sta. Rita	3	190
g.	Arayat	16	3,609
h.	Bacolor	7	855
i.	Mexico	17	2,122
j.	San Fernando	5	210
k.	Sta. Ana	5	614
l.	Candaba	11	7,082
m.	Macabebe	11	2,493
n.	Masantol	3	688
o.	San Luis	5	1,040
p.	San Simon	9	2,001
	Total	122	26,977

Overall Status of CIS/CIP in the Sacobia-Bamban River basin (Tarlac Province) and Abacan River basin (Pampanga Province) are given in Tables K.8 and K.9 and Figure K.1 respectively.

In the Sacobia-Bamban river basin area, about 6,580 ha of 14 existing CISs was directly damaged by lahar and mudflow from 1991 to 1994. For the wet season crop, about 5,050 ha of irrigated area before the eruption of Mt. Pinatubo was changed to 880 ha. These CISs are shown in Location Map (Figure K.5), and detailed conditions are given in Table K.10, and summarized as follows:

Name of C.I.S.	Potential Area 1989 (ha)	Potential Area 1994 (ha)	Irrigated Area 1989 (ha)	Irrigated Area 1994 (ha)	No of I.A. Members
Bamban C.I.S.	1,050	620	750	300	500
San Pedro C.I.S.	145	140	120	0	105
Malonzo C.I.S.	335	250	180	0	150
Bangucu C.I.S.	720	120	700	0	80
Telabanca C.I.S.	390	330	390	0	121
Sta. Rita C.I.S.	135	130	115	0	43
Marita C.I.S.	100	100	100	0	41
San Martin C.I.S.	330	230	240	0	95
Balutu C.I.S.	600	390	600	390	120
Lilibangan C.I.S.	350	240	240	0	116
San Bartolome C.I.S.	375	220	350	0	64
San Isidro C.I.S.	630	600	450	190	235
Magao C.I.S.	960	960	470	0	152
Tabun (MASKUP) C.I.S.	460	460	350	0	37
Total	6,580	4,790	5,055	880	1,859

Sources : 1989 survey by JICA Master Plan for Improvement of Communal Irrigation Systems in Southern Tarlac Province.
1994 survey by Provincial Irrigation offices, Tarlac and Pampanga provinces.

3.3 GOVERNMENT EFFORTS IN THE LAHAR AFFECTED IRRIGATION SYSTEMS/PROJECTS IN THE STUDY AREA

The heavy ashfall compounded with strong precipitation in 1991 brought remarkable damage to existing irrigation systems/projects within the Study Area. In spite of funds already released for rehabilitation works for some of the systems in Tarlac and Pampanga, the rehabilitated systems experienced deterioration in the delivery of

irrigation water due to continuos flow of heavy siltation and caused damaged to diversion structures including the irrigation canals and structures.

After the eruption of Mt. Pinatubo in 1991, NIA received special funds from the Rehabilitation of Areas Affected by Mt. Pinatubo Eruption (RAAMPE). Fund releases under the said program were on piece-meal basis and where the rehabilitation/restoration schemes were intended for limited emergency repairs only.

Other source of rehabilitation fund is the Comprehensive Agrarian Reform Program - Irrigation Component (CARP-IC), under the auspices of the Department of Agrarian Reform (DAR). Fund releases is being directed to NIA through the Project Management Office (PMO) of CARP-IC. However, due to meager resources, allocation of funds to support extensive rehabilitation program of lahar affected irrigation systems may not be possible.

NIA, particularly in the Provincial Irrigation Office (PIO) level, is preparing rehabilitation program for the affected irrigation systems aimed at securing funds from the Mt. Pinatubo Commission (MPC). Again, there is no guarantee of funding support from this Commission because of its other priority undertakings which include relief and resettlement of displaced families.

The Department of Agriculture (DA) has implemented a rehabilitation program called Oplan Sagip Bukid (Save the Fields) in the affected areas to help farmers rehabilitate farmlands, livestock, fishpond, orchards and related farm infrastructure in the Tarlac and Pampanga provinces.

(1) Crop and Soil Rehabilitation Program

The farmlands covered with ashfall have been rehabilitated through the following activities ;

- Collection and analysis of soil and water samples by the Bureau of Soils and Water Management (BSWM) in coordination with DA Region III and formulation of a set of technical recommendations for growing crops in cooperation with other Agencies and Institutions.

- Conduct of plowing demonstration on various depth levels of ash/lahar with the use of four-wheel tractors, hand tractors and carabao-drawn manual plow.

- Conduct of scraping and plowing of affected farmlands with the use of bulldozers and four-wheel tractors.

- Extension of the plowing work (equivalent to Peso 1,000/ha) in 7.5 cm to 15 cm depth of ash/ lahar, and the scraping and plowing (equivalent to Peso 2,000/ha) in the areas of more than 30 cm depth of ash/ lahar.

- Provision of fertilizer, seeds, planting materials and other inputs.

Based on the initial research findings and report as of March 16, 1992, the following activities had been accomplished.

Total area rehabilitated reached 78,757 ha. This accounts for about 92 % of the targeted 85,780 ha for rehabilitation. These area have already been planted with rice (74,077 ha), vegetables (2,401 ha) and rootcrops (1,379 ha). Of the area planted, about 68,333 ha have been provided with plowing and scraping assistance using carabao, hand and 4-wheel tractors or a combination were used involving 56,777 farmers in 528 barangays of 41 municipalities.

(2) Livestock Rescue and Rehabilitation Program

- Evacuation of farm animals from disaster areas to safe shelters or stock farms in the Livestock Feeding Centers (LFCs), i.e. Maria Sinukuan Stock Farm Management, Pampanga and Tarlac Breeding Station, Tarlac.

- Provision of feeds and animal health care to evacuated animals in the LFCs.

- Setting-up of ambulatory services

- Livestock purchasing schemes

- Animal dispersal program

The DA through the Bureau of Animal Industry (BAI) has dispersed poultry and livestock to farmer-victims under the Multi-Livestock Dispersal Loan Program or the dispersal activities of the Region III. Said dispersal program has been implemented during the Resettlement Phase of Oplan Sagip-Bukid.

The DA provided transportation in the evacuation of some animals including carabaos, cattle, swine poultry, goat, sheep and dogs. Livestock Feeding Centers were established in Pampanga, Tarlac, Bulacan, Zambales, Nueva Ecija and Pangasinan. Livestock, pharmaceuticals, biologics and materials were distributed to mitigate spread of diseases in the affected areas.

(3) Establishment of Income Generating Projects (IGPs)

The DA has been setting up income-generating projects under its Livelihood Enhancement for Agriculture Development (LEAD) program to help farmers, fisher folk and other displaced rural folk earn supplemental income.

A total of P 2.65 million was released to Region III to finance various project proposals for affected farmers/ fisher folk for them to earn supplemental income.

(4) Repair of Farm Infrastructure and DA Facilities

In coordination with the National Irrigation Administration (NIA), the DA in 1992 has also restored damaged infrastructure such as Small Water Impounding Projects (SWIPs), irrigation canals and some of its facilities like seed nurseries, farmer's training centers, bangus/ animal breeding stations and several municipal offices and laboratories.

A total of fourteen (14) SWIPs constructed by the DA/BSWM were severely damaged by ashfall and lahar cascading to small river tributaries where such projects are located. The damage consists of slight to heavy siltation, and collapsed river bank control and other major structural components. Of the 14, about 10 SWIPs are rehabilitated in 1992. Other machinery and equipment were made available on credit through the Land Bank of the Philippines (LBP). This is joint project of the LBP and DA through the assistance of the Asian Development Bank (ADB). Damaged DA's facilities such as the crop/animal stations and offices were also rehabilitated in 1992. Funding has been soured again, through the ADB.

K.4 AGRICULTURE DEVELOPMENT PLAN

4.1 GENERAL

Major goals and strategies of the agriculture development plan including the restoration and rehabilitation of agricultural facilities and land reclamation in affected area by Mt. Pinatubo are: (i) to increase gross regional domestic product by increasing agricultural production, (ii) to generate employment opportunities by encouraging the expansion and agro-industries, (iii) to improve basic rural infrastructure and social services, and (iv) to give incentive benefit to the low income families. These goals and strategies coincide with the national development goals adapted under the Medium-Term Philippine Development Plan (1992 - 98).

4.2 THE PROJECT AREA

The affected areas are classified according to depth of the lahar deposits by GIS based on the present land use map. There are four (4) classes as a guide in future agriculture development plan that delineated the affected area, namely; Class-I, Class-II, Class-III and Class-IV. The land classification will be as follows:

Class - I : These areas were slightly affected (below 15 cm) by ashfall of Mt. Pinatubo eruption in 1991. It is expected that the areas' productivity has slightly decreased and farmers in these areas can easily rehabilitation their farms, thereby requiring minimal assistance.

Class - II : These areas were slightly or moderately affected (15 - 30 cm) by lahar flow from 1992 to 1994. The area is potential for quick recovery due to its geographic accessibility and relatively thinner ash cover. Intensified assistance are needed in these areas because of their proximity and foreseen role in balancing the food requirement of the entire affected areas. External assistance will ensure rapid recovery and rehabilitation of these areas.

Class-III : These areas had thick lahar cover (30 - 90 cm) requiring huge amount of resources/ assistance to rehabilitate. Cleaning operations and restoration of agricultural infrastructure where required prior to the introduction schemes.

Class-IV : These areas severely covered with lahar and the damage to agriculture is almost beyond recovery. A depth of lahar more than 90 cm. Soil rehabilitation efforts have been massive and the recovery period longer. These are the areas where the immediate needs were rescue, relief, relocation or settlement activities.

The lahar and mudflow affected land in the Study area are classified according to above land classification. The area of each land class are estimated in Table K.11, and summarized as follow.

(Unit : ha)

Description	Class I	Class II	Class III	Class IV	Total
Sacobia-Bamban River Basin :					
Bamban	2,840	260	640	240	3,980
Capas	7,430	190	0	0	7,620
Concepcion	8,010	2,520	680	1,700	12,910
Mabalacat	19,500	1,160	570	1,340	22,570
Magalang	23,030	920	0	0	23,950
Sub-total	60,810	5,050	1,890	3,280	71,030
Abacan River Basin :					
Angeles City	7,060	590	0	0	7,640
Arayat	12,880	170	0	0	13,050
Santa Ana	10,960	680	0	0	11,640
Mexico	20,910	700	520	0	22,130
Sub-total	51,810	2,140	520	0	54,470
Total	112,620	7,190	2,410	3,280	125,500

Source : These figures are estimated by GIS based on 1/10,000 (1994) of topographic maps.

As shown above, 12,880 ha of Class II, III, and IV land, which is covered by lahar and mudflow, is object area of the agriculture development plan for restoration/rehabilitation of agricultural facilities and land reclamation works. After reduction of build-up area, non-irrigated area and others area, the present cultivated area of proposed agricultural development plan was estimated in Table K.10, and summarized as follows:

(Unit : ha)

Description	Location (Municipality)	Total Area	Cultivated Area Paddy	Cultivated Area Upland Crops
Sacobia-Bamban River Basin Area :				
Bamban C.I.S.	Bamban	1,050	550	250
San Pedro C.I.S.	Bamban	180	30	60
Bangcu C.I.S.	Bamban/ Concepcion	870	370	250
Tabun C.I.P.	Mabalacat	300	0	0
Maskup C.I.P.	Mabalacat, Bamban	1,650	0	0
Santa Rita C.I.P.	Concepcion	560	0	0
Marita C.I.P.	Concepcion	670	0	20
Magao C.I.S.	Concepcion	880	250	180
San Vicente C.I.P.	Concepcion	1,000	620	150
San Bartolome C.I.S.	Concepcion	1,050	530	300
San Isidro C.I.S.	Concepcion	810	510	100
Balutu C.I.S.	Concepcion	150	60	10
Calius Gueco C.I.P.	Concepcion	550	200	150
Sub-total		9,720	3,120	1,470
Abacan River Basin Area :				
San Juan C.I.P.	Mexico	620	260	50
San Patricio C.I.P.	Mexico	600	130	90
San Joaquin C.I.P.	Santa Ana	350	70	10
Sub-total		1,570	460	150
Total		11,290	3,580	1,620

Source : These figures are estimated by GIS based on 1/10,000 (1994) of topographic maps.

4.3 CHANGES IN LAND USE

(1) Sacobia-Bamban River Basin Area

It is obvious that the structural measures of the Project should protect agricultural land and residential areas along Sacobia-Bamban River from further mudflow and flood events in most cases. Thus, agricultural activities or any other economic activities can resume as soon as the permanent structures for the river improvement measures are completed.

With the completion of the proposed agriculture development plans, about 3,150 ha of non-cultivated area, which are affected by lahar and mudflow deposits, will be change in the type of crops to be planted in the area. About 1,000 ha of paddy field and 660 ha of upland crop field will be increased under irrigation condition. About 1,300 ha of the agro-forestation field consists of fruit/fodder trees field, fish pond and livestock yard will be introduced in the Project area severely covered with lahar. The two different scenarios of land use under the present and future conditions are compared as follows:

(Unit : ha)

Description	Present Condition	Future Condition	Difference
Paddy (Rice) Field	3,120	4,170	1,010
Upland Crop Field	1,470	2,130	660
Agro-forestation Field	0	1,360	1,360
Build-up Area	420	545	125
Non-cultivated Area	4,710	1,555	-3,155
Total	9,720	9,720	0

(2) Abacan River Basin Area

No changes in land use along most part of Abacan River should occur as dikes constructed before Mt. Pinatubo eruption. However, the structural measures for the downstream area of Abacan River should be reviewed as the flood events are getting more frequent comparing to before Mt. Pinatubo eruption. The extent of damage is more wide spread than before. With the completion of the proposed restoration and rehabilitation works, 550 ha of present non-cultivated area will be changed to 300 ha of paddy field and 250 ha of upland crop field after completion of restoration and rehabilitation of irrigation facilities.

(Unit : ha)

Description	Present Condition	Future Condition	Difference
Paddy (Rice) Field	460	760	300
Upland Crop Field	150	400	250
Build-up Area	110	110	0
Non-cultivated Area	850	300	-550
Total	1,570	1,570	0

The present and future land use condition in the Project area are given in Table K.12.

4.4 PROPOSED FARMING PRACTICES

It is expected in the future that the farmers will expand their crops to the heavily affected area and even very affected area, because the farmers have strong intention and desire to cultivate if their income remains low according to the interview. Particularly in the heavily affected area the factors governing the crop growth and yield are better than those in the very heavily affected area. Furthermore, cropping or vegetation will develop the surface soil horizon of the cultivated land by providing organic matters. The original soils buried by the lahar deposits were old lahar deposits of the Mt. Pinatubo which occurred several hundreds years ago, and have been developed as cultivated lands. In this regard, there is a possibility that the heavily affected area is included in the near future according to the progress of cultivation by the farmers.

(1) Soil Rehabilitation in the Lahar Affected Area

A lot of agricultural crops suitable to grow in the lahar affected areas could be discovered provided that the proper plant nutrition and moisture is maintained. Spontaneous verification trials have been made in the actual lahar fields within the Project area. The positive impacts can be enhanced through proper rehabilitation management techniques.

The physico-chemical properties of the lahar and mudflow deposits shows that it has very poor physical properties (drought and low water holding capacity) due to its sandy nature. Chemically, it has very low available nutrients and organic matter to sustain plant growth. Fertilization and irrigation is necessary for crop production. Organic matter will be build up specially on the top layer of the lahar is indispensable or sustained productivity. This can be achieved through vegetative means or can be hastened with organic matter or compost in corporation into the lahar. One strategy is the management of biodegradable urban waste. The composted urban waste (biodegradable) from Metro Manila can be hauled to the lahar affected areas and in return the hauling trucks can bring lahar to serve as construction material in Metro Manila. There is a huge volume of decomposed urban waste which can be sieved and hauled to the lahar affected areas for incorporation in to the top layer. This compost must be safe for farmer use. Sugarcane bagasse and mudpress from sugar mills in Central Luzon can be used.

The starting point in the rehabilitation of lahar will be to begin with those which are already stabilizing. This is indicated by the dense growth of wild Saccharum and Calopogonium as the pioneer species. These plants can be cut and the biomes will be incorporated into the lahar as organic matter.

As for the risk of sulfur, there are two (2) kinds of countermeasures, namely (i) improvement of soil pH by reducing the concentration of sulfuric acid and (ii) avoiding formation of hydrogen sulfide. To reduce sulfuric acid concentration, leaching by irrigation water and application of lime could be applied. To avoid hydrogen sulfide, iron rich soils like red soils should be conveyed and mixed. Iron sulfide will be formed and precipitated in the soil. Another way is to keep the lands in dry condition because hydrogen sulfide can be formed in reduced condition under the submerged field.

Accordingly, the Department of Agriculture disseminated the following recommendations to farmers.

a. The area with less than 1 m depth of the lahar deposits is suitable for cultivation.

b. The area with more than 1 m depth of the lahar deposits should be left uncultivated in the meantime. In order to cultivate the land with more than 1 m depth of lahar deposits, one fourth (1/4) of the area should be used and sacrificed as a dump area of the lahar deposits and the remaining three fourth (3/4) of the area be allocated for cultivation. The recommended mixing of volcanic ash or the lahar deposits with soils should be within a ratio of 50 : 50.

(2) Proposed Crops in the Lahar Deposit Area

In the present cultivated area covered by medium to shallow and fine lahar deposits, shallow irrigation pumps were installed to irrigate the farm lands planted with tomato, egg plant, corn and other crops. The surface lahar deposits were mixed with the original soil. According to the farmers, increased fertilizer inputs were needed to produce ordinary yields.

The Bureau of Soils and Water Management, Department of Agriculture, conducted the adaptability test of different field crops in lahar deposits. The results showed that proper application of organic and inorganic fertilizers sustain normal yield of diversified crops in pure volcanic ash and pure lahar. Mixture of 15 cm depth of volcanic ash does not affect the yield of corn and paddy when the lahar deposits is mixed with the original soils by plowing. A lot of crops will be suited to lahar, provided that the proper nutrition and moisture will be provided. The results of adaptability test of different crops under lahar-laden soils are shown below.

Name of Crops	Computed Yield (t/ha) under Lahar	normal	Fertilizer Rate	Suitability
A. Rootcrops :				
Sweet potato	30.90	18.5	42-42-42 NPK	Suitable
Cassava	15.60	20 - 40.0	35-35-35 NPK	Suitable
Yambean	3.67	15.0	21-21-21 NPK	Not suitable
B. Cereal Crops :				
Corn (pcs. ears)	40,000	-	28-28-28 NPK	Suitable
Sorghum	3.65	3.5 - 5.0	28-28-28 NPK	Suitable
C. Field Legume Crops :				
Peanut (shelled)	1.70	1.8 - 2.1	28-28-28 NPK	Suitable
Mungbean	1.29	1.1 - 1.5	28-28-28 NPK	Suitable
Soybean	0.41	1.8 - 2.1	28-28-28 NPK	Not suitable
Cowpea	0.92	1.5 - 2.0	42-42-42 NPK	Suitable
Pigeon pea	0.51	1.5 - 2.0	42-42-42 NPK	Not suitable
D. Other Field Crops :				
Sesame	4.40	0.35 - 1.7	28-28-28 NPK	Suitable
Egg plant	20.0	30.0	50-80-90 NPK	Suitable
Tomato	60.0	20 - 60.0	90-100-150 NPK	Suitable
Okra	12.5	20.0	50-80-90 NPK	Suitable
Cucumber	31.3	30 - 60.0	180-225-135 NPK	Suitable
Water melon	22.5	15 - 30.0	11 ton Organic fertilizer	Suitable

Sources : Bureau of Plant Industry, Bureau of Soils and Water Management, and International Fertilizer Industry Association (IFIA)

Verification trials should be done in the actual lahar field, and should be given priority with large scale research works based on the scientific and commercial basis and that the associated pilot farming can be implemented. A larger scale of government organization, municipality and up, should be responsible for this scheme.

(3) Mechanization of Farming Technology

Mechanization of farming technology should be considered. The future study should focus on the strategic area of mechanization in local agricultural technology in relation to the thickness of lahar/ash deposit since the deep mechanical tillage for optimum mixture of high organic content top soil of the area, now under lahar/ash, is the key element to rapid recovery of soil fertility.

If feasible, establishment of inexpensive farming machinery renting center for the local farming families should be considered as an urgent project in order to increase a number of items of productive and marketable agricultural commodities, while increase in the fertility of the soil and diversification of agricultural technology to avoid mono-cultural tendency rice farming in the study area are achieved. Thereby, in long term, livelihood of the local farmers, especially their extra cash income, will be improved.

4.5 INTEGRATED AGRICULTURAL DEVELOPMENT PLAN IN THE LAHAR AFFECTED AREA

The calamity continues to destroy farmlands, forest and watershed areas and has notably caused damage to the river systems and overall environment of the lahar and mudflow affected areas. This demands careful and more comprehensive land use replanning of the affected areas at the local level. Land use capability and suitability have to be determined to optimize the utilization of the land resources in the affected area. The challenge of preparing comprehensive land use plans becomes more serious, as information requirements such as depth of ash, lahar and mudflow in affected areas, mineral composition, soil condition and related technical information have to be sufficiently and timely provided to generate realistic land use plans for the areas.

To achieve the development goals and objectives, the following activities and strategies are fully considers in designing the agricultural development plan and projects with integrated activities by a joint undertaking of national and local government agencies, the private sector including the NGOs and the farmers themselves.

(1) Availability of Water for Irrigation

Depending on the locations, availability of irrigation water especially in the main course of Sacobia-Bamban will have to be reorganized as diked river banks would limit the farmers access to water for irrigation. Sapang Balen River Improvement Works would divert original course of water way in places and diking would limit the access to the water in the river. Therefore major reorganization of the way the river is used will have to be considered.

(2) Land Ownership

At present, nothing on the land ownership has been discussed openly and thoroughly as no concrete decision has been made on the Project. On the other hand, the structural measures already conducted on site are understood among the local residents that they are of temporary and urgent nature. Thus, no portion of privately owned land has been formally negotiated for purchase, nor paid for the construction of urgent structural measures which has taken place in the Project area.

(3) Protection of Barangays

The most critical impact given by the structural measures of the Project is protection of the badly devastated areas. Thus psychologically stabilizing the mind of people in the Project area is achieved. This will make them come back to their original habitat and resume activities such s to invest in their homes, farms and other properties. This positive impact would last for as long as the control structures serve their purpose.

(4) Employment Opportunities During the Construction Works

The constructing works of the river improvement structures, roads and agricultural facilities would require skilled and unskilled laborers. Recruitment of the local residents from the areas where structures would be built would be relatively easy. This would supplement the deficit of income for those who can not resume agricultural activities in the Project area.

(5) Strengthening the Organization of the Local Communities

Upon completion of the agricultural development project, the adjoining communities would be assigned for the task of maintaining and monitoring the agricultural development activities in the Project area. They would thus be given a concrete opportunity to work together with their neighbors for their common goal. This would function to strengthen their cohesiveness among the communities.

(6) Livelihood Program

Since those of affected by lahar have voiced up of their concern on the agricultural development, and those who have not been previously engaged agriculture are willing to enter into agricultural sector, agriculture development program would have to be the top priority option for the livelihood program.

The livelihood program should be based on the extensive rural development studies based on the present physical conditions of the Project area. It is also important that it would be incorporated with a number of studies associated with Mt. Pinatubo recovery program. One of the alternatives, and most realistic and attractive program, would be to incorporate

it with the "Central Luzon Development Program" being conducted by the Department of Trade and Industry in association with JICA assistance.

(7) Soil Rehabilitation Map

For the strategic planning for livelihood program, soil rehabilitation map should be made urgently. It is divided into three different categories of i) Lahar Affected Areas; ii) Ashfall Areas; and iii) Evacuation/Resettlement Areas

Lahar and mudflow affected areas are further sub-divided into several areas depending on the degree of damage i.e. depth of debris because the thickness of the volcanic materials would be the "key factor" for the vegetation rehabilitation and in turn this is the "key factor" for livelihood program of the area affected by the Mt. Pinatubo eruption as it is directly related to the hopes of the local residents, majority of them are farmers and even the former shop keepers, and the industrial workers used, including those who worked for CAB, are entering to the agricultural sector to help reorganize the local communities. Thus it is essential to make a map of "soil/vegetation rehabilitation" on which strategic livelihood program would depend.

Land rehabilitation map should be made based on the soil survey of which thickness of volcanic materials, physical classification, chemical characteristics and the overall soil fertility and the suitability to food and commercial crop growing are the criteria. Based on this map, strategic land use planning should be established. Thereby, the evacuees and those affected by the aftermath of the eruption can be reorganized to return to the areas of which their livelihood can be ensured.

(8) Irrigation System Development

The existing irrigation systems must be reorganized in order to increase cropping intensity. It is particularly important as soil fertility in the Project area has been drastically changed. It is also necessary as potential changes of the waterway in association with the structural measures of the Project should occur. The future study should focus on the irrigation system development on the each river basin area, including those to the north of Sacobia-Bamban river and the ground water irrigation system.

The study should focus on the best possible combination of surface water irrigation system and the ground water irrigation system, cost implications and their feasibility. The changing nature of upper stream catchment area should be taken into consideration of water availability.

(9) Pilot Farming

As a support project to the Key Commercial Crop Area (KCCA) program of the DA, pilot farms in cooperation with innovative farmers in the Project area will have to be organized and technically assisted by the DA to promote the adoption of field-tested farming technologies conducted by the Bureau of Soils and Water Management (BSWM) and other research institutions in volcanic ash and lahar affected areas. New crops with high export potential (e.g. asparagus, young corn) will also be promoted with livestock, fishpond and agro-reforestation development. The following researches are proposed to be conducted.

a) Monitoring and evaluation of crop responses and productivity

Recent studies should be continued and expanded in coverage to monitor and evaluate responses and productivity of grains, fruit trees, vegetables, forage species in the Project area at varying depth of ashfall and lahar for a period of at least five years. The study shall provide tested technologies to improve management if the affected areas.

b) Assessment and development of shallow ground water irrigation

The Sacobia-Bamban river basins were drastically changed by the eruption of Mt. Pinatubo and subsequent lahar and mud flows. The study would provide alternative source of irrigation for agricultural production in the affected areas.

c) Research on soil improvement technologies

Because of the permanent changes in the soil characteristics of the Project area, proposed crop cropping pattern, their biological growth potentials and their marketability should be assessed to the potential crops. Particular attention should be paid to the system of developing integrated organic farming i.e. a combination of maintaining chicken pen, cattle rearing and regular farming technique. Thereby, the organic input to the soil within the unit of farming area, however individual or collective, would be increased without major spending on fertilizers, risking increasing amount of chemical fertilizers.

For implementation of agricultural development projects, there are many government and non-government organizations engaged in financial and technical assistance should be well coordinated under the integrated framework. Project implementors shall be trained in public administration and funds management for they serve not only as conduits of financing but also as facilitators in planning, programming, monitoring and evaluation of the Projects.

A coordinating body shall be created to orchestrate and oversee all activities. Infrastructure development including providing access roads to strengthen linkages between production areas and the markets, irrigation water supply to ensure continued crop production and other amenities for the community shall be effected. Technical and marketing assistance and technology disseminations to the farmers shall be provided through extension workers.

Likewise, the academe will be tapped to conduct research activities on productivity, use of indigenous materials, recycling of used materials, new and other uses of agriculture and industry by-products and wastes as alternative livelihood projects for farmers. Marketing assistance, on the other hand, shall be provided through facilitation of bulk purchasing agreements, market-product matching, trade fairs, exhibits and display centers.

An information network is necessary to keep the farmers informed on new technologies, sources of local and indigenous raw materials, new products and other information including profits of marketable commodities, potential markets and industry trends.

K.5 PROPOSED AGRICULTURAL DEVELOPMENT PLAN

5.1 GENERAL

At the national level, the objectives of development efforts are to alleviate poverty, promote social equity and attain sustainable development which shall be pursued through people empowerment. In order to achieve people's lives, the major strategies to be pursued within the medium term are i) human development, which will address the spiritual, political, sociocultural and physical aspects of people's lives; and ii) international competitiveness which will be necessary for the attainment of people empowerment in the economic sense.

The Project area located the eastern portion of the region shall remain as the food bowl and the major raw material source of the region. Within the medium term, crop intensification and diversification shall be the area's preoccupation as the means of compensating for the production losses in the Pinatubo affected areas. Its vast agricultural and forest resource potentials shall be developed in a sustainable manner in pursuit of the food security objective while at the same time ensuring the area's environmental integrity.

The long term plan for Central Luzon envisions that eventually a full-blown agro-industrial development shall be pursued through the networking of industrial areas, productivity centers, and agri-business centers located over the region into synergistic production units.

(1) Regional Concerns on Mt. Pinatubo

In connection with the regional development in Central Luzon, the most important concerns and the greatest challenges that the Central Luzon area are currently facing are the devastation caused by the eruption of Mt. Pinatubo, which will cause continuing damages to socio-economic conditions in Central Luzon for next five to ten years. In the Central Luzon Medium Term Development Plan 1993-1998, specific development objectives and strategies targeted for the recovery of Mt. Pinatubo disaster are stated as follows.

a) To mitigate further destruction brought about by the adverse effects of the eruption particularly lahar flows and flash floods,

b) To normalize and accelerate economic recovery including the creation of an attractive investment climate,

c) To provide adequate livelihood and employment alternatives especially for displaced farmers and workers,

d) To promote growth and development in resettlement and new settlement areas serving as alternatives to permanently damaged and high risk areas,

e) To ensure the continuous flow of goods and services when calamity strikes especially during relief operations,

f) To strengthen institutional structures, arrangements and mechanisms for disaster preparedness and responsiveness and raise public awareness on natural disaster and disaster mitigation and reduction,

g) To reduce the susceptibility of vertical and horizontal infrastructure to damages due to lahar and other natural disasters, and

h) To prevent future degradation of environment and rehabilitate damaged ecosystems.

(2) Central Luzon Regional Development Plan

The Master Plan Study for Central Luzon Development Program (CLDP) is covered the whole Region III (Central Luzon) area of the six provinces of Pampanga, Tarlac, Bulacan, Nueva Ecija, Bataan and Zambales. The target year is set at the year 2010. The three alternative development scenarios for Central Luzon are proposed in the Master Plan as shown below:

a) Globalization scenario

To utilize to its maximum the industrial resources for export, the agricultural sector will specialize in a few selected crops other than rice that can be exported.

b) Localization scenario

To utilize the indigenous resources effectively, the agricultural productivity should be enhanced through crop diversification. In addition to agro-industries, handicraft and apparel industries would also be given priority.

c) Glocalization scenario

To transform some traditional industries into internationally competitive ones through market specific development. The promising industries under this scenario include aviation industry, electronics, precision instruments, software and information industries.

5.2 URGENT RESTORATION PROGRAM

This may be considered as an urgent restoration program by the Local Government Unit (LGU) with coordinate to the Provincial Irrigation office under NIA to restore and improve the agricultural production in the Project area by rehabilitating all CIS which are still rehabitable and where protective measures to stave-off further damages due to lahar flow have already been in-place and/or can be easily installed. There are about 9 existing irrigation systems/projects within Tarlac province which are not directly affected by lahar flow. This systems/projects were damaged mainly due to increase in siltation brought about by ashfall and flush flood within their watersheds. Urgent restoration in this 9 systems is necessary in order to attain crop production prior to their pre-eruption condition.

	Name of Municipality	No. of CIS/CIP	Area (ha)
a.	Bamban	1	400
b.	Capas	2	702
c.	Concepcion	6	40,330
	Total	9	41,432

In Pampanga province, there are about 22 existing irrigation systems/projects which are not directly affected by lahar flow. This systems/projects were damaged mainly due to increase in siltation brought about by ashfall and flood within their watersheds. Urgent restoration in this 22 systems is necessary in order to attain crop production prior to their pre-eruption condition.

	Name of Municipality	No. of CIS/CIP	Area (ha)
a.	Angeles	1	120
b.	Mabalacat	3	303
c	Magalang	3	136
g.	Arayat	7	782
i.	Mexico	1	180
j.	San Fernando	2	84
k.	Sta. Ana	1	28
l.	Candaba	3	754
o.	San Luis	1	206
	Total	22	2,593

The Selection Criteria in identifying the priority CIS/CIP for Urgent Restoration Program which are affected by Mt. Pinatubo eruption and under this Study are as follows:

a) Systems that were programmed and/or on-going for rehabilitation prior to eruption but suspended/stopped due to the eruption,

b) Projects that were programmed and/or on-going but were stopped indefinitely due to the eruption, and

c) Systems/projects that had already availed of rehabilitation funds (RAAMPE, CARP-IC or MPC) but still need further rehabilitation/ restoration due to continuos flow of lahar or sediments caused by ashfall.

List of Priority CIS/CIP for Urgent Restoration Works in Tarlac Province and Pampanga Province is shown in Table K.13. The Layout plan and project sheet of each Existing CIS/CIP for Urgent Restoration Works is shown in Figures K-D.1 to K-D.31 of a Data Book.

5.3 RESTORATION AND REHABILITATION PROJECT

A total of 6,240 ha of 9 existing irrigation systems/projects along Sacobia-Bamban and Abacan rivers was directory affected by lahar and mudflow. This systems/projects were damaged mainly due to increase in siltation brought by ashfall and flush flood within watersheds. At present, the these area are already safe from further lahar attack with the completion of both left bank/dike (with lining) and right bank/dike of the Bamban River and because of the diversion of the Sacobia River to a new river channel, and both dikes of the Abacan river.

Agricultural activities in areas where damaged was minimal and/or spared from lahar cover has also been resumed. Farmers harnessed available rainfall and plain run-off including shallow well pumps for irrigation water supplement specially during scarce rainfall.

The improved conditions in the Sacobia-Bamban river basin area and considering that the Marimla/Sapang Cuayan rivers (upstream of Bamban River) which is proposed to be the source of irrigation water under this scheme is free from lahar, the area is presently attractive for irrigation development. However, due to insufficient hydrological data, it is recommended that further study be undertaken to ascertain water availability to meet irrigation requirement for the proposed development scheme. Location of proposed CIS/CIP for restoration and rehabilitation project is shown in Figure K.6, K.7 and K.8. The project description of proposed restoration and rehabilitation project for agricultural facilities in lahar and mudflow affected area are mentioned in Table K.14, and typical section of proposed diversion dam is shown in Figures K.9, and summarized as follow.

Description	Location (Municipality)	Irrigation Area	Water Source	Type /No of Intake
Sacobia-Bamban River Basin Area :		(ha)		
Bamban C.I.S.	Bamban	850	Bamban river	Ogree (1)
San Pedro C.I.S.	Bamban	130	Bamban river	- same -
Bangcu C.I.S.	Bamban	650	Bamban river	- same -
Magao C.I.S.	Concepcion	690	Lucung river	Checkgate (2)
San Vicente C.I.P.	Concepcion	810	Bamban river	Ogree (1)
San Bartolome C.I.S.	Concepcion	830	Sapang Balen creek	Checkgate (2)
San Isidro C.I.S.	Concepcion	650	Dalandanum creek	Checkgate (1)
Balutu C.I.S.	Concepcion	100	Parua Creek	Checkgate (1)
Calius Gucco C.I.P.	Concepcion	370	Balen creek	Checkgate (1)
Sub-total		5,080		
Abacan River Basin Area :				
San Juan C.I.P.	Mexico	460	Abacan river	Ogree (1)
San Patricio C.I.P.	Mexico	460	Abacan river	Ogree (1)
San Joaquin C.I.P.	Santa Ana	240	Joaquin creek	Checkgate (1)
Sub-total		1,160		
Total		6,240		

Source : These figures are estimated by GIS based on 1/10,000 (1994) of topographic maps.

Another alternative which is of medium-term irrigation development for the proposed restoration and rehabilitation project is through extensive ground water irrigation of lahar free areas due to the following reasons:

a) the area is already safe from lahar flow due to the construction of lahar/mudflow control infrastructure facilities,

b) the area is extensively planted with crops even with deficient irrigation facilities, and

c) in order to alleviate the living condition of the farmers and bring Government closer to the lahar affected families.

5.4 SANTA RITA PILOT AGRICULTURAL DEVELOPMENT PROJECT

A Santa Rita pilot project located Concepcion in Tarlac province is being demonstrated an integrated agricultural development which is composed of restoration of agricultural facilities, land reclamation, resettlement works , construction of roads and others. Beside, a pilot demonstration farm to be establish in the Santa Rita CIP area is envisioned to conduct experiments to determine the best crops on lahar heavy covered areas 1.5 to 2.5 m deep. It is also aimed to encourage lahar affected farmers to plant suitable crops based on the result of the crop experimental works.

The selection criteria in identifying areas for the pilot demonstration farm are as follows:

a. Systems or areas which are of run-off-the-river type either partially or wholly covered with lahar but have strong potential for agricultural development,

b. Areas that are already safe from lahar flow where protective infrastructure has already been in-place, and

c. Areas were agricultural activities has resumed despite of deficient agricultural infrastructures.

The Project description is given in Table K.14 and Figure K.7, and summarized as follow.

- Location : Santa Rita, Concepcion, Tarlac province
- Potential Irrigation Area
  present condition : non-cultivated by 1 to 2 m depth of lahar
  future condition : 200 ha of paddy field
  120 ha of upland crops field
  130 ha of agro-frustration field
  450 ha of total irrigated area
- Total Area : 560 ha (30 ha of build-up area)
- Water Source : Bamban river, one Ogree type of intake

5.5 INTEGRATED LAND AND AGRICULTURE DEVELOPMENT PROJECT IN THE HEAVY LAHAR AFFECTED AREA

After the following long-term plans of the Master Plan on Flood and Mudflow Control in Sacobia-Bamban and Abacan Rivers Draining from Mt. Pinatubo, the proposed Project area have been in-place and/or made available as follows:

a. the long-term plan of DPWH to re-channel Sacobia River back to its upstream confluence at the Bamban River, and

b. after substantial lahar deposits has been washed down from the slopes of Mt. Pinatubo

The Bamban-Concepcion Sand Pocket area is the area being utilized by DPWH as lahar catchment basin for the Sacobia River. The proposed projects considered for long-term agricultural development has a potential crop production under irrigation condition of about 2,090 ha of following three (3) CIPs located in Sacobia-Bamban river basin area.

The proposed diversion structure of the ogee-type shall be constructed on Sacobia and Bamban rivers. The Tabun and MASKUP CIPs has a potential irrigable area of about 1,540 ha and where lahar deposits is expected to be very deep. A portion of the proposed Marita CIP area, which was not damaged and/or covered with lahar of about 210 ha is being planted with rice through available rainfall and by shallow well pumps supplement. The Project description is given in Table K.14 and typical layout is shown in Figure K.10, and summarized as follow.

(Unit : ha)

Description	Location (Municipality)	Total Area	Potential Irrigation Area		
			Paddy	Upland Crops	Agro-Forest
Sacobia-Bamban River Basin Area :					
Tabun C.I.P.	Mabalacat	220	0	100	120
MASKUP C.I.P.	Mabalacat, Bamban	1,320	0	500	820
Marita C.I.P.	Concepcion	550	210	170	170
	Total	2,090	210	770	1,110

Source : These figures are estimated by GIS based on 1/10,000 (1994) of topographic maps.

The proposed cropping pattern and farming technology including the type of crops to be used in the proposed project will be based on the result and recommendation of the proposed crop experimental works by the Santa Rita Pilot Project.

K.6 IMPLEMENTATION SCHEDULE OF THE PROJECTS

6.1 GENERAL

The Master Plan will provide an overall plan of mudflow/flood control works for the achievement of reconstruction and further development plan in the affected areas on the basis of the studies of projection of sediment delivery volume to low lying areas, forecast of potential mudflow/flood hazard areas, and formulation of structural measures to minimize further disasters due to mudflow/flood in the region. After completion of the mudflow/flood control works in the Master Plan, the strategy of the agricultural development plan will be formulated under the assumption that the construction of agricultural facilities, soil rehabilitation and land reclamation works would be achieved for the restoration of land resources which are now covered with lahar.

6.2 IMPLEMENTATION SCHEDULE OF THE PROJECT

The Master Plan will provide an integrated agricultural development plan. It will take time for implementation of the schemes. Many urgent restoration and rehabilitation works for agricultural facilities have been conducted by the government and the people in the affected areas just after the eruption and the efforts are being carried out continuously.

The Master Plan of agricultural development project should be organized into the following phased categories which include i) short term plan to be carried out for the period from 1995 to 1998 by the Local Government Unit (LGU), ii) medium term plan which is composed of future study and design and construction works for restoration and rehabilitation project and iii) long term plan which is composed of future study, design and construction works for the land and agricultural development project in the heavy lahar affected areas. In the Master Plan, the formulation of an agricultural development projects are inevitable to ensure the agricultural productivity before the eruption. The following phased development is recommended, and the proposed implementation schedule is given in Table 15.

(1) SHORT TERM PLAN

Restoration and Rehabilitation Program

a. 5,135 ha irrigation service area of 9 CISs/CIPs in Tarlac province
b. 7,730 ha irrigation service area of 22 CISs/CIPs in Pampanga province

(2) MEDIUM TERM PLAN

- Restoration and Rehabilitation Project
  a. 1,810 ha irrigation service area of 4 CISs/CIPs in Sacobia-Bamban river basin area
  b. 960 ha irrigation service area of 3 CIPs in Abacan river basin area
- Santa Rita Pilot Agricultural Development Project
  450 ha irrigation area of Santa Rita CIP, Concepcion
  560 ha of land reclamation area

(3) LONG TERM PLAN

- Restoration and Rehabilitation Project
  3,270 ha irrigation service area of 4 CISs/CIPs in Sacobia-Bamban river basin area
- Land and Agricultural Development Project
  2,090 ha irrigation area of 3 CIPs in Sacobia-Bamban river basin
  2,650 ha of land reclamation area

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TABLES

Table K.1 Population and Household of the Study Area in 1994

Municipality / Barangay	Land use (ha)	Area (sq km)	Household	Population	Population Density (per sq km)	Family Size
ABACAN RIVER BASIN AREA						
ANGELES CITY / PAMPANGA						
1. A. DEL ROSARIO	100	1.00	740	2,840	2,840	3.74
2. AMSIC	238	2.38	720	3,580	1,488	4.97
3. ANUNAS	948	9.48	1,100	6,186	653	5.62
4. BALIBAGO	260	2.60	5,874	27,180	10,501	4.34
5. CAPAYA	166	1.66	865	4,095	2,467	3.02
6. CLARO M. RECTO	187	1.87	1,220	6,220	3,326	5.10
7. CUAYAN	810	8.33	200	1,000	119	3.40
8. CUTCUT	146	1.46	3,360	16,540	11,329	5.07
9. CUTUD	233	2.33	240	1,300	424	5.42
10. LOURDES NORTH WEST	53	0.53	2,425	11,380	21,604	4.57
11. MALABANIAS	93	0.93	2,424	12,340	13,254	4.03
12. MARGOT	138	1.38	640	2,208	1,644	4.45
13. MINING	210	2.14	230	780	330	3.50
14. NINOY AQUINO (MARISOL)	117	1.17	2,200	9,750	8,351	4.41
15. PAMPANG	100	1.05	1,000	4,820	4,777	4.56
16. PANDAN	97	0.97	1,910	7,092	8,139	5.05
17. PULUNG CACUTUD	322	3.22	320	1,440	448	4.50
18. PULUNG MARAGUL	152	1.52	1,460	8,120	5,342	4.00
19. PULUNGBULU	340	3.40	2,070	9,308	2,463	4.05
20. SALAPUNGAN	206	2.40	994	5,123	2,451	5.15
21. SAN JOSE	553	9.01	1,300	6,000	7,065	4.54
22. SAN NICOLAS	430	0.80	380	1,420	3,440	3.36
23. SAPALIBUTAD	317	3.17	540	2,308	3,336	5.37
24. STA. TERESITA	54	0.54	2,200	8,360	14,714	4.25
25. STA. TRINIDAD	116	1.16	3,100	3,450	4,707	4.96
26. STO. CRISTO	112	1.12	720	3,140	3,804	4.56
27. STO. DOMINGO	407	3.22	2,060	11,540	5,207	4.35
28. TABUN	640	1.06	158	1,341	1,265	5.30
29. V. DELOS REYES	43	0.45	300	1,250	3,000	4.30
Sub-total	7,063	68.31	34,121	168,220	2,462 (2,437)	4.36
ARAYAT / PAMPANGA						
1. ARENAS	348	3.88	400	2,320	640	4.30
2. BAUTI	240	2.45	240	1,220	470	5.08
3. BATASAN	190	1.90	284	1,613	840	5.68
4. BUENSUCESO	471	4.71	100	520	110	3.20
5. CANDATING	613	6.14	435	3,432	530	1.40
6. GATIAWIN	639	6.40	580	3,760	540	6.30
7. GUEMASAN	72	0.72	580	3,009	4,184	5.21
8. KALEDIAN (CAMBA)	181	1.81	560	3,220	1,813	5.84
9. LA PAZ (TURU)	745	7.45	100	580	78	5.80
10. LACMIT	515	5.15	620	3,440	668	5.55
11. LAQUIOS	37	0.37	319	1,791	4,824	5.58
12. MANGA-CACUTUD	76	0.78	1,780	8,840	11,333	4.97
13. MAPALAD	1,420	14.22	337	2,001	140	5.94
14. PANDACAQUI	738	7.38	280	1,620	205	5.78
15. PARALAYA	36	0.36	230	930	3,356	6.18
16. PLAZANG LUMA	187	1.87	780	4,760	2,426	6.10
17. SAN AGUSTIN NORTE	74	0.74	440	2,860	3,865	6.50
18. SAN AGUSTIN SUR	37	0.38	210	1,079	2,839	5.14
19. SAN ANTONIO	1,526	5.23	340	1,300	305	5.58
20. SAN JOSE MESULO	115	1.15	680	3,710	3,235	5.44
21. SAN JUAN BANO	897	8.98	840	4,660	519	5.35
22. SAN MATEO	640	6.40	615	3,560	547	5.73
23. SAN NICOLAS	480	1.34	480	2,340	1,746	4.88
24. SAN ROQUE (BITAS)	935	9.36	480	3,220	344	6.71
25. STA. LUCIA CUPANG	72	0.72	386	2,165	3,007	5.60
26. STA. LUCIA MATAMO	122	1.22	311	1,618	1,392	3.46
27. STO. NINO TABUAN	1,063	10.64	310	1,689	130	5.45
28. SUCLAYIN	234	2.34	333	1,341	620	3.03
29. TELAPAYUNG	409	4.09	326	1,727	443	5.40
Sub-total	13,258	132.10	13,475	73,439	556 (579)	5.82
SANTA ANA / PAMPANGA						
1. SAN AGUSTIN	1,654	5.10	330	1,931	364	5.70
2. SAN BARTOLOME	771	2.71	224	1,242	458	5.54
3. SAN ISIDRO	340	3.06	800	4,730	1,548	5.96
4. SAN JOAQUIN (POB.)	305	3.05	568	3,318	1,872	5.97
5. SAN JOSE	533	1.46	370	1,620	1,151	5.40
6. SAN JUAN	250	1.40	258	1,404	142	5.42
7. SAN NICOLAS	480	1.36	520	3,520	2,147	5.62
8. SAN PABLO	539	3.96	580	3,040	778	5.34
9. SAN PEDRO	564	1.66	140	1,067	650	6.34
10. SAN ROQUE	1,901	5.30	393	2,412	455	6.14
11. SANTA MARIA	237	2.37	740	4,300	1,772	5.88
12. SANTIAGO	604	3.12	471	2,647	848	5.62
13. SANTO ROSARIO	404	4.05	113	640	164	5.67
14. STA. LUCIA	3,066	6.30	480	3,469	550	5.59
Sub-total	11,608	44.24	5,867	31,666	728 (247)	5.86
MEXICO / PAMPANGA						
1. ACLI	325	3.25	182	1,089	335	6.06
2. ANAO	108	1.08	339	1,972	1,826	5.35
3. BALAS	205	2.05	320	1,400	683	4.44
4. BUENA VISTA	395	3.96	137	911	230	6.65
5. CAMUNING	184	1.84	230	1,374	747	6.25
6. CAWAYAN	318	3.18	130	743	230	4.95
7. CONCEPCION	67	0.67	240	1,400	2,090	5.50
8. CULUBASA	100	1.57	240	1,683	1,070	6.06
9. DIVISORIA	220	2.20	193	1,125	515	5.83
10. DOLORES (PIRING)	267	2.68	194	1,222	456	6.30
11. EDEN	223	2.23	90	540	242	6.00
12. GANDUS	324	3.24	85	490	136	5.76
13. LAGUNDI	265	2.65	420	2,340	883	4.88
14. LAPUT	118	1.18	234	1,451	1,230	6.20
15. LAUG	159	1.59	340	1,950	1,245	3.42
16. MABALACAT	258	2.58	140	620	240	4.43
17. MASANGSANG	276	2.76	338	1,797	651	5.32
18. NUEVA VICTORIA	401	4.31	120	760	138	6.33
19. PANDACAQUI	529	5.30	140	1,320	240	5.08
20. PANGATLAN	590	5.91	201	1,241	217	6.37
21. PANIPUAN	342	3.43	180	1,300	321	6.11
22. PARIAN (POB.)	30	0.30	630	4,630	12,920	5.71
23. SABANILLA	123	1.23	200	920	732	4.30
24. SAN ANTONIO	1,326	0.28	740	4,160	14,857	5.62
25. SAN CARLOS	1,237	0.84	400	1,974	2,350	4.56
26. SAN JOSE MALINO	230	2.40	580	3,532	1,472	6.54
27. SAN JOSE MATULID	222	2.22	340	2,360	1,073	6.40
28. SAN JUAN	230	1.88	430	2,351	1,328	5.33
29. SAN LORENZO	83	0.83	320	2,080	2,506	6.50
30. SAN MIGUEL	173	1.79	340	1,380	771	3.75
31. SAN NICOLAS	480	1.13	167	926	813	5.54
32. SAN PABLO	500	1.04	140	1,380	1,308	5.67
33. SAN PATRICIO	231	2.31	640	3,800	1,645	5.76
34. SAN RAFAEL	308	2.00	120	700	350	5.83
35. SAN ROQUE	1,301	1.54	130	640	429	5.30
36. SAN VICENTE	1,143	2.20	425	2,673	1,215	6.30
37. SAPANG MAISAC	402	4.05	440	2,560	638	5.57
38. STA. CRUZ	321	3.22	234	1,568	487	5.73
39. STA. MARIA	921	1.74	318	1,778	1,022	5.06
40. STO. DOMINGO	407	1.85	230	1,253	677	4.91
41. STO. ROSARIO	5,024	3.28	400	2,020	616	5.05
42. SUCLABAN	314	3.15	132	622	187	6.10
43. TANGLE (TANGLE)	225	2.25	140	770	346	5.56
Sub-total	22,124	33.20	13,325	70,538	213 (529)	5.62
Total	54,663	323.22	71,143	344,214	1,133 (672)	5.13

Municipality / Barangay	Area of Land use (ha)	Total Area (sq km)	Total Household	Population 1994	Population Density (per sq km)	Family Size
SACOBIA BAMBAN RIVER BASIN AREA						
BAMBAN / TARLAC						
1. BANABA	44	0.16	320	830	5,125	3.75
2. BANGCU	824	2.36	0	0	0	
3. CULUBASA	199	0.12	3	17	142	5.67
4. DELA CRUZ	99	0.03	146	620	180	4.34
5. LA PAZ	437	0.94	123	603	640	4.90
6. LOURDES	140	0.36	160	760	2,062	4.40
7. MALONZO	236	1.42	0	0	0	
8. SAN NICOLAS (POB.)	213	0.36	1,140	5,780	16,056	5.07
9. SAN PEDRO	544	1.64	0	0	0	
10. SAN RAFAEL	500	0.37	123	676	1,136	5.51
11. SAN ROQUE	1,591	1.48	149	653	3,315	4.39
Sub-total	4,224	9.18	2,073	10,132	1,151 (239)	4.92
CAPAS / TARLAC						
1. ARANGUREN	443	4.03	830	3,020	745	4.39
2. CUBCUB (POB.)	174	1.74	618	2,119	1,210	5.08
3. CUTCUT 1ST	146	1.46	887	4,550	3,116	5.13
4. CUTCUT 2ND	87	0.87	320	1,328	1,575	5.08
5. MARUGLU	245	2.45	230	1,340	547	4.78
6. STO. DOMINGO 1ST	259	2.59	348	1,193	420	4.65
7. STO. DOMINGO 2ND	594	5.94	355	2,740	461	4.94
8. STO. ROSARIO	5,024	41.02	390	2,918	71	4.95
Sub-total	7,021	61.00	4,056	18,187	326 (262)	4.82
CONCEPCION / TARLAC						
1. ALFONSO	185	1.86	763	3,318	1,865	5.12
2. BALUTU	267	2.58	708	4,300	2,106	6.06
3. CAPE	8	0.05	365	1,383	246	5.45
4. CALIUS GUECO	58	0.58	240	1,320	2,276	5.50
5. CASTILLO	1,754	17.38	420	2,100	124	5.19
6. DUNGAN	745	7.45	130	673	98	5.18
7. GREEN VILLAGE	90	0.90	377	1,365	1,550	5.04
8. LILIBANGAN	420	4.00	140	708	175	5.00
9. MINANE	242	1.02	730	4,410	1,367	6.14
10. PANALICSICAN	957	9.58	240	1,240	129	5.17
11. SAN ANTONIO	1,326	4.34	520	3,300	740	6.30
12. SAN BARTOLOME	778	5.01	340	2,040	407	5.67
13. SAN FRANCISCO	675	3.06	962	4,139	1,381	5.14
14. SAN ISIDRO (ALMENDRAS)	779	1.79	480	2,360	329	5.53
15. SAN JOSE (POB.)	67	0.67	1,195	6,248	9,325	5.23
16. SAN MARTIN	365	3.66	240	1,098	275	4.57
17. SAN NICOLAS (POB.)	113	0.98	581	2,757	2,825	4.75
18. SAN NICOLAS BALAS	607	4.00	480	2,160	470	5.56
19. SAN VICENTE	3,143	3.26	240	1,340	411	5.58
20. SANTIAGO	604	2.93	459	2,483	847	5.41
21. STA. RITA	308	3.08	960	4,060	1,320	4.23
22. TALIMUNDUC MARIMLA	406	4.06	223	1,133	305	5.52
23. TELABANCA	131	1.32	174	946	341	5.44
Sub-total	13,502	102.86	10,459	55,025	525 (449)	5.26
MABALACAT / PAMPANGA						
1. ATLU BOLA	93	0.93	200	1,060	1,140	5.30
2. BICAL	234	2.34	430	2,300	937	4.96
3. BUNDAGUL	210	2.92	100	500	130	5.00
4. CACUTUD	190	2.00	200	840	420	4.20
5. CAMACHILES	236	2.37	630	2,918	1,232	4.67
6. DAU	125	1.25	10,540	48,140	38,512	4.72
7. DOLORES	1,065	5.45	48	258	47	5.22
8. DUQUIT	540	3.80	430	1,340	320	6.42
9. LAKANDULA	1,428	14.29	1,760	8,808	605	5.07
10. MABIGA	142	1.42	1,340	9,300	6,746	6.34
11. MACAPAGAL VILLAGE	615	6.16	140	720	117	5.14
12. MAMATITANG	201	2.01	233	1,291	640	5.54
13. MANGALIT	216	2.17	100	620	286	6.20
14. MARCOS VILLAGE	580	5.37	100	500	93	5.00
15. MAWAKE	257	2.57	80	500	248	6.30
16. PARALAYUNAN	234	2.36	150	530	222	5.30
17. SAN FRANCISCO	675	1.42	2,020	9,130	4,575	4.58
18. SAN JOAQUIN	663	6.63	932	4,402	664	4.88
19. SAPANG BIABAS	341	3.42	208	1,060	311	5.30
20. SAPANGBALEN	1,133	11.34	0	0	0	
21. STA. INES	277	2.78	780	3,540	1,274	4.59
22. STA. MARIA	921	1.75	280	1,420	830	5.07
23. STO. ROSARIO	5,024	1.40	403	2,000	1,405	5.30
24. TABUN	667	3.62	0	0	0	
25. NOT IDENTIFIED	3,301	31.20			0	
Sub-total	14,223	132.68	21,284	100,581	831 (454)	4.82
MAGALANG / PAMPANGA						
1. AYALA	50	0.40	340	2,000	3,333	5.53
2. BUCANAN	142	1.40	180	640	514	4.79
3. CAMIAS	355	3.56	140	740	213	5.40
4. DOLORES		0.09	140	540	6,222	4.00
5. ESCALER	53	0.55	180	910	1,848	5.44
6. LA PAZ	437	2.19	140	800	340	5.71
7. NAVALING	426	4.36	163	985	238	6.04
8. SAN AGUSTIN	3,654	31.32	240	1,500	48	6.25
9. SAN ANTONIO	1,326	3.22	140	840	241	6.00
10. SAN FRANCISCO	675	2.20	440	2,640	1,134	6.00
11. SAN ILDEFONSO	536	5.36	620	5,200	890	6.18
12. SAN ISIDRO	863	5.63	140	820	142	5.71
13. SAN JOSE	533	2.97	240	1,230	420	5.33
14. SAN MIGUEL	373	1.94	220	1,240	678	5.84
15. SAN NICOLAS 1ST (POB.)	24	0.24	540	2,300	9,363	4.26
16. SAN NICOLAS 2ND	47	0.47	540	2,460	3,860	4.55
17. SAN PABLO (POB.)	932	9.33	140	740	73	5.20
18. SAN PEDRO I	82	0.62	320	1,720	2,908	5.38
19. SAN PEDRO II	187	1.87	440	2,210	1,187	5.08
20. SAN ROQUE	1,301	6.63	321	1,873	275	5.85
21. SAN VICENTE	1,143	3.06	340	1,790	584	5.24
22. STA. CRUZ (POB.)	214	2.14	640	3,860	1,813	5.80
23. STA. LUCIA	1,046	3.48	60	440	131	7.30
24. STA. MARIA	925	5.79	240	1,800	312	6.12
25. STO. NINO	106	1.06	300	1,520	1,434	5.07
26. STO. ROSARIO	5,426	10.53	438	2,460	230	5.31
27. TURU	2,544	23.48	140	796	35	5.49
Sub-total	23,532	136.55	8,073	44,838	328 (150)	5.51
Total	71,932	433.13	46,440	235,733	3,269 (252)	5.08
Abacan River Basin Area	54,663	323.22	71,143	344,214	1,133	5.13
Sacobia Bamban River Basin Area	71,932	433.13	46,440	235,733	544	5.08
Grand Total	125,835	756.35	117,583	563,351	746 (483)	5.12

Sources : Population Survey by JICA Study Team in August 1994.
Land use is measured by GIS based on 1/10,000 of topographic map
Remarks : (00) Population density are calculated by the area of landuse

Table K.2 Physical Properties of Lahar in Sacobia-Bamban and Abacan River Basin Areas

Location	Soil Texture Sand (%)	Silt (%)	Clay (%)	Textual Grade	Bulk Density (gm/cc)	Available Moisture (%)	Hydraulic Conductivity (cm/sec)
SACOBIA-BAMBAN RIVER BASIN AREA							
1. Bamban	86.4	4.6	9.0	Loamy Sand	1.69	8.04	2.0 x 10-2 Fast
2. Culatigan	80.4	10.6	9.0	Sandy Loam	1.78	1.89	1.2 x 10-4 Medium
3. Culatigan	20.4	53.6	26.0	Silty Loam	-	-	-
4. Dolores, Magalang	82.4	9.6	8.0	Silty Loam	-	23.70	-
ABACAN RIVER BASIN AREA							
1. Sapalibutan Angeles City	86.4	5.6	8.0	Loamy Sand	0.98	11.58	2.6 x 10-2 Very fast
2. Sapalibutan Angeles City	86.4	6.6	7.0	Loamy Sand	-	11.88	-
3. Campaya Is., Angeles City	87.4	4.6	8.0	Loamy Sand	1.93	6.36	9.7 x 10-4 Medioum
4. Sapalibutan, Angeles City	95.4	0.6	4.0	Sand	1.40	6.12	6.5 x 10-2 Very fast

Table K.3 Chemical Properties of Lahar in Sacobia-Bamban and Abacan River Basin Areas

Location	pH	OM (%)	Exchangeable Bases (meq/ 100g) Ca	Mg	Na	K	CEC per 100g soil (meq)	BSP (%)	P (ppm)	SO4 (ppm)	Micronutrients (ppm) Zn (ppm)	Cu (ppm)	Fe (ppm)	Mn (ppm)
SACOBIA-BAMBAN RIVER BASIN AREA														
1. Bamban	6.5	0.14	1.05	0.03	0.06	0.05	4.43	26.86	0.10	0	0.20	2.20	4.40	1.00
2. Culatigan	6.4	0.19	0.70	0.26	0.04	0.09	3.25	33.54	4.90	0	0.60	4.80	28.60	0.80
3. Culatigan	6.2	1.46	2.60	1.10	0.11	0.34	6.35	65.35	8.80	0	1.20	15.40	92.40	22.00
4. Dolores, Magalang	5.7	0.02	1.75	0.08	0.14	0.06	3.65	55.62	0.10	830	0.20	2.20	6.00	13.20
5. San Vicente, Concepcion	6.7	0.38	3.56	0.39	0.21	0.26	9.37	47.17	9.71	58	0.27	12.98	142.78	53.53
ABACAN RIVER BASIN AREA														
1. Sapalibutan Angeles City	6.4	0.52	1.00	0.18	0.03	0.08	2.39	53.97	13.20	0	0.60	5.60	41.80	4.00
2. Sapalibutan Angeles City	6.2	0.19	0.85	0.17	0.03	0.05	3.60	28.95	6.00	101	0.20	5.40	17.60	3.20
3. Campaya Is., Angeles City	5.9	0.09	0.70	0.26	0.07	0.06	2.69	40.52	0.50	297	0.20	2.80	6.80	2.00
4. Sapalibutan, Angeles City	6.5	0.14	0.65	0.10	0.03	0.03	1.91	42.40	0.30	0	0.40	2.88	5.60	1.40
5. San Juan, Magalang	6.4	0.02	1.64	0.15	0.07	0.04	1.90	100.00	5.23	0	0.25	2.88	5.28	7.93
6. Purok 4, S. BAlo	6.6	T	1.08	0.03	0.05	0.02	1.18	100.00	1.55	0	0.82	2.45	35.91	8.98

Remarks : OM ; Organic Matter Content, CEC ; Cation Exchange Capacity, BSP ; Base Saturation, P ; Phosphorus, SO4 ; Sulfate

Table K.4 Land Use before and after Mt. Pinatubo Eruption in the Study Area

(Unit : ha)

Province / Municipality		Paddy (Rice)	Sugar -cane	Upland Crops	Fruit Tree	Grass Land	Primary Forest	Secondary Forest	Fish Pond	Swamp Area	Build-up Area	Miscel -laneous	Mud -flow	Total Area
SACOBIA-BAMBAN RIVER BASIN AREA														
TARLAC PROVINCE														
Bamban	Before	2,641	432	18	78	118 0	0	6	0	0	469	216	0	3,978
	After	1,708	396	18	78	118	0	6	0	0	448	69	1,138	3,978
	Difference	-933	-36	0	0	0	0	0	0	0	-22	-146	1,138	0
Capas	Before	707	1,299	0	64	2,932	0	2,078	0	0	496	48	0	7,624
	After	621	1,199	0	63	2,933	0	2,079	0	0	492	48	188	7,624
	Difference	-86	-100	0	-1	1	0	1	0	0	-4	0	188	0
Concepcion	Before	8,017	2,172	8	73	814	0	0	0	0	1,141	682	0	12,907
	After	4,539	1,742	8	73	642	0	0	0	0	920	73	4,910	12,907
	Difference	-3,478	-431	0	0	-172	0	0	0	0	-222	-608	4,910	0
PAMPANGA PROVINCE														
Mabalacat	Before	6,487	3,845	22	108	5,046	0	3,660	0	0	1,595	1,808	0	22,572
	After	5,659	3,076	22	108	4,499	0	3,046	0	0	1,500	1,583	3,079	22,572
	Difference	-828	-769	0	0	-547	0	-613	0	0	-95	-226	3,079	0
Magalang	Before	8,854	4,794	97	252	2,418	632	4,517	0	0	1,726	663	0	23,952
	After	8,231	4,654	97	251	2,418	632	4,517	0	0	1,700	531	921	23,952
	Difference	-624	-139	0	-1	0	0	0	0	0	-26	-132	921	0
Sacobia-	Before	26,706	12,542	145	575	11,328	632	10,260	0	0	5,428	3,416	0	71,033
Bamban River	After	20,758	11,067	145	573	10,610	632	9,648	0	0	5,059	2,305	10,236	71,033
Basin Area	Difference	-5,949	-1,475	0	-2	-718	0	-613	0	0	-368	-1,111	10,236	0
ABACAN RIVER BASIN AREA														
PAMPANGA PROVINCE														
Angeles City	Before	896	2,325	5	25	1,625	0	116	0	13	2,466	173	0	7,643
	After	682	2,180	5	25	1,564	0	17	0	13	2,451	119	587	7,643
	Difference	-214	-145	0	0	-61	0	-98	0	0	-15	-54	587	0
Arayat	Before	5,577	1,442	819	113	278	358	2,109	917	209	983	244	0	13,048
	After	5,487	1,418	819	113	278	358	2,109	917	209	976	195	169	13,048
	Difference	-90	-23	0	0	0	0	0	0	0	-7	-49	169	0
Santa Ana	Before	5,699	1,172	63	200	471	632	2,053	0	0	1,118	230	0	11,638
	After	5,115	1,158	63	200	471	632	2,053	0	0	1,096	176	676	11,638
	Difference	-585	-14	0	0	0	0	0	0	0	-22	-55	676	0
Mexico	Before	9,245	6,207	28	268	1,983	0	2,078	0	0	1,948	378	0	22,134
	After	8,335	6,084	18	267	1,983	0	2,078	0	0	1,928	228	1,215	22,134
	Difference	-910	-124	-10	-1	0	0	0	0	0	-20	-150	1,215	0
Abacan	Before	21,417	11,146	915	606	4,357	989	6,354	917	222	6,514	1,026	0	54,463
River Basin	After	19,619	10,840	905	605	4,296	989	6,256	917	222	6,450	718	2,647	54,463
Area	Difference	-1,799	-306	-10	-1	-61	0	-98	0	0	-64	-308	2,647	0
TOTAL	Before	48,123	23,688	1,060	1,181	15,685	1,622	16,615	917	222	11,941	4,442	0	125,496
STUDY	After	40,376	21,907	1,050	1,178	14,906	1,621	15,904	917	222	11,509	3,023	12,882	125,496
AREA	Difference	-7,747	-1,781	-10	-3	-779	0	-711	0	0	-432	-1,420	12,882	0

Sources : These figures are estimated by GIS of JICA Study team based on 1/10,000 topographic maps.

Table K.5 Cropped Area in Lahar and Mudflow Affected Area

(Unit : ha)

Municipality / Barangay	Paddy (Rice), Irrigated					Paddy (Rice), Rainfed					Sugarcane / Corn					Other Crops					Total Cropped Area				
	1990/91	1991/92	1992/93	1993/94	1994/95	1990/91	1991/92	1992/93	1993/94	1994/95	1990/91	1991/92	1992/93	1993/94	1994/95	1990/91	1991/92	1992/93	1993/94	1994/95	1990/91	1991/92	1992/93	1993/94	1994/95
BACOBIA-BAMBAN RIVER BASIN AREA																									
TARLAC PROVINCE																									
BAMBAN																									
1. Bantog	53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	53	0	0	0	0
2. Bangar	203	76	76	76	76	0	0	0	0	0	25	0	0	0	0	10	0	0	15	15	238	76	76	91	91
3. Culiteo	268	0	136	118	118	0	0	0	0	0	66	50	50	50	50	4	2	2	2	2	338	52	170	170	170
4. Dela Cruz	117	0	30	30	30	0	0	0	0	0	0	0	0	0	0	4	2	2	2	2	121	2	32	32	32
5. La Paz	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0	0	0
6. Maimpis	363	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	364	0	0	0	0
7. Poblacion	170	43	43	170	170	0	0	0	0	0	235	90	90	235	235	20	15	15	20	20	425	148	148	425	425
8. San Pedro	165	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	172	0	0	0	0
9. San Rafael	142	115	115	142	142	0	0	0	0	0	565	365	365	365	365	12	12	12	12	12	539	492	492	519	519
Subtotal	1,503	234	382	536	536	0	0	0	0	0	893	505	505	650	650	58	31	31	51	51	2,252	770	918	1,237	1,237
CONCEPCION																									
1. Balaoa	576	530	550	420	453	0	90	60	120	146	0	0	0	0	6	39	10	11	17	16	615	630	601	557	599
2. Cabut Ovana	230	90	120	180	180	0	40	40	25	40	15	12	20	30	50	23	12	15	27	34	268	154	195	262	284
3. Castillo	0	0	0	0	218	1,072	675	675	675	180	0	0	0	0	0	0	0	0	0	78	1,072	675	675	675	456
4. Dangcol	165	125	125	125	90	0	0	0	0	75	0	0	0	0	0	0	0	0	0	2	165	125	125	125	167
5. Lalimpuyo	119	119	0	0	0	0	0	0	0	59	0	0	0	0	0	0	0	0	0	6	119	119	0	0	65
6. Magao	0	0	0	0	0	685	0	0	432	432	0	0	0	0	0	0	0	0	0	4	685	0	0	432	436
7. Manaoag	126	55	0	0	63	0	0	0	0	16	0	0	0	0	0	0	0	0	0	7	126	55	0	0	86
8. Poblacion	206	146	206	206	0	0	0	0	0	195	0	0	0	0	5	0	0	0	0	7	206	146	206	206	207
9. San Antonio	295	175	175	175	295	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	295	175	175	175	295
10. San Bartolome	591	457	457	457	496	0	0	0	0	0	0	0	0	0	38	0	0	0	0	15	591	457	457	457	551
11. San Francisco	653	552	552	552	500	0	0	0	0	191	0	0	0	0	30	0	0	0	0	36	653	552	552	552	357
12. San Isidro	465	202	202	202	465	0	0	0	0	0	0	0	0	0	35	0	0	0	0	0	465	202	202	202	518
13. San Marcos	544	544	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	544	546	0	0	0
14. San Nicolas Balas	428	308	308	308	221	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	428	308	308	308	227
15. San Vicente	265	63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	265	63	0	0	0
16. Sta. Rita	378	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	378	0	0	0	0
17. Talimunduc Matinale	600	214	386	386	386	190	0	0	0	0	0	0	0	0	0	0	0	0	0	0	790	214	386	386	386
18. Talulong	373	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	373	0	0	0	0
Subtotal	6,236	3,536	3,638	3,666	3,667	1,947	805	775	1,332	1,317	15	12	20	30	166	82	22	29	54	211	8,278	4,177	3,683	4,232	4,836
PAMPANGA PROVINCE																									
MABALACAT																									
1. Camias	142	0	0	0	8	0	0	0	0	0	191	7	7	7	7	5	0	0	0	0	338	7	7	7	15
2. Dapdap	55	0	0	0	0	0	0	0	0	0	146	0	0	0	0	0	0	0	0	0	181	0	0	0	0
3. Sapangbalen	257	0	0	0	0	0	0	0	0	0	194	0	0	0	0	0	0	0	0	0	451	0	0	0	0
4. Tabun	157	0	0	0	0	0	0	0	0	0	349	0	0	0	0	0	0	0	0	0	446	0	0	0	0
Subtotal	332	0	0	0	8	0	0	0	0	0	880	7	7	7	7	5	0	0	0	0	1,426	7	7	7	15
MAGALANG																									
1. Navaling	381	381	318	256	80	0	1	0	0	0	0	2	3	19	25	0	4	8	0	1	381	388	329	255	106
2. San Roque	256	256	251	230	105	35	35	23	14	0	116	118	109	126	120	9	11	4	2	7	416	420	367	372	232
3. San Mario	369	395	361	332	210	22	22	22	0	0	45	43	45	86	185	4	4	2	0	6	442	462	430	418	401
4. San Roseno	406	406	317	171	87	50	50	43	61	0	324	324	213	219	211	9	18	60	1	13	789	798	633	472	311
Subtotal	1,426	1,436	1,207	989	482	107	108	88	95	0	483	487	370	450	541	22	37	74	3	27	2,068	2,068	1,759	1,517	1,050
Total	9,744	5,006	4,448	4,614	4,173	3,054	913	863	1,427	1,317	3,089	1,011	902	1,137	1,363	147	90	134	98	289	16,014	7,022	6,347	7,006	7,136
ABACAN RIVER BASIN AREA																									
PAMPANGA PROVINCE																									
MEXICO																									
1. Balas	125	135	135	151	151	36	36	36	42	42	110	110	110	180	180	60	60	76	76	76	331	341	357	449	449
2. Camaysa	228	211	211	179	179	0	0	0	0	0	0	161	151	143	150	0	0	0	1	0	228	372	362	317	329
3. Dolores	30	30	28	28	28	117	117	106	106	106	0	0	0	0	0	0	0	0	0	0	147	147	134	134	134
4. Lopez	165	165	165	165	165	0	0	0	0	0	90	45	45	27	42	10	8	6	15	10	265	218	216	207	237
5. San Antonio	139	139	79	79	79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	139	139	79	79	79
6. San Lorenzo	240	240	120	120	120	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	240	240	120	125	125
7. San Nicolas	29	25	25	29	29	106	85	106	106	106	0	0	0	0	0	5	0	0	0	7	140	110	131	135	142
8. San Pablo	0	0	0	0	57	0	43	40	40	43	0	0	0	0	0	0	0	0	0	0	0	43	40	40	100
9. San Patricio	125	125	109	113	112	361	361	356	361	361	40	40	44	52	52	3	0	0	0	0	549	566	511	525	525
10. San Vicente	378	378	378	378	378	0	0	0	0	0	20	23	18	20	32	0	0	0	0	0	398	401	396	398	410
11. Sta. Cruz	226	226	226	220	220	0	0	0	0	0	0	159	156	155	150	0	1	0	1	0	226	386	382	376	370
12. Sto Rosario	0	0	0	0	0	92	93	76	76	86	8	0	0	0	0	0	0	0	0	0	100	92	76	76	86
Subtotal	1,675	1,658	1,676	1,651	1,512	752	754	738	731	766	268	338	328	377	446	78	69	82	98	98	2,733	3,015	2,806	2,861	3,002
SANTA ANA																									
1. San Agustin	90	0	0	0	0	150	10	30	82	95	0	0	0	0	0	0	5	15	25	40	200	15	45	107	135
2. San Roque	165	0	0	0	0	273	15	40	80	113	0	0	0	0	0	0	0	10	30	30	438	15	50	110	143
3. San Pablo	225	0	0	0	0	129	3	10	20	29	0	0	0	0	0	0	0	5	8	12	354	3	15	28	41
Subtotal	480	0	0	0	0	552	28	80	185	237	0	0	0	0	0	0	5	30	63	82	992	33	110	245	319
Total	2,155	1,658	1,676	1,651	1,512	1,304	782	788	913	985	268	338	328	377	446	78	74	112	161	180	3,725	3,048	2,916	3,106	3,321

Source : These figures are estimated based on Municipal Agriculture Office.

Table K.6 Paddy Production in Lahar and Mudflow Affected Area

Irrigated Paddy (Area)

Municipality/ Barangay	1990/91 C.A. (ha)	1990/91 U.Y. (t/ha)	1990/91 Prod. (tons)	1991/92 C.A. (ha)	1991/92 U.Y. (t/ha)	1991/92 Prod. (tons)	1992/93 C.A. (ha)	1992/93 U.Y. (t/ha)	1992/93 Prod. (tons)	1993/94 C.A. (ha)	1993/94 U.Y. (t/ha)	1993/94 Prod. (tons)	1994/95 C.A. (ha)	1994/95 U.Y. (t/ha)	1994/95 Prod. (tons)
SACOBIA-BAMBAN RIVER BASIN AREA															
TARLAC PROVINCE															
BAMBAN															
1. Banaba	53	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
2. Bangcu	303	0.0	0	76	4.0	304	76	4.0	304	76	4.0	304	76	4.0	304
3. Calibungan	268	0.0	0	0	0.0	0	118	4.0	472	118	4.0	472	118	4.0	472
4. Dela Cruz	117	0.0	0	0	0.0	0	30	4.0	120	30	4.0	120	30	4.0	120
5. La Paz	22	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
6. Malonzo	363	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
7. Pacalcal	170	0.0	0	43	4.0	172	43	4.0	172	170	5.0	850	170	5.0	850
8. San Pedro	165	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
9. San Rafael	142	0.0	0	115	4.0	460	115	4.0	460	142	4.0	568	142	4.0	568
Sub-total	1,503	0.0	0	234	4.0	936	382	4.0	1,528	536	4.3	2,314	536	4.3	2,314
CONCEPCION															
1. Balutu	576	4.5	2,592	310	4.5	1,395	330	4.5	1,485	420	4.5	1,890	433	4.7	2,054
2. Calius Gueco	230	4.5	1,035	90	4.5	405	120	4.5	540	180	2.8	510	160	4.6	736
3. Castillo	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	218	5.8	1,265
4. Dungan	165	4.5	743	125	4.5	563	125	4.5	563	125	4.5	563	90	4.0	360
5. Lilibangan	119	4.3	506	119	4.3	506	0	0.0	0	0	0.0	0	0	0.0	0
6. Magao	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
7. Minane	128	4.0	512	35	4.0	140	0	0.0	0	0	0.0	0	63	4.0	250
8. Panalicsian	206	4.0	824	146	4.5	657	206	4.0	824	206	4.0	824	0	0.0	0
9. San Antonio	295	4.5	1,328	179	4.0	492	173	1.7	296	173	1.7	296	295	4.5	1,328
10. San Bartolome	591	4.0	2,366	457	4.0	1,828	457	4.0	1,828	457	4.0	1,828	498	4.8	2,366
11. San Francisco	453	4.5	2,039	552	4.5	2,484	552	4.5	2,484	552	4.5	2,484	300	4.0	1,198
12. San Isidro	483	4.0	1,932	202	4.0	808	202	4.0	808	202	4.0	808	483	4.0	1,932
13. San Martin	544	4.6	2,488	544	4.6	2,488	0	0.0	0	0	0.0	0	0	0.0	0
14. San Nicolas Balas	428	4.5	1,926	308	4.5	1,386	308	4.5	1,386	308	4.5	1,386	221	4.5	992
15. San Vicente	285	4.0	1,140	63	4.0	250	0	0.0	0	0	0.0	0	0	0.0	0
16. Sta. Rita	378	4.5	1,701	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
17. Talimundoc Marimla	600	4.5	2,700	214	4.5	963	386	4.5	1,737	386	4.5	1,737	386	4.5	1,737
18. Telabanca	573	4.2	2,435	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
Sub-total	6,256	4.3	27,167	3,338	4.4	14,363	2,839	4.2	11,931	3,008	4.1	12,326	3,147	4.5	14,218
PAMPANGA PROVINCE															
MABALACAT															
1. Camachiles	142	3.5	497	0	0.0	0	0	0.0	0	0	0.0	0	8	3.5	28
2. Dolores	35	3.5	123	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
3. Sapangbalen	257	4.0	1,028	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
4. Tabun	117	4.0	468	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
Sub-total	551	3.8	2,116	0	0.0	0	0	0.0	0	0	0.0	0	8	3.5	28
MAGALANG															
1. Navaling	381	4.6	1,756	381	4.6	1,734	318	3.0	950	236	2.7	645	80	3.2	255
2. San Roque	256	4.2	1,071	256	4.2	1,049	231	3.5	807	230	3.0	699	105	2.8	289
3. Sta. Maria	399	3.7	1,462	393	3.7	1,440	341	3.0	1,008	332	2.6	867	210	3.5	738
4. Sto. Rosario	406	3.7	1,515	406	3.7	1,513	317	3.1	985	171	3.4	573	87	2.5	217
Sub-total	1,436	4.0	5,786	1,436	4.0	5,736	1,207	3.1	3,750	969	2.8	2,784	482	3.1	1,499
Total	9,746	3.6	35,049	5,008	4.2	21,277	4,448	3.9	17,229	4,514	3.9	17,424	4,173	4.3	18,059
ABACAN RIVER BASIN AREA															
PAMPANGA PROVINCE															
MEXICO															
1. Balas	125	4.0	500	135	3.0	405	135	4.0	540	151	4.0	604	151	5.0	755
2. Concepcion	238	5.0	1,190	211	5.0	1,055	211	4.0	844	173	4.0	692	173	5.0	865
3. Dolores	30	4.0	120	30	4.0	120	28	4.0	112	28	4.0	112	28	4.0	112
4. Laput	165	5.0	825	165	5.0	825	165	5.0	825	165	5.0	825	165	5.0	825
5. San Antonio	119	4.0	476	119	4.0	476	79	4.0	316	79	4.0	316	79	3.0	237
6. San Lorenzo	240	4.0	960	240	4.0	960	120	4.0	480	120	4.0	480	120	3.0	360
7. San Nicolas	29	5.0	145	25	4.0	100	25	4.0	100	29	5.0	145	29	4.0	116
8. San Pablo	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	57	4.0	228
9. San Patricio	125	5.0	625	125	4.0	500	109	4.0	436	112	5.0	560	112	4.0	448
10. San Vicente	378	5.0	1,890	378	4.0	1,512	378	4.0	1,512	378	5.0	1,890	378	5.0	1,890
11. Sta. Cruz	226	5.0	1,130	226	5.0	1,130	226	5.0	1,130	220	4.0	880	220	5.0	1,100
12. Sto Rosario	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
Sub-total	1,675	4.7	7,861	1,654	4.3	7,083	1,476	4.3	6,295	1,455	4.5	6,504	1,512	4.6	6,936
SANTA ANA															
1. San Agustin	50	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
2. San Roque	145	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
3. San Pablo	225	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
Sub-total	420	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
Total	2,095	3.8	7,861	1,654	4.3	7,083	1,476	4.3	6,295	1,455	4.5	6,504	1,512	4.6	6,936

Rainfed Paddy (Rice)

Municipality/ Barangay	1990/91 C.A. (ha)	1990/91 U.Y. (t/ha)	1990/91 Prod. (tons)	1991/92 C.A. (ha)	1991/92 U.Y. (t/ha)	1991/92 Prod. (tons)	1992/93 C.A. (ha)	1992/93 U.Y. (t/ha)	1992/93 Prod. (tons)	1993/94 C.A. (ha)	1993/94 U.Y. (t/ha)	1993/94 Prod. (tons)	1994/95 C.A. (ha)	1994/95 U.Y. (t/ha)	1994/95 Prod. (tons)
SACOBIA-BAMBAN RIVER BASIN AREA															
TARLAC PROVINCE															
BAMBAN															
1. Banaba	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
2. Bangcu	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
3. Calibungan	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
4. Dela Cruz	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
5. La Paz	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
6. Malonzo	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
7. Pacalcal	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
8. San Pedro	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
9. San Rafael	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
Sub-total	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
CONCEPCION															
1. Balutu	0	0.0	0	90	4.3	383	60	4.3	255	120	4.3	510	144	4.3	613
2. Calius Gueco	0	0.0	0	40	4.3	170	40	4.3	170	25	4.2	106	40	4.8	190
3. Castillo	1,072	3.9	4,181	675	3.9	2,666	675	3.9	2,666	675	3.9	2,666	160	4.0	640
4. Dungan	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	75	3.0	225
5. Lilibangan	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	59	3.4	200
6. Magao	685	4.0	2,740	0	0.0	0	0	0.0	0	432	4.0	1,728	432	4.0	1,728
7. Minane	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	16	3.0	48
8. Panalicsian	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	195	4.5	878
9. San Antonio	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
10. San Bartolome	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
11. San Francisco	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	191	4.0	764
12. San Isidro	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
13. San Martin	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
14. San Nicolas Balas	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
15. San Vicente	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
16. Sta. Rita	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
17. Talimundoc Marimla	190	4.0	760	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
18. Telabanca	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
Sub-total	1,947	3.9	7,681	805	4.0	3,219	775	4.0	3,091	1,252	4.0	5,010	1,312	4.0	5,286
PAMPANGA PROVINCE															
MABALACAT															
1. Camachiles	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
2. Dolores	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
3. Sapangbalen	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
4. Tabun	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
Sub-total	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
MAGALANG															
1. Navaling	0	0.0	0	0	0.7	0	0	0.0	0	0	0.0	0	0	0.0	0
2. San Roque	35	3.5	122	35	3.4	119	23	2.0	46	14	1.6	23	0	0.0	0
3. Sta. Maria	22	2.7	59	22	2.5	55	22	1.5	33	0	0.0	0	0	0.0	0
4. Sto. Rosario	50	3.4	170	50	3.4	170	43	3.3	140	81	2.5	203	0	0.0	0
Sub-total	107	3.3	351	107	3.2	344	88	2.5	219	95	2.4	226	0	0.0	0
Total	2,054	3.9	8,032	912	3.9	3,563	863	3.8	3,310	1,347	3.9	5,236	1,312	4.0	5,286
ABACAN RIVER BASIN AREA															
PAMPANGA PROVINCE															
MEXICO															
1. Balas	36	4.0	144	36	4.0	144	36	3.0	108	42	3.0	126	42	4.0	168
2. Concepcion	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
3. Dolores	117	3.0	351	117	3.0	351	106	3.0	318	106	4.0	424	106	4.0	424
4. Laput	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
5. San Antonio	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
6. San Lorenzo	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
7. San Nicolas	106	4.0	424	85	4.0	340	106	3.0	318	106	3.0	318	106	4.0	424
8. San Pablo	0	0.0	0	43	4.0	172	40	4.0	160	40	4.0	160	43	4.0	172
9. San Patricio	381	4.0	1,524	381	3.0	1,143	354	3.0	1,062	361	4.0	1,444	361	4.0	1,444
10. San Vicente	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
11. Sta. Cruz	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
12. Sto Rosario	92	5.0	460	92	3.0	276	76	4.0	304	76	4.0	304	88	4.0	352
Sub-total	732	4.0	2,903	754	3.2	2,426	718	3.2	2,270	731	3.8	2,776	746	4.0	2,984
SANTA ANA															
1. San Agustin	150	0.0	0	10	0.8	8	30	1.3	39	82	1.5	123	95	2.0	190
2. San Roque	273	0.0	0	15	0.7	11	40	1.3	50	80	1.5	120	113	2.0	226
3. San Pablo	129	0.0	0	3	0.7	2	10	1.3	13	20	1.5	30	29	2.0	58
Sub-total	552	0.0	0	28	0.8	21	80	1.3	101	182	1.5	273	237	2.0	474
Total	1,284	2.3	2,903	782	3.1	2,447	798	3.0	2,371	913	3.3	3,049	983	3.5	3,458

Source : These figures are estimated based on Municipal Agriculture Offices. Remarks : C.A. ; Cropped Area, U.Y. ; Unit Yield, Prod. ; Production

Table K.7 Sugarcane and Corn Production in Lahar and Mudflow Affected Area

Municipality/ Barangay	Sugarcane 1990/91 C.A. (ha)	1990/91 U.Y. (t/ha)	1990/91 Prod. (tons)	1991/92 C.A. (ha)	1991/92 U.Y. (t/ha)	1991/92 Prod. (tons)	1992/93 C.A. (ha)	1992/93 U.Y. (t/ha)	1992/93 Prod. (tons)	1993/94 C.A. (ha)	1993/94 U.Y. (t/ha)	1993/94 Prod. (tons)	1994/95 C.A. (ha)	1994/95 U.Y. (t/ha)	1994/95 Prod. (tons)	Corn 1990/91 C.A. (ha)	1990/91 U.Y. (t/ha)	1990/91 Prod. (tons)	1991/92 C.A. (ha)	1991/92 U.Y. (t/ha)	1991/92 Prod. (tons)	1992/93 C.A. (ha)	1992/93 U.Y. (t/ha)	1992/93 Prod. (tons)	1993/94 C.A. (ha)	1993/94 U.Y. (t/ha)	1993/94 Prod. (tons)	1994/95 C.A. (ha)	1994/95 U.Y. (t/ha)	1994/95 Prod. (tons)
SACOBIA-BAMBAN RIVER BASIN AREA																															
TARLAC PROVINCE																															
BAMBAN																															
1. Banaba	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
2. Bangcu	25	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	12	3.0	36	12	3.0	36
3. Culiram	66	40.0	2,640	50	50.0	2,500	50	50.0	2,500	50	60.0	3,000	50	60.0	3,000	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
4. Dela Cruz	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
5. La Paz	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
6. Maloma	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
7. Poniol	235	0.0	0	90	60.0	5,400	90	60.0	5,400	235	60.0	14,100	235	60.0	14,100	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
8. San Pedro	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
9. San Rafael	365	39.7	14,500	365	50.0	18,250	365	50.0	18,250	365	60.0	21,900	365	60.0	21,900	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
Subtotal	691	24.8	17,140	505	51.8	26,150	505	51.8	26,150	650	60.0	39,000	650	60.0	39,000	0	0.0	0	0	0.0	0	0	0.0	0	12	3.0	36	12	3.0	36
CONCEPCION																															
1. Balaoa	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	6	5.0	30
2. Cabu Grande	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	15	2.3	35	12	2.1	25	20	2.2	43	30	2.2	65	50	2.3	115
3. Castillo	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
4. Dungao	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
5. Lilimuyan	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
6. Magao	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
7. Mirano	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
8. Pandacaran	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	5	4.0	20
9. San Antonio	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
10. San Bernardino	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	78	4.0	152
11. San Francisco	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	30	5.2	156
12. San Isidro	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	35	5.0	175
13. San Marcos	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
14. San Nicolas Balas	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
15. San Vicente	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
16. Sta. Rita	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
17. Talaycanday Matrala	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
18. Talaycanday	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
Subtotal	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	15	2.3	35	12	2.1	25	20	2.2	43	30	2.2	65	184	4.0	668
PAMPANGA PROVINCE																															
MABALACAT																															
1. Camias	197	70.0	13,370	7	70.0	490	7	70.0	490	7	70.0	490	7	70.0	490	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
2. Dolores	146	70.0	10,220	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
3. Sapangbalen	194	70.0	13,580	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
4. Tabun	349	75.0	26,175	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
Subtotal	886	72.0	63,345	7	70.0	490	7	70.0	490	7	70.0	490	7	70.0	490	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
MAGALANG																															
1. Navaling	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	2	4.0	8	3	4.8	12	19	6.1	115	25	5.1	127
2. San Roque	96	35.0	3,360	98	35.1	3,440	108	35.0	3,770	115	35.1	4,035	115	35.0	4,025	20	8.1	162	20	8.1	161	3	7.3	22	11	6.2	68	5	8.2	41
3. Sta. Maria	34	35.0	1,190	34	35.0	1,190	34	32.4	1,100	34	44.4	1,510	34	44.4	1,510	9	7.8	70	9	7.7	69	11	7.6	84	52	8.5	441	151	6.1	922
4. San Rosario	270	35.0	9,450	270	35.0	9,450	203	32.0	6,550	195	15.0	2,930	195	15.0	2,930	54	7.0	378	54	6.9	373	8	9.5	76	24	6.9	165	16	9.1	146
Subtotal	400	35.0	14,000	402	35.0	14,080	345	32.8	11,360	344	24.6	8,465	344	24.8	8,465	83	7.3	608	85	7.2	610	22	7.9	194	106	7.4	789	197	6.0	1,236
Total	1,971	47.9	94,485	914	44.6	40,720	857	44.3	38,000	1,001	47.9	47,955	1,001	47.9	47,955	98	6.6	643	97	6.5	635	45	5.3	237	148	6.0	890	373	5.1	1,920
ABACAN RIVER BASIN AREA																															
PAMPANGA PROVINCE																															
MEXICO																															
1. Balas	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	110	4.4	480	110	4.0	440	110	4.4	480	180	4.0	720	180	4.4	800
2. Concepcion	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	161	4.6	734	146	4.7	687	143	4.5	647	130	4.6	687
3. Dolores	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
4. Lapac	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	90	4.8	430	45	4.6	205	45	4.4	200	27	4.4	120	82	4.1	340
5. San Antonio	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
6. San Lorenzo	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
7. San Nicolas	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
8. San Pablo	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
9. San Patricio	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	40	4.0	160	40	4.0	160	48	5.0	240	52	5.0	260	52	5.0	260
10. San Vicente	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	20	4.5	90	23	4.3	100	18	5.4	62	20	4.0	80	32	4.6	148
11. Sta. Cruz	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	159	4.6	726	136	4.1	444	155	4.1	639	130	4.6	687
12. Sto Rosario	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	8	4.0	32	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
Subtotal	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	268	4.4	1,192	528	4.4	2,363	523	4.4	2,313	577	4.3	2,466	666	4.5	2,972
SANTA ANA																															
1. San Agustin	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
2. San Roque	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
3. San Pablo	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
Subtotal	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0
Total	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	268	4.4	1,192	528	4.4	2,363	523	4.4	2,313	577	4.3	2,466	666	4.5	2,972

Source : These figures are estimated based on Municipal Agriculture Offices Abbrevia : C.A.; Cropped Area, U.Y.; Unit Yield, Prod.; Production

Table K.8 Overall Status of Existing Irrigation System in Tarlac Province

	Name of Irrigation System	Location	Service Area	Irrigeted Area Wet	Irrigeted Area Dry	Extent Damage by Mt. Pinatubo Eruption	Depth of Lahar / Remarks	Required Works
			(ha)	(ha)	(ha)			
1.	Bamban CIS	Bamban	623	300	532	Heavily covered with Lahar	1.0 - 1.5 m	
2.	Malonzo CIS	Bamban	250	-	-	Heavily covered with Lahar	sand pocket area	
3.	Panaisan CIS *	Bamban	400	300	200	Partially damaged by Lahar	Rehabilitable	A. B. C.
4.	Bancu CIS	Bamban	119	-	100	Heavily covered with Lahar	0.1 - 1.0 m	
5.	San Pedro CIS	Bamban	140	-	-	Heavily covered with Lahar	0.1 - 1.0 m	
6.	Lab CIS *	Capas	362	242	120	Partially damaged by Lahar	Rehabilitable	A. B. C. D. E.
7.	O'Donnel No. 1 CIS	Capas	80	-	80	Heavily damaged with Lahar	source w/ lahar	
8.	O'Donnel No. 2 CIS	Capas	-	-	-	Heavily covered with Lahar	source w/ lahar	
9.	Susuba-Cutcut CIS	Capas	30	-	-	Heavily covered with Lahar	Not Rehabilitable	
10.	Kawili-wili CIP	Capas	340	-	-	Partially damaged by Lahar	Rehabilitable	A. B. C.
11.	Lawy CIS	Capas	1,200	1,200	500	Partially damaged by Lahar	No Available Data	
12.	Baloy PIP	Capas	160	160	50	Partially damaged by Lahar	No Available Data	
13.	Baluto CIS	Concepcion	390	330	-	Heavily damaged with Lahar	source w/ lahar	
14.	Talabanca CIS	Concepcion	328	-	-	Heavily damaged with Lahar	sand pocket area	
15.	San Bartolome CIS	Concepcion	223	-	-	Heavily damaged with Lahar	source w/ lahar	
16.	Sta. Cruz Gugo CIS	Concepcion	80	80	50	Heavily damaged with Lahar	Not Rehabilitable	
17.	Balucuk CIS *	Concepcion	119	100	100	Partially damaged by Lahar	Rehabilitable	B. C. E.
18.	Lucong CIS *	Concepcion	2,250	1,600	1,000	Partially damaged by Lahar	Rehabilitable	A. B. C. D. F.
19.	Sta. Monica CIS *	Concepcion	740	300	300	Partially damaged by Lahar	Rehabilitable	A. F.
20.	Sto. Rosario CIS *	Concepcion	210	200	100	Partially damaged by Lahar	Rehabilitable	A. F.
21.	Sta. Rita CIS	Concepcion	165	-	-	Heavily covered with Lahar	1.0 - 1.5 m	
22.	Marita CIS	Concepcion	100	-	-	Heavily covered with Lahar	0.1 - 1.5	
23.	San Martin CIS	Concepcion	230	-	-	Heavily covered with Lahar	1.5 - 2.0	
24.	Lilibangan CIS	Concepcion	240	-	80	Heavily covered with Lahar	0.1 - 1.00	
25.	Magao CIS	Concepcion	960	-	-	Heavily covered with Lahar	source w/ lahr	
26.	San Isidro CIS	Concepcion	600	190	40	Heavily covered with Lahar	source w/ lahar	
27.	Tinang CIS	Concepcion	600	190	40	Partially damaged by Lahar	Rehabilitable	A. B. C.
28.	Caluluan PIS	Concepcion	114	114	70	Partially damaged by Lahar	Rehabilitable	B. C.
	Total Service Area		11,053	5,306	3,362			

Remarks : A ; Repair and desilting of dam and reservoir, B ; Desilting of irrigation canals, C ; Installation of slidegates,
D ; Upgrading of service roads, E ; Installation of pumps, F ; Canal lining
* CIS/CIP already availed of rehabilitation of areas affected by Mt.Pinatubo Eruption (RAAMPE)

Table K.9 Overall Status of Existing Irrigation Systems in Pampanga Province (1/3)

	Name	Location	Service Area	Irrigated Area Wet	Irrigated Area Dry	Extent of Damage by Mt. Pinatubo Eruption	Remarks	Required Works
			(ha)	(ha)	(ha)			
1.	Cutud CIS *	Angeles City	120	21	11	Partially damaged by lahar	Rehabilitable	A. B. C.
2.	Pulong Cacutud CIS	Angeles City	50	0	0	Not covered by PIO monitoring	-	
3.	Lico CIS	Angeles City	70	0	0	Not covered by PIO monitoring	-	
4.	Natividad CIS	Angeles City	163	126	80	Not covered by PIO monitoring	-	
5.	Tabon CIS	Angeles City	70		0	Not covered by PIO monitoring	-	
6.	Mabalacat CIS	Mabalacat	143	0	0	Not covered by PIO monitoring	-	
7.	Mawaque CIS *	Mabalacat	80	80	25	Partially damaged by lahar	Rehabilitable	A. B. F.
8.	Sapang Biabas CIS *	Mabalacat	110	50	20	Partially damaged by lahar	Rehabilitable	B. C. F.
9.	Sta. Maria CIS	Mabalacat	113	75	75	Partially damaged by lahar	Rehabilitable	A. B. F.
10.	Quitanguil CIS	Mabalacat	114	60	30	Not covered by PIO monitoring	-	
11.	Camachili CIS	Mabalacat	279	0	0	Not covered by PIO monitoring	-	
12.	Mabiga CIS	Mabalacat	279	0	0	Not covered by PIO monitoring	-	
13.	Tabon CIS	Mabalacat	460	0	0	Not covered by PIO monitoring	-	
14.	Dau CIS	Mabalacat	206	65	65	Not covered by PIO monitoring	-	
15.	Mascup CIS	Mabalacat	460	0	0	Heavily damaged by Lahar	Not Rehabilitable	
16.	Sapang Balen CIS	Mabalacat	140	0	0	Heavily damaged by Lahar	Not Rehabilitable	
17.	Upper Camachili CIS	Mabalacat	30	0	0	Not covered by PIO monitoring	-	
18.	San Agustin CIS *	Magalang	65	65	50	Partially damaged by lahar	Rehabilitable	A. B. C. F.
19.	Camias CIS *	Magalang	58	48	48	Partially damaged by lahar	Rehabilitable	A. B. C.
20.	Banquili CIS	Magalang	13	13	0	Partially damaged by lahar	Rehabilitable	A. B. C. F.
21.	Sta. Cruz CIS	Magalang	335	50	50	Not covered by PIO monitoring	-	
22.	San Vicente CIS	Magalang	275	275	0	Not covered by PIO monitoring	-	
23.	Balen San Roque CIS	Magalang	450	0	0	Not covered by PIO monitoring	-	
24.	La Paz CIS	Magalang	250	153	92	Not covered by PIO monitoring	-	
25.	San Pedro CIS	Magalang	229	63	43	Not covered by PIO monitoring	-	
26.	Magalang CIS	Magalang	80	0	0	Not covered by PIO monitoring	-	
27.	Camansi CIS	Magalang	120	0	0	Proposed Proj. Funded by CARP	Under Processing	
28.	Punto CIS	Magalang	300	0	0	Proposed Proj. Funded by CARP	Under Processing	
29.	Tugtugan CIS	Florida Blanca	211	0	0	Heavily damaged by Lahar	Not Rehabilitable	
30.	Sapang Matua CIS	Lubao	800	0	0	Not covered by PIO monitoring	-	
31.	Dampol CIS	Sta. Rita	77	28	0	Not covered by PIO monitoring	-	
32.	Macapagal CIS	Sta. Rita	63	0	0	Not covered by PIO monitoring	-	
33.	Laxamana CIS	Sta. Rita	50	0	0	Not covered by PIO monitoring	-	
34.	Bitas Libutad CIS *	Arayat	265	108	10	Partially damaged by Lahar	Rehabilitable	A. B. F.
35.	Gatiawin CIS *	Arayat	62	63	0	Partially damaged by Lahar	Rehabilitable	A. B. F.
36.	Inumang Baca CIS *	Arayat	132	85	0	Partially damaged by Lahar	Rehabilitable	A. B. F.
37.	San Roque Bitas CIS *	Arayat	126	103	3	Partially damaged by Lahar	Rehabilitable	A. B.
38.	La Paz Turo CIS	Arayat	800	0	0	Not covered by PIO monitoring	-	
39.	Lacmit CIS *	Arayat	138	138	0	Partially damaged by Lahar	Rehabilitable	A. B.
40.	Padlinlang CIS *	Arayat	29	29	10	Partially damaged by Lahar	Rehabilitable	A. B. F.
41.	Cabeza CIS	Arayat	90	40	0	Proposed Proj. Funded by CARP	Under Processing	
42.	San Juan Baño CIS	Arayat	365	199	199	Not covered by PIO monitoring	-	
43.	Buenavista CIS *	Arayat	30	30	0	Partially damaged by Lahar	Rehabilitable	A. B. F.
44.	San Nicolas PIS	Arayat	130	0	0	Not covered by PIO monitoring	-	
45.	Sta. Cruz Candating I PIS	Arayat	202	112	202	Proposed Proj. Funded by CARP	Under Processing	
46.	Sto. Cristo PIS	Arayat	140	20	30	Not covered by PIO monitoring	-	
47.	Candating CIS II	Arayat	480	0	0	Not covered by PIO monitoring	-	
48.	Nabau PIS	Arayat	270	0	0	Proposed Proj. Funded by CARP	Under Processing	
49.	Dalayap SRIP	Arayat	350	0	0	Not covered by PIO monitoring	-	
50.	Bacolor CIS	Bacolor	112	30	20	Heavily damaged with Lahar	Not Rehabilitable	
	Sub Total		9,984	2,128	1,063			

Remarks: A ; Repair and desilting of dam and reservoir, B ; Desilting of irrigation canals, C ; Installation of slidegates, D ; Upgrading of service roads, E ; Installation of pumps, F ; Canal lining

* CIS/CIP already availed of rehabilitation of areas affected by Mt.Pinatubo Eruption (RAAMPE)

Table K.9 Overall Status of Existing Irrigation Systems in Pampanga Province (2/3)

	Name of Irrigation Sistem	Location	Service Area	Irrigated Area Wet	Irrigated Area Dry	Extent of Damage by Mt. Pinatubo Eruption	Remarks	Required Works
			(ha)	(ha)	(ha)			
51.	Lower Sta. Barbara CIS	Bacolor	162	0	0	Heavily damaged with Lahar	Not Rehabilitable	
52.	Macabali CIS	Bacolor	60	0	0	Heavily damaged with Lahar	Not Rehabilitable	
53.	Cabetican CIS	Bacolor	55	0	0	Heavily damaged with Lahar	Not Rehabilitable	
54.	Cabalantian CIS	Bacolor	150	100	20	Heavily damaged with Lahar	Not Rehabilitable	
55.	Parulog CIS	Bacolor	36	0	0	Heavily damaged with Lahar	Not Rehabilitable	
56.	Dolores CIS	Bacolor	280	0	0	Heavily damaged with Lahar	Not Rehabilitable	
57.	Pandacaqui CIS	Mexico	180	77	12	Partially damaged by Lahar	Rehabilitable	A. B. C. D. F.
58.	San Antonio CIS	Mexico	68	0	0	Not covered by PIO monitoring	-	
59.	Bettis LPN CIS	Mexico	103	0	0	Not covered by PIO monitoring	-	
60.	San Jose Malino CIS	Mexico	77	75	75	Not covered by PIO monitoring	-	
61.	San Lorenzo CIS	Mexico	70	0	0	Not covered by PIO monitoring	-	
62.	Nueva Victoria CIS	Mexico	100	0	70	Not covered by PIO monitoring	-	
63.	Anao CIS	Mexico	162	112	0	Not covered by PIO monitoring	-	
64.	Divisoria CIS	Mexico	30	72	72	Heavily damaged by Lahar	Not Rehabilitable	
65.	Bungan Guinto CIS	Mexico	90	0	0	Heavily damaged by Lahar	Not Rehabilitable	
66.	Buenavista CIS	Mexico	30	22	0	Heavily damaged by Lahar	Not Rehabilitable	
67.	Abacan CIS	Mexico	90	0	0	Heavily damaged by Lahar	Not Rehabilitable	
68.	Mexico CIS	Mexico	157	0	0	Heavily damaged by Lahar	Not Rehabilitable	
69.	San Antonio CIS	Mexico	120	0	0	Heavily damaged by Lahar	Not Rehabilitable	
70.	San Rafael CIP	Mexico	120	0	0	Not covered by PIO monitoring	-	
71.	San Miguel CIP	Mexico	100	0	0	Not covered by PIO monitoring	-	
72.	Sabanilla CIP	Mexico	325	0	0	Not covered by PIO monitoring	-	
73.	Sto. Rosario CIP	Mexico	300	75	60	Not covered by PIO monitoring	-	
74.	Calulut I CIS *	San Fernando	60	60	51	Partially damaged by Lahar	Rehabilitable	A. B.
75.	Telabastagan CIS *	San Fernando	24	24	7	Partially damaged by Lahar	Rehabilitable	A. B.
76.	Calulut II CIS *	San Fernando	36	21	21	Partially damaged by Lahar	No Available Data	
77.	San Jose CIP	San Fernando	90	70	60	Not covered by PIO monitoring	-	
78.	San Pedro Cutud PIP	San Fernando	100	0	0	Not covered by PIO monitoring	-	
79.	Santiago CIS	Sta. Ana	173	0	0	Heavily damaged by Lahar	Not Rehabilitable	
80.	San Roque CIS *	Sta. Ana	99	76	10	Partially damaged by Lahar	DAR-JICA 1992	
81.	San Agustin CIS	Sta. Ana	28	26	0	Partially damaged by Lahar	Rehabilitable	A. B. C. F.
82.	San Isidro CIS	Sta. Ana	160	100	100	Not covered by PIO monitoring	-	
83.	San Pablo Central CIP	Sta. Ana	54	0	0	Partially damaged by Lahar	DAR-JICA 1992	
84.	Barangca CIS	Candaba	205	0	0	Proposed Proj. Funded by CARP	Under Processing	
85.	Mandasig PIS	Candaba	265	50	180	Project Funded by CARP	Completed	
86.	Lanang Pasig PIS	Candaba	312	148	218	Partially damaged by Lahar	Rehabilitable	E.
87.	Mapanigue PIS	Candaba	1,200	1,200	400	Not covered by PIO monitoring	-	
88.	Pansinao PIS	Candaba	163	120	120	Partially damaged by Lahar	Rehabilitable	E.
89.	Salapungan CIS	Candaba	688	70	0	Not covered by PIO monitoring	-	
90.	Sto. Rosario PIS	Candaba	280	220	50	Partially damaged by Lahar	Rehabilitable	E.
91.	Villongco PIS	Candaba	80	20	80	Not covered by PIO monitoring	-	
92.	Lower Maasim Dam	Candaba	2,500	0	0	Not covered by PIO monitoring	-	
93.	Gulap PIS	Candaba	311	40	320	Partially damaged by Lahar	Rehabilitable	E.
94.	Vigen CIP	Candaba	1,078	0	0	Proposed Proj. Funded by CARP	Under Processing	
95.	Castuli CIS	Macabebe	285	0	0	Not covered by PIO monitoring	-	
96.	Telacsan CIS	Macabebe	180	0	0	Not covered by PIO monitoring	-	
97.	San Jose CIS	Macabebe	289	0	0	Not covered by PIO monitoring	-	
98.	Sta. Maria CIS	Macabebe	271	0	0	Not covered by PIO monitoring	-	
99.	Batasan CIS	Macabebe	112	0	0	Not covered by PIO monitoring	-	
100.	San Gabriel CIS	Macabebe	194	150	150	Not covered by PIO monitoring	-	
	Sub-Total		12,101	2,928	2,075			

Remarks : A ; Repair and desilting of dam and reservoir, B ; Desilting of irrigation canals, C ; Installation of slidegates, D ; Upgrading of service roads, E ; Installation of pumps, F ; Canal lining

* CIS/CIP already availed of rehabilitation of areas affected by Mt.Pinatubo Eruption (RAAMPE)

Table K.9 Overall Status of Existing Irrigation Systems in Pampanga Province (3/3)

Name of Irrigation System	Location	Service Area	Irrigated Area Wet	Irrigated Area Dry	Extent of Damage by Mt. Pinatubo Eruption	Remarks	Required Works
		(ha)	(ha)	(ha)			
101. San Juan CIS	Macabebe	208	0	0	Not covered by PIO monitoring	-	
102. San Rafael CIS	Macabebe	238	0	0	Not covered by PIO monitoring	-	
103. San Roque CIS	Macabebe	134	0	0	Not covered by PIO monitoring	-	
104. Sapa Libutad CIS	Macabebe	206	0	0	Not covered by PIO monitoring	-	
105. Saplad David CIS	Macabebe	376	0	0	Not covered by PIO monitoring	-	
106. Malauli CIS	Masantol	213	0	0	Not covered by PIO monitoring	-	
107. Nigui CIS	Masantol	234	0	0	Not covered by PIO monitoring	-	
108. Sagrada CIS	Masantol	241	0	0	Not covered by PIO monitoring	-	
109. San Sebastian PIS	San Luis	206	206	120	Partially damaged by Lahar	Rehabilitable	B
110. Kalubasan PIS	San Luis	180	80	180	Not covered by PIO monitoring	-	
111. Malique PIS	San Luis	160	50	160	Not covered by PIO monitoring	-	
112. Piss (Sta. Cruz) PIS	San Luis	314	70	314	Not covered by PIO monitoring	-	
113. San Agustin PIS	San Luis	180	0	0	Not covered by PIO monitoring	-	
114. Bagong Silang PIS	San Simon	160	50	160	Not covered by PIO monitoring	-	
115. San Miguel PIS	San Simon	200	200	140	Proposed Proj. Funded by CARP	Under Processing	
116. Sta. Cruz Pambilog PIS	San Simon	315	100	315	Not covered by PIO monitoring	-	
117. Sta. Cruz PIS	San Simon	126	126	126	Proposed Proj. Funded by CARP	Under Processing	
118. Sta. Monica PIS	San Simon	220	200	100	Not covered by PIO monitoring	-	
119. Sta. Rita PIS	San Simon	130	100	130	Not covered by PIO monitoring	-	
120. Tagumpay PIS	San Simon	250	0	0	Not covered by PIO monitoring	-	
121. San Pablo CIP	San Simon	350	0	0	Not covered by PIO monitoring	-	
122. San Simon PIS	San Simon	250	0	0	Not covered by PIO monitoring	-	
123. Sta. Cruz PIS	San Simon	126	0	0	Not covered by PIO monitoring	-	
Sub-Total		5,017	1,182	1,745			
Total Service Area		27,103	6,238	4,883			

Remarks: A ; Repair and desilting of dam and reservoir, B ; Desilting of irrigation canals, C ; Installation of slidegates, D ; Upgrading of service roads, E ; Installation of pumps, F ; Canal lining

* CIS/CIP already availed of rehabilitation of areas affected by Mt.Pinatubo Eruption (RAAMPE)

Table K.10 Present Condition of Existing C.I.S. in Sacobia-Bamban River Basin Area

Name of CIS	Water Source	Type of Intake Weir	Survey year	Potential Area (ha)	Irrigated Area. Wet Season (ha)	(ha)	Dry Season (ha)	(ha)	No of I.A. Members	Covered Barangay	Remarks (Lahar depth, others)
1. Bamban	Bamban/ Parua river	Brush dam	1989	1,050	751		532		500	La Paz, San Pedro, Culubasa Pacalcal, Dela Cruz, Anupul, Banaba, San Roque, San Mafael	Heavily covered with Lahar 1.0 - 1.5 m
			1994	623	300		532				
2. San Pedro	Bamban river	Brush dam	1989	145	120		120		105	San Pedro, Culubasa, Pacalcal	Heavily covered with Lahar Sand pocket area
			1994	140	0		0				
3. Malonzo	Bamban river	Brush dam 2 dams	1989	335	179		240		150	Malonzo	Heavily covered with Lahar Rehabilitable
			1994	250	0		0				
4. Bangcu	Parua River	Brush dam	1989	720	700		500		80	Bangcu, Dungan, Macangcong, Ligaya	Heavily covered with Lahar 0.1 - 1.0 m
			1994	119	0		100				
5. Telabanca	Parua river	Brush dam 3 dams	1989	390	390		364		121	Telabanca	Heavily damaged by Lahar Sand pocket area
			1994	328	0		0				
6. Sta. Rita	Bamban river	Diversion dam	1989	135	115		80		43	Sta. Rita	Heavily covered with Lahar 1.0 - 1.5 m
			1994	130	0		0				
7. Marita	Parua river	Brush dam	1989	100	100		0		41	Sta. Rita, San Martin	Heavily covered with Lahar 0.1 - 1.5 m
			1994	100	0		0				
8. San Martin	Parua river	Brush dam 4 dams	1989	330	240		80		95	San Martin	Heavily covered with Lahar 1.5 - 2.0 m
			1994	230	0		0				
9. Balutu	Parua river	Check Gate 2 gates	1989	600	600	(219)*	0	(320)*	120	Balutu, Calius Gueco	Heavily damaged by Lahar source with Lahar
			1994	390	390		330				
10. Lilibangan	Parua river	Brush dam	1989	350	240		200	(40)*	116	Lilibangan	Heavily covered with Lahar 0.1 - 1.0 m
			1994	240	0		80				
11. San Bartolome	Sapang Balen creek	Diversion dam 2 dams	1989	375	350		120	(140)*	64	San Bartolome	Heavily damaged by Lahar source with Lahar
			1994	223	0		0				
12. San Isidro	Excess water from San Bartolome CIS	non	1989	630	450		0	(330)*	235	San Isidro	Heavily covered with Lahar source with Lahar
			1994	600	190		40				
13. Magao	Balico creek	Diversion dam 2 dams	1989	960	468		468		152	Magao	Heavily covered with Lahar source with Lahar
			1994	960	0		0				
14. Tabun (MASKUP)	Sacobia/ Bamban river	Brush dam	1989	460	350		100		37	Tabun	Heavily covered with Lahar Sand pocket area
			1994	460	0		0				
Total			1989	6,580	5,053		2,804		1,859		
			1994	4,793	880		1,082				

Sources : (1) ; 1989 survey by the JICA Master Plan for Improvement of Communal Irrigation Systems through Physical and Institutional Development and Rural Development in Southern Tarlac Province
(2) ; 1994 survey by Provincial Irrigation Office, Tarlac and Pampanga Provinces

Remarks : (*) ; Pump irrigation area, I.A. ; Irrigator's Association

Table K.11 Land Classification of Ashfall and Lahar/Mud Flow Affected Area

Province / Municipality	Description		Class I (below 15 cm)	Class II (15 - 30 cm)	Class III (15 - 90 cm)	Class IV (above 90 cm)	Total Area
ABACAN RIVER BASIN AREA							
PAMPANGA PROVINCE							
1. Angeles City	No of affected Barangay	(nos.)	27	2	0	0	29
	Total Area	(ha)	6,510	1,140	0	0	7,650
	Affected Area	(ha)	7,060	590	0	0	7,650
2. Arayat	No of affected Barangay	(nos.)	27	2	0	0	29
	Total Area	(ha)	11,240	1,810	0	0	13,050
	Affected Area	(ha)	12,880	170	0	0	13,050
3. Santa Ana	No of affected Barangay	(nos.)	9	5	0	0	14
	Total Area	(ha)	7,800	3,840	0	0	11,640
	Affected Area	(ha)	10,960	680	0	0	11,640
4. Mexico	No of affected Barangay	(nos.)	28	8	7	0	43
	Total Area	(ha)	9,760	5,540	6,830	0	22,130
	Affected Area	(ha)	20,910	700	520	0	22,130
Sub-total	No of affected Barangay	(nos.)	91	17	7	0	115
	Total Area	(ha)	35,310	12,330	6,830	0	54,470
	Affected Area	(ha)	51,810	2,140	520	0	54,470
SACOBIA-BAMBAN RIVER BASIN AREA							
TARLAC PROVINCE							
1. Bamban	No of affected Barangay	(nos.)	2	6	7	0	15
	Total Area	(ha)	230	2,700	810	240	3,980
	Affected Area	(ha)	2,840	260	640	240	3,980
2. Capas	No of affected Barangay	(nos.)	7	2	0	0	9
	Total Area	(ha)	2,000	5,620	0	0	7,620
	Affected Area	(ha)	7,430	190	0	0	7,620
3. Concepcion	No of affected Barangay	(nos.)	5	12	2	4	23
	Total Area	(ha)	960	8,600	1,540	1,810	12,910
	Affected Area	(ha)	8,010	2,520	680	1,700	12,910
PAMPANGA PROVINCE							
1. Mabalacat	No of affected Barangay	(nos.)	12	9	2	2	25
	Total Area	(ha)	4,870	14,750	1,150	1,800	22,570
	Affected Area	(ha)	19,500	1,160	570	1,340	22,570
2. Magalang	No of affected Barangay	(nos.)	18	8	0	0	26
	Total Area	(ha)	10,270	13,680	0	0	23,950
	Affected Area	(ha)	23,030	920	0	0	23,950
Sub-total	No of affected Barangay	(nos.)	44	37	11	6	98
	Total Area	(ha)	18,330	45,350	3,500	3,850	71,030
	Affected Area	(ha)	60,810	5,050	1,890	3,280	71,030
Total	No of affected Barangay	(nos)	135	54	18	6	213
	Total Area	(ha)	53,640	57,680	10,330	3,850	125,500
	Affected Area	(ha)	112,620	7,190	2,410	3,280	125,500

Remark : These figures are estimated by GIS based on 1/10,000 topographic map.

Table K.12 Present and Future Land Use in the Proposed Project Area

Proposed CIS/CIP	Land Use	Paddy Field (ha)	Upland Field (ha)	Agro-Forest. Field (ha)	Build-Up Area (ha)	Non-Cultivated Land (ha)	Total Area (ha)	Covered Municipality/ Barangay	
SACOBIA-BAMBAN RIVER BASIN AREA									
1. Bamban C.I.S.	Present Land Use	550	250	0	50	200	1,050	Bamban	Banaba, La Paz,
	Future Land Use	600	250	0	50	150	1,050		Pacalcal, San Rafael
	Increment	50	0	0	0	-50	0		
2. San Pedro C.I.S.	Present Land Use	30	60	0	15	75	180	Bamban	San Pedro
	Future Land Use	80	50	0	15	35	180		
	Increment	50	-10	0	0	-40	0		
3. Bangcu C.I.S.	Present Land Use	370	250	0	70	180	870	BAMBAN	Bangcu, Pacalcal
	Future Land Use	430	220	0	70	150	870	Concepcion	Dungan, San Francisco
	Increment	60	-30	0	0	-30	0		
4. Tabun C.I.P.	Present Land Use	0	0	0	0	300	300	MABALACAT	Tabun
	Future Land Use	0	100	120	50	30	300		
	Increment	0	100	120	50	-270	0		
5. MASKUP C.I.P.	Present Land Use	0	0	0	0	1,650	1,650	Mabalacat	Tabun, Dolores
	Future Land Use	0	500	820	60	270	1,650		Cacutud, Sapangbalen
	Increment	0	500	820	60	-1,380	0	Bamban	Malonzo
								Concepcion	Telabanca
6. Sat. Rita C.I.P.	Present Land Use	0	0	0	25	535	560		
	Future Land Use	200	120	130	30	80	560	Concepcion	Minane, Sta. Rita
	Increment	200	120	130	5	-455	0		San Martin
7. Marita C.I.P.	Present Land Use	0	20	0	10	640	670	Concepcion	San Martin, Lilibangan
	Future Land Use	210	170	170	20	100	670		
	Increment	210	150	170	10	-540	0		
8. Magao C.I.S.	Present Land Use	250	180	0	50	400	880	Concepcion	Talimudue Marimula
	Future Land Use	450	120	120	50	140	880		Magao
	Increment	200	-60	120	0	-260	0		
9. San Vicente C.I.P.	Present Land Use	620	150	0	40	190	1,000	Concepcion	San Vicente, Baluto
	Future Land Use	710	100	0	40	150	1,000		
	Increment	90	-50	0	0	-40	0		
10. San Bartolome C.I.S.	Present Land Use	530	300	0	70	150	1,050	Concepcion	San Nicolas Balas,
	Future Land Use	560	270	0	70	150	1,050		Navating, San Bartolome
	Increment	30	-30	0	0	0	0		
11. San Isidro C.I.S.	Present Land Use	510	100	0	40	160	810	Concepcion	San Isidro
	Future Land Use	560	90	0	40	120	810		
	Increment	50	-10	0	0	-40	0		
12. Baluto C.I.S.	Present Land Use	60	10	0	20	60	150	Concepcion	Baluto
	Future Land Use	90	10	0	20	30	150		
	Increment	30	0	0	0	-30	0		
13. Calula Gueco C.I.P.	Present Land Use	200	150	0	30	170	550	Concepcion	Calula Gueco
	Future Land Use	240	130	0	30	150	550		
	Increment	40	-20	0	0	-20	0		
Total Area	Present Land Use	3,120	1,470	0	430	4,710	9,720		
	Future Land Use	4,130	2,130	1,360	545	1,555	9,720		
	Increment	1,010	660	1,360	115	-3,155	0		
ABACAN RIVER BASIN AREA									
1. San Juan C.I.P.	Present Land Use	260	50	0	60	250	620	Mexico	San Juan, Concepcion
	Future Land Use	360	100	0	60	100	620		Sta. Cruz, Sto Rosario
	Increment	100	50	0	0	-150	0		Balas, San Antonio
2. San Patricio C.I.P.	Present Land Use	130	90	0	40	340	600	Mexico	San Patricio, Sto Rsario
	Future Land Use	250	210	0	40	100	600		San Pablo, San Lorenzo
	Increment	120	120	0	0	-240	0		
3. San Joaquin C.I.P.	Present Land Use	70	10	0	10	260	350	Santa Ana	San Nicolas, Dolores
	Future Land Use	150	90	0	10	100	350		
	Increment	80	80	0	0	-160	0		
Total Area	Present Land Use	460	150	0	110	850	1,570		
	Future Land Use	760	400	0	110	300	1,570		
	Increment	300	250	0	0	-550	0		

Remarks : These figures are estimated based on 1/10,000 topographic map.
Agro-forestoration field are included fruits/ fodder trees field, fish ponds, livestock yard.
Non-Cultivated land is included grass, swamp and lahar covered area.

Table K.13 List of Priority CIS/CIP for Urgent Restoration Program

	Name of Irrigation System	Location	Parts Damaged by Lahar	Estimated Restoration Cost	Potential Irrigation Area	Irrigation Area: Wet Season a/	Irrigation Area: Wet Season b/	Irrigation Area: Dry Season a/	Irrigation Area: Dry Season b/	Crop Yield in Cavans/ha: Wet Season a/	Crop Yield in Cavans/ha: Wet Season b/	Crop Yield in Cavans/ha: Dry Season a/	Crop Yield in Cavans/ha: Dry Season b/	Number of Farmer Beneficiaries
	TARLAC PROVINCE			(million Peso)	(ha)	(ha)	(ha)	(ha)	(ha)					
1.	Panaisan CIS *	Bamban	A. B. C.	2.522	400	300	112	200	50	80	80	85	85	60
2.	Lab CIS *	Capas	A. B. C. D. E.	2.975	362	242	242	120	120	80	80	85	85	140
3.	Kawili-wili CIP	Capas	A. B. C.	29.500	340	0	0	0	0	0	0	0	0	300
4.	Balucuk CIS *	Concepcion	B. C. E.	0.820	119	100	100	100	100	85	85	85	85	45
5.	Lucong CIS *	Concepcion	A. B. C. D. F.	30.677	2,250	1,600	1,300	1,000	900	85	85	90	90	700
6.	Sta. Monica CIS *	Concepcion	A. F.	3.017	740	300	300	300	150	85	85	85	85	193
7.	Sto. Rosario CIS *	Concepcion	A. F.	2.580	210	200	200	100	100	85	85	90	90	102
8.	Tinang CIS	Concepcion	A. B. C.	2.980	600	190	190	40	40	80	80	85	85	170
9.	Caluluan PIS	Concepcion	B. C.	0.300	114	114	114	70	50	75	75	85	85	42
			Sub-total	75.371	5,135	3,046	2,558	1,930	1,510	655	655	690	690	1,752
	PAMPANGA PROVINCE													
10.	Cutud CIS *	Angeles City	A. B. C.	0.821	120	27	21	14	11	50	40	40	35	16
11.	Mawaque CIS *	Mabalacat	A. B. F.	0.116	80	80	80	31	25	70	55	80	70	46
12.	Sapang Biabas CIS *	Mabalacat	B. C. F.	0.070	110	70	50	25	20	70	55	65	52	96
13.	Sta. Maria CIS	Mabalacat	A. B. F.	6.500	113	98	75	94	75	70	50	65	51	95
14.	San Agustin CIS *	Magalang	A. B. C. F.	0.120	65	65	65	63	50	70	70	65	65	22
15.	Camias CIS *	Magalang	A. B. C.	0.520	58	58	48	58	48	85	85	65	65	28
16.	Banquili CIS	Magalang	A. B. C. F.	0.570	13	13	13	0	0	65	65	0	0	14
17.	Bitas Libutad CIS *	Arayat	A. B. F.	0.550	265	140	108	13	10	65	65	50	50	69
18.	Gatiawin CIS *	Arayat	A. B. F.	0.500	62	63	63	0	0	70	70	0	0	30
19.	Inumang Baca CIS *	Arayat	A. B. F.	0.950	132	110	85	0	0	60	60	0	0	55
20.	San Roque Bitas CIS*	Arayat	A. B.	0.070	126	126	103	4	3	70	70	50	50	80
21.	Lacmit CIS *	Arayat	A. B.	0.100	138	138	138	0	0	60	60	0	0	72
22.	Panlinlang CIS *	Arayat	A. B. F.	0.250	29	29	29	13	10	30	30	50	50	15
23.	Buenavista CIS *	Arayat	A. B. F.	0.405	30	30	30	0	0	60	60	0	0	15
24.	Pandacaqui CIS *	Mexico	A. B. C. D. F.	1.330	180	100	77	16	12	80	80	55	55	54
25.	Calulut I CIS *	San Fernando	A. B.	0.180	60	60	60	66	51	85	85	75	75	40
26.	Telabastagan CIS *	San Fernando	A. B.	0.100	24	24	24	9	7	75	75	60	60	15
27.	San Agustin CIS	Sta. Ana	A. B. C. F.	0.410	28	26	26	0	0	70	70	0	0	16
28.	Pansinao PIS	Candaba	E.	0.200	163	120	120	120	120	85	85	95	95	93
29.	Sto. Rosario PIS	Candaba	E.	0.200	280	220	220	50	50	35	35	95	95	115
30.	Gulap PIS	Candaba	E.	0.200	311	40	40	320	320	70	70	110	110	136
31.	San Sebastian PIS	San Luis	E.	0.200	206	206	206	120	120	45	45	100	100	176
			Sub-total	14.362	2,593	1,843	1,680	1,014	931	1,440	1,380	1,120	1,078	1,298
			Grand Total	89.733	7,728	4,889	4,238	2,944	2,441	2,095	2,035	1,810	1,768	3,050

Note : * CIS/CIP already availed of Rehabilitation of Areas Affected by Mt. Pinatubo Eruption (RAAMPE) Funds

A. Repair and desilting of dam and reservoir B. Desilting of Irrigation Canals C. Installation of Control Slidegates
D. Upgrading of Service Roads E. Installation of Pumps and/or Desilting at the Intake Works
F. Canal Lining

a/ - Before Eruption

b/ - After eruption and/or after partial rehabilitation using RAAMPE Funds in 1993;
Note that after rehabilitation, some systems were again affected by lahar flow.

Table K.14 Project Description of the Proposed CIS/CIP

Proposed CIS/CIP	Potential Irrigation Area				Water Source	No of Intake	Type of Diversion Dam	Length of Main Canal
	Paddy (ha)	Upland (ha)	Agro-forest. (ha)	Total (ha)				(km)
BAMBAN RIVER BASIN AREA								
1. Bamban C.I.S.	600	250	0	850	Bamban river	1	Ogree type	12.5
2. San Pedro C.I.S.	80	50	0	130	Banban river	same as Bamban C.I.S.		3.5
3. Bangcu C.I.S.	430	220	0	650	Bamban river	same as Bamban C.I.S.		9.6
4. Tabun C.I.P.	0	100	120	220	Marimla river	1	Ogree type	4.2 6.7 #
5. MASKUP C.I.P.	0	500	820	1,320	Sacobia/ Bamban rivers	2	Intake	9.4 26.5 #
6. Sat. Rita C.I.P.	200	120	130	450	Bamban river	1	Ogree type	5.5
7. Marita C.I.P.	210	170	170	550	Bamban river	same as Marita C.I.S.		10.7
8. Magao C.I.S.	450	120	120	690	Lucung river	2	Check-Gate	6.2
9. San Vicente C.I.P.	710	100	0	810	Bamban river	1	Ogree type	12.5
10. San Bartolome C.I.P.	560	270	0	830	Sapan Belen creek	2	Check-Gate	10.3
11. San Isidro C.I.S.	560	90	0	650	Dalandanum creek	1	Check-Gate	9.0
12. Balutu C.I.S.	90	10	0	100	Parua creek	1	Check-Gate	1.4
13. Caluis Gueco C.I.P.	240	130	0	370	Balen creek	1	Check-Gate	4.5
Total Area	4,130	2,130	1,360	7,620				
ABACAN RIVER BASIN AREA								
1. San Juan C.I.P.	360	100	0	460	Abacan river	1	Ogree type	9.4
2. San Patricio C.I.P.	250	210	0	460	Abacan river	1	Ogree type	8.6
3. San Joaquin C.I.P.	150	90	0	240	Joaquin creek	1	Check-Gate	3.4
Total Area	760	400	0	1,160				

Remarks : These figures are estimated based on 1/10,000 topographic map.
Agro-forestoration field are included fruits/ fodder trees field, fish ponds, livestock yard.
(#) ; Secondary canal

Table K.15 Proposed Implementation Schedule for Agricultural Development Project (1/2)

Description	Potencial Service Area	Location (Municipality)	Executing Agency	Implementation Schedule 1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Potenci 2008
SHORT TERM PLAN	(ha)																(ha)
Urgent Restoration Program :																	
Tarlac Province :																	
1. Panasian CIS*	400	Bamban	LGU	●	●												
2. Lab CIS*	362	Capas	LGU	●	●												
3. Kawili-wili CIP	340	Capas	LGU		●	●	●										
4. Balucuk CIS*	119	Concepcion	LGU	●	●												
5. Lucong CIS*	2,250	Concepcion	LGU	●	●												
6. Sta. Monica CIS*	740	Concepcion	LGU	●	●												
7. Sto. Rosario CIS*	210	Concepcion	LGU	●	●												
8. Tinang CIS	600	Concepcion	LGU		●	●	●										
9. Caluloan PIS	114	Concepcion	LGU		●	●	●										
Pampanga Province :																	
10. Cutod CIS*	120	Angeles City	LGU	●	●												
11. Mawaque CIS*	80	Mabalacat	LGU	●	●												
12. Sapang Biabas CIS*	110	Mabalacat	LGU	●	●												
13. Sta. Maria CIS	113	Mabalacat	LGU		●	●	●										
14. San Agustin CIS*	65	Magalang	LGU	●	●												
15. Camias CIS*	58	Magalang	LGU	●	●												
16. Banquili CIS	13	Magalang	LGU		●	●	●										
17. Bitas Libutad CIS*	265	Arayat	LGU	●	●												
18. Gatiawin CIS*	62	Arayat	LGU	●	●												
19. Inumang Baca CIS*	132	Arayata	LGU	●	●												
20. San Roque Bitas CIS*	126	Arayat	LGU	●	●												
21. Lacmit CIS*	138	Arayat	LGU	●	●												
22. Panlinlang CIS*	29	Arayat	LGU	●	●												
23. Buenavista CIS*	30	Arayat	LGU	●	●												
24. Pandacaqui CIS*	180	Mexico	LGU	●	●												
25. Calulut CIS*	60	San Fernando	LGU	●	●												
26. Telabastagan CIS*	24	San fernando	LGU	●	●												
27. San Agustin CIS	28	Magalang	LGU		●	●	●										
28. Pansinao PIS	163	Candaba	LGU		●	●	●										
29. Sto. Rosario PIS	280	Sto. Rosario	LGU		●	●	●										
30. Gulap PIS	311	Candaba	LGU		●	●	●										
31. San Sebastian PIS	206	San Luis	LGU		●	●	●										

Remarks : CIS ; Communal Irrigation System, CIP ; Communal Irrigation Project, PIS ; Pump Irrigation System
LGU ; Local Government Unit, NIA ; National Irrigation Administration, DA ; Department of Agriculture
DPWH ; Department of Public Works and Highways, DAR ; Department of Agrarian Reform
(*) ; CIS/CIP already availed of Rehabilitation of Areas Affected by Pinatubo Eruption (RAAMPE) Funds.

☆ ; Study
★ ; Design
● ; Construction

Table K.15 Proposed Implementation Schedule for Agricultural Development Project (2/2)

Description	Potencial Service Area	Location (Municipality)	Executing Agency	Implementation Schedule 1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
MEDIUM TERM PLAN	(ha)																
Restoration and Rehabilitation Projects																	
1. Magao CIS	690	Concepcion	LGU / NIA		★	●	●										
2. San Isidro CIS	650	Concepcion	LGU / NIA		★	●	●										
3. Balutu CIS	100	Concepcion	LGU / NIA		★	●	●										
4. Caluis Gueco CIP	370	Concepcion	LGU / NIA		☆	★	●	●									
5. San Juan CIP	360	Mexico	LGU / NIA		☆	★	●	●									
6. San Patricio CIP	460	Mexico	LGU / NIA		☆	★	●	●									
7. San Joaquin CIP	140	Mexico	LGU / NIA		☆	★	●	●									
Santa Rita Pilot Demonstration Project																	
1. Santa Rita CIP	450	Concepcion															
- Land reclamation work			LGU / DPWH		☆	★		●	●	●							
- Resettlement work			LGU / DAR		☆	★		●	●	●							
- Agriculture development work			LGU/ DA/ NIA		☆		★			●	●	●					
- Crop experimental work			DA / NIA		☆		★	O	O	O	O	O	O	O	O	O	O
LONG TERM PLAN																	
Restoration and Rehabilitation Projects																	
1. Bamban CIS	850	Bamban	LGU / NIA				☆		★	●	●						
2. San Pedro CIS	130	Bamban	LGU / NIA				☆		★	●	●						
3. Bangu CIS	650	Bamban / Concepcion	LGU / NIA				☆		★	●	●						
4. San Vicente CIP	810	Concepcion	LGU / NIA				☆		★	●	●						
5. San Bartolome CIP	830	Concepcion / Magalang	LGU / NIA						★	●	●						
Integrated Land and Agriculture Development Projects in Heavy Lahar Affected Area																	
1. Marita CIP	550	Concepcion															
- Land reclamation work			LGU / DPWH				☆		★	●	●	●					
- Resettlement work			LGU / DAR				☆		★		●	●					
- Agriculture development work			DA/ NIA				☆		★			●	●	●			
2. Tabun CIP	220	Mabalacat															
- Land reclamation work			LGU / DPWH				☆		★	●	●	●					
- Resettlement work			LGU / DAR				☆		★		●	●					
- Agriculture development work			DA/ NIA				☆		★			●	●	●			
3. MASKUP CIP	1,320	Bamban / Concepcion / Mabalacat															
- Land reclamation work			LGU / DPWH				☆		★	●	●	●	●	●			
- Resettlement work			LGU / DAR				☆		★			●	●	●	●		
- Agriculture development work			DA/ NIA				☆		★			●	●	●	●	●	●

Remarks : CIS ; Communal Irrigation System, CIP ; Communal Irrigation Project, PIS ; Pump Irrigation System
LGU ; Local Government Unit, NIA ; National Irrigation Administration, DA ; Department of Agriculture
DPWH ; Department of Public Works and Highways, DAR ; Department of Agrarian Reform

☆ ; Study
★ ; Design
● ; Construction
O ; Experiment & Demonstration

FIGURES

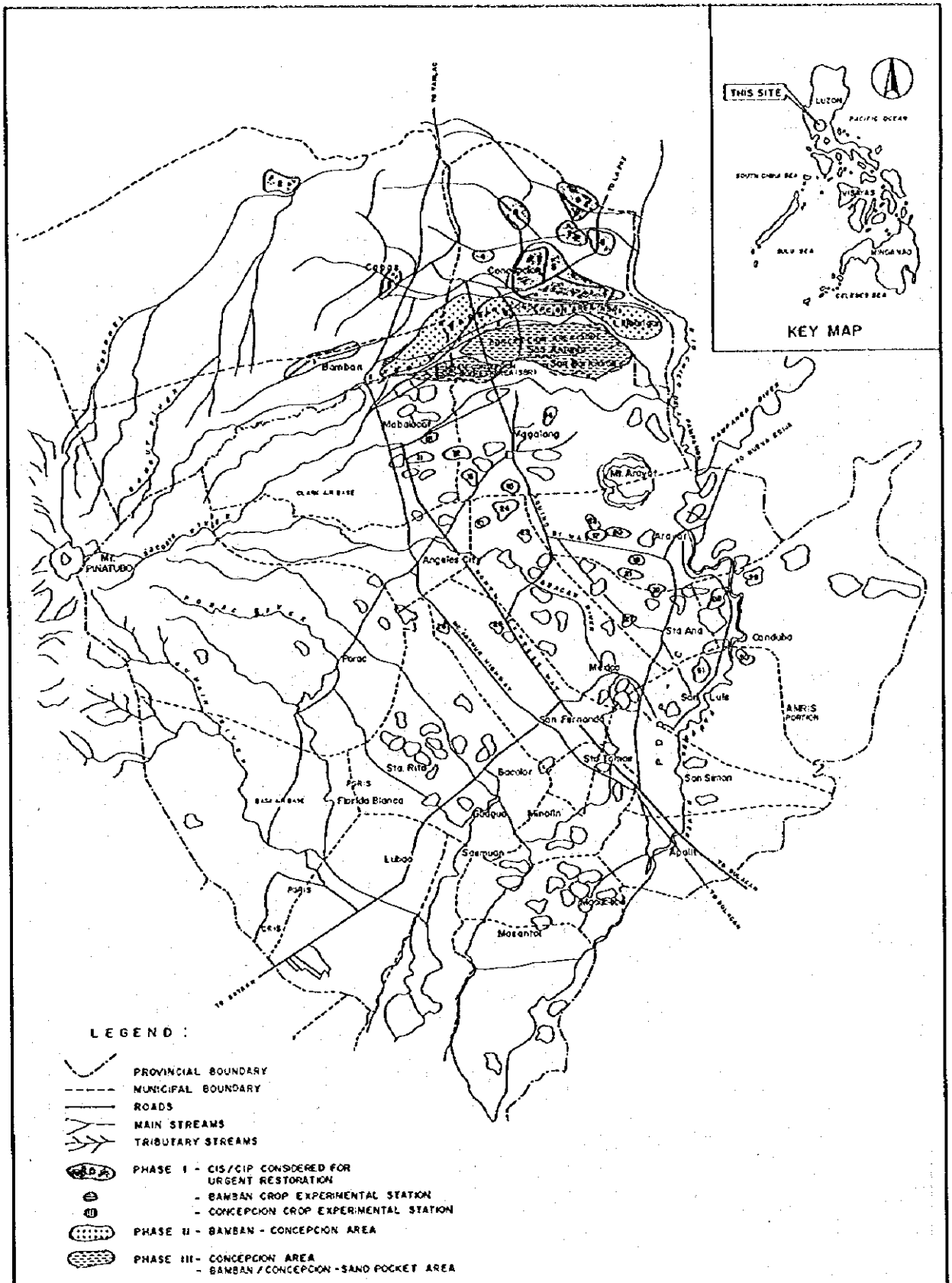
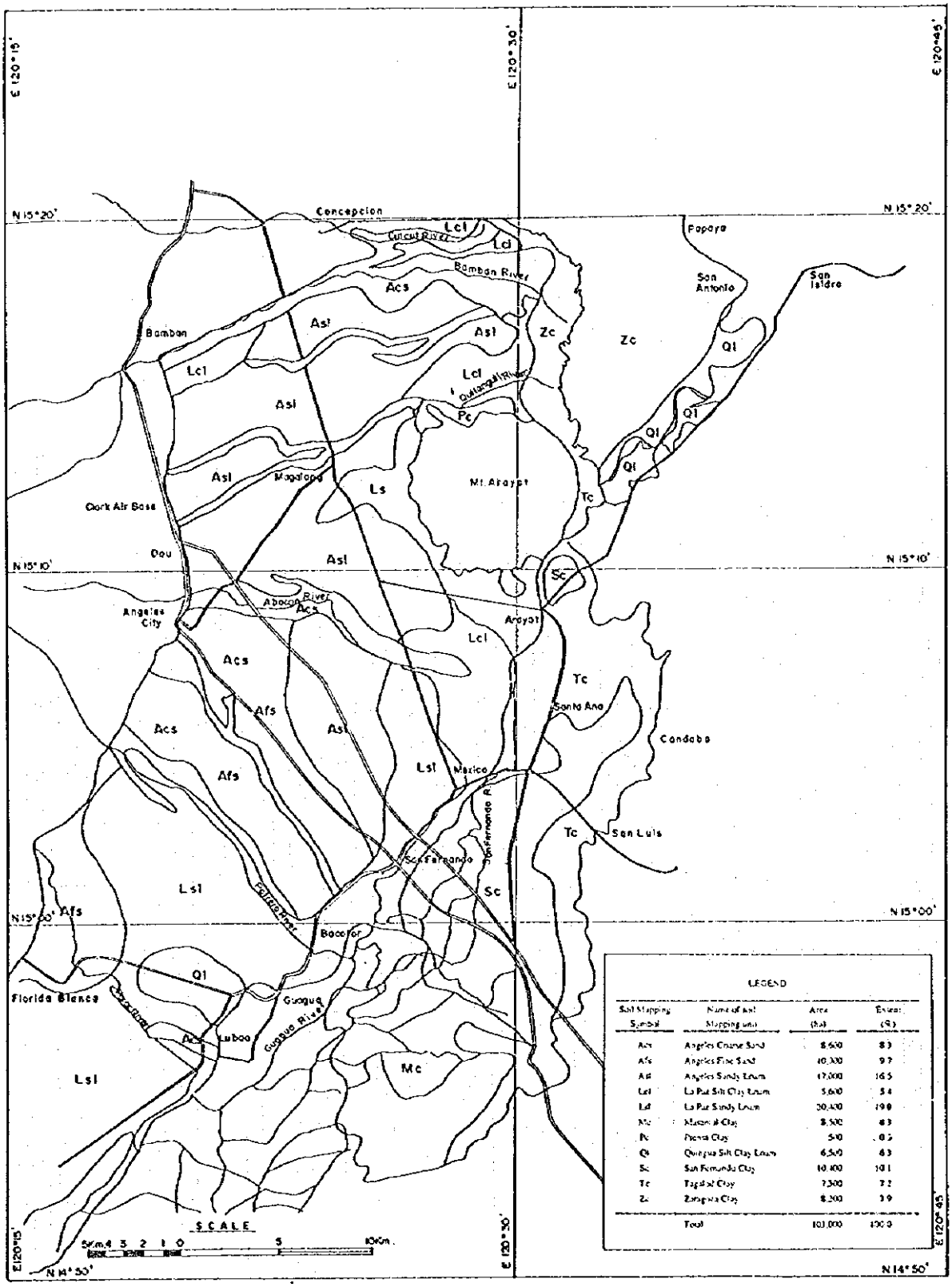


Figure K.1 Location Map of the Study Area

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY



LEGEND

Soil Mapping Symbol	Name of Soil Mapping unit	Area (ha)	Extent (%)
Acs	Angeles Coarse Sand	8,600	8.3
Afs	Angeles Fine Sand	10,300	9.7
Asl	Angeles Sandy Loam	17,000	16.5
Lcl	La Paz Silt Clay Loam	5,600	5.4
Lsl	La Paz Sandy Loam	20,400	19.8
Mc	Macabebe Clay	8,500	8.3
Pc	Pampa Clay	540	0.5
Qt	Quingua Silt Clay Loam	6,540	6.3
Sc	San Fernando Clay	10,400	10.1
Tc	Tagudin Clay	7,300	7.1
Zc	Zaragoza Clay	3,200	3.9
	Total	103,000	100.0

Figure K.1 Soil Map before the Mt.Pinatubo Eruption

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

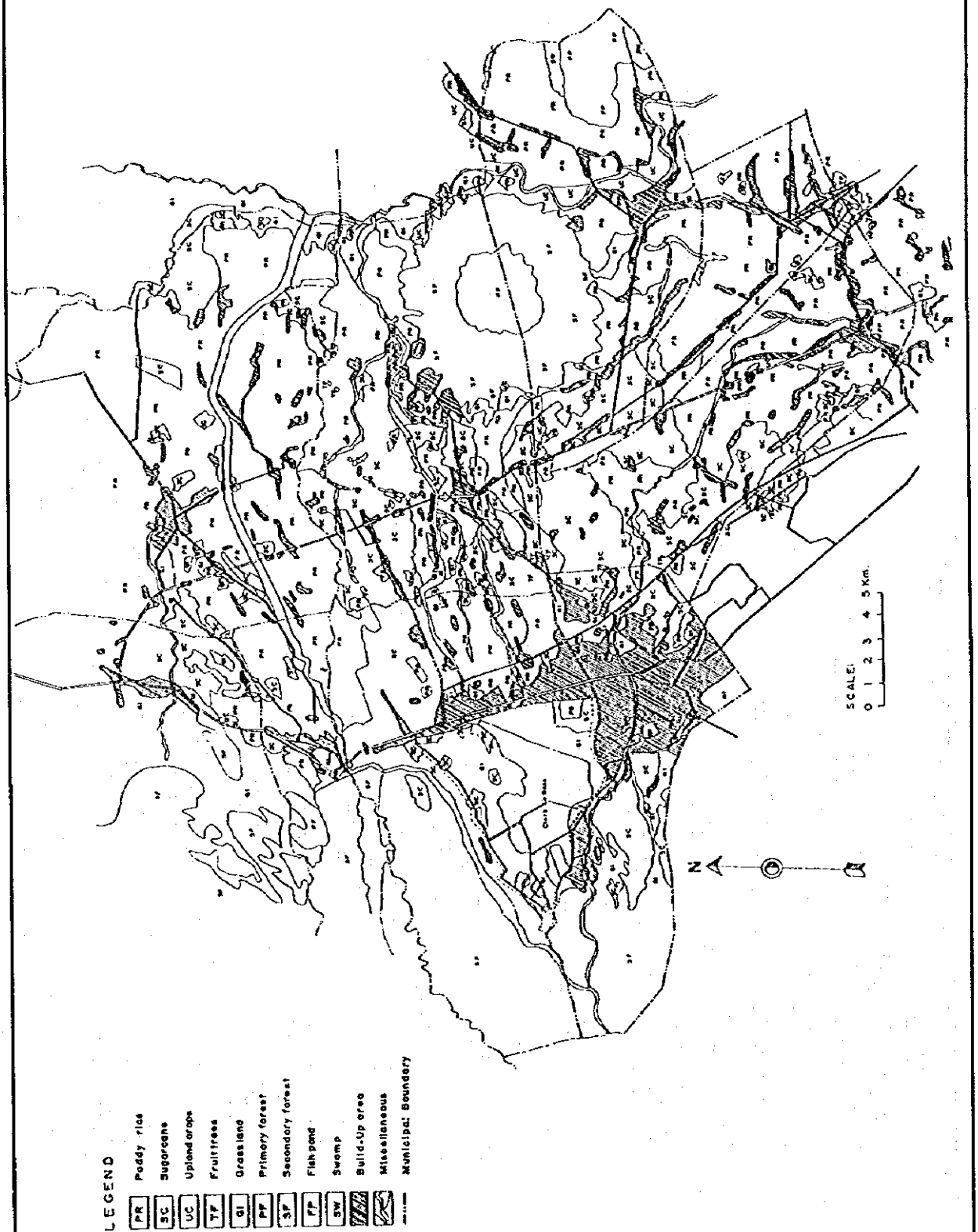


Figure K.3 Land Use Map before the Mt.Pinatubo Eruption

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

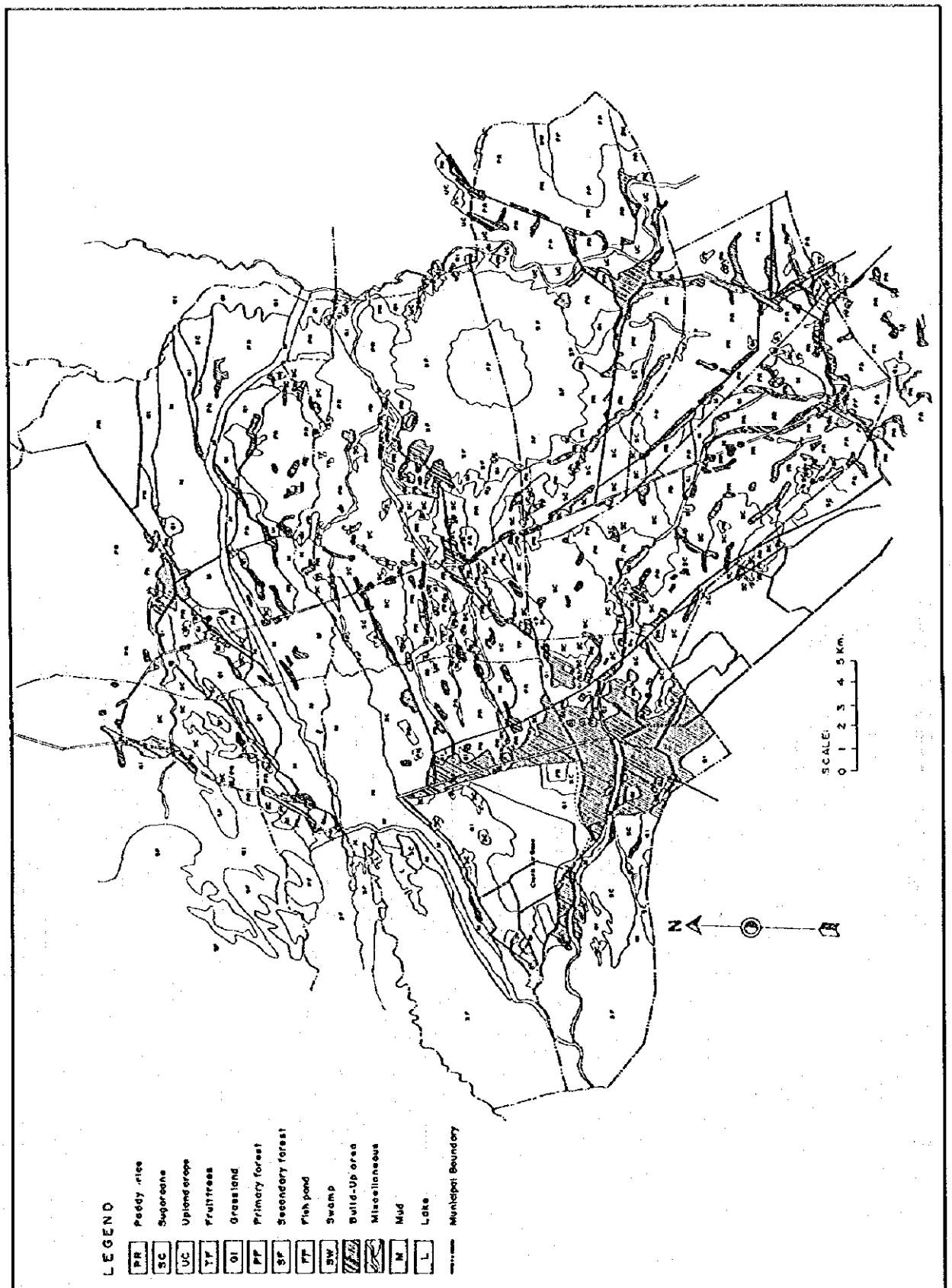


Figure K.4 Land Use Map after the Mt.Pinatubo Eruption

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

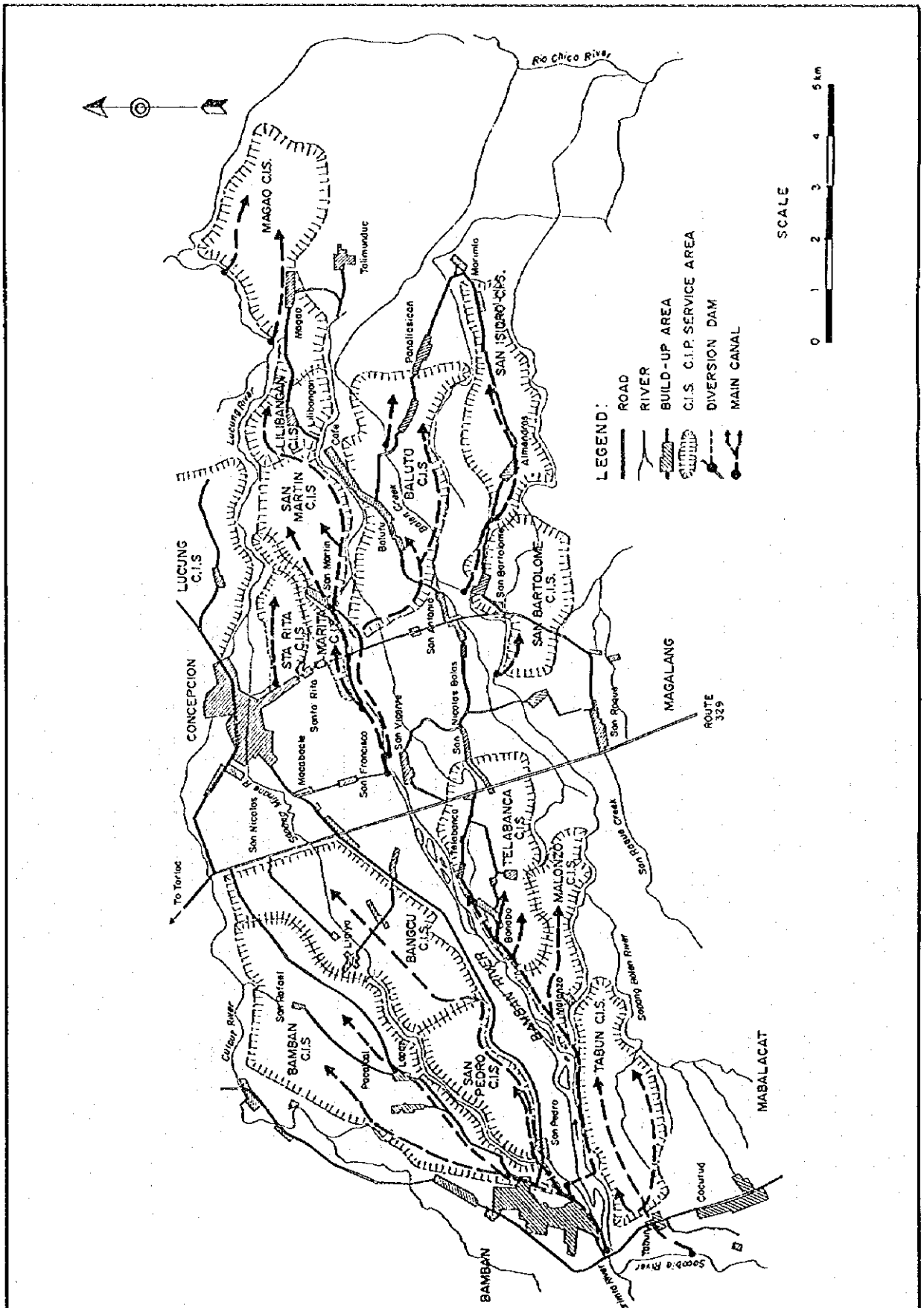


Figure K.5 Location Map of the Existing CIS/CIP in Sacobia-Bamban River Basin

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

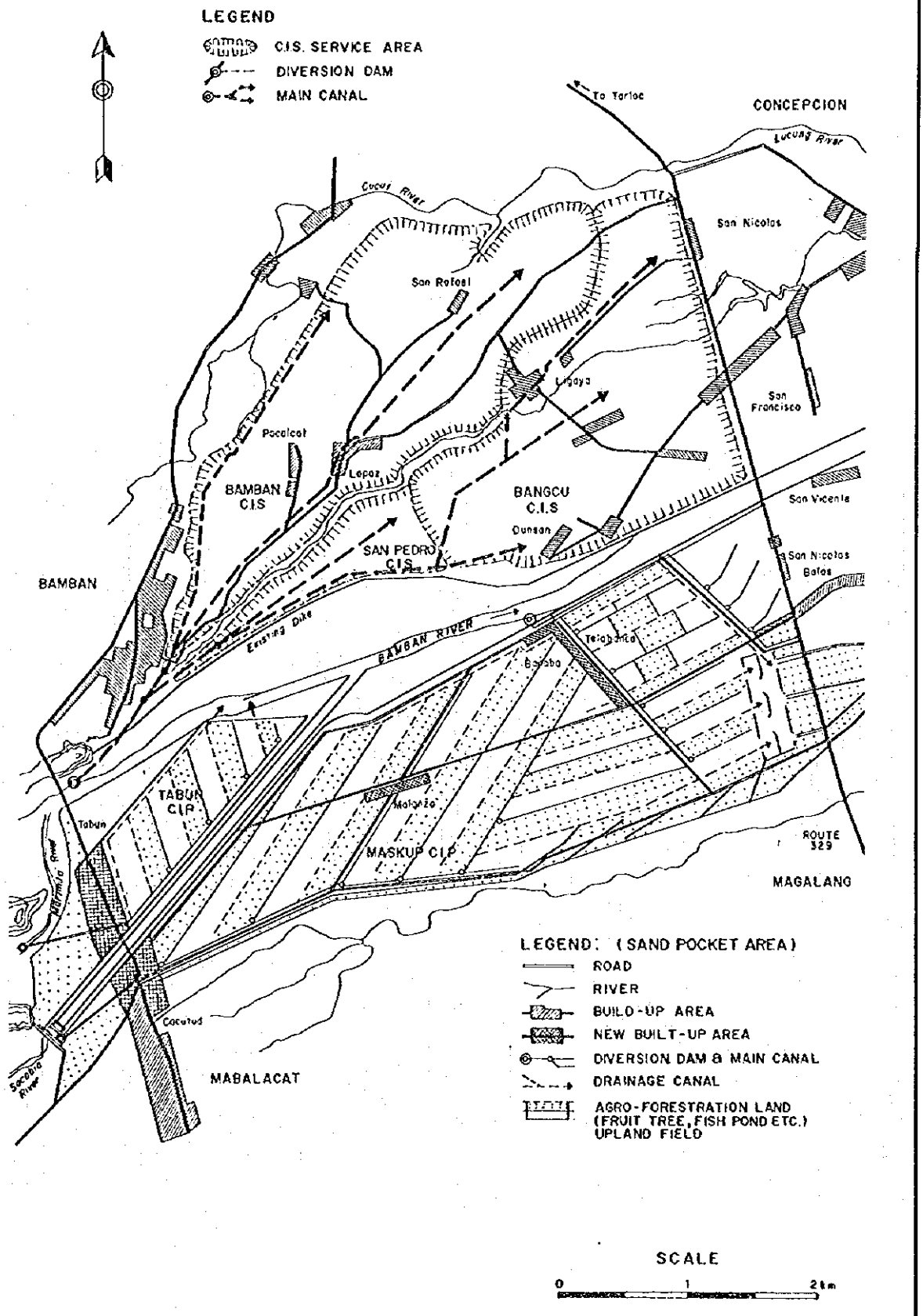


Figure K.6 Location Map of the Proposed Project in Upper Sacobia-Bamban River Basin

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
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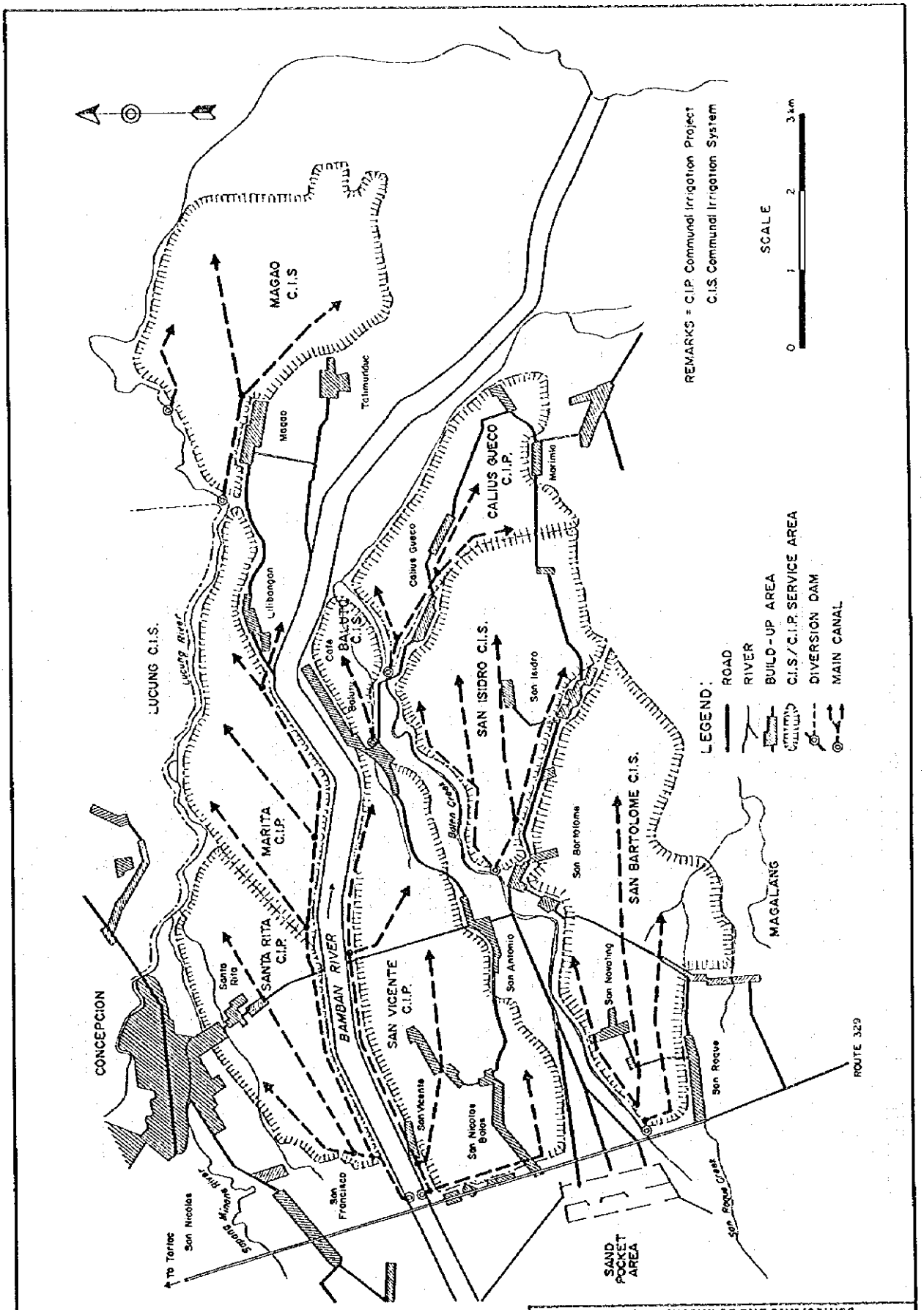

Figure K.7 Location Map of the Proposed Project in Lower Sacobia-Bamban River Basin

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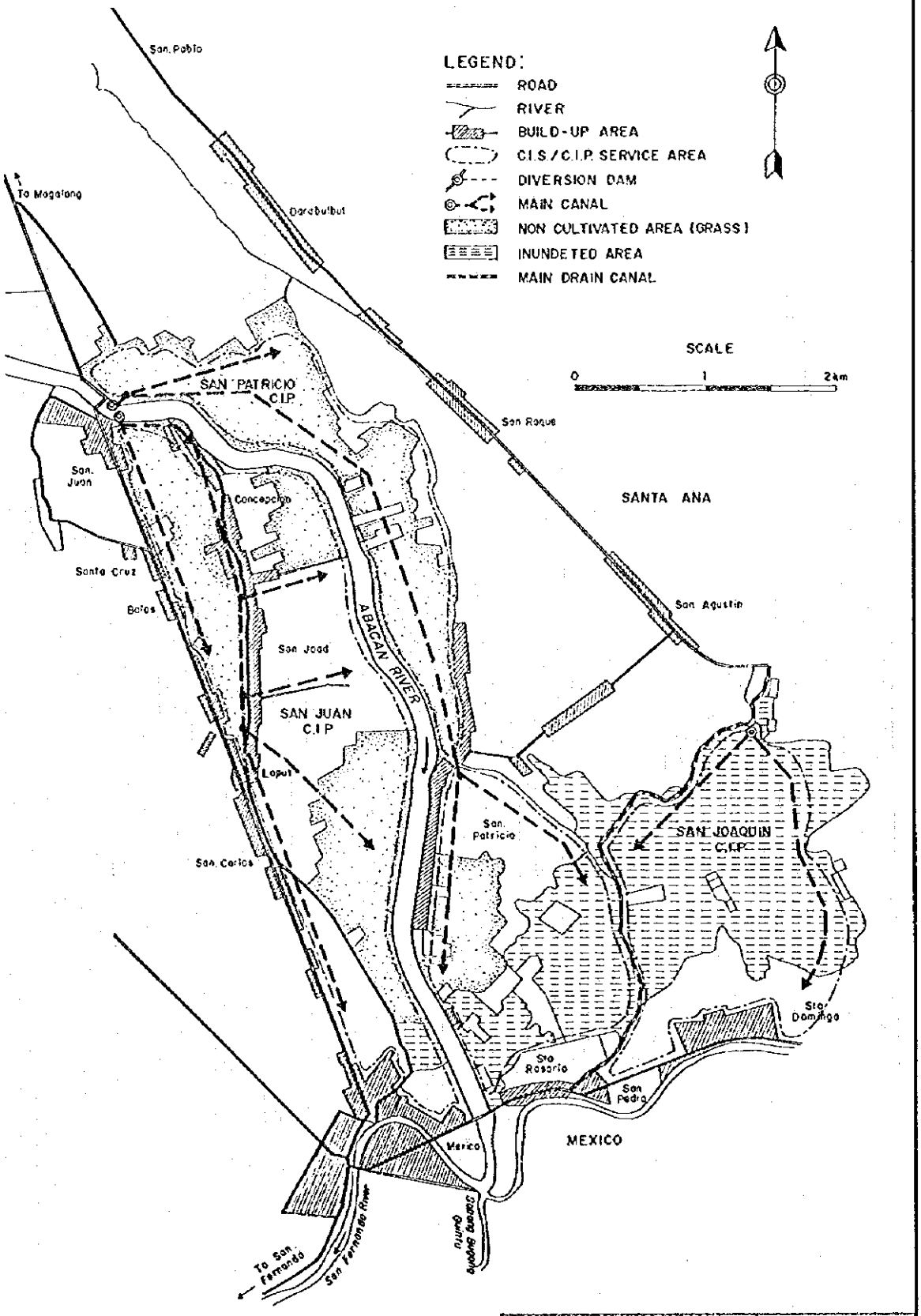

Figure K.8 Location Map of the Proposed Project in Abacan River Basin

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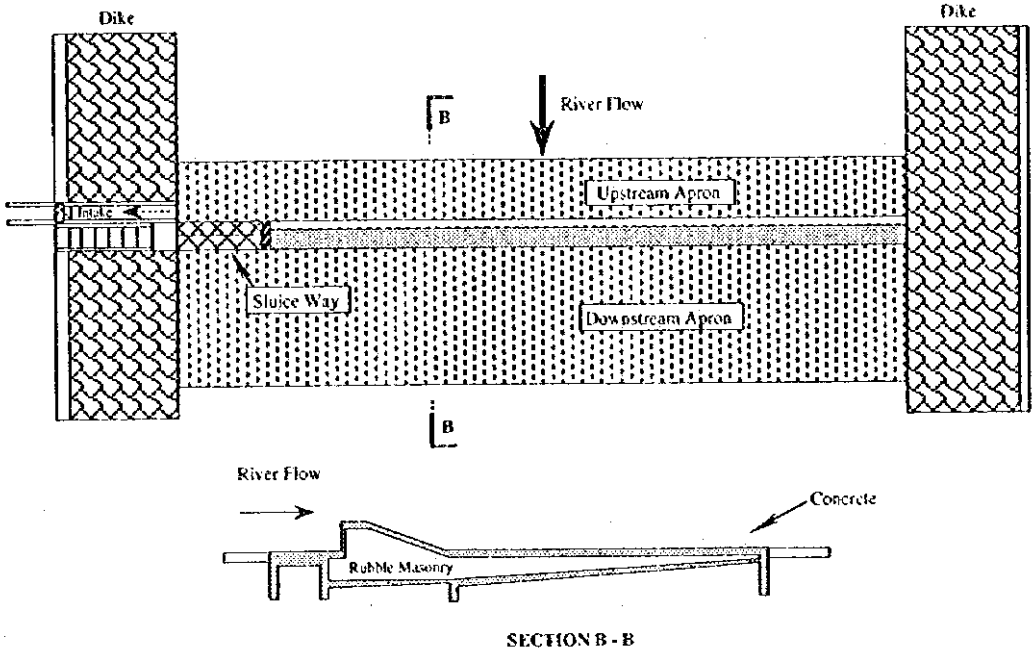
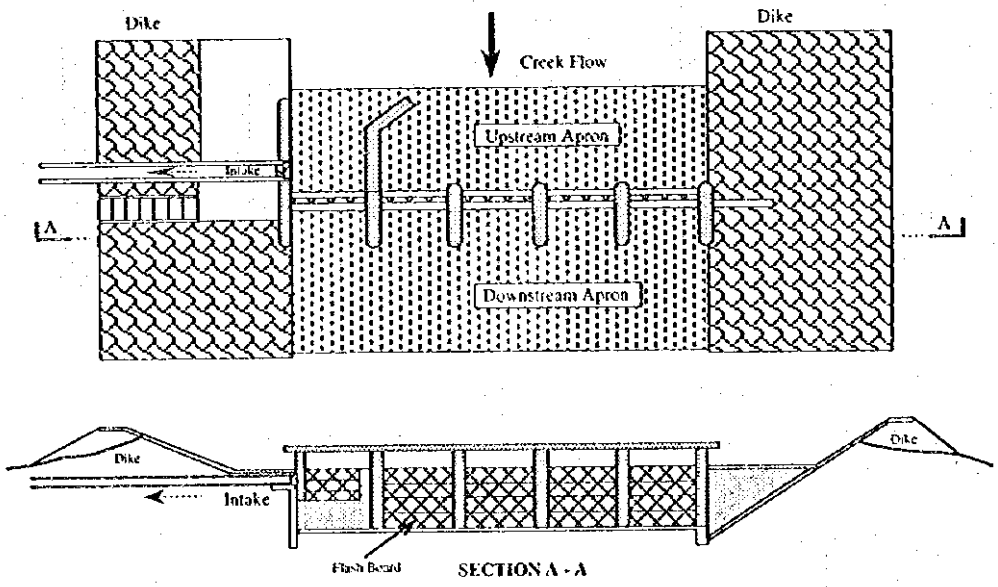


SECTION B - B

PROPOSED OGEE-TYPE DIVERSION DAM



SECTION A - A

PROPOSED CHECK-GATE TYPE DIVERSION DAM

Figure K.9

Typical Section of Proposed Diversion Dam

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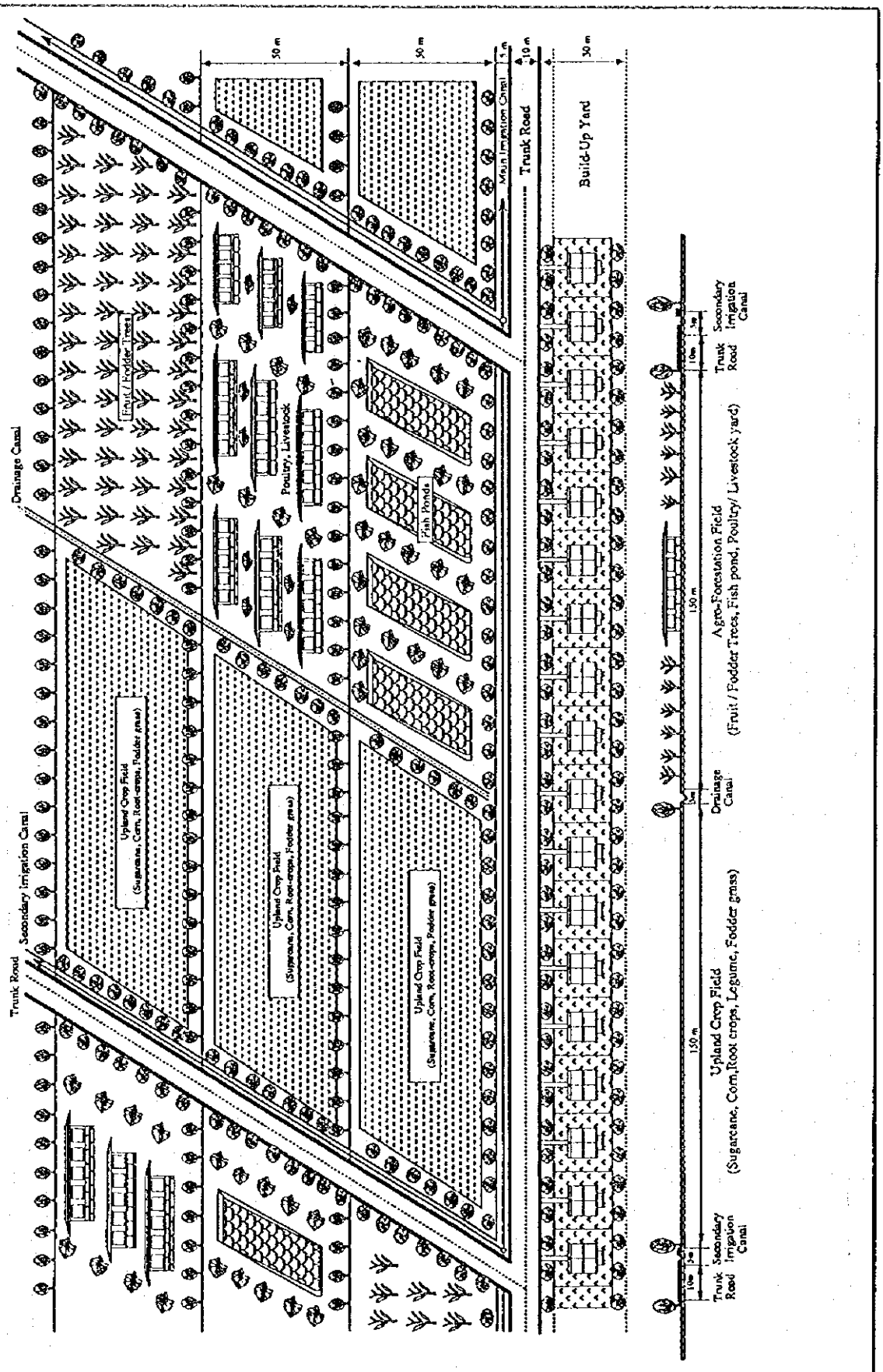

Figure K.10

Typical Layout of the Land and Agricultural Development Plan in Lahar Affected Area

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APPENDIX L

LAHAR MATERIAL SURVEY

APPENDIX L

LAHAR MATERIAL SURVEY

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L.1 LAHAR CHARACTERISTICS

1.1 TERMINOLOGY

"Lahar" is an Indonesian term, defined as "... a rapidly flowing mixture of volcanic rock debris and water from a volcano" (Ref.L.1). Lahars from Mt. Pinatubo which were triggered by heavy monsoon or typhoon rainfalls on erodible erupted materials has been flowing into densely populated areas of central Luzon since the major eruption of June 1991, although the toll of lives were small but enormous property losses and social disruption were caused. For the past four years (1991-1994), the most devastating lahars were generated during prolonged southwesterly monsoonal rains that were induced by the passage of tropical typhoons in the vicinity of Luzon. Indeed, the term of "lahar" has now received so much attention that it has become a metaphor for practically any disaster in the Philippines.

1.2 LAHAR FLOW CHARACTERISTICS

Lahar is typically with 40 to 90 % sediment by weight (20 to 60 % by volume), and thus, having consistency ranging from muddy water to a dense slurry (Ref.L.2). Direct sampling of lahars during rainy season was carried out by the PHIVOLCS in 1991. As given in Table L.1, a sample of muddy streamflow from the Sacobia River collected between lahars has finer sediment and is much less concentrated, while dip samples which were collected directly from the surface of very turbulent lahar in the Sacobia and Abacan River show that the lahars generally became more delute with distance from sediment source areas, and had reached the alluvial fans (Ref.L.3).

Lahar may refer to one or more discreet processes, such as debris flow and hyper-concentrated stream flow (Ref.L.4). Debris flow are non-Newtonian fluids having water contents generally less than 25% by weight, and moving as fairly coherent masses in generally laminar fashion. Debris flows resemble smoothly flowing slurries of freshly mixed concrete because of high density, and tend to erode riverbed and may lift large boulder. Hyper-concentrated stream flows have sediment concentrations between 40-80 % by weight, and generally move in fluid fashion. Hyper-concentrated stream flow are often turbulent, and tend to erode laterally.

A single lahar event may change in character from debris flow to hyper-concentrated stream flow to normal stream flow, and vice versa. According to the observation by the PHIVOLCS, lahars typically move at about 8 m/sec (30 km/hour) on an average, and are generally very erosive. Upon reaching relatively flat areas, however, they generally slow down to about 2-3 m/sec (7-11 km/hour), lose much of their energy, and deposit their sediment load.

1.3 PHYSICAL PHENOMENON

The lahars from Mount Pinatubo are poorly-sorted, rich in sand and contains little coarse and clay-sized particles (Ref.L.5). Sediments components consist mainly of juvenile pumice fragments with minor lithic fragments (mostly andesite, dacite and gabbro) incorporated with the old pumice fragments developed from lateral and vertical channel scouring.

In 1991, lahar deposition occurred primarily on low-gradient alluvial fans 25 to 45 km downstream from the caldera at the base of Mt. Pinatubo, where lahars typically transformed from debris flow to hyper-concentrated flow. Deposit thickness ranged from 0.5 to 5 m, but mean thickness were estimated to range from 1.5 to 2 m.

The lahar flow deposits found at Mt. Pinatubo are lobate in nature with each lobe having a convex-upward cross-sectional profile and a narrow U-shaped channel incision at the

center of each lobe. Common along the inner flanks of these channel incisions are slump features. The lobes vary in width from less than a meter to about 200-400 m and about 5-8 m thick. Some of the smaller lobes are steep, narrow and exhibit levee-like features along their margins where the most of the coarser particles are deposited.

The surface topography near the sources area is generally irregular and gently undulating since this is where most of the lahar flow deposits predominate. At the distal portion of the lahar deposition, surface topography is generally smooth and flat since this is where debris flows had been progressively diluted to normal streams and hyper-concentrated flows.

The surface of the hot lahar flow deposits are covered with thin, indurated crusts littered with pebble-to cobble-sized pumice fragments, armored and non-armored earth balls incorporated from the erosion of older deposits and charred or uncharred plant debris. Successive fillings and downcutting of the active channel formed most of the lahar terraces (Ref.L.6).

On the other hand, the hyper-concentrated flow deposits lack flow structures except for crude stratification marks with lenses of coarse-grained, cast-supported pumice. The deposits resulting from lake breakouts are well sorted, well-stratified and cross-bedded. Along channels where the flows overtopped the banks, well-sorted, cast-supported sieve deposits of pumice fragments are very common. In stagnant areas, such as abandoned channels and interlobe margins, fine-grained deposits abound. These are thickest within boundaries of aggradating lahar channels and lahar-dammed lakes.

1.4 CHEMICAL STATUS OF LAHAR DEPOSIT

Table L.2 shows the reaction of the lahar in the six sampling sites in the Abacan river basin ranges from medium acid to slightly acid (pH 5.9-6.6). Organic matter content (OM) of lahar all sites is very low (<1.0%). Cation exchange capacity (CEC) is very low (<4 meq/100 g soil). Base saturation of the four sites is moderate (20-60%) and the two sites, adequate (>60%). Phosphorous content of the lahar in Sapang Libutad, Angeles City is adequate (>10 ppm P), moderate (6.0 ppm) for the other site in Sapang Libutad and marginal (<6.0 ppm) for the other four sites. Available potassium is very low (<0.15 meq/100 g soil). Only lahar samples from Angeles City have extractable sulfate for these could be recent deposition. The available micronutrient (Zinc, Copper, Iron and Manganese) are very low to low.

In Sacobia-Bamban river basin, the reaction (pH) of the lahar in the five sampling sites ranges from medium acid to slightly acid (pH 5.7-6.7). Organic matter content is very low, except for the sediment from Culatingan, Concepcion which is moderate (1.46%). Cation exchange capacity is very low, except for the lahar in San Vicente, Concepcion which is moderate (9.37 meq/100 g soil). Base saturation is moderate, except for the sediment in Culatingan which is adequate (65.35%). Phosphorous is low, except for the sediments in Culatingan and San Vicente which are moderate (8.8 ppm and 9.71 ppm, respectively). Available Potassium is low, except for the sediments in Culatingan and San Vicente which are adequate (0.34 and 0.26 m/100 g soil, respectively).

Only soils from San Vicente and Dolores, Magalang have extractable sulfate (58 and 830 ppm SO_4, respectively). The lahar in Dolores is a recent deposit. Micronutrient levels (Zinc, Copper, Iron and Manganese) in most of the sites are low to very low. The lahar deposit in Culatingan and San Vicente have adequate amount of copper and iron.

Lahar in Sacobia-Bamban and Abacan watersheds are low in natural fertility, except for the sediments in Culatingan and San Vicente, Concepcion, Tarlac which are moderate.

Thin layers of ashfalls of less than 10 cm thick when incorporated into the soil by plowing has a favorable influence on the rejuvenation of underlying older soils by supplying them with a source of plant nutrients. Ashfalls of Mt. Pinatubo contain large amount of

feldspars. These are easily weatherable minerals and contribute to the formation of secondary minerals and a source of supply for Ca, Na and K (Ref.L.7).

1.5 PHYSICAL CHARACTERISTICS OF LAHAR DEPOSIT

Samples of lahar deposit from Sacobia-Bamban and Abacan rivers watersheds as given in Table L.3 consist largely of sand (80.4 -95.4 percent), silt (0.6 - 10.6 percent) and small amount of clay (4.0 - 9.0 percent). At the downstream of the Sacobia-Bamban river (Culatingan, Concepcion, Tarlac), the mudflow deposits are finer and consist largely of silt (53.6 percent) and a small amount of sand (20.4 percent) and clay (26.0 percent).

The coarse to sandy upstream sediment deposits have a medium to very fast hydraulic conductivity which ranges from 1.2×10^{-4} to 6.5×10^{-2} cm/sec. Bulk density varies from 0.98 gm/cc for the loosely structured loamy sand to 1.83 gm/cc for compacted loamy sand due to heavy machinery (bulldozer). Available moisture is very low (1.89%) to low (6.12 - 8.04%), except for the lahar in Dolores, Magalang which is high (23.70%).

The sediment deposits in Culatingan, Concepcion, Tarlac have poorly drained condition due to finer texture with high silt and clay content. The pozzolanic property of the volcanic materials (especially the fine-textured) may hamper agricultural productivity. This is being experienced by farmers in Culatingan, the hardening or crusting of the sediment when dry. Pozzolans are materials containing a high amount of reactive silica which reacts with other binding medium in the presence of water to form compounds possessing cement-like properties.

L.2 LAHAR EVENT

Annual incremental lahar disaster area after the eruption of Mt. Pinatubo is shown in Figure L.1.

2.1 LAHAR I (1991 Occurrence)

(1) Sacobia-Bamban River

In the Sacobia-Bamban River, lahar flow began in June 14, affecting some barangays in Concepcion. Flood protection dikes along the Bamban River were first breached by lateral erosion or overtopping of lahar on June 15. As the river channel of the Bamban River was filled with lahar deposition and most channel capacity was lost by August 17. Sediment continued to be widely dispersed on both sides of the channel until early September. The Damming of the Marimla River and other tributary valleys by aggradating the Sacobia river channel has led to intermittent formation of lakes, one of which was breached and added to the lahar that destroyed Bamban bridge on August 31. Deposits are estimated to average 2.0 m thick over much of the lower fan, and the average rate of lahar occurrence per day (late June to mid-September), was 0.83 and 3 to 5 events per day were common during the rainiest period.

(2) Abacan River

On the Abacan river, the first major lahar flow occurred on June 15. Lahar events after the 1991 monsoon season, more than 40 in all, destroyed and damaged all of the bridges across the Abacan River and caused bank collapse which destroyed hundreds of buildings in Angeles City.

(3) Volume of Lahar I

The volume of lahar deposit on the Sacobia-Bamban and Abacan river basins in 1991 was estimated at about 150 million m^3 and 50 million m^3, respectively (Ref.L.8).

2.2 *LAHAR II (1992 Occurrence)*

Along the Sacobia-Bamban River, moderate lahar flow occurred at the barangays of Mabalacat, Bamban and Conception in June and July. Lahar events from August 28 to 30 buried the northern barangay (Tabun) of Mabalacat by 3-4 m, and parts of Bamban by 1-3 m. The stretch of Bamban River near the Route 3 at Bamban river bridge was aggradated by 4.5 m of lahar and the bridge floor was covered by 0.5 m of deposits. The town of Bamban was also affected by flooding from the Marimla River which was dammed by lahar from the Sacobia River. On September 3 to 5, lahar flow along the Sacobia-Bamban River destroyed the northeastern corner fence of Clark Field, while barangay Dolores was inundated by 2-4 m. The volume of lahar deposit on the Sacobia-Bamban river basin was estimated at about 80 million m^3 in 1992 (Ref.L.2).

2.3 *LAHAR III (1993 Occurrence)*

In the Sacobia-Bamban River, during the passage of typhoon Kadiang at Barangay Dolores, scouring occurred during the early part of the lahar flow on October 5 and portions of the gabion matting of the Mabalacat dike were destroyed. Flows resulted in 2.0-2.5 m in channel deposition, and 2-3 m thick deposition at Barangay Sapang Balen (Ref.L.9). No lahar was observed since the upper catchment of the Sacobia River was annexed to the Pasig River on October 5-6, 1994. The volume of lahar deposit in the Sacobia-Bamban river basin was estimated at about 65 million m^3 in 1993 (Ref.L.10).

2.4 *LAHAR IV (1994 Occurrence)*

Since the catchment area of upper Sacobia was reduced to about 20 km^2 in October 1993, the sediment source for the Sacobia River was diminished drastically. Although a few lahar flow were identified at Mactan Gate of Clark Field by PHIVOLCS, the lahar flow did not reach to the downstream end of sand pocket structures. In the rainy season of 1994, the sediment transported to the sand pocket was not only the sediment from uppermost reach of the Sacobia River but also the secondary/lateral erosion of lahar deposition of previous years for the reach from Mactan Gate to Mascup. The sediment into sand pocket structure was estimated at 11 million m^3 in 1994 which was organized into 8 million m^3 from pyroclastic flow deposit in uppermost reach and 3 million m^3 from the secondary/lateral erosion for the reach from Mactan Gate to Mascup.

In the downstream reach from sand pocket structures, the water channel was silted heavily and the breached dike resulted in the siltation of 118 ha at right bank of the Sapang Balen River. A siltation with shallow depth was also occurred along the right bank of the lower reach of Bamban River.

2.5 *LAKE DEVELOPMENT*

Immediately after the eruption of Mt. Pinatubo in 1991, rapid riverbed aggradation by lahar of the Sacobia River blocked streamflow from Marimla and Sapang Cauayan rivers. Potential sites for deposition from hyper-concentrated streamflows and the configuration of the blockage were partly determined by the geometry of the stream junction. This geometry changed during and after each major lahar event.

Overtopping and breaching had almost always occurred at the blockage of lahar, where the blockage was at its lowest height. The breach started initially as a small stream that gradually increased in size by lateral erosion of the channel bank and headward erosion from local steepening on the surface of damming of lahar. The discharge hydrographs of lake breakout were observed at the junction between Marella and Mapanuepe rivers in the southwestern slope of Mt. Pinatubo. During the first 10 hours after the initial overtopping, discharge from the outlet increased gradually followed by a rapid climb to peak flow at 6 hours later as shown in Figure L.2. This exponential increase in discharge

may have resulted from mass failure of the dammed lake and accelerated erosion rates. The water-saturated condition of lahar blockage makes it prone to mass failure, as shown by frequent slumping along sides of the channel breach (Ref.L.4).

While, the Damming of Marimla and Sapang Cauayan rivers by aggradating the Sacobia river channel has led to intermittent formation of lakes, one of which was breached and added to the lahar that destroyed Bamban bridge on August 31, 1991.

In 1994, the major dammed lake in the Sacobia-Bamban river basin is still located at the confluence between Sacobia and Sapang Cauayan rivers as shown in Figure L.3. The storage volume is estimated at 6 million m^3 (a surface area of 1.27 km^2 and water depth of 13 m in deepest) at water level of El.99.0 m in December 1994. The outlet of dammed lake shows the strong color contrast between the dark-gray, sediment-rich discharge from the Sacobia River and the mostly clear water from the Sapang Cauayan River.

L.3 SIEVE ANALYSIS OF LAHAR DEPOSITS

The grain sizes and specific gravity have a great influence on sediment transportation. The objectives of the soil testing are to grasp grain-size distribution and specific gravity of lahar materials. These are indispensable to analysis on lahar avalanche under the condition of probable rainfall. Sampling points for lahar material survey were determined taking into account the annual extension of lahar disastered area as shown in Figure L.4.

The amount of the various sizes of soil particles present in a lahar can be determined in the laboratory by means of sieving analysis. The laboratory results are presented in the form of a cumulative grain-size curve as shown in Table L.4 and Figures L.5 to L.8.

Regardless of its origin as primary hyper-concentrated flows or as the runouts of debris flows, flows with hyper concentrations of sediment volumetrically dominate the flow system and depositional records in the downstream reach.

Hyper-concentrated flow deposits in the eastern drainages of Mt. Pinatubo are dominated by sand-size phenocrysts from the pyroclastic flow deposits with an admixture of mineral grains from older deposits. Pumice clasts are present but are volumetrically minor; most are preserved in coarse deposits near the surface (Ref.L.2).

Comparing the laboratory results of the Study with those of Mt. St. Helens (USGS) and Mt. Pinatubo (PHIVOLCS), cumulative curves of deposits show that Pinatubo flows contain slightly more fine sediment that those of Mt. St. Helens as shown in Figure L.9. Most fine sediment of Mt. Pinatubo, including devitrified glass and comminuted mineral and vitric material, is flushed through the fan environment to be deposited in axial lowland drainages and deltaic mudflats. This mineralogic fractionation is a partial analog of an example in the geologic records (Ref.L.11).

L.4 LAHAR DEPOSITS AS CONSTRUCTION MATERIAL

4.1 CONSTRUCTION MATERIAL PROPERTIES

Lahar deposits are highly erodible because of the relative paucity of either cohesive fine material or material coarser than sand. Populated lowlands are widely underlain by the lahar deposits of similar flows from previous eruptions, the availability of effectively erosion-resistant materials for dike construction is severely limited. This limitation is crucial to the economics of mitigation plans.

Local aggregate thus became less reliable as an economical construction material. However, vast and unlimited amounts of lahar material were deposited which could be utilized as aggregate in the production of economical concrete for restoration work