8. MASTER PLAN FOR COMMUNITY DISASTER PREVENTION PROGRAM

Background and Objectives of the CDPP

Community disaster prevention program (CDPP) is generally defined as "Disaster prevention activities with the leadership of the people and the community organization". The flood fighting and evacuation activities, and participation in disaster training are typical activities under the CDPP.

In the study area, however, it is highly required to rehabilitate the basic infrastructures, residential houses, and farmland to recover the daily living of the communities. Unfortunately, the target communities have been severely damaged, and no intensive recovery actions have been taken. As a result, the affected people in the mountain and riverside areas are still suffering from the after-effects of the disasters for more than 10 years.

Under such conditions, it is unclear whether an ordinary CDPP could be effective or not. The important issues are to formulate the CDPP to meet the needs of the severely affected communities. In the case of the study area, it is essential to formulate the CDPP through livelihood development, which is the highest need of the people. Accordingly, the objectives of the CDPP in this study are as follows:

1) ***To formulate a livelihood development program that would stimulate the local communities to upgrade their capability for self-protection against future disasters,***
2) ***To prioritize the recovery of basic infrastructures in the community to stimulate and support various types of economic activity.***

Issues and Needs Identification in the Study Area

The following field investigations were conducted to identify the issues and needs in the study area:

1) Interview survey (320 HH along the river area, which were severely affected by lahar)
2) PCM (Project Cycle Management) workshop in five different areas to identify the problems and problem tree (a total of 309 persons attended).

Based on the above investigations the following issues and needs were identified:

a) ***Lack of livelihood*** is the most serious issue for the people, particularly for farmers in the severely damaged communities, as their farmland is buried by lahar and is still un-productive.
b) The most serious problem for the resettled people is also ***"lack of livelihood"*** in the resettlement centers. Because of this, 40% of the resettled people have already returned to their original barangay in the mountain area and many other people are currently forced into temporary settlements between the original barangays and resettlement centers and are seeking a livelihood in the original barangays.
c) ***Many of the Aeta people have returned to the original areas*** immediately after being resettled in the resettlement centers as they cannot adjust to the life style of the lowland area. The government declared the ancestral domain of land ownership in the Mount Pinatubo Area for the Aeta people in 1997 to preserve the cultural heritage of the Aeta Tribe. But the land ownership transfer process has not been smooth due to the complexity of the application process and a lack of funds for parcel survey.
d) ***No public services are provided to the communities in the upstream mountain area*** because no access road exists. A community access road existed before the eruption, but it was completely damaged due to the disasters and has still not been rehabilitated. Rehabilitation of the community road is expected to provide various government services, which would contribute considerably to environmental management in the upstream areas

and encourage economic activities such as agro-forestry and slope agriculture through SALT.

The formulation of the CDPP plan was based on the identified issues and needs listed above.

CDPP Overall Plan

Taking into account the above issues and needs in the target communities, the CDPP overall plan was formulated as shown in Figure 8.1. The components of the CDPP overall plan are listed in Table 8.1. They are 1) Community infrastructure development in Tektek Resettlement Center, 2) Community based Forest Management Program, 3) Agriculture development on lahar areas, 4) Community development in Mapanuepe Lake Basin, 5) Community road rehabilitation and 6) Establishment of Aeta Assistance Station.

Throughout the implementation of the proposed CDPP program, training and public dissemination for community based disaster management should always be included as a part of the program. Also, strengthening of the community organization would be a major component of the respective CDPP program, which would contribute to upgrading disaster management capability.

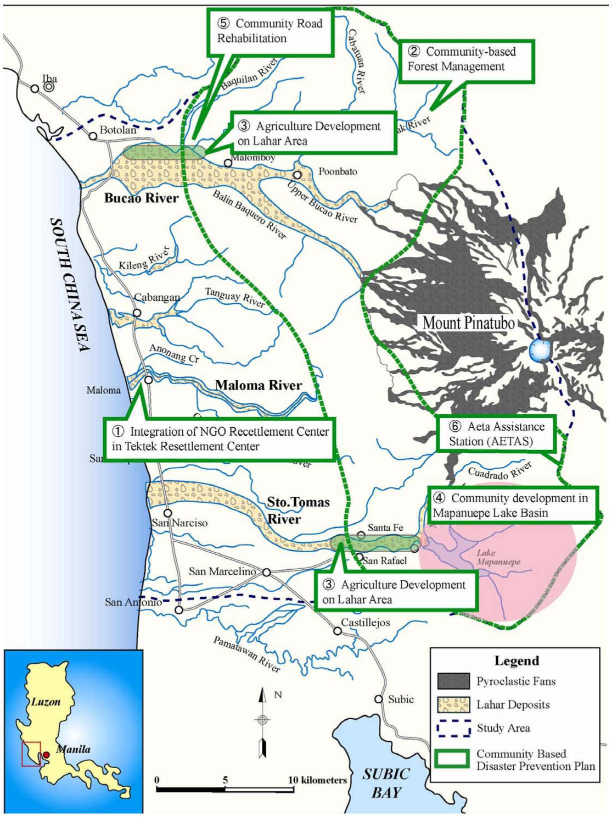

Figure 8.1 Master Plan for the CDPP

Table 8.1 CDPP Overall Plan

No.	CDPP components	Objectives and General information
①	Community infrastructure development in Tektek Resettlement Center	To integrate three NGO's resettlement centers in Tektek RC and provide community infrastructure for improvement of living conditions for the people in these RCs.
②	Community based forest management (CBFM)	To develop 25,000 ha of forest including agro-forestry under a CBFM program as livelihood development for the remote community in the mountain area.
③	Agriculture development in lahar area	To develop lahar covered areas as agricultural land for livelihood development for the people severely affected by the disasters,
④	Community development in Mapanuepe Lake Basin	To utilize water resources of Mapanuepe Lake, for irrigation, inland fishery and tourism as income generation measures in the communities submerged by the dammed-up Mapanuepe Lake,
⑤	Community road rehabilitation	To rehabilitate community road for the Bucao River basin (48 km) and the Sto.Tomas River basin (60 km) to trigger various community developments in the mountainous remote area.
⑥	Establishment of Aeta Assistance Station (AETAS)	To recover the Aeta community and preserve their culture, history, and the traditional life, comprehensive supporting activities shall be conducted under AETAS.

Note: Feasibility study explained in chapter 10 to 12 revealed that the above ①community infrastructure development in Tektek resettlement center and ④community development in Mapanuepe Lake basin are not feasible. Therefore, future discussion with people, monitoring of water quality and study are recommended before implementation of these programs.

9. ECONOMIC EVALUATION, SELECTION OF PRIORITY PROJECTS AND IMPLEMENTATION SCHEDULE OF MASTER PLAN

Economic Evaluation and Selection of Priority Projects

The results of economic evaluation are described in the following Table 9.1. The economic evaluation was conducted for each component of the master plan. Priority projects were selected based on the economic evaluation of the structural measures. For non-structural and CDPP measures, the priority projects were selected not only from economic viewpoints, but consideration of social impacts and poverty reduction aspects.

Table 9.1 Results of Economic Evaluation and Selection of Priority Projects

Development Plan		Project Cost** (million pesos)	EIRR	Selection*	Reasons for selection
Structural Measures					
Bucao River- (1)	Dike Heightening & Strengthening	981 (US$19.4 million)	15.2%	○	Highest EIRR among the alternatives.
Bucao River-(2)	Bucao (1) + Consolidation Dam	1,710 (US$33.9 million)	6.7%	×	
Bucao River-(3)	Bucao (2) + Sand Pocket	3,301 (US$65.4 million)	negative	×	
Maloma River	Channel Widening & Dike Construction	1,298 (US$25.7 million)	negative	×	
Sto.Tomas River-(1)	Dike Heightening & Strengthening	1,505 (US$29.8 million)	48.2%	○	Highest EIRR among the alternatives.
Sto.Tomas River-(2)	Sto.Tomas (1) + Channel Work	5,473 (US$108.4 million)	17.1%	×	
Sto.Tomas River-(3)	Sto.Tomas (1) + Sand Pocket	3,556 (US$70.4 million)	25.5%	×	
Non-Structural Measures					
Mudflow warning and evacuation system		115 (US$2.3 million)	15.1%	○	Highly effective to mitigate damages to human life.
Community Disaster Prevention Plans					
Infrastructure development at Tektek Integrated Resettlement Center		35 (US$0.69 million)	14.6%	△	Low EIRR, but high needs from a social viewpoint.
Community based forest management		80 (US$1.6 million)	60.8%	○	High EIRR and high benefit expected for poverty reduction and soil erosion control.
Agriculture development on Lahar area		30 (US$0.59 million)	12.3%	○	Low EIRR, but high benefit expected as livelihood program for the affected people.
Community development for Mapanuepe Lake Basin		70 (US$1.4 million)	N.A.	△	High development potential for irrigation, inland fishery and tourism sectors.
Community Road Rehabilitation Program		326 (US$6.5 million)	1.5%	○	Low EIRR, but highly required from a social viewpoint.
Establishment of Aeta Assistance Station		15 (US$0.3 million)	N.A.	○	For preservation of tradition & culture for minorities.

Notes * ○ : Selected as priority projects × : Not selected △ : Selected as priority projects in the master plan stage, however, discarded in the feasibility study and future review is recommended.
** Construction cost of bridges is included in each structural measure.

For the structural measures, dike heightening and strengthening for the Bucao and Sto.Tomas Rivers were selected as priority projects. Re-construction of the Bucao Bridge is included in the Bucao dike heightening and strengthening. But the Maculcol Bridge was not included because the detailed design has already been conducted by DPWH and reconstruction of the bridge is ready for implementation.

For the flood control works for the Maloma River, it has so far not been feasible from an economic viewpoint, and is not selected as a priority project.

All the nominated non-structural and CDPP measures were selected as priority projects. The high needs in the sociological viewpoints are confirmed, and the project cost is not too expensive to be managed/implemented by provincial initiative. In view of the comprehensive disaster prevention approach, which is the basic concept for the master plan formulation, a combination of structural, non-structural and CDPP measures has been selected for the priority projects.

Among these CDPP measures, however, infrastructure development at Tektek center and community development in Mapanuepe Lake basin were found to be not feasible as the result of the feasibility study. Future review and studies are, hence, recommended for these programs.

Implementation Plan and Schedule for Master Plan

The implementation plan was formulated based on a multi-sectoral approach requiring comprehensive activities from the viewpoints of 1) upstream and downstream reaches, 2) structural and non-structural measures, and 3) economic growth and poverty reduction for the study area. However, the multi-sectoral approach is so far not appropriate under the existing government structure, which is basically single sectoral approach in view of budget allocation and project management. To formulate a multi-sectoral Project Management Office (PMO) would require many processes to realize, and this is recommended in the long-term. Instead, single-sector implementation with due attention to a multi-sectoral viewpoint is recommended as the first step by establishment of a Project Coordination Committee (PCC) for monitoring all the projects identified in the master plan. The details are discussed in Chapter 11.

Table 9.2 shows the implementation schedule for the comprehensive master plan. The implementation period is set at 20 years and is divided into three stages, 1) short-term (6 years, 2003-2008), 2) mid-term (8 years, 2009-2016), and 3) long-term (6 years, 2017-2022). The implementation schedule was formulated based on the results of economic evaluation and taking special attention to the urgency of projects from a sociological viewpoint.

Table 9.2 Implementation Schedule for Master Plan

	Planning Scale	SHORT TERM DEVELOPMENT						MID TERM DEVELOPMENT								LONG TERM DEVELOPMENT						REMARKS
	No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
	Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
Structural Measures																						
Bucao River	1) Urgent Dike Repair Works																					
	2) Maraunot Notch																					*Monitoring of Pinatubo Crater Lake is to be continued
	3) Dike Heightening/Strengthening																					
	4) Malomboy Consolidation Dam <Review>																					* Depend on further sediment delivery
	5) Sandpocket / Channel works <Review>																					* Depend on further sediment delivery
	6) Re-construction of Bucao Bridge																					
Maloma River	1) Urgent Dike Repair Works																					
	2) Permanent Channel Works <Review>																					* Small scale urgent remedial meaure is required.
	3) Re-construction of Maloma Bridge <Review>																					
Sto.Tomas River	1) Urgent Dike Repair Works																					
	2) Dike Heightening (Vega Hill to D/S) including Gabor improvement																					
	3) Dike Strengthening (Vega Hill ~ Mt.Bagang)																					
	4) Consolidation Dam <Review>																					*Depend on further sediment delivery
	5) Channel works / Sand Pocket <Review>																					*Depend on further sediment delivery
	6) Re-construction of Maculcol Bridge																					*D/D completed by DPWH.
Non-Structural Measures																						
Monitoring / Warning	**1) Telemeter / Warining through Cell-phone networks**																					
Evacuation System	**1) Hazard Map Dissemination**																					
	2) Increase Evacuation Center																					
	3) Upgrade Evacuation Center																					
	4) Continuous Update Disaster Management Disseminations																					
Community Based Disaster Prevention																						
	1) Community Infra. Development for NGO Resettlement Centers																					* Required continuouse discussion with people
	2) Lahar-Agriculture Development						Pilot Area															
	3) Rehabilitation of Community Road to Mountain Areas																					
	4) Extension of CBFM					Pilot Project					Full Development											
	5) Mapanuepe Lake Basin Development																					* water quality monitorin to be continued prior to project implementation
	6) Establishment of Aeta Assistance Station			Pilot Project					Full Development													

Notes: 1) [highlighted box] : Proposed priotity projects

2) Measures proposed in 2003 are those scheduled to be initiated by GOP.

3) [open box] means the projects for which reviews and/or further studies area recommended based on the monitoring resutls of sediment, sociological conditions, and so forth

4) ■ ■ ■ ■ ■ means the programs for which discussion with people, monitoring of water quality and studies are required.

10. FEASIBILITY DESIGN FOR THE PRIORITY PROJECTS

10.1 Dike Heightening and Strengthening in the Lower Bucao River

Project Description

Dike heightening and strengthening with new dike construction in the downstream reach of the Bucao River and re-construction of the Bucao Bridge were selected as priority projects. The design heights of the dike and bridge were determined based on long-term riverbed movement analysis. Figure 10.1 shows the general plan for the priority projects for the Lower Bucao River.

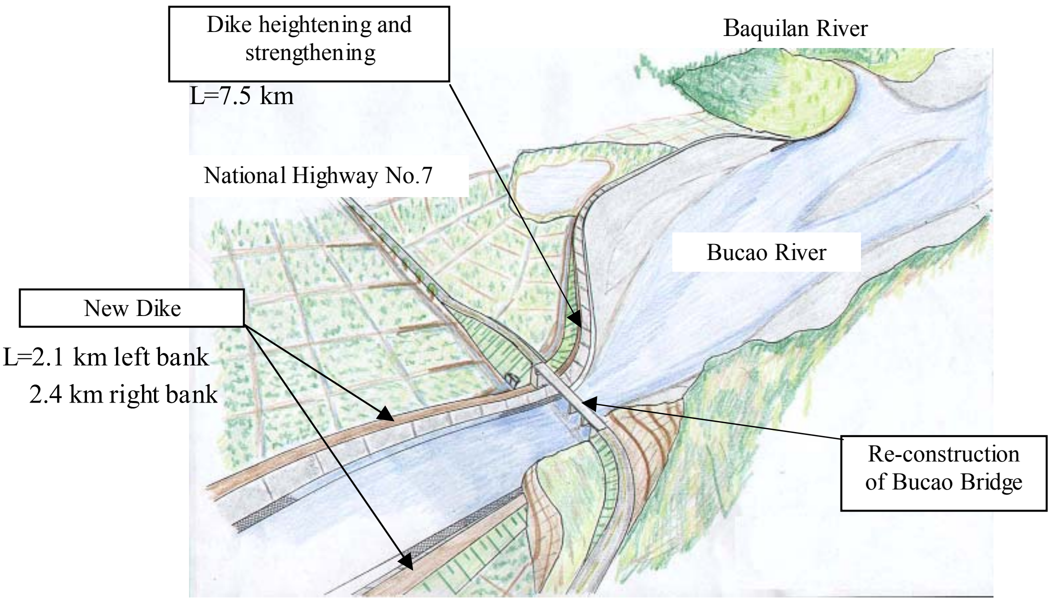

Figure 10.1 General View of the Priority Projects for the Bucao River

Design Flood Level and Design Dike Profile

The design flood scale was determined for the 20-year probable flood (3,800 m^3/s) for the dike construction and 50-year probable flood (4,900 m^3/s) for the bridge re-construction, which was determined by the optimization study for the dike and according to the design standard in the Philippines for bridges. The procedures on the determination of the design flood level and the design dike profile are shown in the flow chart in Figure 10.2. The design flood hydraulic calculation was conducted after estimation of the future riverbed elevation by the 20-year riverbed movement analysis. The average dike height design was then set at 5.6 m (from the present riverbed) for 2.35 km downstream of the Bucao Bridge and at 7.7 m for 7.4 km upstream of the Bucao Bridge. The design for the soffit girder elevation of the Bucao Bridge was set at El.16.95 m, which is 10.55 m higher than the present riverbed and 6.27 m higher than the existing bridge.

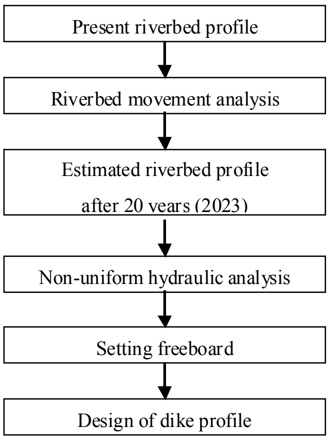

Figure 10.2 Flowchart of Design of Dike Profile

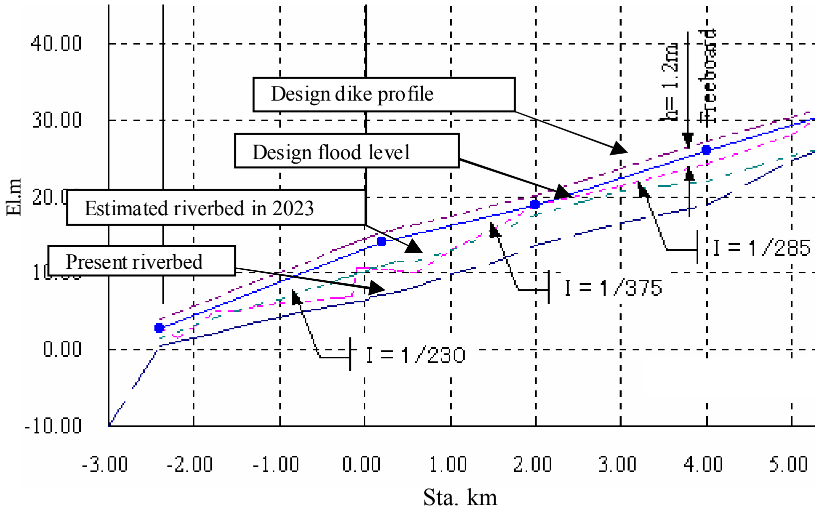

Figure 10.3 Design Dike Profile

Preliminary Design of Dike

The principal feature of the dike is described in Table 10.1, and a typical cross section of the dike is shown in Figure 10.4.

Table 10.1 Principal Features on Bucao Dike Design

Design Items	Design Description
Top width of dike	8 m (same as the existing dike)
Height of dike	Average 5.6 m (downstream of bridge), Average 7.7 m (upstream of bridge)
Riverside slope	H:V=2.0:1 (with revetment work)
Landside slope	H:V>3.0:1 (depend on stability analysis, without revetment)
Embankment material	Lahar material (mountain soil on the landside slope t=500 mm)
Riverside slope protection	Grouted Riprap or equivalent
Landside slope protection	Mountain soil and sodding
Dike road	Gravel road on the top of the dike

The design of the inland side-slope of the dike depends on the design flood level, by which the seepage line through the dike section is estimated. The inland side-slope was designed using stability analysis against slope collapse under the condition of the highest expected seepage line. The design of all structures is in accordance with design standard of DPWH. It is anticipated that liquefaction phenomena would not occur judging from property of embankment material and foundation.

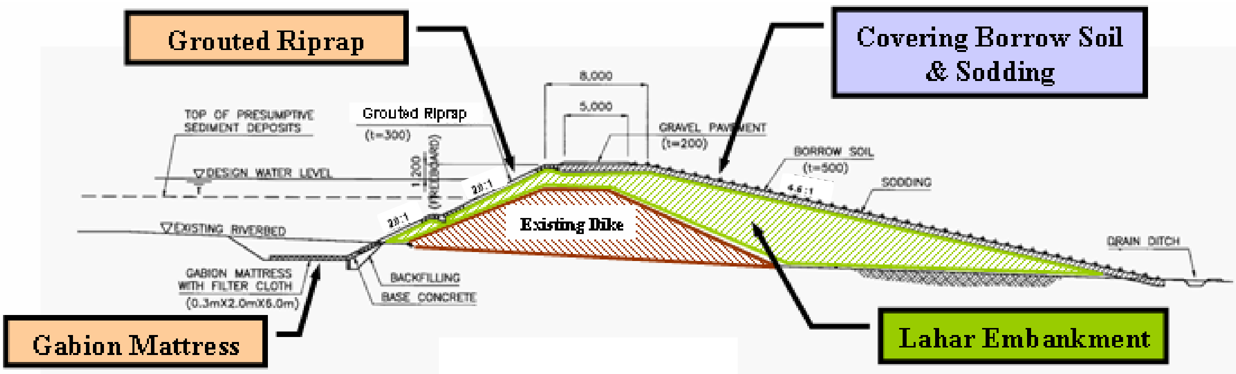

Figure 10.4 Typical Cross Section of the Bucao River Dike Strengthening Work

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

Preliminary Design of the Bucao Bridge

Table 10.2 shows the principal features of the new Bucao Bridge. The typical sections of the existing and new bridges are shown in Figure 10.5. Riverbed movement simulated after 50 years was considered to determine design water level though it was analyzed with limited data.

A study of alternatives was conducted to determine the type of new bridge that should be adopted from among 1) RC bridge, 2) PC bridge and 3) Steel girder bridge. Based on the cost comparison, a steel girder bridge was selected as the optimum type. The location of the new bridge was also compared for 1) the downstream side, 2) the same location as the existing bridge, and 3) the upstream side. Because of the bridge length and the cutting volume of the left side mountain for the access road, 1) the downstream side was selected as the least-cost scheme. The existing bridge is required to be demolished after completion as it may affect the new downstream bridge during floods.

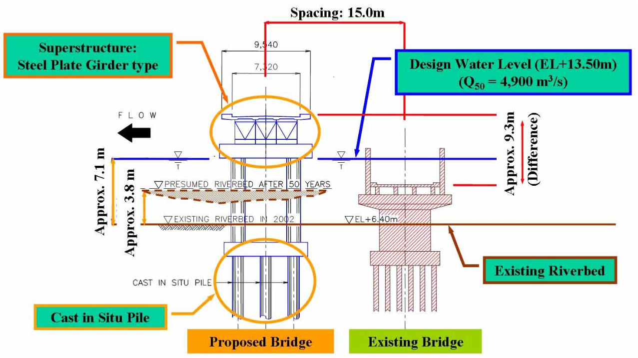

Figure 10.5 Typical Section of the Bucao Bridge

Table 10.2 Principal Features of the Bucao Bridge

Design Items	Unit	Design Description
Design Flood Discharge	m^3/s	4,900 (50-year probable flood)
Design Water Level	El.m	13.50
Existing Riverbed Elevation	El.m	6.40
Estimated Maximum Riverbed up to 2053	El.m	10.16
Soffit Girder Elevation	El.m	16.95
Design Speed	km/hr	50
Bridge Length	m	321
Type of Bridge		Steel Plate Girder Bridge
Span	m	46, 50x2, 50, 72, 53
Bridge Width	m	9.54

Construction Schedule

A schedule was prepared for the dike construction and bridge re-construction. For the dike construction, the embankment work is defined as the critical work. The work volume is estimated at 1.8 million m^3, for which three dry seasons (total 18 months) will be required to complete the works. The construction equipment should be arranged for 100,000 m^3/month capacity for the embankment works. No embankment work is considered during the rainy season from May to October because it rains almost every day and the rainfall amount is remarkably high. The work quality for embankment is generally not favorable during the rainy season. Total period for the dike construction is then estimated at 35 months.

For the re-construction of the Bucao Bridge, the total construction period was set at 24 months with two dry seasons. The substructure should be completed within the first dry season. The superstructure and access construction will be then carried out in the second dry season. No works are considered for the rainy season due to the severe rainfall conditions in the study area.

Project Cost

The project cost was estimated based on international tender prices for recent similar projects in the adjacent areas. The total construction cost for the dike and bridge is estimated at 1,035 million pesos including taxes and duties. The total project cost, including land acquisition, engineering services, and contingencies, is estimated at 1,678 million pesos with the breakdown as shown in Table 10.3.

Table 10.3 Project Cost on Priority Project for the Bucao River

Unit:1,000 Pesos

No.	Item	L/C	F/C	Total
1	Civil Works	551,281	483,219	1,034,500
2	Land acquisition / compensation	44,878	0	44,878
3	Administration	31,035	0	31,035
4	Engineering Services	88,205	77,315	165,520
5	Sub-Total	715,399	560,534	1,275,933
6	Price contingency	182,428	67,101	249,529
7	Physical contingency	89,783	62,763	152,546
8	TOTAL	987,610	690,398	1,678,008

Economic Evaluation

Economic evaluation was conducted under the conditions described in Table 10.4.

Both direct and indirect benefits were estimated for the economic evaluation. The direct benefit was counted for the inundation of buildings, farm land, and economic infrastructure (roads and irrigation facilities).

The indirect benefits were calculated from the cost of taking detours, loss of GRDP, evacuation cost, and urgent cleaning cost. Only items countable in monetary terms were considered.

Based on the above, the EIRR for the priority projects of the Bucao River was estimated at 15.7%, which is above the threshold for implementation set by NEDA. The results of the economic evaluation are compiled in Table 10.5.

Table 10.4 Conditions for Economic Evaluation

Item	Conditions
Project life	30 years after completion
Economic cost	82.8% of economic conversion rate
Initial cost distribution	4 years (20%, 30%, 30%, 20%)
Annual maintenance cost	1.5% of economic cost
Annual discount rate	15%
Economic benefit	Refer to Table 10.5
Economic benefit amount	85% of the market value
Development benefit	Not to be counted

Table 10.5 Result of Economic Evaluation for the Bucao River

Item	Unit	Result
Total project cost	million Pesos	1,678
Economic cost	million Pesos	1,182
Annual maintenance cost	million Pesos/year	17.74
Direct benefit	million Pesos/year	131.63
Indirect benefit		
Detour cost due to bridge collapse	million Pesos/year	150.28
Loss of Non-agriculture GRDP	million Pesos/year	0.79
Evacuation cost	million Pesos	0.02
Urgent cleaning cost	million Pesos/year	0.90
Annual total benefit	million Pesos/year	283.62
B-C (discount rate: 15%)	million Pesos	35.8
EIRR	%	15.7

10.2 Dike Heightening and Strengthening for the Sto.Tomas River

Project Description

In the master plan study, it was concluded that the sediment control structures in the upstream sediment source zone will not prevent further riverbed aggradation, so dike heightening and strengthening is recognized as the optimum measure to prevent further mudflow disasters. The dike heightening and strengthening with new dike construction and Gabor River drainage improvement were selected in the downstream and midstream as the priority projects. The general view of the dike strengthening site at the middle reach of the Sto.Tomas River is illustrated in Figure 10.6.

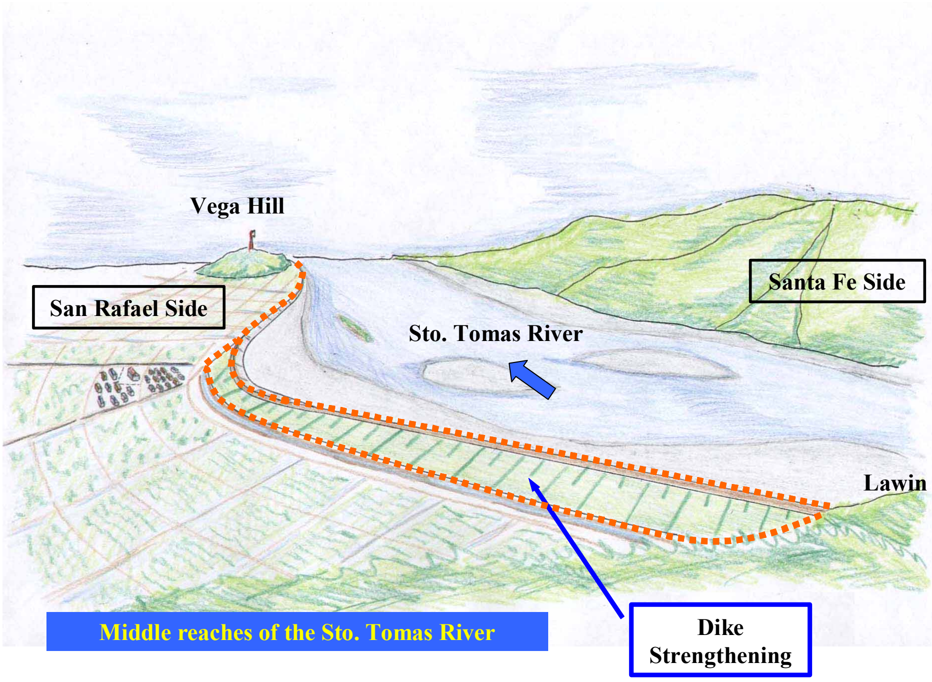

Figure 10.6 Dike Strengthening at Middle Reach of the Sto.Tomas River

Design Flood Level and Design Dike Profile

The same approach as applied to the Bucao River was taken to determine the design flood level and dike profile for the Sto.Tomas River. They are, 1) to estimate future riverbed profile in 2023 by long-term riverbed movement analysis, 2) to conduct non-uniform flow analysis to seek the design flood level under 20-year probable flood, 3) to set the freeboard of 1.0 m on the design flood level, and 4) to design the dike profile. Figure 10.7 shows the results of the design dike profile and average dike height from the present riverbed elevation.

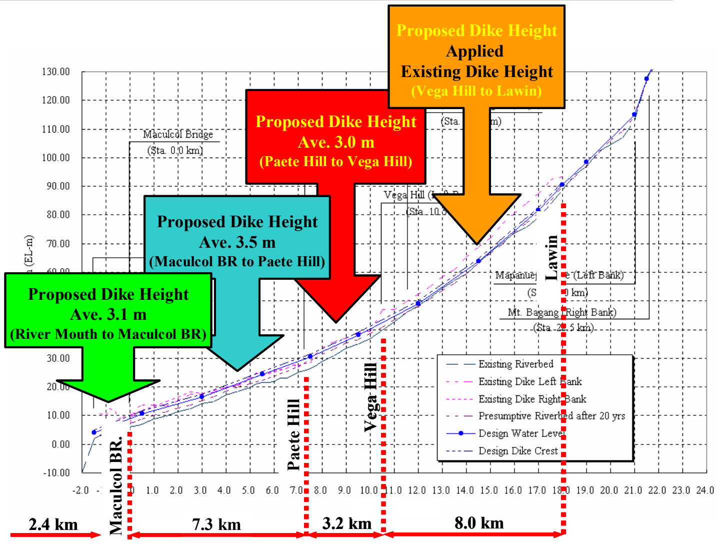

Figure 10.7 Design Dike Profile in the Sto. Tomas River

Preliminary Design for Dike Heightening and Strengthening at the Downstream Reach

Works included in the downstream reach are 1) new dike construction, 2) dike heightening, 3) dike strengthening, and 4) drainage channel excavation. In this reach, frequent dike breaches are experienced particularly on the left side dike. Recently, the dike was breached in 2000, 2002 and 2003 and the residential houses and farmland along the river were buried to a depth of more or less 1 m. For the Maculcol Bridge, the re-construction work is urgently required, and DPWH has completed the detailed design. Immediate re-construction of the Maculcol Bridge is highly desired to upgrade the reliability of the national highway No.7.

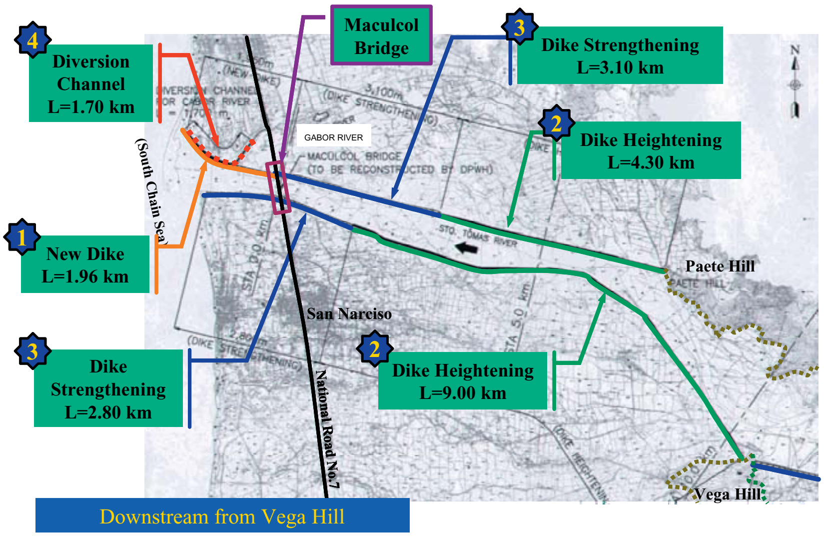

Figure 10.8 General Plan for the Downstream Reach of the Sto.Tomas River

A proposal for drainage channel excavation for the Gabor River, which flows into the downstream reach of the Sto.Tomas River, was newly identified in the course of the feasibility study stage. The mouth of the Gabor was blocked due to the riverbed aggradation of the Sto.Tomas River. As maintenance of the confluence is difficult taking into account the anticipated further riverbed aggradation of the Sto.Tomas River, a diversion channel along the right dike of the Sto.Tomas River is designed. The flow from the Gabor River is therefore separated from the Sto.Tomas River and directly flows to the South China Sea.

Preliminary Design for Dike Strengthening in the Middle Reaches

Plenty of deep gully erosions are observed on the existing inland slope of the dike in the middle reaches of the Sto.Tomas River. The gully erosion is not caused by rainfall but is due to the outlet of seepage water on the inland side slope. The erosion at the seepage outlet occurs on a small scale and then develops upslope. The riverbed elevation is about 7 m higher than the land, and the seepage water from the river side through the existing dike is remarkable. There is further concern that slope erosion may be caused by the piping through the dike or boiling.

Figure 10.9 shows the different elevation of the riverbed and the landside on the left bank of the Sto.Tomas River. The gully erosion is observed on the upstream sites as shown in Figures 10.10 and 10.11, which illustrate the remarkable differences in the elevation between the riverbed and inland side. According to the local people, the seepage water spouts out from the dike slope during the rainy season.

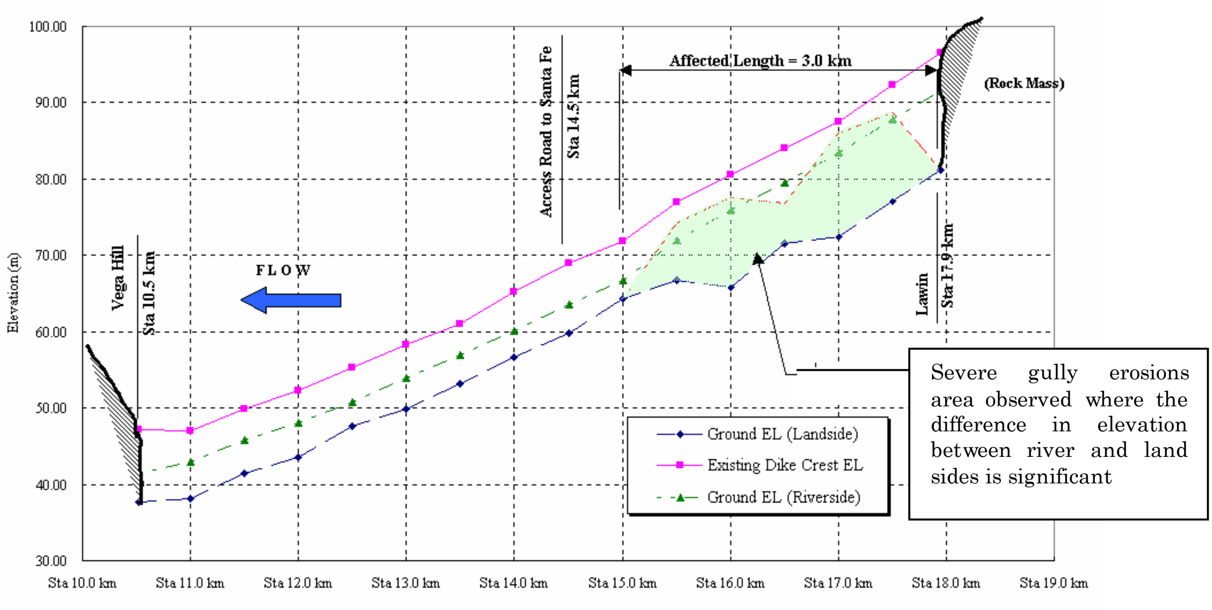

Figure 10.9 Riverbed and Land Profile at the Middle Reach of the Sto.Tomas River

Figure 10.10 Gully Erosion at Sta.17 km

Figure 10.11 Gully Erosion at Sta.17.5 km

The proposed countermeasure is to reduce the inland slope gradient from 3.0:1 at present to 4.5:1 or 5.0:1 to extend the seepage line. The proposed typical cross section for dike strengthening is shown in Figure 10.12.

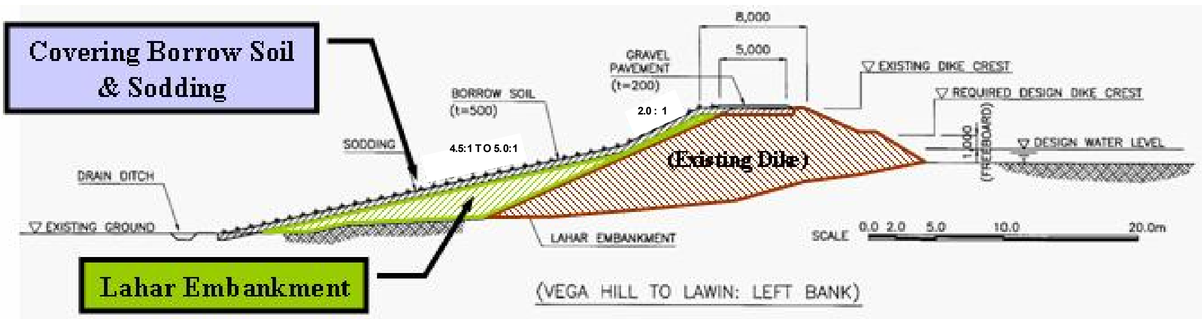

Figure 10.12 Typical Section of Dike Strengthening at Middle Reach of the Sto.Tomas River

Construction Schedule

Critical work for dike heightening and strengthening of the Sto.Tomas River is the embankment work, just as for the Bucao River work. The total volume is 1.8 million m^3. The construction period is accordingly set to 35 months, including three dry seasons.

Project Cost

The same unit rate was applied to the Bucao and Sto.Tomas Dike works. The construction cost is estimated at 1,192 million pesos, and the project cost at 1,960 million pesos. The cost breakdown is described in Table 10.6.

Table 10.6 Project Cost for the Sto.Tomas Priority Works

Unit:1,000 Pesos

No.	Item	L/C	F/C	Total
1	Civil Works	687,044	505,085	1,192,129
2	Land acquisition / compensation	37,988	0	37,988
3	Administration	35,764	0	35,764
4	Engineering Services	109,927	80,814	190,741
5	Sub-Total	870,723	585,899	1,456,622
6	Price contingency	245,391	79,459	324,850
7	Physical contingency	111,611	66,536	178,147
8	TOTAL	1,227,725	731,894	1,959,619

Economic Evaluation of the Project

Table 10.7 summarizes the results of economic evaluation for the Sto.Tomas priority project. The EIRR is estimated at 26.3%, which indicates quite high economic viability. The main reason for the high economic viability is the large amount of the sunk cost for the existing dike, which is not included in the cost even though its full benefit is taken into account for the economic evaluation. The mudflow prone area is also quite large compared with the other Mount Pinatubo river basins, which is another reason for the high EIRR.

Table 10.7 Results of Economic Evaluation for the Sto.Tomas River

Item	Unit	Result
Total project cost	million Pesos	1,960
Economic cost (*)	million Pesos	1,624
Annual maintenance cost	million Pesos/year	24.4
Direct benefit	million Pesos/year	479.43
Indirect benefit		
Detour cost due to bridge collapse	million Pesos/year	185.56
Loss of Non-agriculture GRDP	million Pesos/year	2.60
Evacuation cost	million Pesos	0.10
Urgent cleaning cost	million Pesos/year	1.40
Annual total benefit	million Pesos/year	669.09
B-C (discount rate: 15%)	million Pesos	815.4
EIRR	%	26.3

(*) Economic cost for Maculcol Bridge was added

Possibility of Stage-wise Development

In the case of the Sto.Tomas River, there are three independent inundation blocks in the project area. The work locations and the beneficial areas can therefore be divided into three areas. In the case of a shortage of funds for implementation, it would be possible to arrange a stage-wise development of the heightening and strengthening of the Sto.Tomas dike. The economic comparison was therefore conducted for each block. The following table and figures show the results of flood inundation analysis for the respective inundation block. The location of the three inundation blocks is shown in Figure 5.3 in Chapter 5.

Table 10.8 Results of Flood Inundation Analysis for Stage-wise Development

Return Reriod	Left Bank, Middle Reach			Left Bank, Downstream			Right Bank, Downstream		
	Inundation Area (ha)	Inundated HH (Nos)	Inundated farm land (ha)	Inundation Area (ha)	Inundated HH (Nos)	Inundated farm land (ha)	Inundation Area (ha)	Inundated HH (Nos)	Inundated fam land (ha)
2-year	2,570	2,973	1,610	1,200	765	805	870	295	395
5-year	3,140	3,974	1,908	1,456	968	979	1,087	505	500
10-year	3,490	4,555	2,100	1,599	1,082	1,076	1,196	589	549
20-year	3,840	5,103	2,312	1,756	1,251	1,181	1,277	658	582
30-year	4,060	5,348	2,445	1,842	1,350	1,239	1,336	736	602
50-year	4,330	5,744	2,598	1,952	1,490	1,308	1,407	811	626
100-year	4,660	6,258	2,805	2,081	1,634	1,391	1,497	974	655

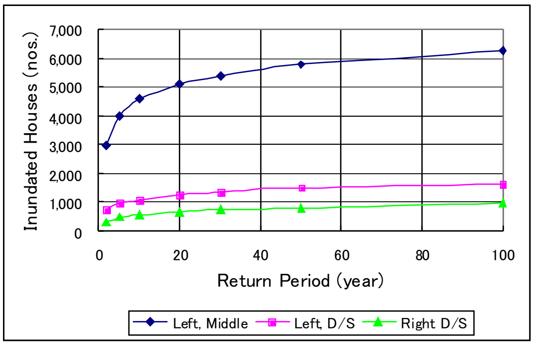

Figure 10.13 Damage Curve for Inundated Houses

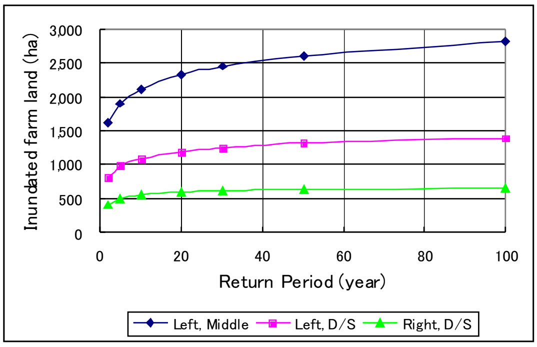

Figure 10.14 Damage Curve for Inundated Farm Land

Based on the flood inundation analysis, implementation of strengthening the left bank section of the middle reach would produce the greatest benefits. The results of the economic evaluation are compiled in Table 10.9.

Table 10.9 Results of Economic Evaluation for Stage-wise Development

Item	Unit	Left, Mid-stream	Left, Downstream	Right, Downstream
Project Cost	million Pesos	334	730	651
Economic Cost (*)	million Pesos	273.94	598.66	533.95
Annual Maintenance Cost	million Pesos/year	4.1	9.3	8.3
Direct Benefit	million Pesos/year	446.18	117.21	79.4
Indirect Benefit (*)	million Pesos/year	20	10	5
Total Annual Benefit	million Pesos/year	466.18	127.21	84.4
B-C (Annual Discount Rate: 15%)	million Pesos	1,520	-5	-112
EIRR	%	67.7	14.9	10.9

Note: (*) No detour cost for bridge collapse is included. (Cost for bridge is also not included)

The economic evaluation indicates that the left side of the middle reach has the highest economic viability because it has the largest area of inundation, highest population, and most farm land among the three blocks. The middle reach has an abnormal riverbed profile, which is about 7 m higher than the mudflow prone area, so almost all the area within the inundation area will be damaged by mudflow if the dike is breached. The EIRR is estimated at 67.7% and so this reach is the top priority section for implementation.

On the other hand, both banks of the downstream reach have a rather lower EIRR of less than 15%. However, this would be improved if the cost and benefit of the Maculcol Bridge was taken into account. In this case, both of the left and right sides implementation should be carried out simultaneously.

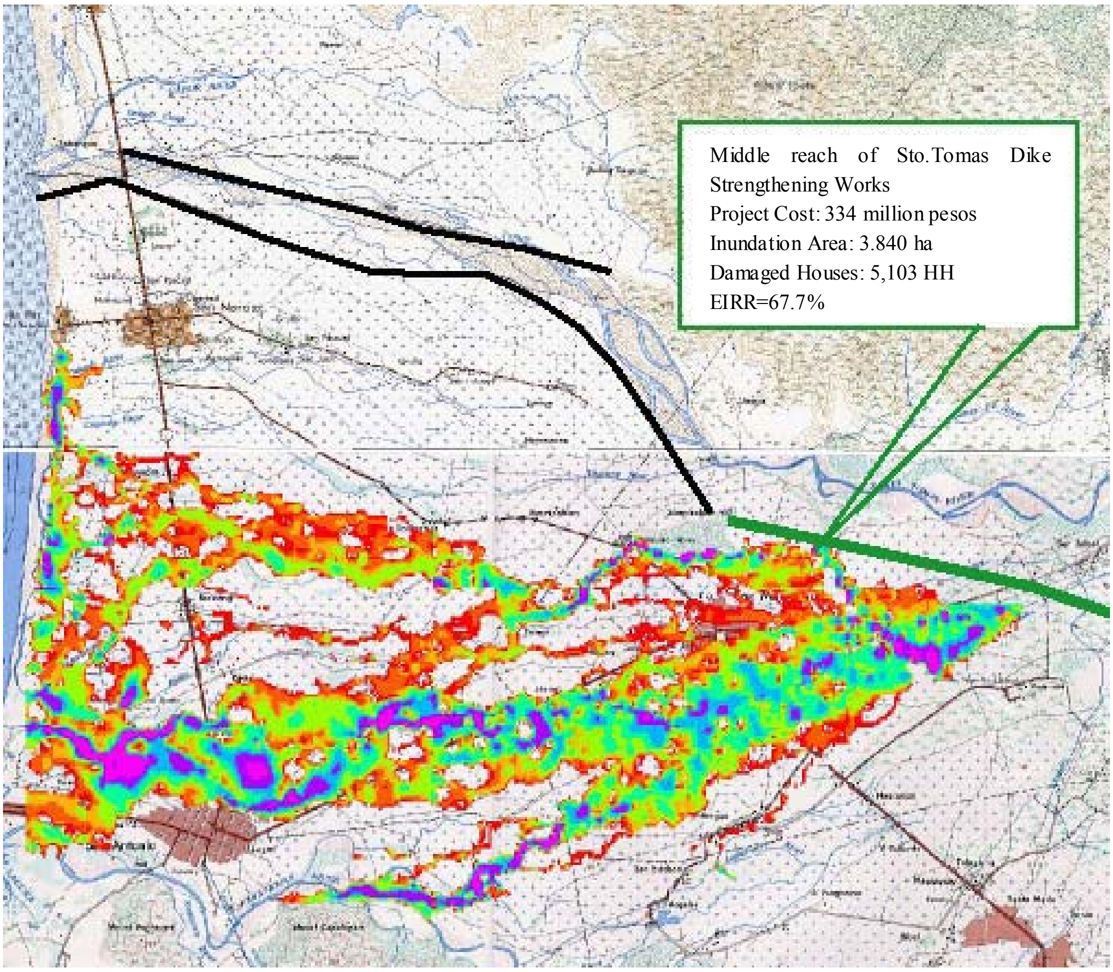

Figure 10.15 Mudflow Inundation Area of Middle Reach of the Sto.Tomas River, Left Bank