5 MONITORING OF PILOT WORKS

5.1 Pilot Works

5.1.1 Monitoring Survey for Pilot Works

Outline of the cross-sectional surveys and velocity measurements is described here, which were carried out for the monitoring of the Pilot Works. The detail specification is described in Volume 4, Sector G-Monitoring Survey for Pilot Works.

(1) Cross-sectional Survey

Cross-sectional surveys were carried out to obtain the topographical condition in/around three completed pilot work sites for the monitoring under the condition in the dry (low water) seasons. Quantity of works is as shown in Table 5.1. The survey works were conducted three (3) times as follows by a local contractor under the supervision of the Study Team:

1. February 2002 <before the construction of the Pilot Works>
2. June 2003 <after the completion of the Pilot Works>
3. January 2004

Table 5.1 Quantity of Cross-sectional Survey

Location of Cross-sectional survey	Unit	Quantity	Remark
1) Ban Dongphosi Site	Line	43	pitch=20m, line length=50m
2) Wat Chom Cheng Site		21	
3) Sibounheuang Site		16	

(2) Velocity measurement

Velocity measurements were carried out to obtain the current speed and direction in/around three completed pilot work sites for the monitoring under the condition in both dry (low water) and rainy (high water) seasons. Quantity of works is as shown in Table 5.2. The survey works were conducted six (6) times as follows by a local contractor under the supervision of the Study Team:

1. January/October 2002 <before the construction of the Pilot Works>
2. June 2003 <after the completion of the Pilot Works>
3. September 2003
4. January 2004
5. August 2004

Table 5.2 Quantity of Velocity Measurement Works

Work Item	Quantity
a) Ban Dongphosi Site	9 lines x 20 points/line = 180 points
b) Wat Chom Cheng Site	3 lines x 20 points/line = 60 points
c) Sibounheuang Site	3 lines x 20 points/line = 60 points

5.1.2 Topographic Condition

In conclusion, the Pilot Works are proved effective for the bank condition at each site in view of the topographical monitoring including visual observation.

(1) Ban Dongphosi site

The result of the topographical monitoring at the site including visual observation is summarized as follows:

- Amount of sedimentation is found on the work.
- No remarkable changes of the work are found except:
  - two (2) local scoring spots at the toe of the slope (refer to Figure 5.1)
  - local gaps between Soda mattress and riprap foundation work
- As for the foot protection work, supply of ripraps will be effective if further deformation of the foundation work is detected through successive monitoring works.

Figure 5.1 Local Scoring at the toe of Slope Protection Work

Note: The Study Team already repaired the local scouring of Figure 5.1 in January 2004.

(2) Wat Chom Cheng site

The result of the topographical monitoring at the site including visual observation is summarized as follows:

- Amount of sedimentation is found between groynes especially at just downstream of the groynes as shown in Figure 5.2. No remarkable changes of the wooden piles are observed.
- Slight inclination of wooden piles is found presumably due to soil mass movement as shown in Figure 5.3.
- Maximum local scouring depth: approx. 0.6 m in 2003
- Appropriate interval of groynes will be 3 times of groyne length.

Figure 5.2 Sedimentation between Wooden Pile Dike Groyne Works

Figure 5.3 Inclination of Wooden Piles at Line No.3+40

(3) Sibounheuang Site

The result of the topographical monitoring at the site including visual observation is summarized as follows:

- Amount of sedimentation is found on the work. No remarkable changes of the work are found.
- Upper natural bank seems to relatively stable to have some vegetation growth on it.

5.1.3 Hydraulic Condition

Monitoring surveys on hydraulic condition were executed according to the program as shown in Table 5.3.

Table 5.3 Hydraulic Monitoring Program

Monitoring Items	Site	Nos	Interval	2001	2002		2003		2004	
				Dry season	Rainy season	Dry season	Rainy season	Dry season	Rainy season	Dry season
River water stage	All Sites		Everyday	—	—	—	—	—	—	—
Flow velocity and direction	All Sites	6		–	–	–	–	–	–	
Construction of Pilot Works						—				

Change in Flow velocity and direction after the Construction of the Works is summarized as follows:

- Flow velocities have become relatively small, especially at Wat Chom Cheng site due to the effect of groynes.
- Flow directions have become relatively uniform due to the effect of straightened topography.
- Main current has shifted offshore judging from velocity concentration ratio analyzed.

The Mekong water level variations at each site are shown in Figure 5.4.

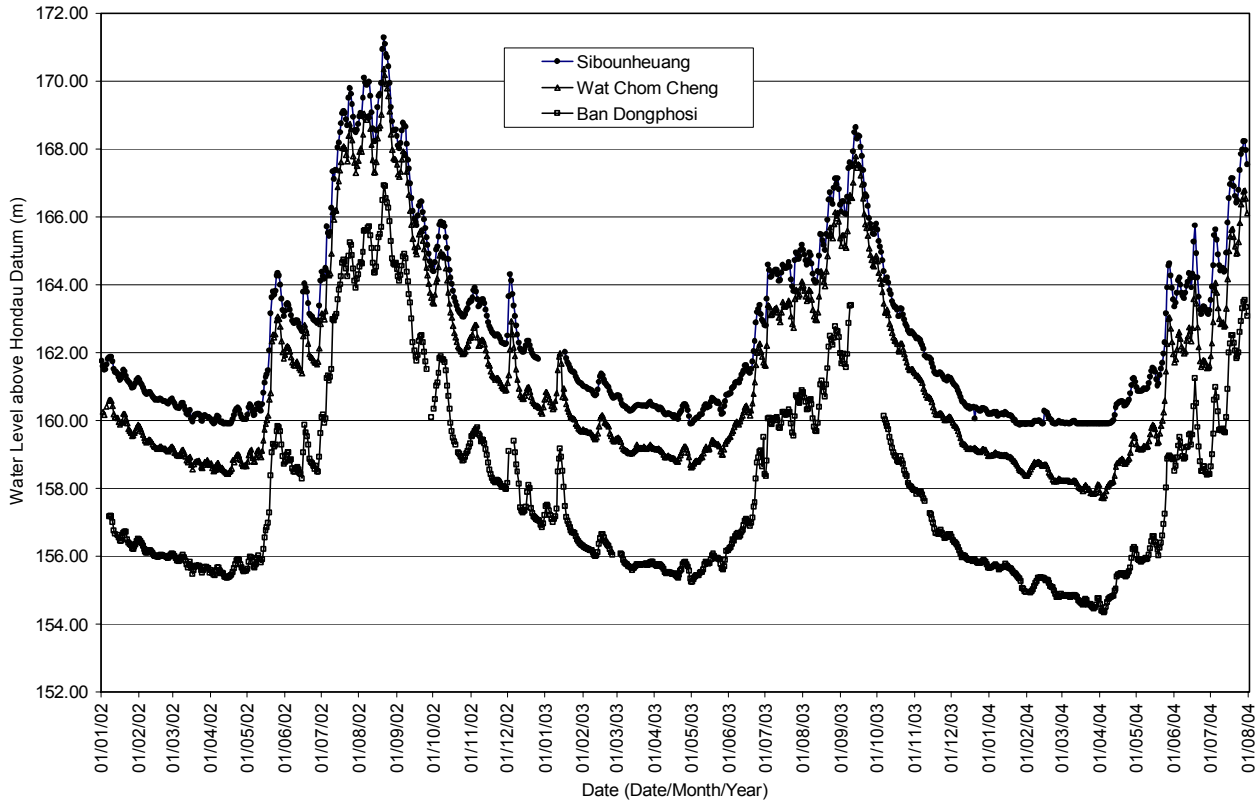


Figure 5.4 Daily Water Level at Pilot Work Sites

5.1.4 Vegetation Condition at Pilot Work Sites

Vegetation condition on the slope protection work at Ban Dongphosi site has been monitored by conducting test planting of willow as summarized below:

- Execution of planting willow at Ban Dongphosi Site (refer to Figure 5.5)
  - Planting method: 1) seedling in small plastic bucket, 2) stump directly planting and 3) seed sowing
  - Willow species: 1) Khai Nun and 2) Kok Khai
- Period : Jul. 2003 - Dec. 2004 (refer to Table 5.4)
- Result: Survival rate: seedling (32.8%), stump directly (2.4%) and seed sowing (0%) (refer to Figure 5.6)

Table 5.4 Vegetation Monitoring Items and Schedule

Monitoring Items	Unit	Q'ty	2003												2004											
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Planting willow	Time	2						■						■	■											
Growth situation of willow	Time	1												■	■											
Photograph of planted willow (0nce/1M)	Time	3						■						■		■										
Distribution of vegetation	Time	1																	■							

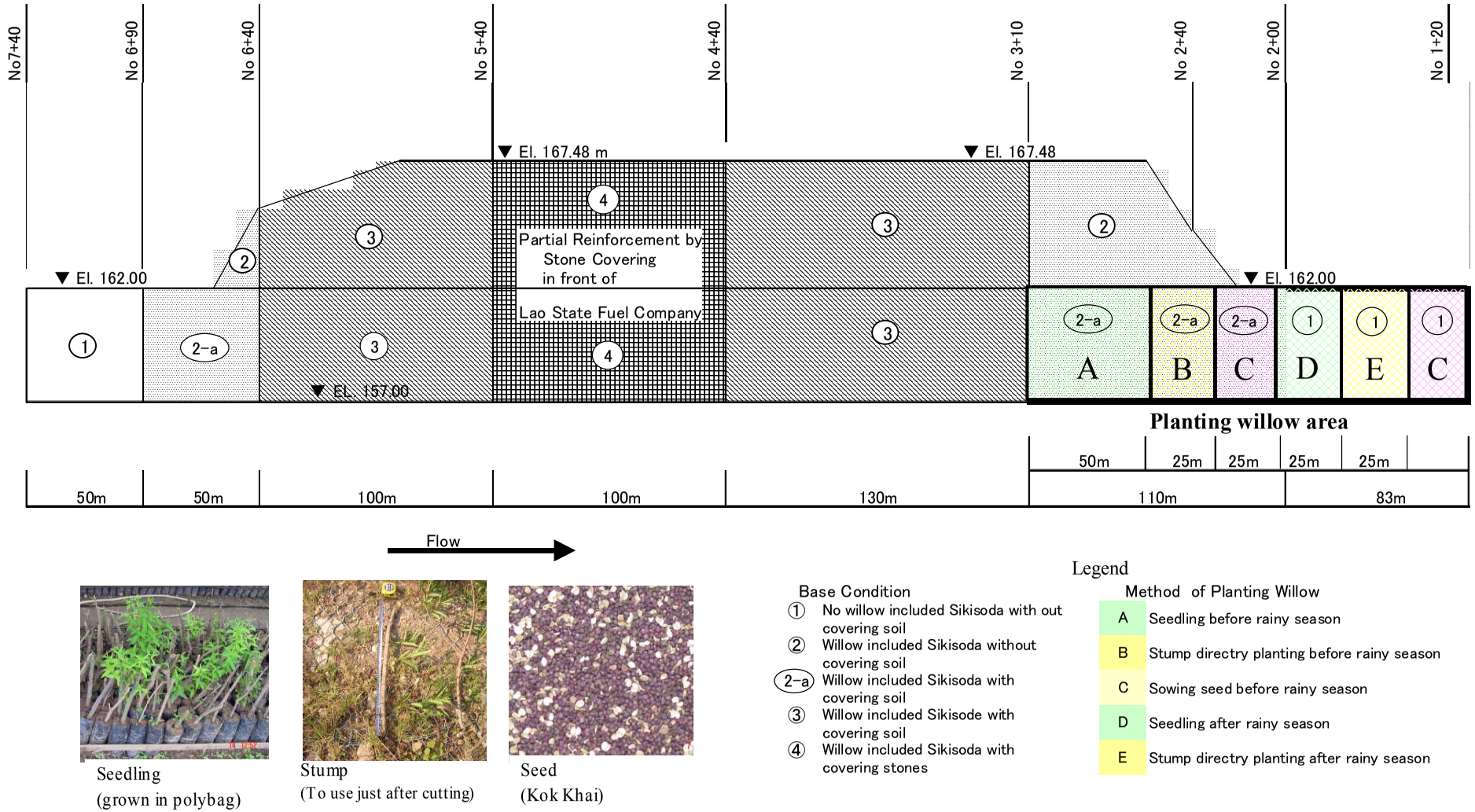
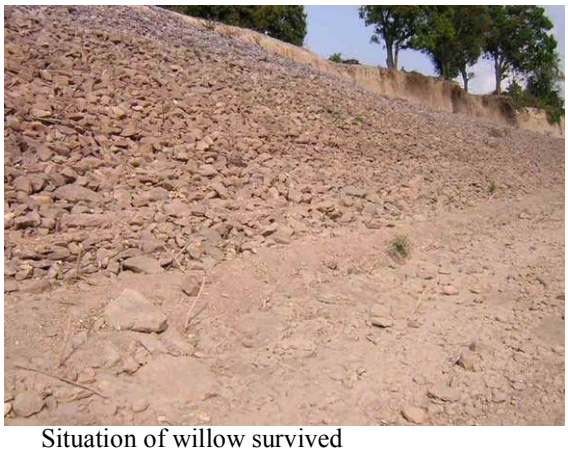


Figure 5.5 Design of Planting Willow at Ban Dongphosi Site

Situation of willow survived (Seedling) Dec/2003



Situation of willow survived (Stump directly planting) Dec/2003

Growth Situation of willow (Seedling, Kok khai) Jan/2004

Growth Situation of Willow Root (Seedling, Kok khai) Jan/2004

Growth Situation of Willow (Stump directory planting, khai Nun) Jan/2004

Growth Situation of Willow Root (Stump directory planting, khai Nun) Jan/2004

Figure 5.6 Growth Performance of Willow on Ban Dongphosi Site

5.2 Vegetation Condition at Related Sites

5.2.1 Riverine Vegetation Survey

Vegetation condition at related riverbank sites has been monitored to know the characteristic of the riverine vegetation in the Mekong River as summarized below:

- Location: 3 existing bank protection works and 1 natural riverbanks shown in Figure 5.7
- Monitoring schedule and items: refer to Figure 5.4
- Result: In general, there were similar vegetation, annual community and gramineae community, at middle and upper layer in existing bank protection sites and natural slope. There were gramineae community and willow community at the lower layer of riverbank.

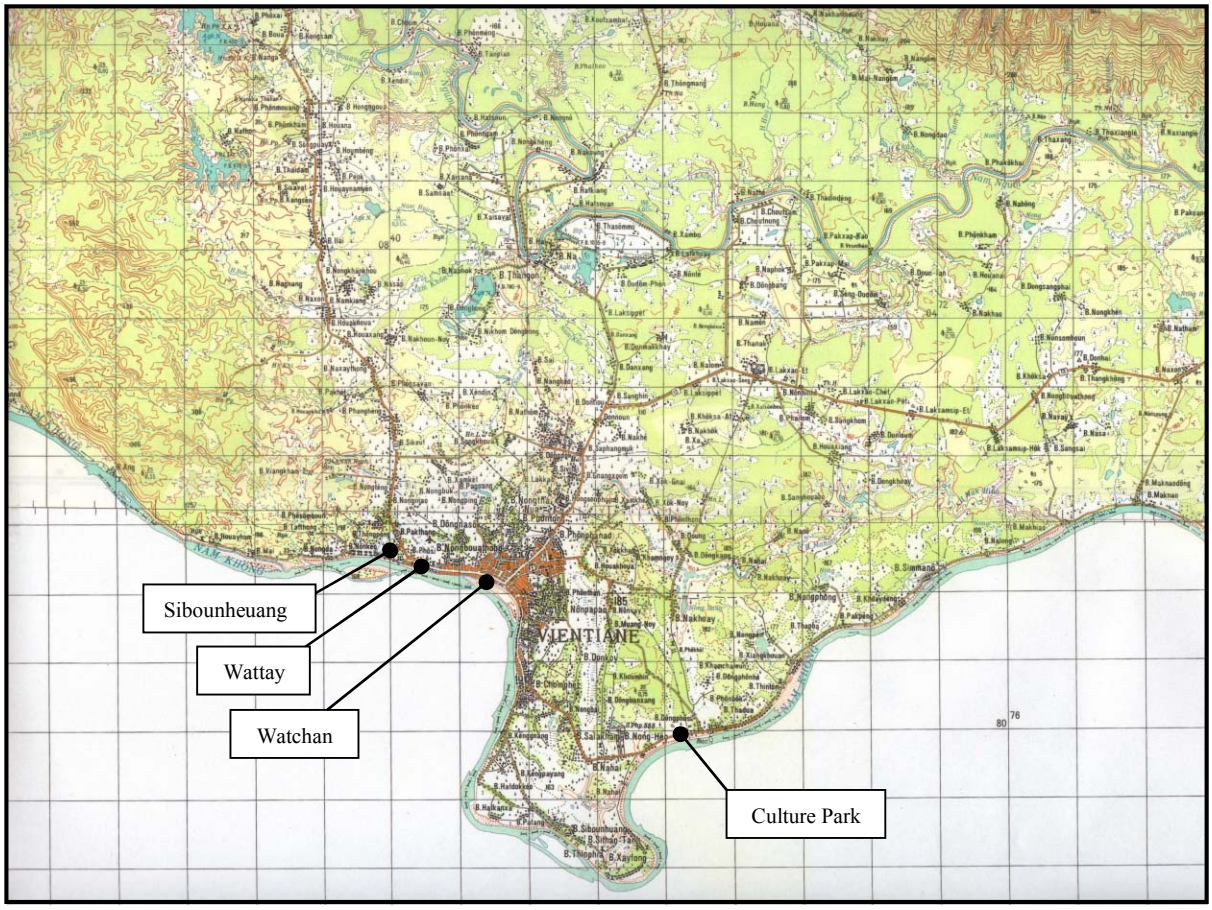


Figure 5.7 Location of Riverine Vegetation Survey

Table 5.5 Program for Riverine Vegetation Monitoring

Location	Monitoring Items	Unit	Q'ty	2003												2004											
				1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Culture Park	Distribution of vegetation and flora	Time	3			—									—											
Watty	Distribution of vegetation and flora	Time	3			—									—											
Sibounheuang (Constructed by IDI)	Distribution of vegetation and flora	Time	3			—									—											
WatChan	Distribution of vegetation and flora	Time	3			—									—											

5.2.2 Soda Materials and Willow Branch Collection Site for Pilot Works

(1) Soda Materials

Sosa materials were collected at several forest sites such as Danxi, Nongpen and Laxanship, etc. The survey of forest condition was executed at Nongpen site on February 2004. It is judged that the vegetation was recovered as it is and was almost the same before and after the collection as shown in Figure 5.8.

Figure 5.8 Vegetation Condition at Nongpen Site

6 RIVERBANK PROTECTION MASTER PLAN

This Chapter 6 compiles the gross outline of the Riverbank Protection Master Plan around Vientiane City (hereinafter referred to as "the Master Plan") formulated during the 4th Work in Lao P.D.R. from December 2003 to February 2004. All the process and result are compiled in Volume 4 Supporting Report, Sector H -Riverbank Protection Master Plan.

6.1 Basic Framework and Principles of Master Plan

6.1.1 General

Principal matters related with the implementation of bank protection of the Mekong River around Vientiane City are put together as the Master Plan. The Master Plan therefore sets forth principles for bank protection activities, criteria for selection of work sites and their priority, work quantities and cost, implementation plan of the priority works. In addition to the above, the following issues are discussed in the Master Plan to ensure the smooth implementation of the bank protection works.

1. Development of rational bank protection measures to fit with the nature of the Mekong River in the Study Area.
2. Establishment of proper river management system for planning and designing, construction work, management and maintenance including set up of organizational and institution, and capacity building.
3. Securing stable supply of construction materials such as wooden and stone materials locally.

The Master Plan is the principles and guideline for the bank protection activities:

1. to be implemented by the Government of Lao P.D.R. (GOL) by themselves using national budget in principle after 2005, and
2. introducing traditional river works of Japan in principle.

6.1.2 Basic Framework and Principles

Basic framework and principles for sustainable and realistic bank protection master plan is established through the enthusiastic discussion between GOL and the Study Team, based on above mentioned concept and reflecting the monitoring result of the Pilot Works. The Master Plan should be sustainable from technical, economic, social and environmental viewpoints. The Master Plan is composed not only of structural measures but also of non-structural measures. The following are the basic planning frame of the Master Plan.

- Target year: 2020 corresponding to National Poverty Eradication Programme (NPEP) (GOL, 2003).
- Objective Area: Mekong riverbank around Vientiane City with L=approx. 65 km (Thadeua - Ban Ang)
- Planning Methodology:
  - Selection of high priority stretches: selected from cliffy riverbanks

- Implementation schedule: 1) design, 2) cost estimate and 3) implementation schedule by 2020 are preliminarily prepared for the Objective Stretches to be protected, which is selected from the High Priority Stretches:
- The extension of the Objective Stretches is determined by the followings:
  - ✧ Setting up of sustainable organization and institution
  - ✧ Type of work & cost applied to each Objective Stretches
    (low cost type is proposed according to required safety level of each site
  - ✧ Sustainable & achievable budgetary allocation
  - ✧ Minimum resettlement (JICA Pilot Works completed with no resettlement.)
  - ✧ Resident's Participation

- Sustainable Supply of Materials
  - Soda materials: Sustainable supply with proper forest preservation proved possible through the experience of Pilot Work in 2003.
  - Quarry:
    - ✧ The following three (3) quarries have been utilized for bank protection works in recent years in the Study Area:
      - ➢ Ban Sakai Permanent site (the only site under operation, 50 km from Vientiane, lime stone)
      - ➢ Nong Teng temporary site (utilized for JICA Pilot Works, sand stone)
      - ➢ Tat Thong temporary site (utilized for GOL recent works, sand stone)
    - ✧ Development of new quarry exclusive for bank protection: low feasibility in view of project scale and limited usage of sand stone
    - ✧ Selection of quarry is the option of local contractors in principle in the future.
- Coordination with Relating Projects (refer to Section 2.1)
  - On-going and proposed bank protection plan/projects are principally:
    - ✧ incorporated into the Master Plan as it is, and
    - ✧ consist of a part of the Master Plan with high priority.

6.2 Mechanism of Bank Erosion

6.2.1 Geomorphologic Background

Materials forming the river channel of the Mekong River come from mainly two different sources as follows:

- Vientiane Gravel:
  - A fan-deposit transported from the Himalayas by the Mekong River during the Glacier Age.
  - The gravel would hardly be transported by the present flood flows
- Silty Sand:
  - A recent alluvial deposit of the Mekong River with the thickness 6 to 15 m.
  - The silty sand is transported by the present river flows as suspended loads.

Riverbed during the flood:

- is basically formed with the gravel
- the depth to the gravel layer is a ruling factor of depth of the river

6.2.2 Changes in Plan-form and Riverbank Erosion

- Changes in Plan Form of River (during past 30 years, 1961/62-1991/1992)
  - The following 5 islands in the Mekong River remained at almost the same places:
    - ✧ Don Tam (Thailand)
    - ✧ Don Khieonoi (Thailand)
    - ✧ Don Chan (Lao PDR)
    - ✧ Don Xingsou/Don Ching Chu (Lao PDR)
    - ✧ Don Mun/Dor Makmo (Lao PDR)
  - Tam Island expanded 3 to 4 times, which caused severe bank erosion at Ban Hom.
  - As for islands in the upper reaches, their sizes are almost the same.
  - Vestiges of old river course of the Mekong River are as shown in Figure 6.1.
- Recent Bank Erosion
  - The Study Area experienced historical 2nd biggest flood in August 2002.
  - Riverbanks suffering from active erosions are the cliffy banks of 1) Nahai to Sithantai, 2) Thakhek to Wat Chomthong, 3) Hatdokkeo to Bo O, and 4) Wat Muang Wa to Mekong Breeze Hotel.
  - Erosion is most active from Thakhek to Wat Chomthong, where the bank was eroded by about 25 m in 2003 and about 35 m since 2001.
  - These erosions mostly took place during the recession period of floods.
  - The Pilot Work Site (erosion due to the 2002 flood before construction):
    - ✧ Ban Dongphosi site: riverbank was eroded 2.3 m on average
    - ✧ Wat Chom Cheng and Sibounheuang sites: no significant erosion except for some local portions
- Forecast of Progress of Erosion:
  - It is difficult to forecast because of limited data available, the following could be clarified:
    - ✧ Sites of riverbank erosion would not change so much in future, judging from small change in river plan-form in the past.
    - ✧ Recent active erosions take place in the cliffy riverbanks.

6.2.3 Types of Riverbanks and Coping Measures to Erosion

- Classification of Types of Riverbank

The riverbanks in the Study Area can be classified into four types for bank protection purpose as shown in Table 6.1 and Figure 6.2.

- Objective stretch: L= 59.24 km (Thadeua to Wat Thampha)
- 5 km from Ban Ang to Wat Thampha: not important in view of bank protection

Table 6.1 Classification of Types of Riverbank

Type	Length (Km)	Characteristics in view of bank protection
1) Cliffy riverbanks	19.18 (32%)	erosion prevails and is in most critical erosion condition with almost vertical slope with little vegetation
2) Mild-slope riverbanks	20.71 (35%)	in the condition between erosion and sedimentation and in favorable state as a whole with vegetation
3) Riverbanks with sand bar and island	16.89 (29%)	This stretches would not require specific bank protection works
4) Riverbanks with exposed rocks	2.46 (4%)	
Total	59.24	

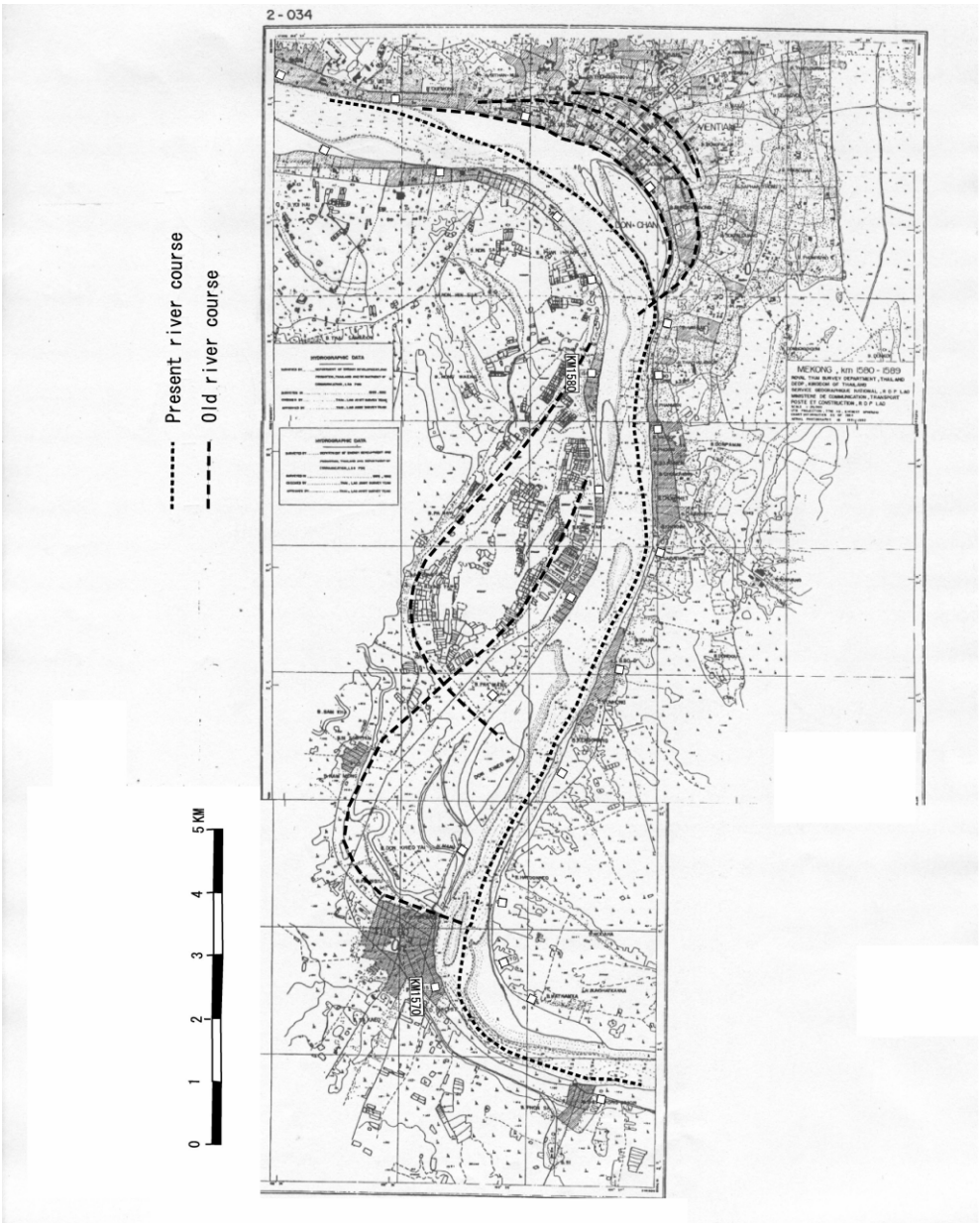


Figure 6.1 Old River Courses of Mekong River near Vientiane

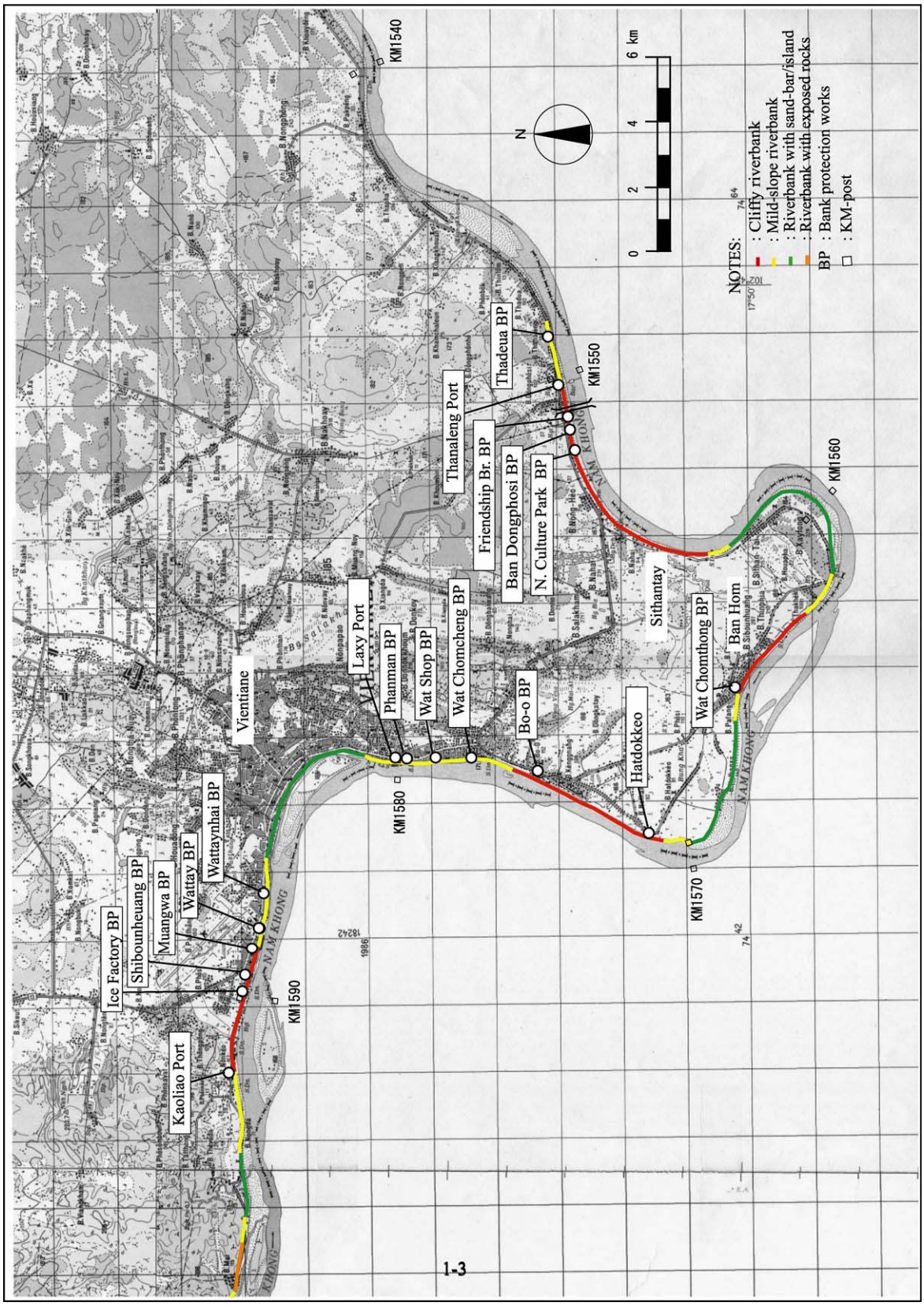


Figure 6.2 Classification of Types of Riverbank

- Coping Measures for Erosion
  - Bank protection works of the Mekong River consist of following component works in general:
    - ✧ 1) foot protection works, 2) foundation works and 3) slope protection works
  - Various types of works can be conceived for the bank protection.
  - Type of works for the bank protection measure should be selected considering the type of riverbank and expected safety level as well as availability of construction materials and fund.
  - Types of riverbank and advisable combinations of the component works are summarized in Table 6.2 for reference. The types of works and their coping measures are not limited to those mentioned in the table, and they should be improved and developed based on the monitoring results of the works constructed.

Table 6.2 Types of Riverbank and Protection Measures

Items	Type-C1 bank	Type-C2 banks	Type-C3 bank
Physical Conditions			
Shape of bank	Cliffy bank		
Bank materials	Silty sand (gravel bed is not seen above water surface)	Silty sand on loose gravel bed	Silty sand on consolidated gravel bed
River flows	Facing or contacting to the main flow of the Mekong R.		
Mechanism of Bank Erosion/Failure	Scour of bank toe and erosion of slope due to attacks of river flows.	Scour of loose gravel bed at the toe of slope and erosion of slope due to attacks of river flows.	Erosion of bank slope due to attacks of river flows.
Typical Riverbanks in Study Area	- Upstream reaches of Ice Factory - Ban Hom	- Hatdokkeo to Bo O - Wat Muang Wa to Sibounheuang.	- Ban Dongphosi to Sithantai, though Type-C2 banks are found in places.
Coping Measures	- To protect foot of bank-slope from scour. - To protect bank-slope from erosion. - To reduce flow velocity near riverbank.		- To protect bank-slope from erosion. - To reduce flow velocity near riverbank.
Advisable Protection Works			
Important protection sites of higher safety	Cobble stone w/willow branch (LS&US) + Riprap or log-hurdle foundation + Soda mattress	Cobble stone w/willow branch (LS&US) + Riprap or log-hurdle foundation + Soda mattress	Cobble stone w/willow branch (LS&US) + Riprap foundation + Soda mattress
Other protection sites	1) Cobble stone w/willow branch (LS) + Riprap or log-hurdle foundation + Soda mattress 2) Riprap groyne	1) Cobble stone w/willow branch (LS) + Riprap or log-hurdle foundation + Soda mattress 2) Riprap groyne	Riprap groyne

6.3 Selection of Objective Banks for Protection

Bank protection budget of GOL in the past was very small in comparison with the works required for the Mekong River around Vientiane City. Therefore, it is essential to implement the works from the sites of higher priority. The priority sites for bank protection are selected through screenings.

6.3.1 Selection of High Priority Stretches for Protection

Objective riverbanks from Thadeua to Wat Thampha (59.24 km in total) are evaluated through three stages of screening based on general bank condition, vulnerability to erosion, and social importance. The result is summarized in Figure 6.3. High Priority Stretches (L=8.77 km) are nominated for the Master Plan to be implemented by the year 2020 through a series of screening as shown in Table 6.3.

Table 6.3 Selection of High Priority Stretches for Protection

Unit: km

No	Site Name	Initial Screening (General Bank Condition)			Secondary Screening (Vulnerability to erosion)	Tertiary Screening (Social Importance)
		Cliffy bank	Existing work	Passed	Passed	Passed
1)	Ban Dongphosi - Sithantai	7.51	1.50	6.01	3.32	3.32
2)	Ban Hom	2.61	0.16	2.45	2.45	2.45
3)	B. Hatdokkeo - u/s Bo O	5.12	0.63	4.49	1.51	0.97
4)	Muang Wa -Kaoliao Port	3.94	0.86	3.08	2.03	2.03
	Total length	19.18	3.15	16.03	9.31	8.77

6.3.2 Arrangements for Implementation

For the implementation of the works by the year 2020, the nominated High Priority Stretches are divided into two project groups as shown in Table 6.4, i.e.,

- Urgent Projects (L=2.70 km) to be implemented immediately considering seriousness of erosion and possible damage under the present conditions, and
- Second Priority Projects (L=6.07 km) to be implemented after the completion of the Urgent Projects.

Table 6.4 Selection of Urgent and 2nd Priority Projects

Site Name	Location by KM post	High Priority Stretches nominated for M/P	Length (meter)	Priority	
				Urgent	2nd Priority
Sithantai	From 1553+0.85km To 1555+1.28km	Sithantai (1) Sithantai (2)	1,280 2,040	√	 √
Ban Hom	From 1563+1.15km To 1565+1.14km	Ban Hom (1) Ban Hom (2) Ban Hom (3) Ban Hom (4)	760 50 760 880	√ √	 √ √
Hatdokkeo	From 1571+0.97km To 1571+1.74km	Hatdokkeo	770		√
Bo O	From 1575+0.10km To 1575+0.21km	Bo O	200	√	
Sibounheuang - Muang Wa	From 1587+1.80km To 1589+0.28km	Sibounheuang - Muang Wa	410	√	
Upper Sibounheuang	From 1589+0.56km To 1591+0.00km excluding existing BP	Upper Sibounheuang (1) Upper Sibounheuang (2) Upper Sibounheuang (3) Upper Sibounheuang (4) Upper Sibounheuang (5)	810 190 350 40 230		√ √ √ √ √
Total			8,770	2,700	6,070

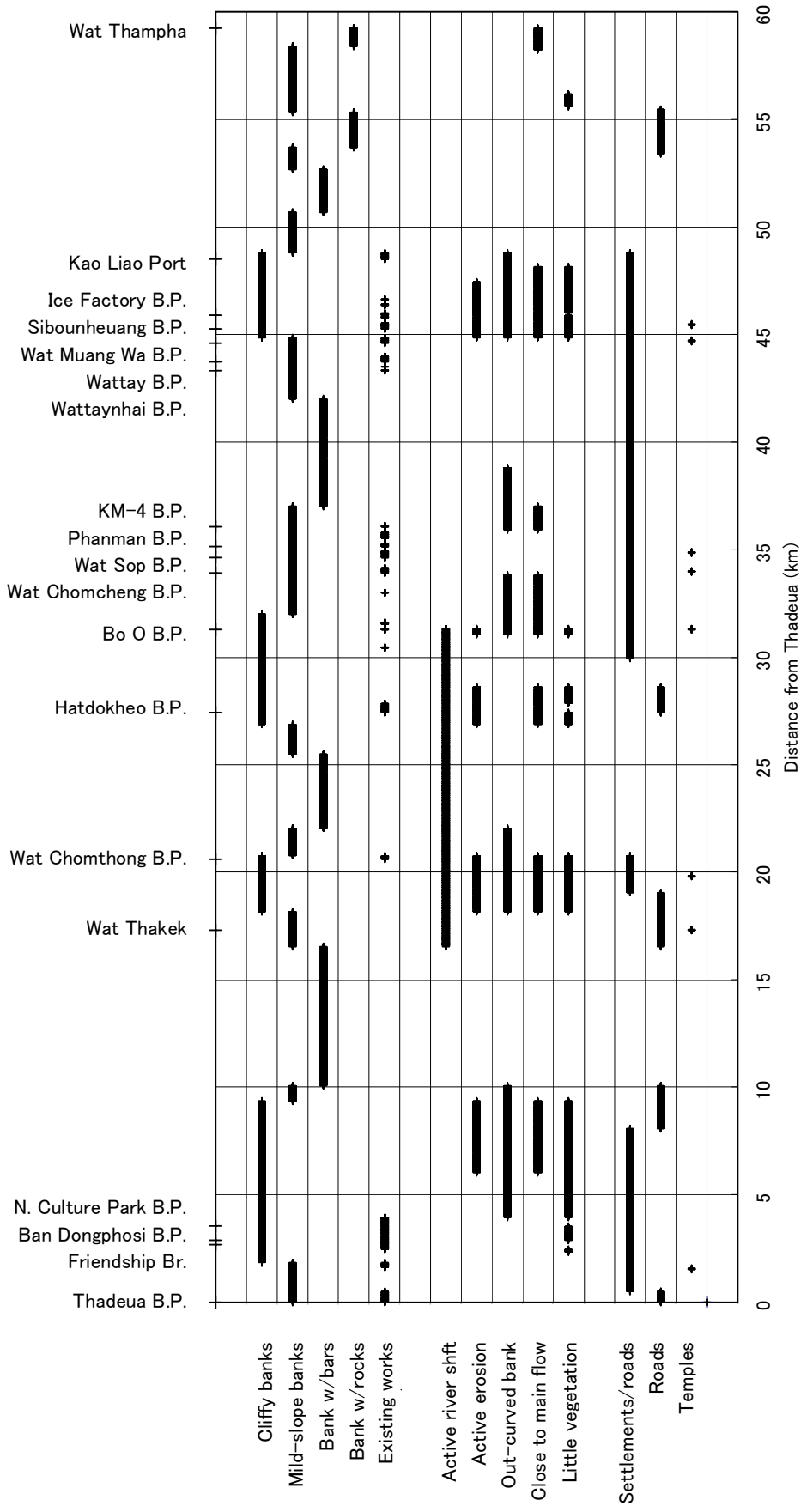


Figure 6.3 Summary of Riverbank Conditions

6.4 Preliminary Design of Bank Protection Facilities

Preliminary design of the riverbank protection facility is carried out for four (4) sites including the proposed Urgent Projects. The sites are 1) Sithantai, 2) Ban Hom, 3) Sibounheuang-Muang Wa and 4) Bo O sites.

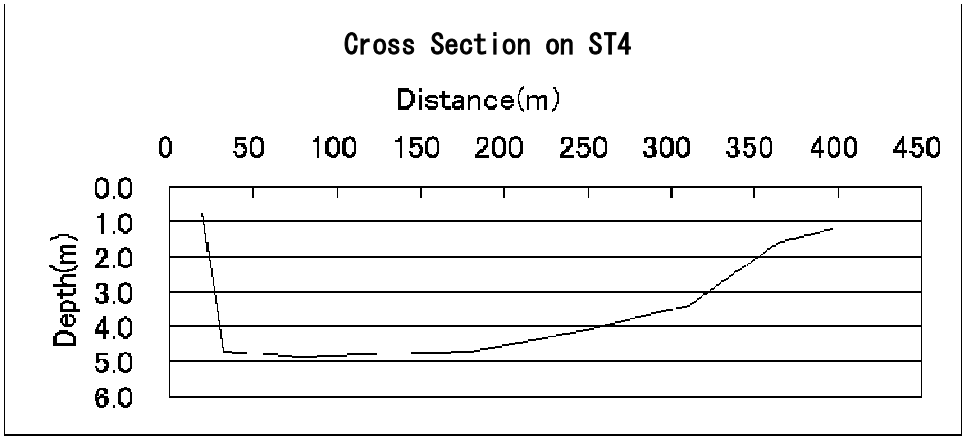
Out of 4 sites, design of Bo O site is to be prepared by Lao-Flanders River Works Project of MCTPC with the assistance of the Government of Belgium (hereinafter referred to as "GOB") and is incorporated into the Master Plan as it is.

6.4.1 Condition of Site

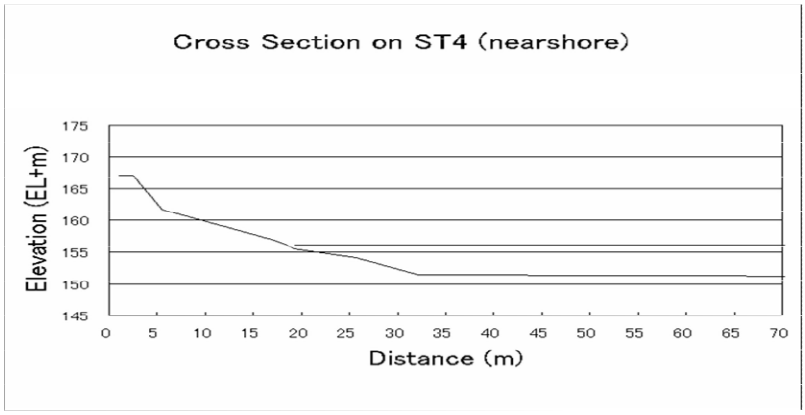
Condition of 3 sites is as shown in Figure 6.4 and summarized as shown in Table 6.5.

Table 6.5 Condition of Objective Sites for Preliminary Design

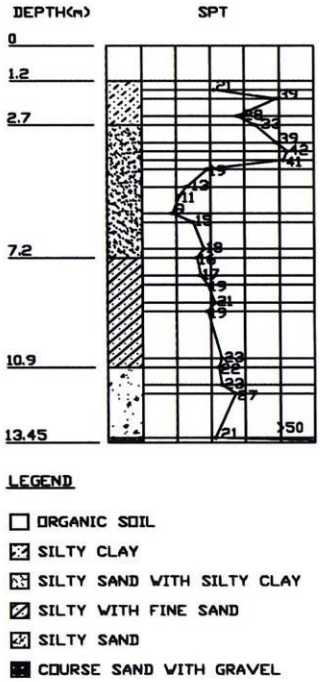
Item	Site Name		
	1) Sithantai	2) Ban Hom	3) Sibounheuang-Muang Wa
Total length	3,320m	2,450m	410m
Conditions of river bank slope	Upper vertical cliff and lower slopes of relatively new aged silt layer on the layer of gravel and silt mixture. Both are vulnerable to erosion	Vertical high cliff of relatively new aged silt layer on the layer of gravel and silt mixture. Both are vulnerable to erosion	Vertical cliff of relatively old aged silt layer on the layer of gravel and silt mixture. Lower layer is vulnerable to erosion
Type of erosion	Falling of cliff material accompanied with setback of lower layer of gravel and silt that is vulnerable to scoring during flood period.		Falling of cliff material as block undermined through lower layer of gravel and silt forming notches at the foot of slope during flood period.
Protection principle	To reduce erosion at lower gravel and silt mixture layer.	To protect not only lower gravel and silt mixture layer, but upper silt layer.	To protect the lower gravel and silt mixture layer



Typical River Cross Section (whole section)



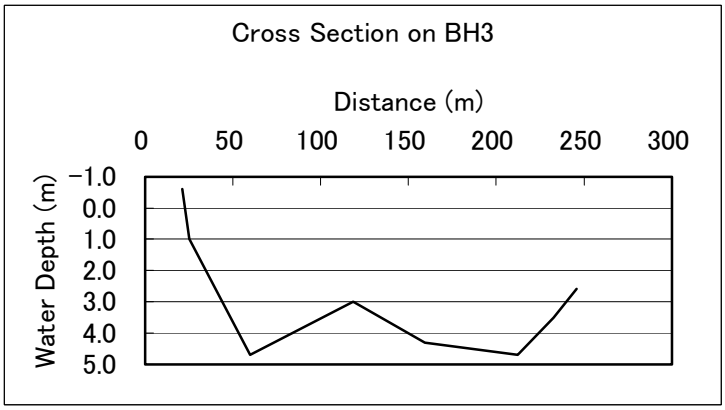
Typical River Cross Section (near left bank)



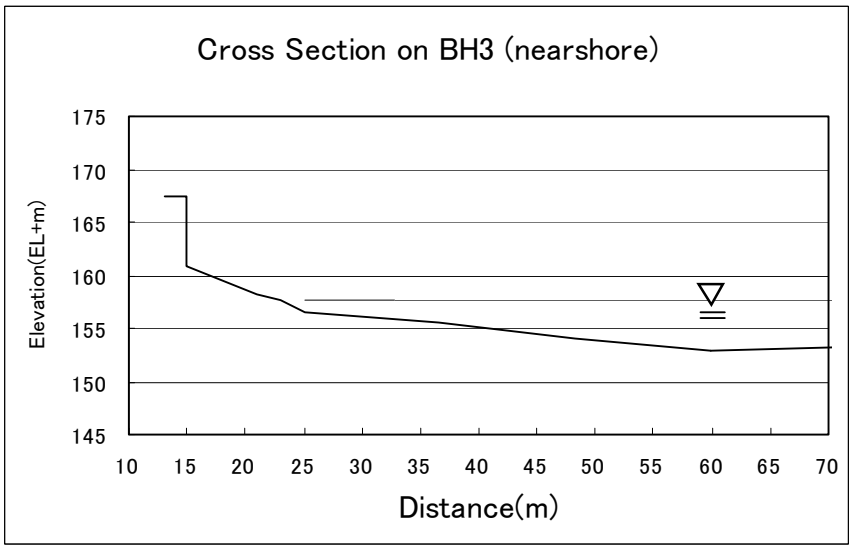
Boring Log

Typical Riverbank

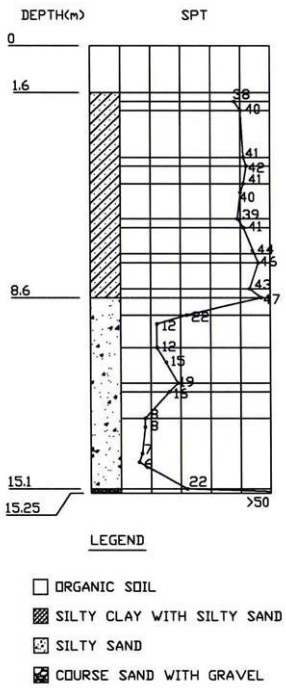
Figure 6.4 (1/3)
Condition of Objective Sites for Preliminary Design (Sithantai Site)



Typical River Cross Section (whole section)

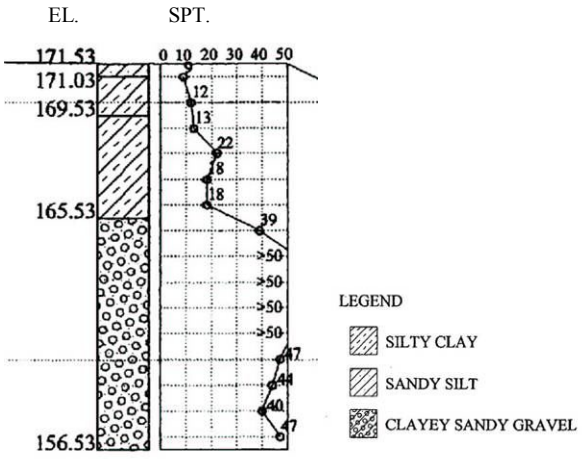


Typical River Cross Section (near left bank)

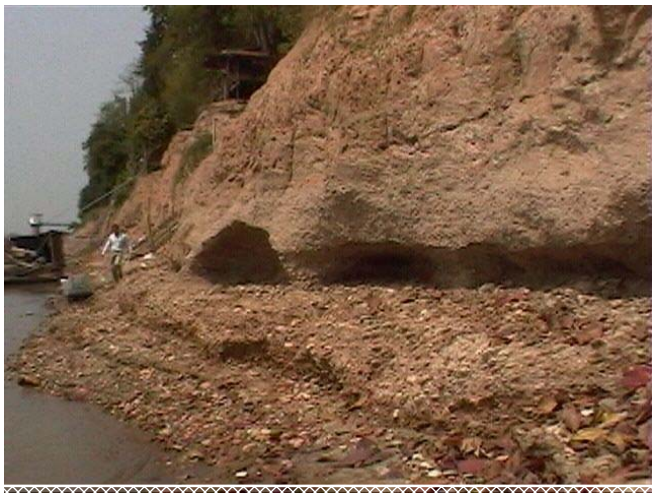


Typical Riverbank

Figure 6.4 (2/3)
Condition of Objective Sites for Preliminary Design (Ban Hom Site)



Boring Log



Notches Development at the foot of Riverbank Slope

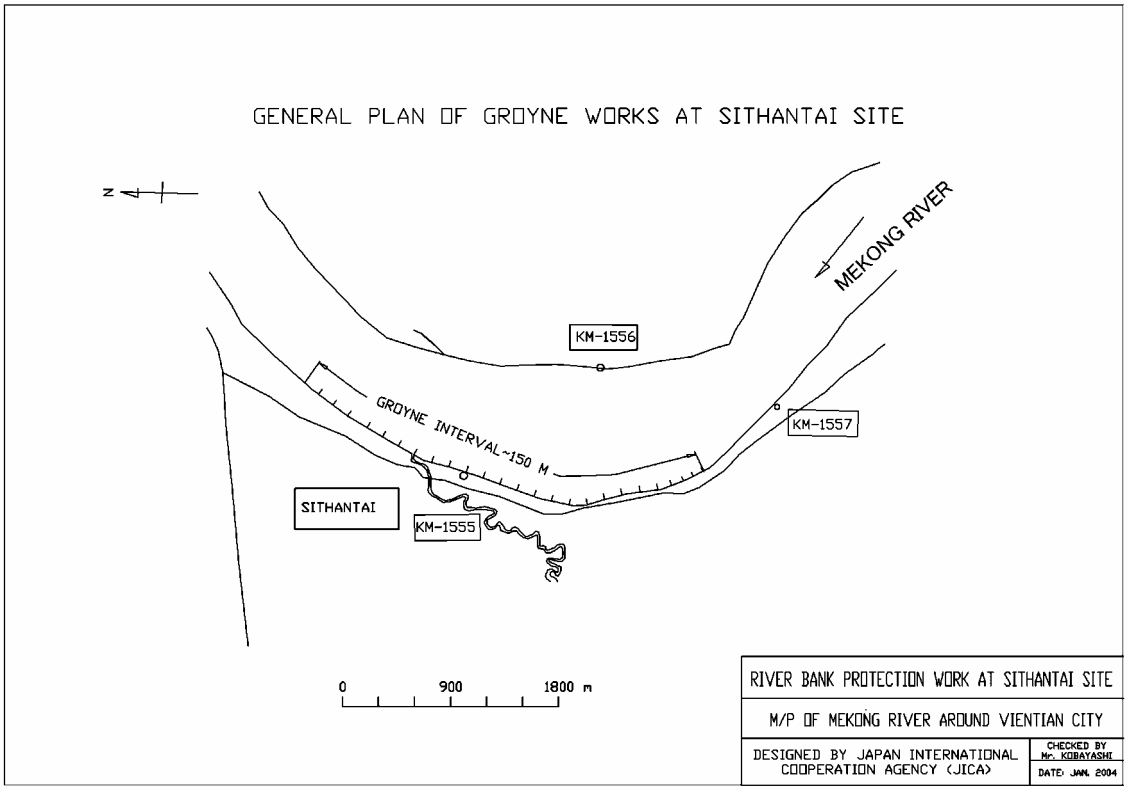
Figure 6.4 (3/3)
Condition of Objective Sites for Preliminary Design
(Sibounheuang - Muang Wa Site)

6.4.2 Preliminary Design

Outline of the design for 3 sites is as shown in Table 6.6. The general layout and typical cross section are as shown in Figure 6.5

Table 6.6 Outline of Preliminary Design

Site Name	Type of Construction Work
1) Sithantai	Riprap groyne work (L=50 m, Interval=150 m, Height=4.5m - 2.0 m)
2) Ban Hom	<Type A> (low dense riverine land use) 1) Slope protection work (Cobble stone with willow branch work covering lower half of the cliffy bank for cost reduction) 2) Foundation work (Riprap work) 3) Foot protection work (Soda mattress work "in every others" for cost reduction)
	<Type B> (in front of Wat Thong that) 1) Slope protection work (Cobble stone with willow branch work) 2) Foundation work (Riprap work) 3) Foot protection work (Soda mattress work)
3) Sibounheuang-Muang Wa	1) Slope protection work (Cobble stone with willow branch work) 2) Foot protection work (Log-hurdle work) 3) Foot protection work (Soda mattress work)



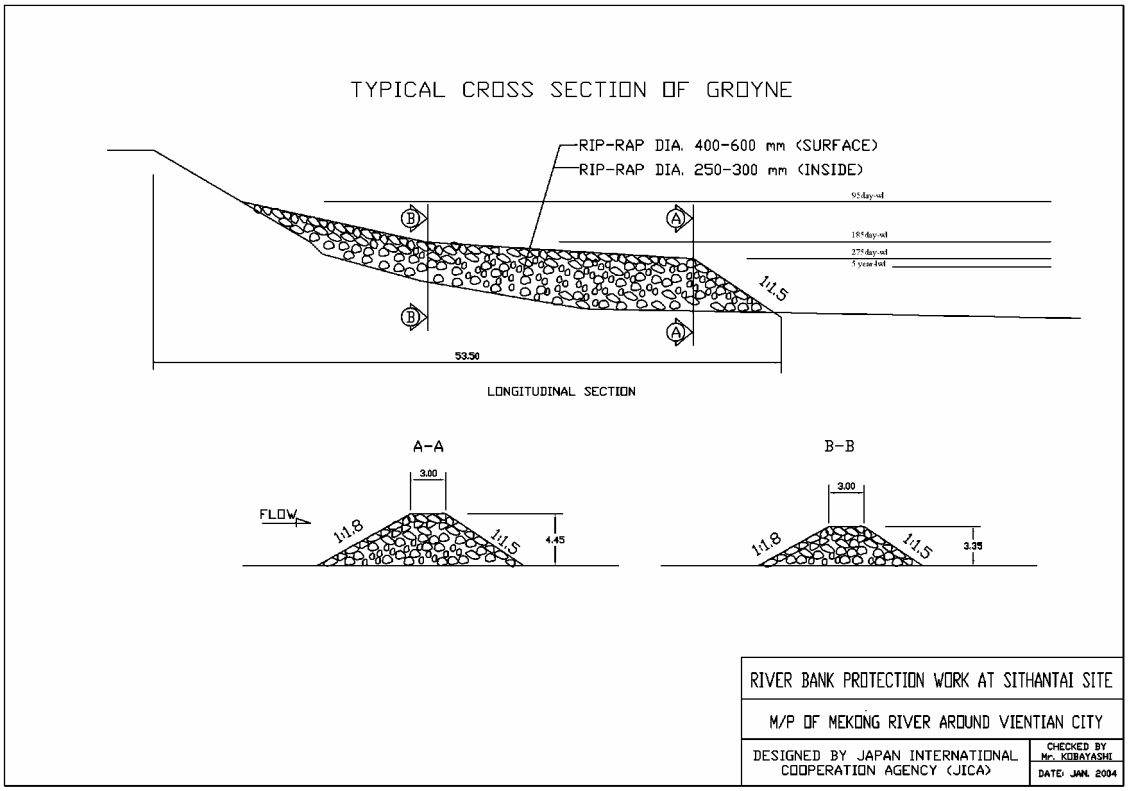


Figure 6.5 (1/5) Preliminary Design of Riverbank Protection Works (Sithantai Site)

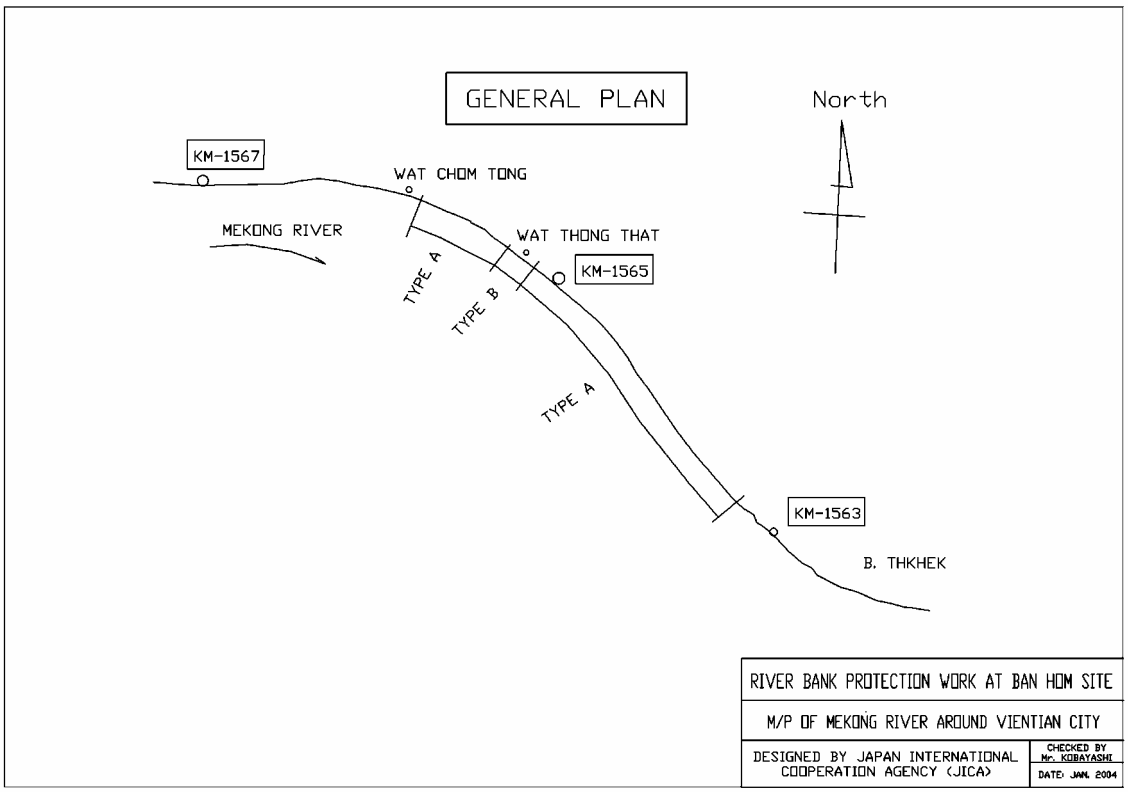
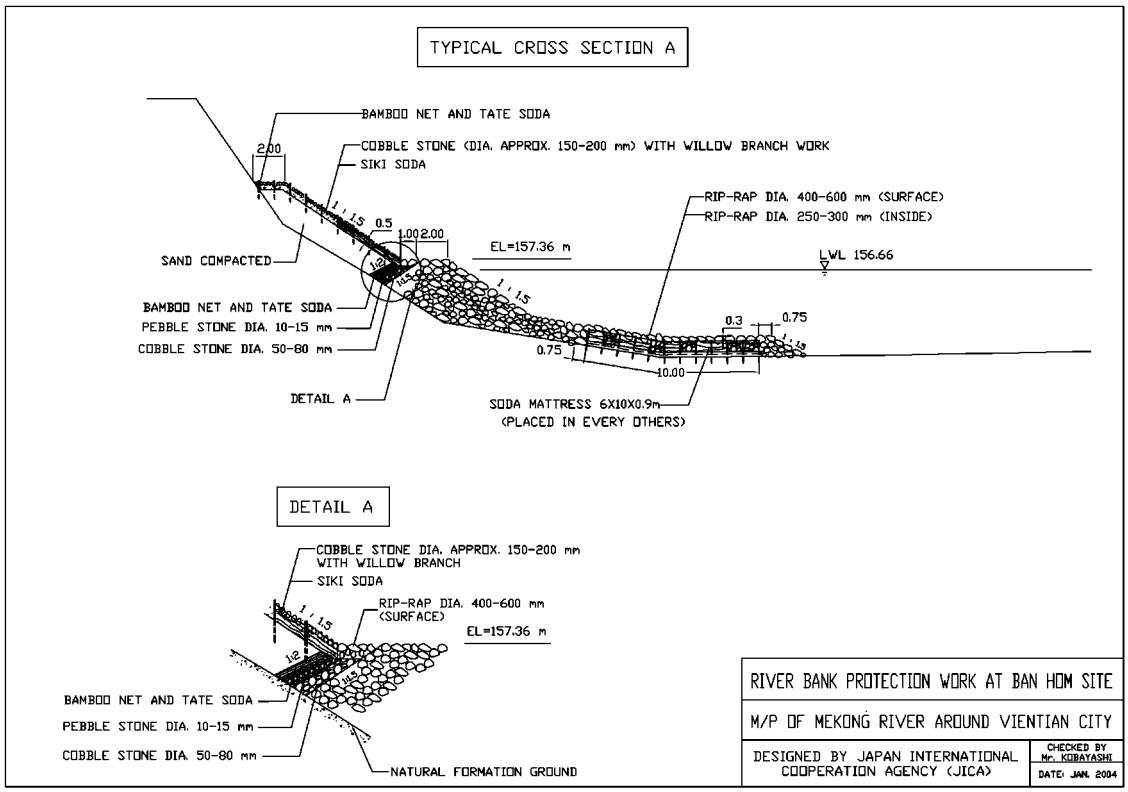
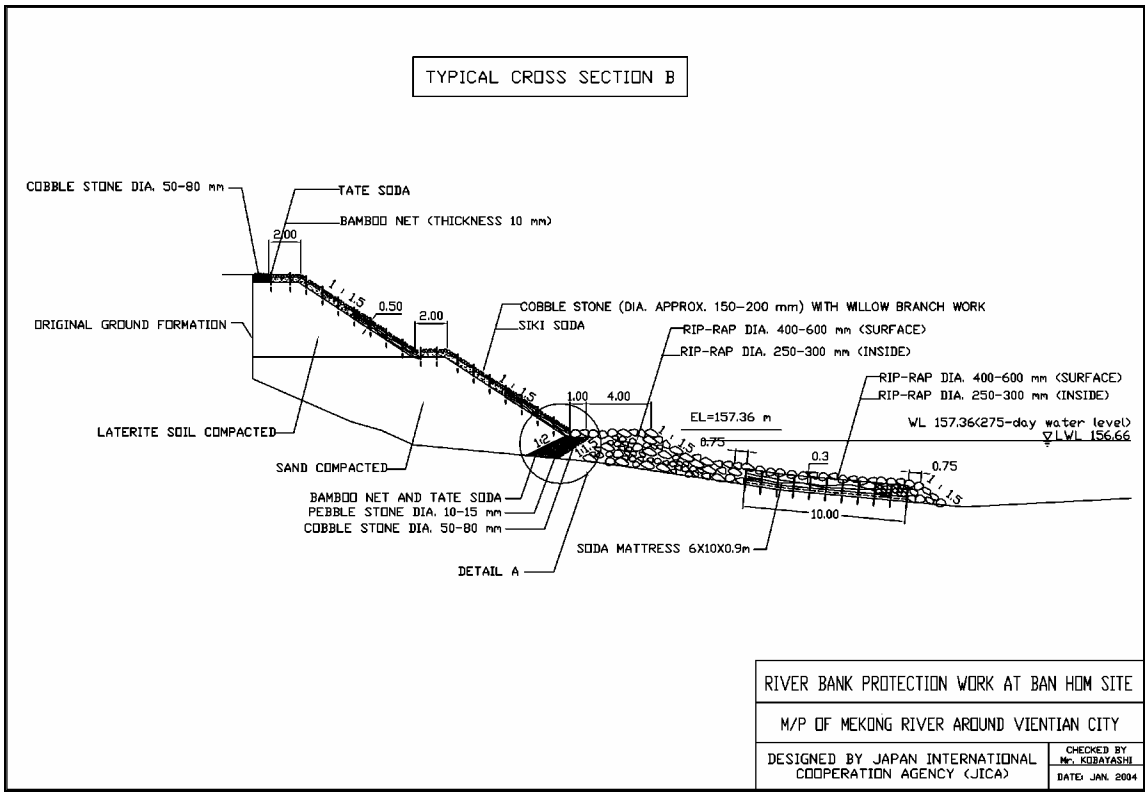


Figure 6.5 (2/5) Preliminary Design of Riverbank Protection Works (Ban Hom Site (1/2))

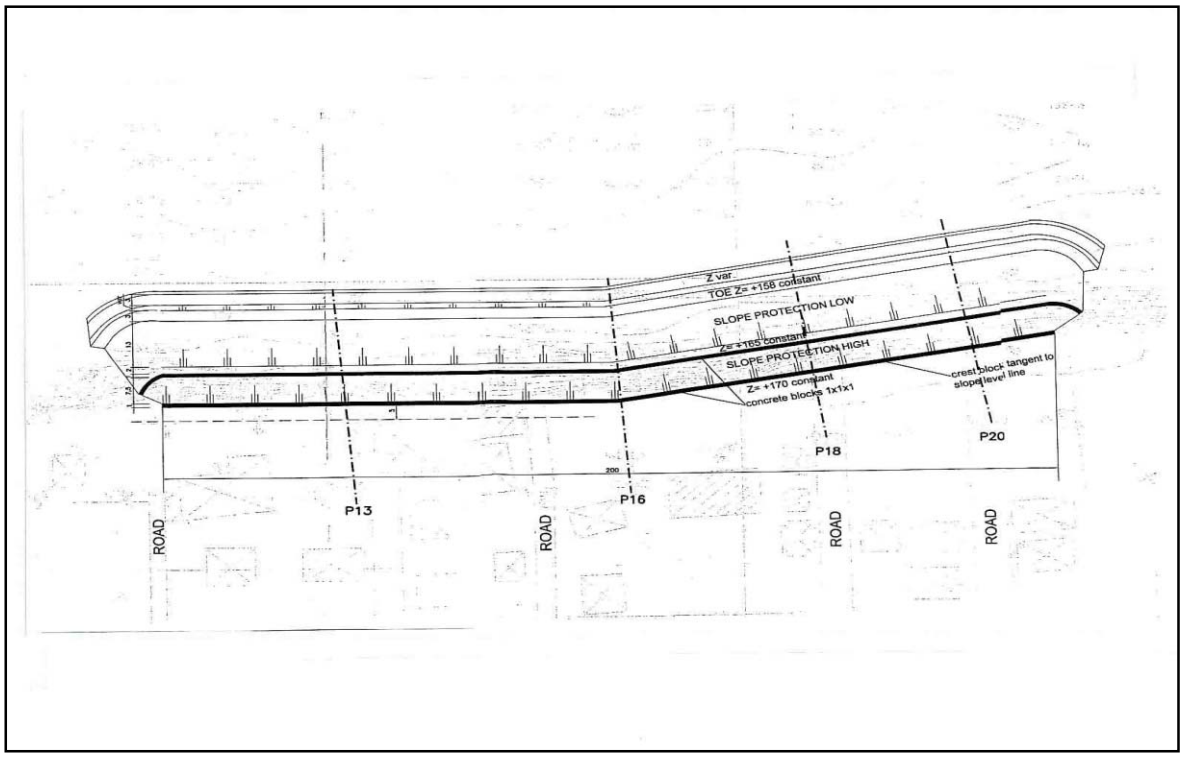


Cross-Section (Type A)

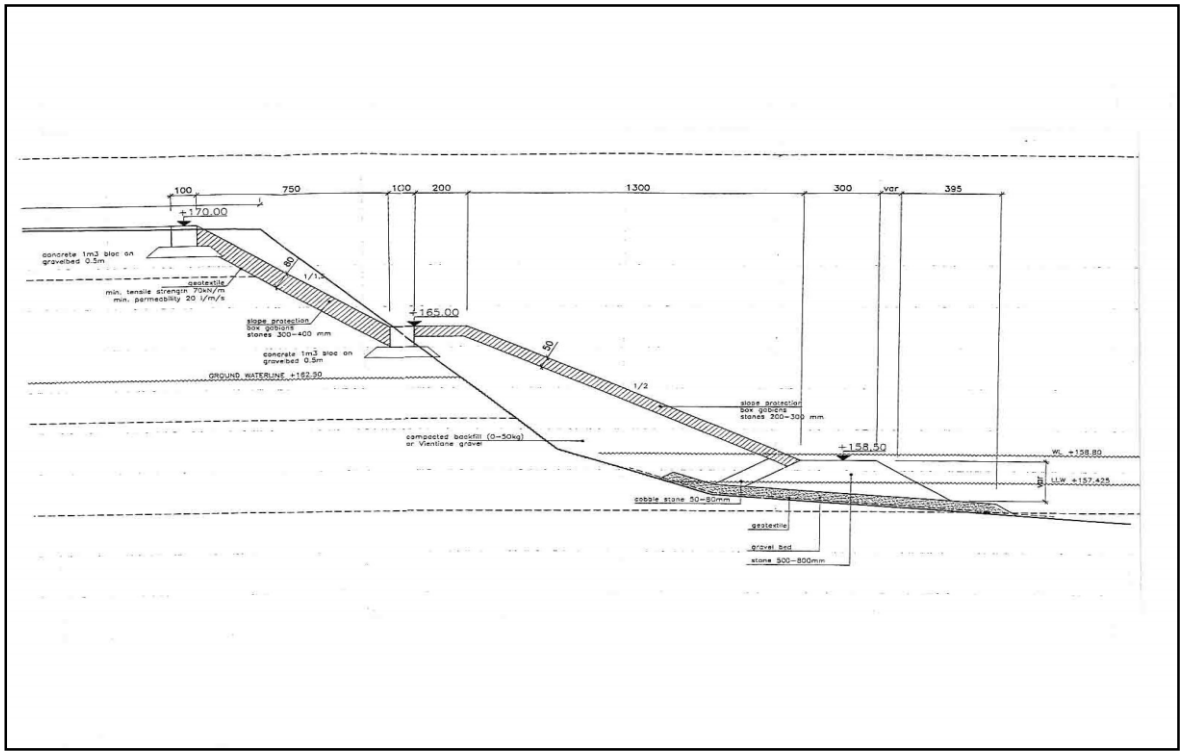


Cross-Section (Type B)

Figure 6.5 (3/5) Preliminary Design of Riverbank Protection Works (Ban Hom Site (2/2))



General Layout



Typical Cross Section

Figure 6.5 (4/5) Preliminary Design of Riverbank Protection Works (Bo O Site)

Note: These are the draft drawings prepared by "Lao-Flanders River Works Project" of MCTPC with the assistance of the GOB. Final design by the project will be incorporated into JICA Master Plan as it is.

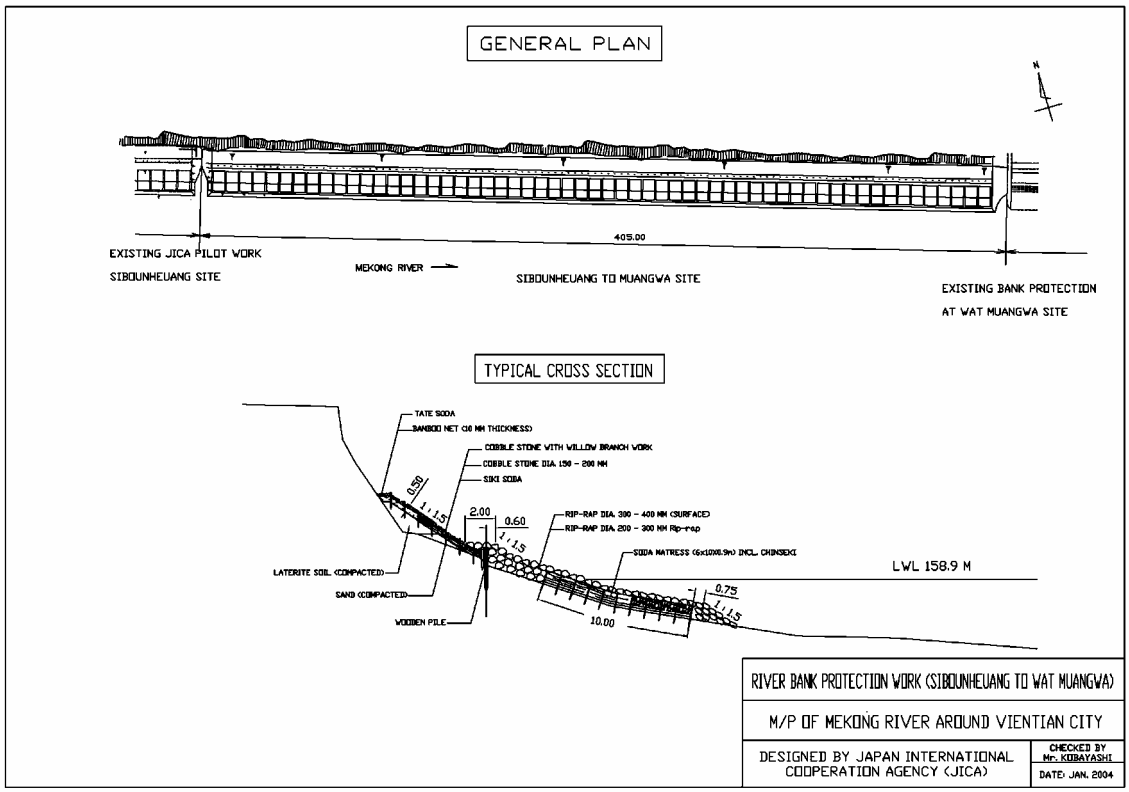


Figure 6.5 (5/5) Preliminary Design of Riverbank Protection Works (Sibounheuang - Muang Wa Site)

6.5 Institution and Organization

Key issues to implement sustainable bank protection project by GOL according to the Master Plan (2005-2020) is as follows; Out of above, items 1 - 3 are discussed here:

1. Set up of organization and institution
2. Human resources arrangement
3. Human recourses development
4. Budgetary allocation (based on national budget in principle)
5. Resident's participation

6.5.1 Set up of New Permanent Organization

No permanent organization name relating to bank protection can be seen in the organization chat of DOR, MCTPC (refer to Figure 6.6), DCTPC has permanent "Bank Protection Project" (refer to Figure 6.7), though. The Study office in MCTPC is temporarily one on a project basis and will be closed after 2005. "Mekong Riverbank Protection Unit (tentative name)" as new permanent organization for riverbank protection should be established in MCTPC:

- to realize sustainable implementation of the project proposed by the Master Plan, and
- as the preparation to receive possible future donor's technical assistance after year 2005 to assist the implementation.

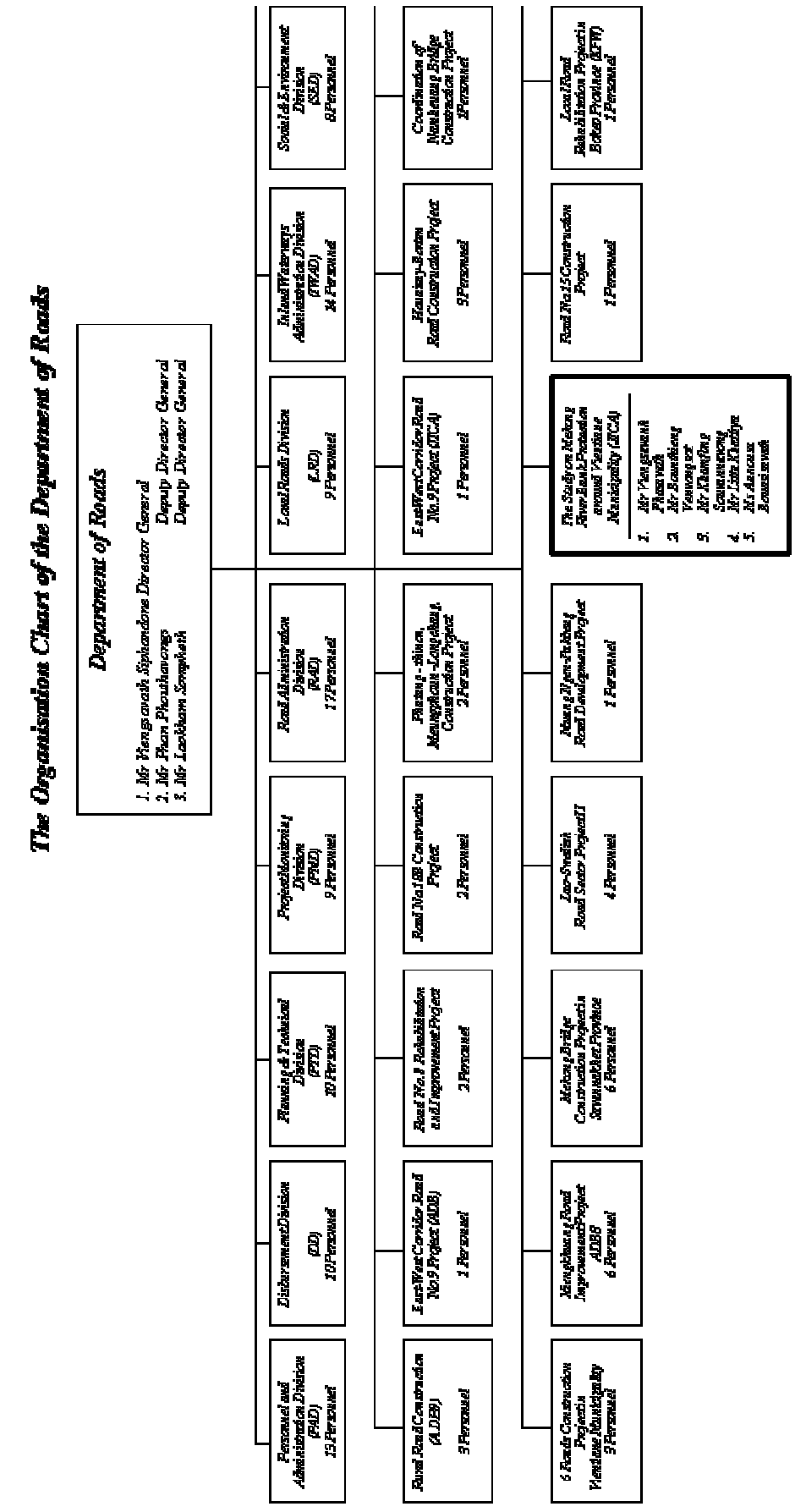


Figure 6.6 Organization Chart of DOR, MCTPC

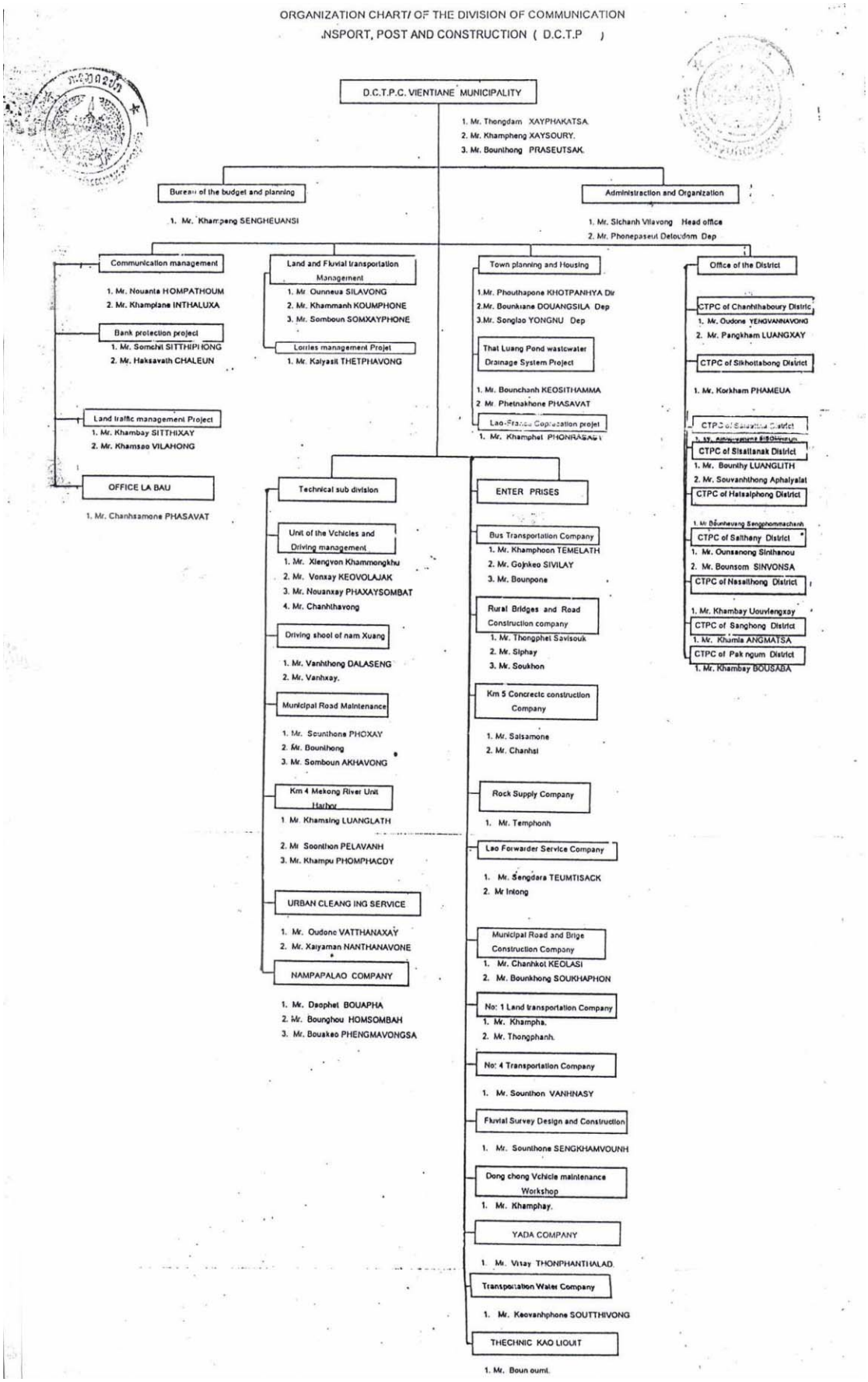


Figure 6.7 Organization Chart of DCTPC

6.5.2 Human Resources Arrangement

Proper human resources arrangement to the New Organization is one of the crucial preconditions for the success of sustainable implementation of the Master Plan projects.

Present MCTPC counterpart personnel for the Study shall be the core of the New Organization especially in the early stage of the implementation.

6.5.3 Human Resources Development

Continuous human resources development is also the essentials to transfer knowledge on river bank protection from one generation to the next in GOL.

The following activities will be necessary for the human resources development:
- Proper arrangement of new employees to the New Organization
- Practical training of the new employees
- Development of the teaching material for the training
- Various public education to disseminate the information on the importance of the river bank protection and for future recruitment as follows:
  - Receiving the trainee from various educational institutions
  - Making lectures and having seminar at various educational institutions and relating agencies by the New Organization staff and the experts of donors

6.6 Non-structural Measures

The Master Plan is composed not only of structural measures but also of non-structural measures described here.

6.6.1 Public Awareness Campaign

- Launching a campaign by GOL to educate the population of Vientiane City on the importance:
  - to protect riverbank from erosion, and
  - to create environmental friendly riparian zone by nature-oriented works.
- Public relations using media (newspaper/TV) should be continued and expanded.
- Prior to the construction of the Master Plan projects, GOL should ask representatives of local residents at each project site to understand the contents and importance of the works.

6.6.2 People's Involvement

- It is virtually impossible for GOL to protect throughout the Cliffy riverbanks (16.03 km) owing mainly budgetary limitation; length of Master Plan projects is 7.38 km in total.
- An approach "planting willow" is also essential by simple vegetation work only by manpower of local residents introducing Soda technique.
- GOL support and train local community leaders, provide guidance and information

6.6.3 Riparian Land Use Regulation

- in accordance with the principles proposed by revised "Vientiane Urban Development Master Plan" (URI-MCTPC, 2003) as follows:
  - Construction of new building & heavy weight facilities is not allowed in principle except for light weight public facilities.
  - Present resident can live as usual except for GOL require resettlement for bank protection works.
    - ✧ Target of JICA Master Plan = 0 resettlement
  - Temple and cultural assets should be preserved as it is.
- Riverbank area (L=20 km) along city center is categorized as riverside area in above plan.

6.6.4 Preservation and Planting of Riparian Trees

- The riparian trees should be preserved as much as possible
  - unless caused negative impact to riverbank stability
  - for example, trees hanging down from the edge of riverbank.
- Shade of trees can protects bank soil from drying and helps plant grows on the bank.
- Planting trees on riverbank is recommended.
- Future ideal image: attractive greenbelt for local residents & foreign tourist.

6.6.5 Monitoring and Maintenance System

- Early diagnosis is of great importance in riverbank protection.
- Regular visual inspection of natural riverbank and existing protection works in a dangerous condition
- Regular monitoring and maintenance of the Pilot Works by GOL after 2005
  - Period: 5 years after the completion in 2003, i.e. 2008, until the vegetation and sedimentation on the works is stabilized
  - The monitoring is essential:
    - ✧ to detect damaged portion and rehabilitate in earliest stage
    - ✧ to localize traditional river works of Japan to Lao P.D.R.
  - Wat Chom Cheng Site (real test work): inspection is continued without any rehabilitation work unless unforeseen erosion
- Monitoring cross-sectional survey on riverbed fluctuation
  - Objective: to reflect the result for the design of the projects by GOL
  - Location: Sithantai, Ban Hom and Sibounheuang - Muang Wa site
  - Program: 1time at each site (3-4 surveys during the rainy season)

6.7 Preliminary Estimation of Project Cost

Preliminary cost of the bank protection project nominated for the Master Plan is estimated preliminary.

6.7.1 Material and Equipment

- 1) Specification of materials (refer to Table 6.7), 2) procurement, 3) equipment: in accordance with these applied for the Pilot Works. (All material and equipment can be procured in Laos.)
- Unit cost (material, equipment rental, major work) for the cost estimate is in accordance with these utilized for the Pilot Works in 2003 in principle.

Table 6.7 Specification of Main Material for Protection Work

Item	Specification	Unit
Soda Mattress		
Soda	Length: 2.7m, 45cm rise peripheral: 60cm 200cm rise peripheral:55cm	bundle
Taisya	Length:2.7m, φ2～3cm at butt end φ1.0 cm at 2.7m rise, 25 twigs per bundle	bundle
Kogui (Short Pile)	Length: 1.2m,φ3～5cm at butt end	pieces
Rubble stones	φ400～200 mm, φ150～50 mm	m^3
Straw rope	φ10 mm	m
Zinc-coated whip	10# & 12#	m
Log Hurdle Work		
Wooden pile	Length:3 – 4.0 m, tip end:φ15 cm (primary pile) Length:3.5m, tip end:φ9cm (secondary pile)	piece
Bolt	L=30 cm, d=13 mm	unit
Nail	L=15 cm	kg
Back rubble stone	φ150～50 mm	m^3
Embankment Work		
River sand & Gravel	Procured from pit in the Mekong river	m^3
Laterite	Procured from borrow area	m^3
Foundation Riprap Work		
Rubble	φ200～150 mm (riprap), φ400～200 mm (deposition)	m^3
Bamboo net	B=2.5 m L=1.0 m	m^2
Slope Protection Work		
Soda	L=3.0 m, S=0.7 m	bundle
Taisya	L=3.0 m, 1 bundle =25 unit	bundle
Kogui (Short Pile)	L=1.2 m, φ=4 cm	unit
Willow	L=1.2 m, S=0.9 m (collected from the Mekong River)	bundle
Pebble	φ=150 – 200 mm	m^3
Piling (Groyne) Work		
Wooden pile	Length:4.0 – 6.0 m, tip end>φ15 cm	piece
Tie-beam	L=3.2 m, tip end>φ9cm	piece
Bolt	L=30 cm, d=13 mm	piece

6.7.2 Pleliminary Project Cost

Bank protection type and estimated project cost at 14 projects nominated for the Master Plan is as shown in Table 6.8.

Regarding Bo O project, the design is to be prepared by on-going Lao-Flanders River Works Project of MCTPC with the assistance of the GOB. Therefore, work type concept of the Master Plan is temporarily applied for the cost estimate instead.

Table 6.8 Project Cost for High Priority Stretches nominated for Master Plan

Phasing by Priority	Urgent Projects					Second Priority Projects								
Stretch No.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Project Name	Sithantai	Ban Hom		Bo O	Sibounheuang-Muang Wa	Sithantai	Ban Hom		Hatdokkeo	Upper Sibounheuang				
Project No.	(1)	(1)	(2)	Bo O	Sibounheuang-Muang Wa	(2)	(3)	(4)	Hatdokkeo	(1)	(2)	(3)	(4)	(5)
Stretch Length (meters)	1280	760	50	200	410	2040	760	880	770	810	190	350	40	230
Bank Protection Type														
CSWB-Work (A)		○		○	○		○	○		○	○	○	○	○
CSWB-Work (B)			○											
LH-Work				○	○					○	○	○	○	○
SF-Work		○	○				○	○						
SM-Work		○	○	○	○		○	○		○	○	○	○	○
RG-Work	○					○			○					
Unit: US$														
Construction Cost (A)	228,410	914,000	61,360	139,070	272,110	363,070	914,000	1,105,690	141,730	528,310	129,570	233,940	34,690	163,410
Administration Cost (B)	11,420	45,700	3,060	6,950	13,600	18,150	45,700	55,280	7,080	26,410	6,470	11,690	1,730	8,170
Project Cost (US$)	240,000	960,000	65,000	147,000	286,000	382,000	960,000	1,161,000	149,000	555,000	137,000	246,000	37,000	172,000

NOTE: CSWB-Work (A): Cobble Stone with Willow Branch Work, Type (A)
CSWB-Work (B): Cobble Stone with Willow Branch Work, Type (B)
LH Work: Log Hurdle Work
SF-Work: Stone Foundation Work
SM-Work: Soda Mattress Work
RG-Work: Riprap Groyne Work

6.8 Alternative Study

Alternative study is conducted here to find out sustainable and realistic Master Plan. The optimum plan is determined not only by technical viewpoint but also by financial viewpoint in consideration of the basic principles of the Master Plan that GOL will conducts riverbank protection activity after 2005 by using national budget in principle. Therefore, two (2) kinds of alternatives, i.e. 1) Work Type Alternatives and 2) Financial Alternatives are examined here.

6.8.1 Work Type Alternatives

Work type is selected considering the following criteria; some of Japanese traditional river works satisfied the criteria. Type selection of bank protection work at each objective site is as shown in Table 6.9

- using local construction material/ manpower as much as possible
- construction can be done by the manpower of Laotian as much as possible
- pay attention to keep and/or create better riparian environment
- without using imported materials; gabion mattress and concrete block are excluded from the selection

Table 6.9 Type Selection of Bank Protection Work

Item	Location		
	Sithantai Site	Bon Hom Site	Sibounheuang-Muang Wa Site
Length of riverbank protection work	3,320m	2,450m	410m
Conditions of river bank slope	Upper vertical cliff and lower slopes of relatively new aged silt layer on the layer of gravel and silt mixture. Both layers are vulnerable to erosion	Vertical high cliff of relatively new aged silt layer on the layer of gravel and silt mixture. Both layers are vulnerable to erosion	Vertical cliff of relatively old aged silt layer on the layer of gravel and silt mixture. Lower layer is vulnerable to erosion
Type of erosion	Falling of cliff material accompanied with set-back of lower layer of gravel and silt that is vulnerable to scoring during flood period.	Falling of cliff material accompanied with set-back of lower layer of gravel and silt that is vulnerable to scoring during flood period.	Falling of cliff material as block undermined through lower layer of gravel and silt forming notches at the foot of slope during flood period.
Conditions of river bank slope	To reduce erosion at lower gravel and silt mixture layer.	To protect not only lower gravel and silt mixture layer, but upper silt layer.	To protect the lower gravel and silt mixture layer
Major bank protection work type	Groyne work / foot protection and slope protection work	Foot protection and slope protection work	Foot protection work and lower part of slope protection
Candidate type of Slope protection works	1)Cobble Stone with Willow Branch Work, Rip-rap foundation and SODA Mattress Work	1)Cobble Stone with Willow Branch Work, Rip-rap foundation and SODA Mattress Work	1)Cobble Stone with Willow Branch Work, Rip-rap foundation and SODA Mattress Work
	2) Wooden Pile Groyne work	2)Cobble Stone with Willow Branch Work, Log-Hurdle Work and SODA Mattress Work	2)Cobble Stone with Willow Branch Work, Log-Hurdle Work and SODA Mattress Work
	3) Rip-rap groyne work	3) Rip-rap groyne work	3) Rip-rap groyne work

"Priority 1" in the following Table 6.10 is selected as the most suitable work type for each sites by comparing candidate types with respect to various factors such as strength, easiness of material collection, construction cost, etc. The preliminary design of each objective site is conducted according to this result.

Table 6.10 Evaluation of Work Type Alternatives

Site Name	Candidate Type of Construction Work	Priority
Sithantai	Cobble stone with willow branch work + Riprap foundation + Soda mattress work	2
	Wooden pile groyne work	3
	Riprap groyne work (main river flow is shifted away from the riverbank with low cost at low dense riverine land use)	1
Ban Hom	Cobble stone with willow branch work + Log-hurdle work + Soda mattress work	3
	Cobble stone with willow branch work + Riprap foundation + Soda mattress work (less impact to the opposite bank , Don Tam island, comparing with groyne type)	1
	Riprap groyne work	2
Sibounheuang -Muang Wa	Cobble stone with willow branch work + Log-hurdle work + Soda mattress work (similar work type with that the adjacent JICA Pilot Work)	1
	Cobble stone with willow branch work + Riprap foundation + Soda mattress work	2
	Riprap groyne work	3

6.8.2 Financial Alternatives

Financial affordability is a crucial precondition for successful implementation of the Master Plan. In order to formulate sustainable Master Plan, the Study Team conducted financial alternative study by preparing five financial alternatives as shown in Table 6.11. As a result of discussion with MCTPC on the alternatives, "Alternative 3" (total project cost=US$4.89 million, L=7.38 km) in the table has been selected as the most appropriate plan from the financial viewpoints.

The remaining 4 Second Priority Projects, Hatdokkeo and Upper Sibounheuang (3), (4) & (5) are to be implemented after Fiscal Year 2020/2021.

Table 6.11 Alternative Budgeting Plans

	Unit	Alternative 1	Alternative 2	**Alternative 3**	Alternative 4	Alternative 5
1.Base Year Budget (FY2003/04)	M Kip	2,800 Calculated budget to complete all the priority stretches by 2020	2,300 MCTPC's investment plan for riverbank protection around Vientiane City in FY2003/04.	2,300 MCTPC's investment plan for riverbank protection around Vientiane City in FY2003/04.	2,300 MCTPC's investment plan for riverbank protection around Vientiane City in FY2003/04.	1,000 Actual average investment by national budget for ban protection around Vientiane City for last 4 years.
2. Budget in the 1st Year of the M/P (FY2004/05)	M Kip	3,000 7% increase from FY2003/04	2,450 6.5% increase from FY2003/04 based on NPEP	2,445 6.3% increase from FY2003/04	2,392 4% increase from FY2003/04	1,063 6.3% increase from FY2003/04
3. Growth rate of budget from FY2004/05 to FY2019/20	%	7 Economic development target of the country for 2020 stated in National Poverty Eradication Programme (NPEP)	7	6.3 Average annual economic growth rate for the last 10 years	4 The lowest annual economic growth rate for the last 10 years	6.3 Average annual economic growth rate for the last 10 years
4. Project Cost	US$1,000	5,497	5,176	**4,893**	3,634	1,698
5. Length of BP	km	8.77	7.77	**7.38**	5.95	2.70
1) Urgent project	km	2.70	2.70	**2.70**	2.70	2.70
2) 2nd priority proj.	km	6.07	5.07	**4.68**	3.25	0.00

The annual investment and cumulative length of riverbank protection of above-mentioned Alternative 3 is illustrated in Figure 6.8 and summarized in Table 6.12.

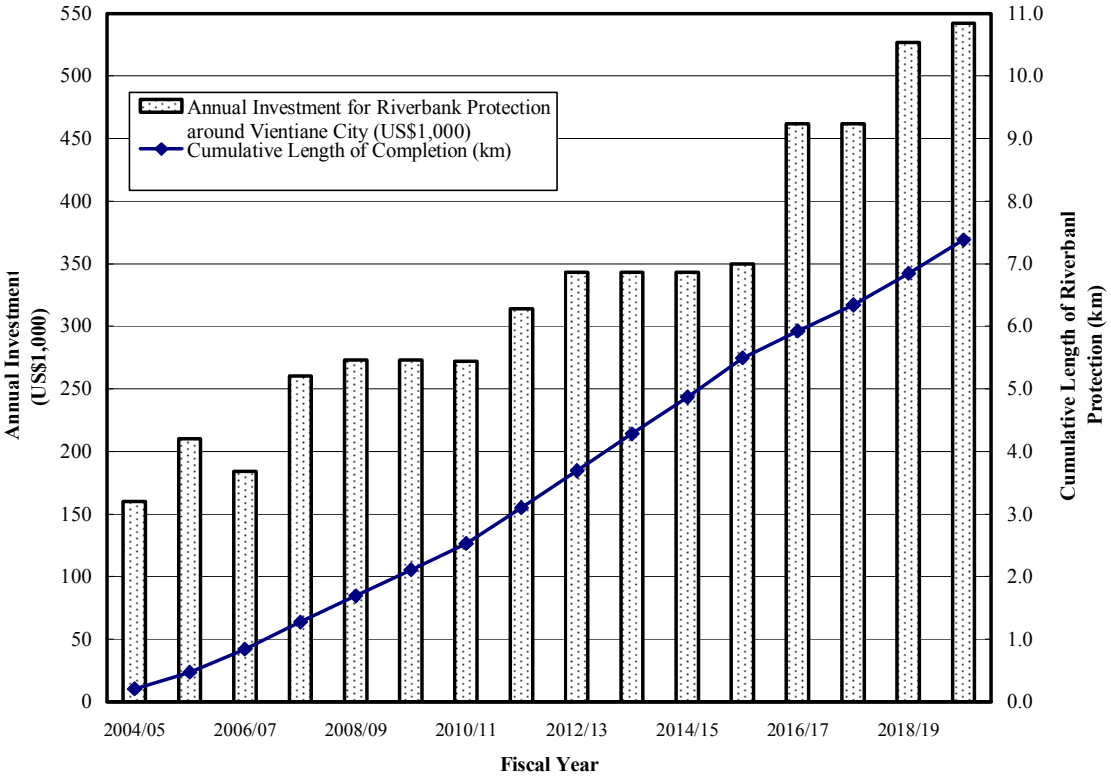


Figure 6.8 Annual Investment and Cumulative Length of Riverbank Protection
(Alternative 3)

Table 6.12 Investment and Budgeting Plan for River Bank Protection

Alternative 3: Moderate Budget with 6.3% growth, projects within budget

Project	Total Cost (US$1,000)	Length (m)	Annual Investment (US$1,000) 2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20
I. Investment Plan																		
1. Urgent Projects																		
(1) Sithantai (1)	240	1,280	-	-	47	47	49	49	48	-	-	-	-	-	-	-	-	-
(2) Ban Hom (1)	960	760	-	-	-	139	202	202	202	215	-	-	-	-	-	-	-	-
(3) Ban Hom (2)	65	50	-	-	65	-	-	-	-	-	-	-	-	-	-	-	-	-
(4) Bo O	147	200	-	44	51	52	-	-	-	-	-	-	-	-	-	-	-	-
(5) Sibounheuang-Muang Wa	286	410	140	146	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sub-total of 1	1,698	2,700	140	190	163	238	251	251	250	215	-	-	-	-	-	-	-	-
2. Second Priority Projects																		
(6) Sithantai (2)	382	2,040	-	-	-	-	-	-	-	75	75	75	75	82	-	-	-	-
(7) Ban Hom (3)	960	760	-	-	-	-	-	-	-	-	240	240	240	240	-	-	-	-
(8) Ban Hom (4)	1,161	880	-	-	-	-	-	-	-	-	-	-	-	-	290	290	290	291
(9) Hatdokkeo			To be implemented after FY2020/21				-	-	-	-	-	-	-	-	-	-	-	-
(10) Upper Sibounheuang (1)	555	810	-	-	-	-	-	-	-	-	-	-	-	-	137	137	137	144
(11) Upper Sibounheuang (2)	137	190	-	-	-	-	-	-	-	-	-	-	-	-	-	-	65	72
(12) Upper Sibounheuang (3)			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(13) Upper Sibounheuang (4)			To be implemented after FY2020/21				-	-	-	-	-	-	-	-	-	-	-	-
(14) Upper Sibounheuang (5)			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sub-total of 2	3,195	4,680	-	-	-	-	-	-	-	75	315	315	315	322	427	427	492	507
Sub-total (1+2)	4,893	7,380	140	190	163	238	251	251	250	290	315	315	315	322	427	427	492	507
3. Maintenance & repair			20	20	21	22	22	22	22	24	28	28	28	28	35	35	35	35
Total (1+2+3)			160	210	184	260	273	273	272	314	343	343	343	350	462	462	527	542
II. Budgeting Plan (Million Kip)			2,445	2,599	2,763	2,937	3,122	3,319	3,528	3,750	3,986	4,237	4,504	4,788	5,090	5,411	5,752	6,114
(Equiv. US$1,000)			235	249	265	282	300	319	339	360	383	407	432	460	488	519	552	587
Balance by Fiscal Year (US$1,000)			75	39	81	22	27	46	67	46	40	64	89	110	26	57	25	45

Basic Condition of Estimation:

1) Each project is implemented by one contract even the project is implemented over several years.
2) Increase of work volume due to progress of riverbank erosion is assumed to be covered by physical contingency.
3) The budget for riverbank protection around Vientiane City in FY2004/05 is estimated by 6.3% increase from 2,300 million Kip, investment plan of MCTPC for riverbank protection in Vientiane City for FY2003/04.
4) The budget for riverbank protection around Vientiane City is assumed to increase 6.3% per annum in accordance with the average economic growth rate for the last 10 years.
5) Price escalation are not included in neither investment plan nor budgeting plan.
6) Applied foreign exchange rate: US$1 = 10,420 Kip (February 1, 2004).
7) As maintenance and repairing cost, 0.5% per annum of the project cost is assumed after completion of the facilities.
8) As maintenance and repairing cost of the existing riverbank protection facilities, US$20,000 per annum is assumed.
9) The proposed annual budget plans still have some balance even after implementation of the proposed projects so that unexpected urgent projects can be implemented.

6.9 Proposed Master Plan

The optimum Riverbank Protection Master Plan around Vientiane City is proposed here as the result of the 1) Work Type (technical) and 2) Financial alternative study. The Master Plan is to be implemented by GOL by themselves using national budget in principle after the year 2005. The financial issues are the key determinant of the scale of the Master Plan rather than technical ones. Consequently, the financial Alternative 3 is selected as the most appropriate, sustainable and practical plan.

The outline of the Master Plan is as follows:

- Total Project cost (national budget in principle): US$4.89 million (Alternative 3)
- Total length of 10 Master Plan projects: 7.38 km
  - Five (5) Urgent Projects: 2.70 km
  - Five (5) Second Priority Projects: 4.68 km
- Implementation Schedule: 16-year (2005-2020)

General layout of the proposed Master Plan is as shown in Figure 6.9 and the basic features are as shown in Table 6.13. The principles of protection measures by riverbank type in the Study Area are summarized as shown in Table 6.14.

Table 6.13 Basic Features of Riverbank Protection Master Plan

Phase	Site Name	Project Name	Location by KM post (km)		Length	Project Cost	Implementation	Riverbank Protection Type					
			From	To	(meter)	(US$1,000)	Fiscal Year	CSWB(A)	CSWB(B)	LH	SF	SM	RG
Urgent Projects	Sithantai	Sithantai (1)	1555+0.00	1555+1.28	1,280	240	2006/07-2010/11						○
	Ban Hom	Ban Hom (1)	1565+0.38	1565+1.14	760	960	2007/08-2011/12	○			○	○	
		Ban Hom (2)	1565+0.33	1565+0.38	50	65	2006/07		○		○	○	
	Bo O	Bo O	1575+0.01	1575+0.21	200	147	2005/06-2007/08	○		○		○	
	Sibounheuang - Muang Wa	Sibounheuang - Muang Wa	1587+1.80	1589+0.28	410	286	2004/05-2005/06	○		○		○	
	Sub-total				2,700	1,698							
2nd Priority Projects	Sithantai	Sithantai (2)	1553+0.85	1555+0.00	2,040	382	2011/12-2015/16						○
	Ban Hom	Ban Hom (3)	1563+2.03	1565+0.33	760	960	2012/13-2015/16	○			○	○	
		Ban Hom (4)	1563+1.15	1563+2.03	880	1161	2016/17-2019/20	○			○	○	
	Upper Sibounheuang	Upper Sibounheuang (1)	1590+0.25	1591+0.00	810	555	2016/17-2019/20	○		○		○	
		Upper Sibounheuang (2)	1590+0.02	1590+0.21	190	137	2018/19-2019/20	○		○		○	
	Sub-total				4,680	3,195							
	Total				7,380	4,893							

Note:- Project cost is estimated on the price level at the beginning of February 2004.
- Applied foreign currency exchange rate: US$1=Lao Kip 10,420 (Middle rate on February 1, 2004)
- Project cost does not include price escalation.
- Riverbank Protection Types:

CSWB(A)	Cobble Stone with Willow Branch covering lower bank (A)	SF	Stone Foundation
CSWB(B)	Cobble Stone with Willow Branch covering whole bank (B)	SM	Soda Mattress
LH	Log Hurdle	RG	Riprap Groyne
SF	Stone Foundation		
SM	Soda Mattress		
RG	Riprap Groyne		

-Bo o site: Design to be prepared by On-going Lao-Flanders River Work Projects of MCTPC in future. Therefore, work type concept of the Master Plan is temporarily applied for the preliminariliy cost estimate at the site instead.

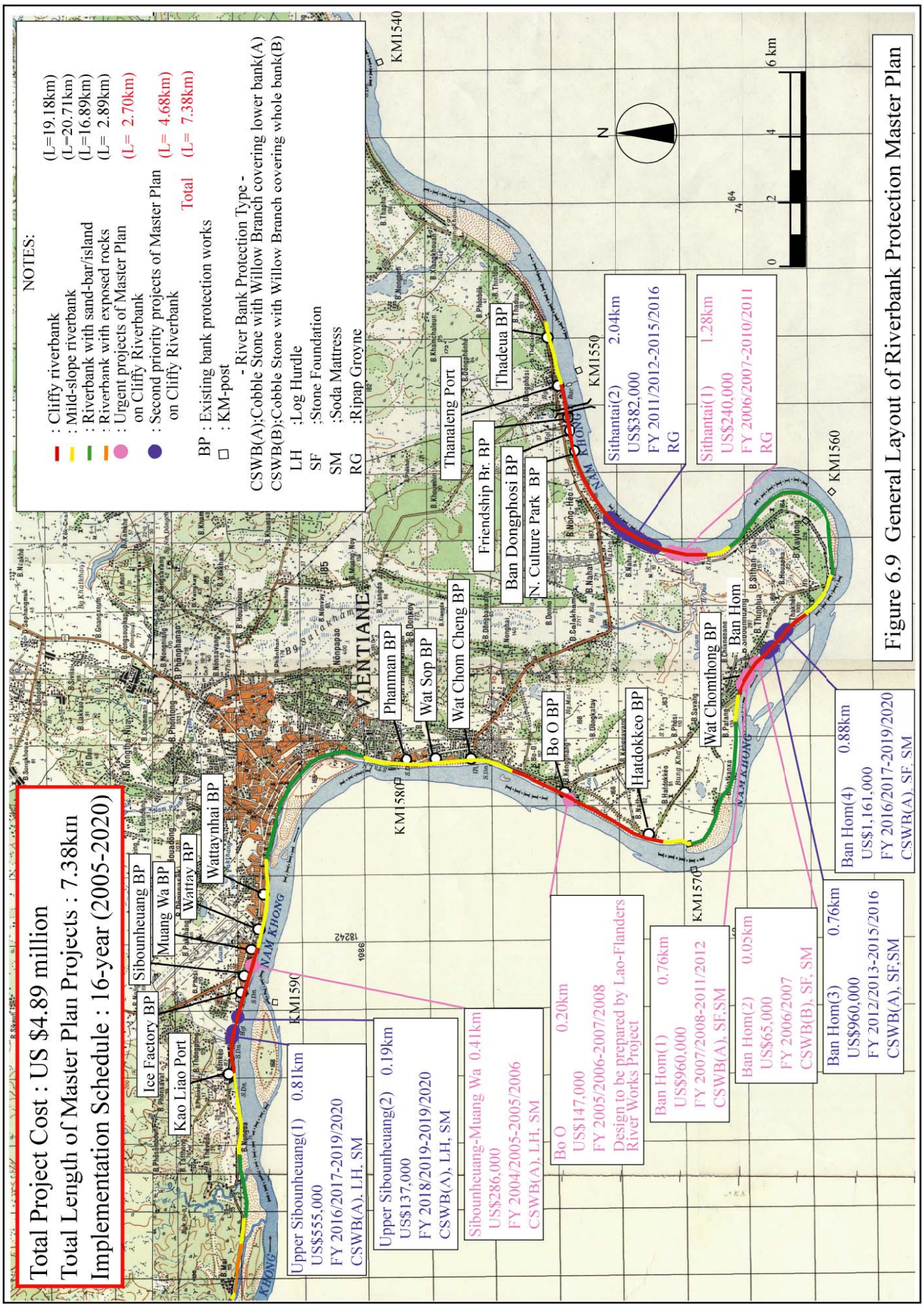


Figure 6.9 General Layout of Riverbank Protection Master Plan

Table 6.14 Basic Principles of Protection Measures of Master Plan

Type of Riverbank	Classification of Cliffy riverbanks	Length (km)	Principles of Bank Protection Measures
1)Cliffy Riverbanks	Existing riverbank protection works	3.15 (5.3%)	This stretches is to be monitored and rehabilitated if necessary by GOL (O&M).
	Objective stretches for Urgent Projects	2.70 (4.6%)	*This stretches is to be implemented by GOL from 2004/2005 to 2011/2012.
	Objective stretches for Second Priority Projects	4.68 (7.9%)	*This stretches is to be implemented by GOL from 2011/2012 to 2019/2020. *This stretches would also be protected by people's involvement as the need arises until the start of the Projects by GOL at each sites.
	Remaining Stretches including 4 Second Priority Projects to be implemented after 2020/2021	8.65 (14.6%)	*This stretches is to be protected by GOL after 2020/2021 *This stretches would be protected by people's involvement as the need arises.
Sub-total	19.18 (32.4%)		
2)Mild-slope riverbanks	20.71 (35.0%)		This stretches with no active erosion in general would be protected by people's involvement as the need arises.
3) Riverbanks with sand bar and island	16.89 (28.5%)		These stretches would not require specific bank protection activities.
4) Riverbanks with exposed rocks	2.46 (4.2%)		
Total	59.24(100%)		

As a selection guideline of the M/P construction method, the combination of construction methods and its reason for application in consideration of mechanism of bank erosion and situation of the property distributed on eroded riverbanks is shown in the following table 6.15

Table 6.15 Combination of construction methods and its reason for application

Property and land use situation on cliffy bank	Typical M/P project sites	Mechanism of bank erosion	Construction method combination and the reason for application			Note
			Foot protection work	Foundation work	Slope protection work	
High density of properties (important property, such as factory, national road, temple and public facilities)	-Wat Thong That (Ban Hom) -Bo O temple	Falling of cliff material accompanied with setback of lower layer of gravel and silt that is vulnerable to scoring during flood period	Soda mattress work<SM> [Reason] -Executable by using only local material and equipment -Mattress are so flexible, that they can change the form and follow the riverbed changes -Environmental friendly by using natural material	Riprap work <SF> [Reason] To protect foot of slope firmly united with foot protection work	Cobblestone with willow branch work <CSWB(B)> (covering whole bank to secure high safety level taking the importance of property into consideration) [Reason] -Executable by using only local material and equipment -Adaptable to gentle slope river as the M/P area -Environmental friendly by using natural material	-Applied for the Pilot Woks for oil stockyard at Ban Dongphosi -Design at Bo O temple was already prepared using conventional gabion with the assistance of the Government of Belgium
Middle density of properties (Although private houses in urban area is distributed, there are relatively little important properties)	-Bo O -Sibounheuang ~Muang Wa -Upper Sibounheuang	Falling of cliff material as block undermined through lower layer of gravel and silt forming notches at the foot of slope during flood period		Log hurdle work<LH> [Reason] lower cost by using less riprap than stone foundation	Cobblestone with willow branch work <CSWB(A)> (covering lower half of the cliffy bank to lower construction cost in consideration of the balance between safety level and density of property) [Reason] -as above -capable of stabilizing upper cliffy bank by prevention of scouring based on covering lower bank	Applied for the Pilot Works at Sibounheuang
Low density of properties (peripheral part of important facilities, or farmland with low dense distribution of houses)	Ban Hom	Falling of cliff material accompanied with setback of lower layer of gravel and silt that is vulnerable to scoring during flood period	Soda mattress work<SM> (installed in every others for cost reduction taking the balance of safety level and the property density into consideration) [Reason] as above	Stone foundation work<SF> [Reason] difficulty of construction because of the relation between bank topography and river water level		-Applied for the Pilot Works at peripheral part of Ban Dongphosi site -Applied as alternative of riprap groyne to avoid the influence of groyne to opposite bank due to narrow river width
	Sithantai		Riprap groyne work<RG>			This method was not tested in the Pilot Works.

6.10 Project Evaluation

6.10.1 Economic Evaluation

The riverbank protection along the Mekong River is given the status of an indispensable public investment to conserve national land, to maintain the border, and to protect Buddhist temples which is an integral part of people's life.

Average construction costs of the works proposed in the Master Plan and conventional gabion works implemented around Vientiane City is as shown in Table 6.16.

Table 6.16 Average Construction Cost by Type of Construction Works

	Construction Method	Average Construction Cost (US$/meter)
1.	Conventional Gabion Works implemented around Vientiane City	2,000
2.	Work Types proposed in the Master Plan	
(1)	Riprap groyne work (L=50m, interval=150m)	190
(2)	1) Cobble stone with willow branch work covering whole bank, 2) stone foundation and 3) soda mattress	1,300
(3)	1) Cobble stone with willow branch work covering lower bank, 2) stone foundation and 3) soda mattress (in every other)	1,290
(4)	1) Cobble stone with willow branch work covering lower bank, 2) log hurdle work and 3) soda mattress	700
3.	JICA Pilot Works (Reference)	
(1)	Ban Dongphosi Site <1) Cobble stone with willow branch work covering whole bank, 2) stone foundation and 3) soda mattress>	1,690
(2)	Wat Chom Cheng Site <Wooden pile groyne work>	200
(3)	Sibounheuang Site <1) Cobble stone with willow branch work covering lower bank, 2) log hurdle work and 3) soda mattress>	810

The Master Plan projects have direct economic benefit to save US$9.9 million or 66% comparing with that by the conventional gabion works for GOL as shown in Table 6.17.

Table 6.17 Comparison of Construction Cost by Type of Construction Works

	Construction Method	Average Unit Constr. Cost (US$/meter)	Length (m)	Construction Cost (US$1,000)
1.	Conventional Gabion Method	2,000	7,380	14,760
2.	Work Types proposed in the Master Plan	663	7,380	4,893
(1)	Riprap groyne work with a length of 50m and an interval of 150m	187	3,320	622
(2)	Cobble stone with willow branch covering whole bank with stone foundation and soda mattress	1,300	50	65
(3)	Cobble stone with willow branch covering lower bank with stone foundation and soda mattress in every other	1,284	2,400	3,081
(4)	Cobble stone with willow branch covering half bank with log hurdle and soda mattress	699	1,610	1,125
3.	Difference (1.- 2.)			9,867

The Master Plan projects will create new job opportunities equivalent to cash income of US$77,000 during construction works as shown in Table 6.18.

Table 6.18 Creation of New Job Opportunity

	New Job Opportunity (man-day)		
	Urgent Projects	2nd Priority Proj.	Total
1. Skilled labor	2,200	4,000	6,200
2. Unskilled labor	8,800	16,000	24,800
Total	11,000	20,000	31,000

6.10.2 Initial Environmental Examination

Initial Environmental Examination (IEE) is conducted based on the preparatory environmental assessment conducted in January - February 2003 in assistance with local consultant and the investigation of the four (4) sites involving the Objective Stretches for the proposed Master Plan. Around 120 villagers were interviewed using questionnaire at five (5) typical villages within 50 m from the Mekong riverbank in Vientiane City. The result is summarized as follows:

(1) General environmental impacts

- Impact on local people
  - Some riverbank slopes are utilized and possessed by the local people. However, bank protection works will not require resettlement of the people.
  - Unsuitable design of protection works may disturb the access to the river of the local people. However, these disturbances can be avoided or mitigated by the dissections with the affected peoples.
- Impact on forest resources
  - A large quantity of fascine material (wooden branches) has been collected from the several forests by permission for the pilot works.
  - According to the monitoring, the impact of the collection is negligible and damage is recoverable.
  - Because the collection has been conducted widely and shallowly without tree-felling and cutting big trees.
- Impact of construction works
  - Convey of construction materials, heavy equipment operation and earthworks will generate harmful dust, noise and vibration, these are unavoidable to some degree, though.
  - However, these impacts can be mitigated by proper construction plan, advance explains to the local people and dissections with the affected people, since the impact are temporary and limited.
  - Local people inhabited close to the pilot work site fully agreed the works and have no complaints to the construction works.

(2) Initial Environmental Examination

This section describes the environmental impacts of the four (4) sites with cliffy riverbanks involving the Objective Stretches of the Master Plan. The environmental check items are based on "JICA Environmental Guideline on Rivers and Sediment Control". Only check items concerned with the projects in the Master Plan are selected. The results of the IEE are summarized in Table 6.19. The IEE proves that the projects have no serious environmental impact potentially as follows, since the projects create better riparian environment:

- During construction stage: Most of check items are D (no impact).
- Operation/maintenance stage: Most of check items are D (no impact)

Table 6.19 (1/4) Result of IEE (Ban Dongphosi - Ban Sithantai Site)

Project Components	: Riverbank protection works
Riverbank Length	: 7.51 km (Ban Dongphosi - Sithantai)
Land Use / Riverbank Type of Site	: Industrial Area, Farmland / Cliff
Major Facilities of Site	: Lao State Fuel Company, National Culture Park, Intake facility for irrigation, Rural road

Check Item	During Construction			Operation		
	Assessment of Impact		Mitigating Measures	Assessment of Impact		Mitigating Measures
Social Environment						
Resettlement	D			D		
Economic Activity	C	Construction might impose inconvenience to the activity	Proper construction plan, measures against complaint	D		
Traffic and public facilities	B	Construction might impose inconvenience to traffic	Proper construction plan, measures against complaint	D		
Split of communities	D			D		
Cultural property	B	Construction might cause accidental damage	Proper construction plan, measures against complaint	D		
Water rights, Right of common	D			D		
Public health condition	D			D		
Waste	B	Littered construction waste	Proper disposal plan	D		
Hazard	B	Risk of fire at Soda stockyard	Fire management	D		
Natural Environment						
Topography and geology	D			D		
Soil erosion	B	Erosion caused by excessive cutting of Soda material	Proper design and construction plan	C	Erosion by damage of bank protection works	Proper periodical monitoring
Groundwater	D			D		
Hydrological situation	D			D		
Coastal zone	D			D		
Flora and fauna	B	Impact caused by excessive cutting of Soda material	Proper tree-felling management	D		
Landscape	D			C	Change by vegetation growth on bank protection works	Proper periodical monitoring
Public Nuisance						
Air pollution	B	Dust by heavy equipment	Water spray during operation	D		
Water pollution	D			D		
Soil contamination	D			D		
Noise and vibration	C	Heavy equipment operation affects residents near site	Proper construction plan, measures against complaint	D		
Ground subsidence	D			D		
General Assessment: Major environmental impacts will occur at only construction stage. But the monitoring program of the riverbank from a viewpoint of erosion and landscape will be needed during operation.						

Assessment: A: High Negative Impact, B: Low Negative Impact, C: Unknown Impact, D: No Impact

Table 6.19 (2/4) Result of IEE (Ban Hom Site)

Project Components	: Riverbank protection works
Riverbank Length	: 2.61 km
Land Use / Riverbank Type of Site	: Residential Area, Farmland / Cliff
Major Facilities of Site	: Rural road

Check Item	During Construction			Operation		
	Assessment of Impact		Mitigation Measures	Assessment of Impact		Mitigation Measures
Social Environment						
Resettlement	D			D		
Economic Activity	C	Construction might impose inconvenience to the activity	Proper construction plan, measures against complaint	D		
Traffic and public facilities	B	Construction might impose inconvenience to traffic	Proper construction plan, measures against complaint	D		
Split of communities	D			D		
Cultural property	C	Construction might cause accidental damage	Proper construction plan, measures against complaint	D		
Water rights, Right of common	D			D		
Public health condition	D			D		
Waste	B	Littered construction waste	Proper disposal plan	D		
Hazard	C	Risk of fire at Soda stockyard	Fire management	D		
Natural Environment						
Topography and geology	D			D		
Soil erosion	B	Erosion caused by excessive cutting of Soda material	Proper design and construction plan	C	Erosion by damage of bank protection works	Proper periodical monitoring
Groundwater	D			D		
Hydrological situation	D			D		
Coastal zone	D			D		
Flora and fauna	B	Impact caused by excessive cutting of Soda material	Proper tree-felling management	D		
Landscape	D			D		
Public Nuisance						
Air pollution	B	Dust by heavy equipment	Water spray during operation	D		
Water pollution	D			D		
Soil contamination	D			D		
Noise and vibration	B	Heavy equipment operation affects residents near site	Proper construction plan, measures against complaint	D		
Ground subsidence	D			D		
General Assessment: Major environmental impacts will occur at only construction stage. But the monitoring program of the riverbank from a viewpoint of erosion will be needed during operation.						

Assessment: A: High Negative Impact, B: Low Negative Impact, C: Unknown Impact, D: No Impact

Table 6.19 (3/4) Result of IEE (Ban Hatdokkeo - u/s Bo O Site)

Project Components	: Riverbank protection works
Riverbank Length	: 5.12 km (Hatdokkeo - Bo O)
Land Use / Riverbank Type of Site	: Residential Area, Farmland / Cliff
Major Facilities of Site	: Bo O Temple, Rural road, Fish farm

Check Item	During Construction			Operation		
	Assessment		Mitigation Measures	Assessment		Mitigation Measures
Social Environment						
Resettlement	D			D		
Economic Activity	C	Construction might affect residential area and fish farm		D		
Traffic and public facilities	B	Construction might obstruct access to river	Proper construction plan, Measures against complaint	D		
Split of communities	D			D		
Cultural property	C	Construction might cause accidental damage	Proper construction plan and management	D		
Water rights, Right of common	D			D		
Public health condition	D			D		
Waste	B	Littered construction waste	Proper disposal plan	D		
Hazard	D			C	Steep slope in residential area	Proper periodical monitoring
Natural Environment						
Topography and geology	D			D		
Soil erosion	B	Erosion caused by excessive cutting of Soda material	Proper design and construction plan	C	Erosion by damage of bank protection works	Proper periodical monitoring
Groundwater	D			D		
Hydrological situation	D			D		
Coastal zone	D			D		
Flora and fauna	B	Impact caused by excessive cutting of Soda material	Proper tree-felling management	D		
Landscape	D			D		
Public Nuisance						
Air pollution	B	Dust by heavy equipment	Water spray during operation	D		
Water pollution	D			D		
Soil contamination	D			D		
Noise and vibration	B	Heavy equipment operation affects residents near site	Proper construction plan, measures against complaint	D		
Ground subsidence	D			D		
General Assessment: Major environmental impacts will occur at only construction stage. But the monitoring program of the riverbank from a viewpoint of erosion and safety will be needed during operation.						

Assessment: A: High Negative Impact, B: Low Negative Impact, C: Unknown Impact, D: No Impact

Table 6.19 (4/4) Result of IEE (Muang Wa - Kaoliao Port Site)

Project Components	: Riverbank protection works
Riverbank Length	: 3.94 km (Muang Wa - Kaoliao Port)
Land Use / Riverbank Type of Site	: Residential Area, Industrial area, Farmland / Cliff
Major Facilities of Site	: Temples, Kaoliao Port, Factories, Intake facility for water supply (Kaoliao Plant), Rural road

Check Item	During Construction			Operation		
	Assessment		Mitigation Measures	Assessment		Mitigation Measures
Social Environment						
Resettlement	D			D		
Economic Activity	C	Construction might affect residential or industrial areas	Proper construction plan, measures against complaint	D		
Traffic and public facilities	B	Construction might obstruct access to river	Proper construction plan, measures against complaint	D		
Split of communities	D			D		
Cultural property	C	Construction might cause accidental damage	Proper construction plan and management	D		
Water rights, Right of common	D			D		
Public health condition	D			D		
Waste	B	Littered construction waste	Proper disposal plan	D		
Hazard	D			C	Steep slope in residential area	Proper periodical monitoring
Natural Environment						
Topography and geology	D			D		
Soil erosion	B	Erosion caused by excessive cutting of Soda material	Proper design and construction plan	C	Erosion by damage of bank protection works	Proper periodical monitoring
Groundwater	D			D		
Hydrological situation	D			D		
Coastal zone	D			D		
Flora and fauna	B	Impact caused by excessive cutting of Soda material	Proper tree-felling management	D		
Landscape	D			D		
Public Nuisance						
Air pollution	B	Dust by heavy equipment	Water spray during operation	D		
Water pollution	D			D		
Soil contamination	D			D		
Noise and vibration	B	Heavy equipment operation affects residents near site	Proper construction plan, measures against complaint	D		
Ground subsidence	D			D		
General Assessment: Major environmental impacts will occur at only construction stage. However, the monitoring program of the riverbank from a viewpoint of erosion and safety will be needed during operation.						

Assessment: A: High Negative Impact, B: Low Negative Impact, C: Unknown Impact, D: No Impact

6.10.3 Overall Evaluation

The proposed Master Plan is evaluated feasible, sustainable and appropriate from the technical, financial, economical and environmental viewpoint through the alternative study and the project evaluation discussed in this section.

The riverbank protection projects to be implemented by GOL for 16-year (2005-2020) using national budget in principle according to the Master Plan are with total cost of around US$4.9 million and total length of new bank protection works of around 7.4 km.

The Master Plan activities not only by GOL projects mentioned above but also local resident's participation for simple vegetation bank protection would greatly contribute to the prosperity of social and economic activities and the people's welfare in Vientiane Capital City as the center of the political and socio-economic activities in Lao P.D.R. by protecting riverbanks certainly as well as creating rich riparian greenbelt.

6.11 Implementation Schedule

The proposed implementation schedule of the Master Plan is presented in Figure 6.10.

Project	Length (m)	Implementation (meters)															
		2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20
I. Implementation																	
1. Urgent Projects																	
(1) Sithantai (1)	1,280			250	250	260	260	260									
(2) Ban Hom (1)	760				110	160	160	160	170								
(3) Ban Hom (2)	50			50													
(4) Bo O	200		60	70	70												
(5) Sibounheuang-Muang Wa	410	200	210														
Sub-total of 1	2,700	200	270	370	430	420	420	420	170	-	-	-	-	-	-	-	-
2. Second Priority Projects																	
(6) Sithantai (2)	2,040								400	400	400	400	440				
(7) Ban Hom (3)	760									190	190	190	190				
(8) Ban Hom (4)	880													220	220	220	220
(9) Hatdokkeo		To be implemented after FY2020/21															
(10) Upper Sibounheuang (1)	810													200	200	200	210
(11) Upper Sibounheuang (2)	190															90	100
(12) Upper Sibounheuang (3)																	
(13) Upper Sibounheuang (4)		To be implemented after FY2020/21															
(14) Upper Sibounheuang (5)																	
Sub-total of 2	4,680	-	-	-	-	-	-	-	400	590	590	590	630	420	420	510	530
Total (1+2)	7,380	200	270	370	430	420	420	420	570	590	590	590	630	420	420	510	530
II. Maintenance works																	

Figure 6.10 Implementation Schedule of Master Plan

7 PREPARATION OF MANUAL FOR RIVERBANK PROTECTION

7.1 General

Manual for Riverbank Protection (the Manual) is prepared for the planning & design, construction of the Mekong riverbank protection activities around Vientiane City to complement the formulated Master Plan taking into account of technical/economic sustainability, financial condition and personnel organization in GOL. The Manual includes basic principles for these works, technical standards and criteria. Objective user of the Manual will be working-level Laotian counterpart personnel. The contents are practical, concise, precise and visual ones so that the counterpart personnel could revise it and translate it into Laotian by themselves after completing the Study in 2004.

7.2 Contents

The Manual is appended to Volume 3 of this Final Report as "Manual for Riverbank Protection" and the main contents are as shown below:

Sector A: Planning & Design

1 PLANNING
1.1 Introduction
1.2 Riverbanks around Vientiane City
1.3 Planning Riverbank Protection
2 DESIGN
2.1 Design Parameters
2.2 Design of Riverbank Protection Work
2.2.1 General
2.2.2 Structure of Revetments
2.2.3 Slope Protection Work
2.2.4 Foundation Work
2.2.5 Foot Protection Work
2.2.6 Groyne Work
2.3 Monitoring

Sector B: Construction

1 INTRODUCTION
1.1 Outline
2 EXECUTION OF PILOT WORK AT BAN DONGPHOSI SITE
2.1 Outline
2.2 Drawings
2.3 Construction Schedule
2.4 Construction Equipment and Materials
2.5 Construction Works
2.5.1 Preparatory Works
2.5.2 Foundation Works
2.5.3 Foot Protection Works

2.5.4 Earth Works
2.5.5 Slope Protection Works
3 EXECUTION OF PILOT WORK AT WAT CHOM CHENG SITE
3.1 Outline
3.2 Drawings
3.3 Construction Schedule
3.4 Construction Equipment and Materials
3.5 Construction Works
3.5.1 Preparatory Works
2.5.2 Groin Works
4 EXECUTION OF PILOT WORK AT SIBOUNHEUANG SITE
4.1 Outline
4.2 Drawings
4.3 Construction Schedule
4.4 Construction Equipment and Materials
4.5 Construction Works
4.5.1 Preparatory Works
4.5.2 Foundation Works
4.5.3 Slope Protection Work
4.5.4 Foot Protection Works
5 CONSTRUCTION DATA
5.1 Construction Work Progress
5.2 Construction Rate

8 TRANSFER OF TECHNOLOGY

8.1 Technology Transfer Seminar

Technology transfer seminars were held twice at Lao Plaza Hotel, Vientiane in the course of the Study, i.e., the first seminar on October 4, 2002 before the execution of the Pilot Work and the second seminar on October 12, 2004 after the formulation of riverbank protection master plan. The objective of the seminars was to exchange technical ideas as well as to transfer technology by promoting further understanding of bank protection works and the Study results. The JICA Study Team organized the Seminars in cooperation and assistance with MCTPC to include various bank protection-related themes presented by both Laotian and Japanese speakers and free discussion sessions by all attendants.

The program of the seminars including themes, speakers and schedule are presented in Volume 4, Supporting Report, Sector J-Transfer of Technology.

8.2 Indoor and Field Session

The following two small sessions was held in January and February, 2004 (4th Work in Lao P.D.R.) to transfer technology and to exchange technical ideas. The agendas are appended to Volume 4, Supporting Report, Sector J-Transfer of Technology.

Type	Date	Venue	Objective and Contents
Indoor Session	2004/01/26 (14:00~18:00)	Meeting Room in MCTPC	Presentation and discussion to exchange technical ideas with the Laotian relating agencies and to make the Study information public by promoting the process & results up to date
Field Session	2004/02/10 (13:30~15:30)	Nongheo site (along Thadeua road)	Demonstration of simple vegetation riverbank protection works by the Study Team using Soda technique, that is expected to be applied to the independent bank protection activities by resident's participation

8.3 Technical Guidance for Soda Technique

Technical guidance for Soda (fascine) technique, traditional river works of Japan was held by Soda Technique experts of the Study Team as a part of technical transfer through the execution of the pilot works. The outline of guidance is as follows:

1. Period: February and March 2003 (2nd Work in Lao P.D.R.)
2. Location: pilot work sites including Soda stock yards and Soda material collecting sites
3. Items:
   a) Soda Mattress work: 1) preparation works (selection, collection and trimming of materials), 2) assembling of mattress and 3) installation of mattress

b) Cobble stone with willow branch work (Demonstration of assembling was conducted by using a model slope prepared at Ban Dongphosi site attended by many participants from counterpart personnel of MCTPC/DCTPC, contractor and the Study Team.)

8.4 Counterpart Training in Japan

Counterpart training in Japan was conducted in 2002 mainly to learn "Soda Technique" prior to the execution of the Pilot Works in the Study Area as follows:

1. Trainee:
   a) Mr. Viengsavanh PHASAVATH, MCTPC
   b) Mr. Somchith SITHIPHONG, DCTPC
2. Period:
   a) Mr. Viengsavanh PHASAVATH (2002/08/15 - 2002/09/28)
   b) Mr. Somchith SITHIPHONG (2002/08/26 - 2002/09/28)
3. Main training items:
   a) Learning Soda technique, traditional river works in Japan by outdoor training in Niigata, Japan
   b) Learning traditional/ modern river works in Japan by indoor lecture and field tour
4. Training institutes:
   a) Hokuriku Regional Development Bureau, Ministry of Land, Infrastructure and Transport
   b) Kinki Regional Development Bureau, Ministry of Land, Infrastructure and Transport
   c) Foundation for Riverfront Improvement and Restoration
   d) NIKKEN Consultants, Inc.
   e) NEWJEC Inc.
   f) Hokuriku Soda Industry Development Association

8.5 Transfer of Technology to Counterpart

The contents and result of the technology transfer to the MCTPC counterpart (C/P) through the teamwork with the Study Team are shown in Table 8.1. It is considered that in general good result was obtained. However, in view of the challenge described in Table 8.1, in order for Lao side to be able to implement the M/P project independently in the future, continuous Japanese technical cooperation will be desired for several years.

Table 8.1 Transfer of Technology to Counterpart

	Contents	Result	Future Challenge
Study and Planning	A series of basic study and planning work relating to the Master Plan	C/P understood the procedure and outline of work required for M/P planning.	-Future M/P revision by themselves -Systematic study of river engineering
	Preparation of manual for riverbank protection	C/P understood the contents of the manual.	The revision and the Laotian translation by themselves
	Field investigation for the design of the M/P project	C/P carried out topographical survey by themselves under conditions similar to the Pilot Work (Sibounheuang – Muang Wa Site).	Investigation for other M/P project sites with some unknown factor
	Explanation of contents of the Study and the Pilot Works to the agencies concerned	-C/P prepared PowerPoint materials (Laotian) by themselves and performed effective presentation at the technology transfer seminar and the MCTPC departmental meeting. -C/P carried out the explanation to related research group and the seminar for provincial MCTPC with the assistance of JICA experts.	C/P plans and organized seminars for public relations of the M/P projects.
Design	Preparation of the plan of bank protection facilities by CAD	C/P created the plan of simple bank protection works by themselves, and assisted the Study Team (when basal condition was ready).	Design under conditions with some unknown factor
	Design of the M/P projects	C/P designed a M/P project by themselves under conditions similar to the Pilot Work (Sibounheuang – Muang Wa Site).	Design for other M/P project sites with some unknown factor
Construction	Acquisition of Soda technique required for execution of traditional river works of Japan	C/P mastered collection of Soda material, and the assembling of Soda mattress to some extent through on-the-job training in Japan.	Spread, tradition and localization of Soda Technique
	Acquisition of bank protection works through execution of the Pilot Works	-C/P understood detailed process of bank protection works practically by teamwork with the Study Team. -C/P assisted the supervision by the Study Team. -C/P conducted quality control of Soda material based on training experience in Japan.	Sustainable implementation of the M/P project by themselves
	Acquisition of simple vegetation bank protection works	C/P understood the construction process practically by teamwork with the Study Team.	Spread and support of the construction by C/P to riverine local community
Monitoring and Maintenance	Periodical visual inspection of the completed Pilot Works	C/P carried it out and reported the result to the Study Team by e-mail.	Correspondence at the M/P project site with some unknown factor
	Arrangement with the chart of monitoring result (change in water level and topography) of the Pilot Works	C/P arranged the result with charts (MS Excel, AutoCAD) by themselves.	
	Acquisition of data of automatic water gauge	C/P performed the computer processing by themselves.	
	Installation of staff gauge and observation of daily water level	C/P have observed the water level and repaired the gauge after damaged, which was originally installed by the Study Team.	
Organization and Institution	The necessity for permanent organization establishment for the M/P implementation	C/P recognizes necessity and is working towards setting up the organization.	Setting up a permanent organization for riverbank protection
Human Resources Development	Explanation to the public of the contents of the Study and the Pilot Works	C/P gave lectures on the Study content to the trainee of faculty of technology, National university of Laos on their own.	・Giving lectures at the university ・Continuous acceptance of the trainee ・Enlightenment of local residents

9 RECOMMENDATION

(1) Set Up of Organization and Institution

It is strongly recommended that GOL implement the following as an absolutely necessary condition to implement the bank protection projects of the Master Plan by GOL using national budget in principle:

1. Setting up "Mekong Riverbank Protection Unit (tentative name)" (New Unit) as a new permanent organization in MCTPC,
2. Proper human resources arrangement to the New Unit,
3. Budget allocation for riverbank protection certainly based on the annual investment schedule of the Master Plan, and
4. Continuous human resources development.

(2) Review and Revision of the Master Plan

The Master Plan is formulated targeting the year 2020, the plan is not unchangeable one, though. There are many uncertainties about the estimate of the conditions of 10 years, 15 years from now. Therefore, it is advisable that the Master Plan be reviewed and revised by GOL if necessary in 2010 and 2015, in accordance with 5-year Socio-economic development plans, taking the following factors in consideration:

1. Financial factors (Unforeseen change in financial condition of GOL), and
2. Technical factors.
   a) The result of the long-term monitoring of the Pilot Works
   b) Unforeseen change in the conditions of riverbank erosion

(3) Avoidance of Resettlement on Construction Work

It is recommendable to avoid negative social environmental impact such as resettlement as much as possible on the construction of the bank protection works proposed by the Master Plan. The Pilot Works of the Study (L= approx. 1 km in total) completed with no resettlement by introducing proper construction method.

(4) Facility Design and Cost Estimate to be conducted by GOL

The facility design and the cost estimate in the Master Plan are the preliminarily ones to conduct overall planning targeting the year 2020. On the commencement of each projects of the Master Plan by GOL, it is essential for GOL to conduct the detail design and the cost estimate by conducting topographic and hydrological surveys at each site.

(5) Status of On-going Bo O project in the Master Plan

Design of "Lao-Flanders river works project" at Bo O site is underway by MCTPC with the assistance of the Government of Belgium (GOB), which is one of the Urgent Project sites of JICA Master Plan. The project is incorporated into the JICA Master Plan as it is in principle and is given high priority in the Master Plan. However, the design has not been completed

and accordingly no definite cost estimate is available so far. It is noted that Japanese traditional river works proposed by the Master Plan is temporarily applied for the preliminarily cost estimate at the site in this Study instead. The cost in the Master Plan shall be reviewed by MCTPC in future upon the definite cost based on the final design is determined by the river works project.

(6) Collection of Available Quarry Information

The cost of crushed stone from quarry constitutes large percentage of the total cost of bank protection works. It is obvious that the development of the new quarry around Vientiane exclusive for bank protection is not virtually feasible in view of lithology (sand stone) and the project scale of the Master Plan. Therefore, the selection of quarry will be the option of local contractors as before in principle on the construction of the projects of the Master Plan. It is advisable to secure available quarries information for sustainable implementation of the Master Plan projects.

(7) Maintenance of the Pilot Works

The Study Team arranged to repair slightly scoured spots on the foundation work of the Pilot Work at Ban Dongphosi Site in January 2004 with cooperation of the contractor who had undertaken the Pilot Works. As for Ban Dongphosi and Sibounheuang Sites, this kind of maintenance work of the Pilot Works after 2005 shall be conducted under the responsibility of GOL, the owner of the Works as one of the regular maintenance activities based on the budget allocation of the Master Plan.

As for Wat Chom Cheng Site, the work is implemented as “essential test work” and accordingly the inspection should be continued without any rehabilitation work unless serious negative influence to local residents happens by unforeseen erosion.