

SECTOR H

RIVERBANK PROTECTION MASTER PLAN

**THE STUDY ON MEKONG RIVERBANK PROTECTION
AROUND VIENTIANE MUNICIPALITY
IN THE LAO PEOPLE'S DEMOCRATIC REPUBLIC**

**FINAL REPORT
VOLUME 4
-SUPPORTING REPORT-**

SECTOR H

RIVERBANK PROTECTION MASTER PLAN

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SECTOR H

RIVERBANK PROTECTION MASTER PLAN

This Sector H compiles all the process and result of the formulation of the Riverbank Protection Master Plan around Vientiane City (hereinafter referred to as “the Master Plan”) conducted during the 4th Work in Lao P.D.R. from December 2003 to February 2004.

1 BASIC FRAMEWORK AND PRINCIPLES OF MASTER PLAN

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 GOL by themselves using national budget in principle after the year 2005, and
2. introducing traditional river works of Japan in principle.

The Manual for Riverbank Protection is also prepared as a supplement of the Master Plan to support definite bank protection activities by GOL (refer to Volume 3 (Manual for Riverbank Protection)).

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 described in Sector F (Monitoring of Pilot Works) of this Supporting Report. 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 basic planning frame is discussed from here on:

1. Target year
2. Study area
3. Planning methodology
4. Sustainable supply of materials
5. Coordination with relating projects
6. Organization and institution
7. Non-structural measures

Among the items listed above, item 5 is described in Section 1.3 and items 6 and 7 are specially discussed in Chapter 5 and 7, respectively.

1.2.1 Target Year

Year 2020 (16-year: 2005-2020) is set up as the target year of the Master Plan corresponding to the target year of existing national development policy, National Poverty Eradication Programme (GOL, 2003). The target year of the following relating plans and projects is also taken into account as a reference:

1. Revised Vientiane Urban Development Master Plan (URI-MCTPC, 2003):
10-year: 2000-2010
2. Vientiane Urban Infrastructure and Service Project (VUIISP) (VUDAA-ADB, 2001):
5-year: 2001-2006
3. Water Supply Master Plan in Vientiane (JICA, 2003): 2020; the implementation program:
2015 (year 2020 is judged too far; too much unknown factors)

1.2.2 Study Area

The Mekong river stretches from Thadeua to Ban Ang (L=approx. 65 km) is determined as the Study Area for the Master Plan.

1.2.3 Planning Methodology

(1) Selection of high priority stretches

The Mekong river stretches in the Study Area are classified according to their priority. High priority stretches is selected from classified cliffy riverbanks as the nominated stretches for the implementation of the Master Plan.

(2) Concept of work scale

The work scale such as 1) location, 2) extension, 3) type of erosion and 4) type of works suitable for each type of erosion is preliminarily proposed for each site including the High Priority Stretches.

(3) Implementation schedule

The followings are prepared for the Objective Stretches to be protected by 2020, which is selected and determined from the High Priority Stretches.

1. Preliminary design
2. Preliminary cost estimate
3. Preliminary implementation schedule by 2020 (16-year: 2005-2020)

The extension of the Objective Stretches is determined by the following condition examined and discussed with GOL:

1. Setting up of sustainable organization and institution
2. Type of work & cost applied to each objective reaches
(low cost type is proposed according to required safety level of each site)
3. Sustainable budgetary allocation
4. Minimum resettlement (JICA Pilot Works completed with no resettlement.)

1.2.4 Sustainable Supply of Materials

(1) Soda materials

Sustainable supply with proper forest preservation proved possible through the experience of Pilot Work in 2003.

(2) Quarry

The following three (3) quarries have been utilized for bank protection works in recent years:

1. Ban Sakai (the only site under operation, 50 km from Vientiane, lime stone)
2. Nong Teng (new temporary quarry for JICA Pilot Works, sand stone, approximately 23 km from Vientiane)
3. Tat Thong (small-scale temporary quarry utilized for Bo O and Ban Hom, sand stone)

MCTPC has no intention to develop new quarry around Vientiane exclusive for bank protection in principle because of its low feasibility in view of project scale. Therefore, selection of quarry is the option of local contractors in principle. It is advisable to secure available quarries for sustainable implementation of bank protection projects.

1.2.5 Coordination with Relating Projects

On-going and proposed bank protection plan/projects described in Sector A (Present Condition in the Study Area) of this Supporting Report are 1) incorporated into the Master Plan as it is in principle, and 2) consist of a part of the Master Plan with high priority in principle.

2 MECHANISM OF BANK EROSION

2.1 Geomorphologic Background

The Vientiane Plain lies on the continental stable plane which is in the process of gently sinking since some tens of thousand years ago. A gravel layer deposited on the basement plane covered with a sand layer on its surface. The gravel layer called as Vientiane Gravel is a fan-deposit transported from the Himalayas by the Mekong River during the Glacier Age. The silty sand is a recent alluvial deposit of the Mekong River. The thickness of the silty sand layer ranges from 6 m to 15 m around Vientiane City, which generally becomes thicker toward downstream.

The materials forming the river channel of the Mekong come from mainly two different sources, i.e., Vientiane Gravel and silty sand. The gravel transported during Glacier Age would hardly be transported by the present flood flows, since the grain size of the gravel (around 5 to 10 cm) exceeds the critical tractive force of the flows. On the other hand, the silty sand is transported by the present river flows as suspended loads, forming riverbed of dune to transition state on the gravel bed of which source would be nearby riverbeds or riverbanks.

Riverbed during the flood is basically formed with the gravel, and the depth to the gravel layer is a ruling factor of floodwater depth of the river. The sand is a substantial sediment load closely related to the formation of riverbank and bars.

2.2 Changes in Plan-form and Riverbank Erosion

2.2.1 Changes in Plan-form of River

There are five islands in the objective stretch for study as listed below from the downstream:

- 1) Don Tam (Thailand)
- 2) Don Khieonoi (Thailand)
- 3) Don Chan (Lao PDR)
- 4) Don Xingsou/Don Ching Chu (Lao PDR)
- 5) Don Mun/Dor Makmo (Lao PDR)

A comparative study was made using hydrographic maps of the Mekong River in 1961/62 and 1991/92. During the past 30 years the above islands remained at almost the same places, and the changes in plan-form of the river are not significant except for the reaches from KM-1562 near Thakhek to KM-1574 near Bo O, in which changes in riverbanks and sizes of islands are relatively large. Near Bo O suffering from active bank erosion, Khieonoi Island extended toward the left bank side (Bo O side) though its size was reduced. In Ban Hom, Tam Island expanded 3 to 4 times during past 30 years, which brought about severe bank erosion at Ban Hom on the left bank and that on the right bank as well. Bank erosion rates in the reaches of Bo O and Ban Hom are estimated at around 5m/year at maximum during the past 30 years.

As for other islands located in the upper reaches, their sizes are almost the same, though it seems to have slight tendency of becoming smaller.

According to the hydrographic maps (Figure 2.1), vestiges of old river course of the Mekong River are clearly seen on the right bank in the stretch from Ban Hatdokkeo to Don Chan. From these vestiges the followings are considered:

The Mekong River which severely bent at Vientiane City is gradually changing to larger curvature.

In accordance with the changes of curvature, riverbank in front of the City sifted toward southwest, and the location of the downstream bend sifted toward south.

The present left riverbank from Chinaimo to Don Chan seems to be stable coping with the past flood flow attacks.

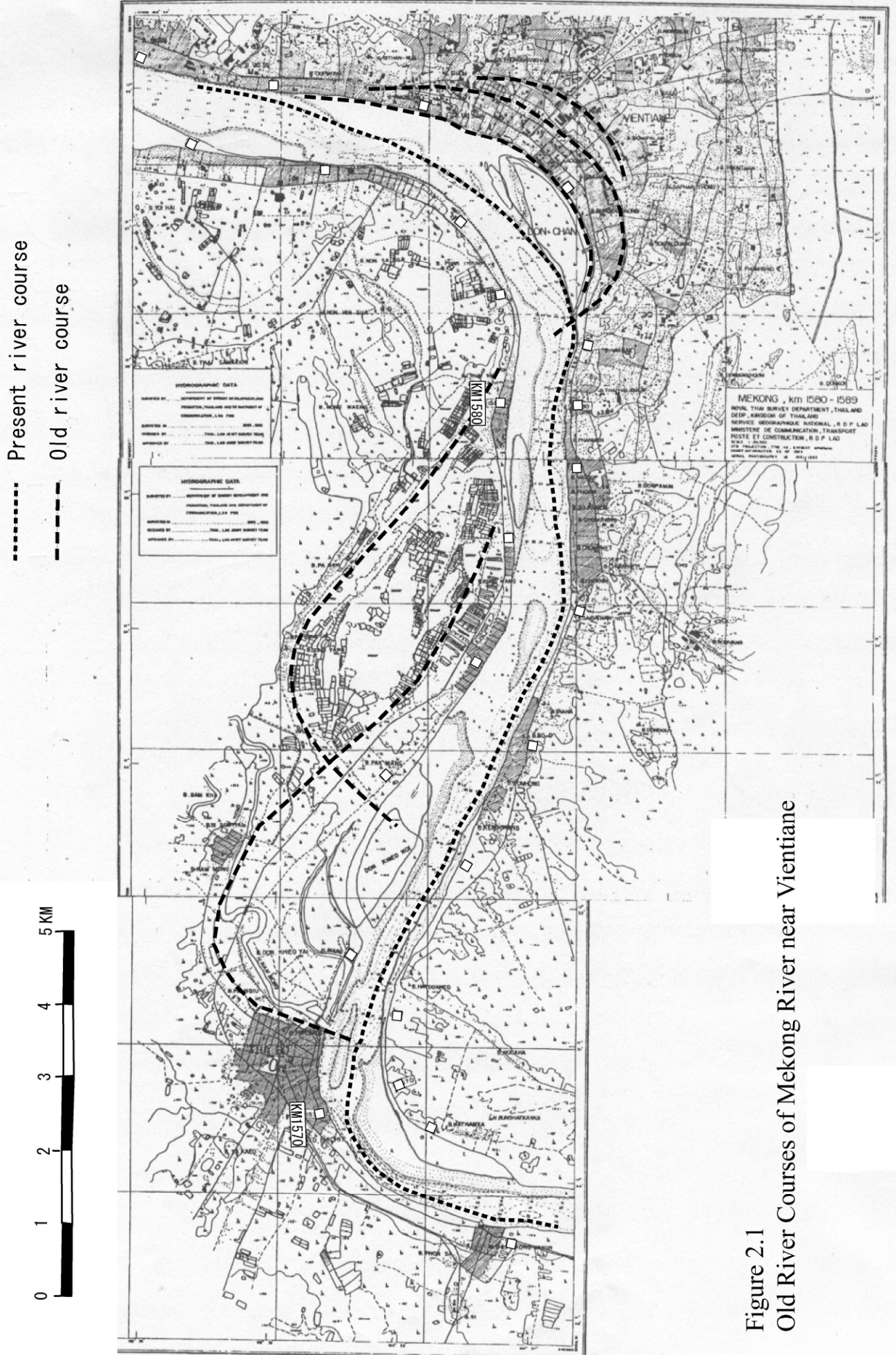


Figure 2.1
Old River Courses of Mekong River near Vientiane

2.2.2 Recent Bank Erosion

The Study Area experienced a big flood in August 2002. The 2002-flood is the 2nd biggest following the 1966-flood according to the water level records at Laxy Port (KM-4) since 1960. Bank erosion in and around the 2002-flood was studied based on (1) interviews to the local residents, (2) riverbank survey results by the Study Team at the pilot work sites, and (3) comparison of photos taken in 2001 and at present. Main findings are as follows:

- 1) Riverbanks recently suffering from active erosions are (1) Ban Nahai to Ban Sithantai, (2) Ban Thakhek to Wat Chomthong, (3) Ban Hatdokkeo and Bo O, and (4) Wat Muang Wa to Mekong Breeze Hotel. All of these banks are located in the stretches of cliffy banks.
- 2) Among these stretches, erosion is most active at the riverbank from Ban Thakhek to Wat Chomthong. At Wat Thongthat in this stretch, riverbank was said to be eroded by about 25 m in 2003 and about 35 m since 2001. According to the monks, this temple was moved three times during past 30 years. In other stretches mentioned above, riverbanks were eroded locally 2 to 5 m in these two years. The residents said these bank erosions mostly took place during the recession period of floods.
- 3) At the pilot work site of Ban Dongphosi, riverbank was eroded 2.3 m on average due to the 2002-flood. In some sections the bank erosion amount to about 10 m locally. At other pilot work sites of Wat Chom Cheng and Sibounheuang, significant bank erosion was not observed except for some local erosion. The riverbank at Ban Dongphosi site has already been protected by the pilot works of the Study Team.
- 4) The existing bank protection works at Hatdokkeo are suffering from severe scouring at their feet. The foot of bank protection works at National Culture Park is also eroded. Repair of bank protection works at Hatdokkeo is partly executed by DCTPC.

2.2.3 Forecast of Progress of Erosion

Although it is difficult to forecast future progress of the bank erosion because of limited data available, the following could be clarified based on the studies in the previous sub-sections:

- 1) Sites of riverbank erosion would not change so much in future, judging from small change in river plan-form in the past.
- 2) Recent active erosions take place in the cliffy riverbanks.
- 3) The erosion is active in particular in the stretch from KM-1562 (near Thakhek) to KM-1574 (near Bo O). In this stretch average erosion rate amount to around 5m/year at maximum.

2.3 Types of Riverbanks and Coping Measures to Erosion

2.3.1 Classification of Types of Riverbank

Total length of left riverbank from Thadeua to Ban Ang is about 65 km. Out of the total length, the uppermost portion of about 5 km from Wat Thampha takes route in the hilly lands. At Wat Thampha the Mekong River forms a gorge and the river flows are controlled by exposed rocks on the riverbank and gorges. This portion of riverbank is considered not so important from bank protection viewpoint. Therefore, the study was made for the stretch along the left (Lao side) bank of about 59.2 km from Thadeua to Wat Thampha.

The riverbanks in the study area can be classified into four types for bank protection purpose. They are shown in Figure 2.2 and their total lengths are listed below.

1) Cliffy riverbanks:	19.18 km (32%)
2) Mild-slope riverbanks:	20.71 km (35%)
3) Riverbanks with sand bar and island:	16.89 km (29%)
4) Riverbanks with exposed rocks:	2.46 km (4%)
Total	59.24 km

The cliffy riverbank is located at the place where erosion prevails and is in most critical conditions. The riverbank with bar/island is located where sedimentation prevails. The mild-slope riverbank seems to be in the conditions between erosion and sedimentation. The mild-slope riverbank is in the favorable state as a whole with vegetation on the slope, though slope failures are locally found in places. The riverbanks with exposed rocks are located in the upper reaches close to the hilly lands.

From the bank protection viewpoint, riverbanks with sand-bar/island and exposed rocks are not so important and the erosion is not serious protected in their front. Further descriptions are made on the cliffy riverbanks and the mild-slope riverbanks in the following paragraphs.

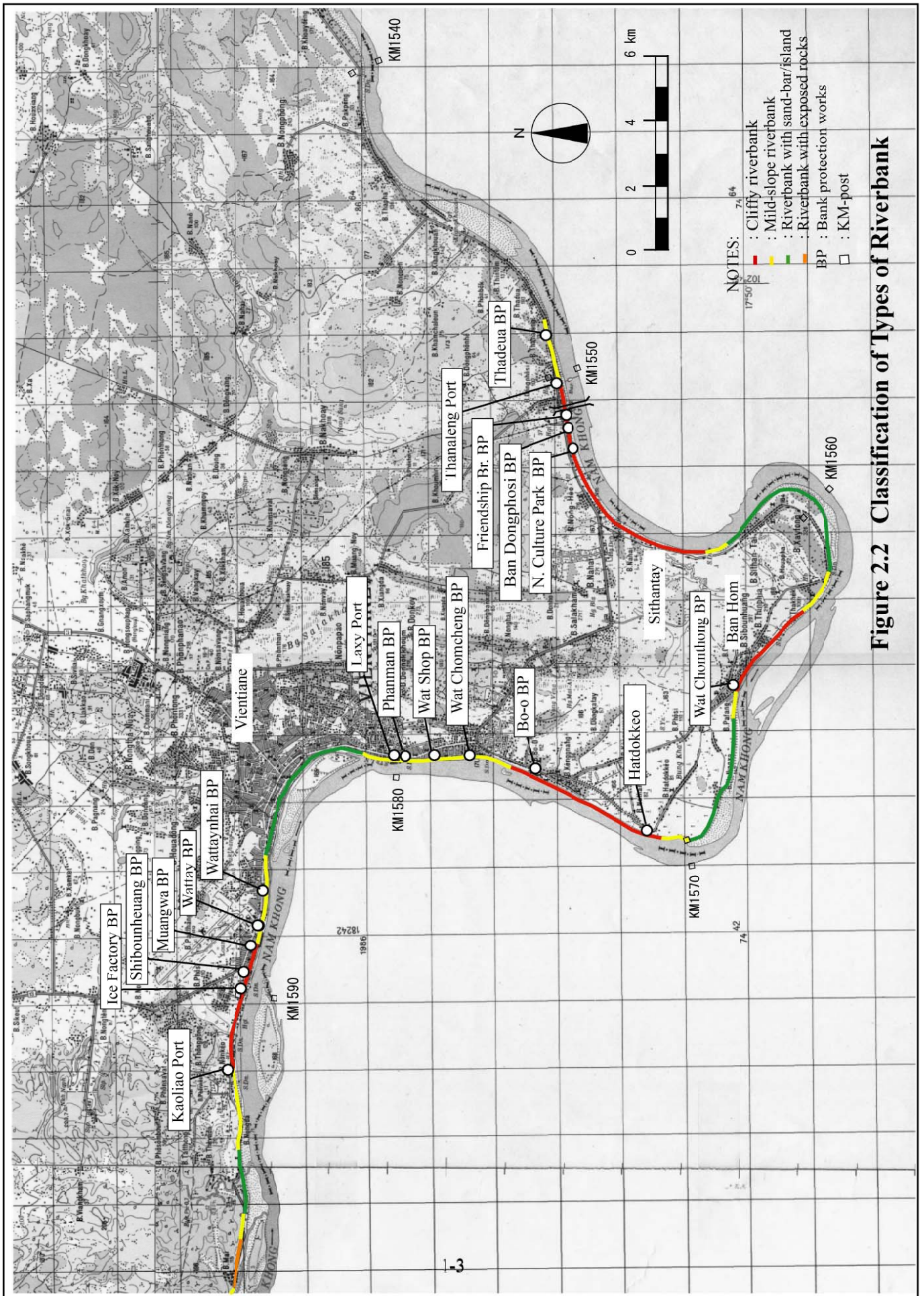


Figure 2.2 Classification of Types of Riverbank

2.3.2 Clifty Riverbanks

The clifty riverbank has almost vertical bank slope with little vegetation located in the out-curved riverbank where the main flow is in contact with the bank. Erosion of this type of riverbank is caused by in principle scouring at the foot of bank slope, and the scouring at the slope foot induces the fall of bank soil. Protection of the erosion at the foot of bank slope is essential. From the bank protection viewpoint, the clifty banks are further classified into three types as follows:

- 1) Clifty silty sand riverbank (Type-C1): Bank slope is clifty standing out from the water surface. This type of bank is seen at and upstream of the bank protection works of ice factory and at Ban Hom.
- 2) Clifty silty sand riverbank on loose gravel bed (Type-C2): Steep bank slope stands on loose gravel bed. Erodibility of the riverbank is high due to the existence of the loose gravel layer. This type of bank is seen in the reaches from Hatdokkeo to Bo O and from Wat Muang Wa to Sibounheuang.
- 3) Clifty silty sand riverbank on consolidated gravel bed (Type-C3): Steep bank slope stands on consolidated gravel bed. Milder slope of gravel layer is seen at the foot of the bank slope, and erodibility of the riverbank is relatively high. This type of bank is found in the reaches from Ban Dongphosi to Sithantai.

The above classification is not always definite and various geological formations thrust locally in each type of riverbank. For Type-C1 riverbank, gravel layer is not seen above the water surface but it must exist under the water. Therefore, the difference of Type-C1 from other types may only be the depth to gravel layer.

2.3.3 Mild-Slope Riverbanks

The riverbank of mild slope (Type-M) distributes adjacent to the reaches of clifty banks and/or riverbanks with sand bar/island and those with exposed rocks. Geological formation of this type of riverbank is not generally seen covered with sediment deposit and vegetation. The mild-slope riverbank is located in the reaches subject alternately to erosions and depositions or in the equilibrium conditions. The riverbank is resistible to some extent to the erosion due to river flow.

This type of riverbank, however, would suffer from erosion due to excess pore pressure during the recession period of river water level aggravated by unconsolidated and lower permeability deposited soil. Due to its milder slope, the bank slopes are used for farming in places. Consolidation of bank soil by step works and vegetation cover would be effective for protection of the slope.

As for the riverbank from Chinaimo to Don Chan, wooden pile groyne works would be also applicable to stabilize the deposited soil on the slope, reducing flow velocity near the bank slopes. According to the results of geological investigation by the Study Team, the gravel layer is deeper in this section, probably due to the past flood attacks along the riverbank. The silty sand cover on the gravel is thick enough to support wooden piles for the groyne.

2.3.4 Coping Measures to Erosion

Bank protection works of the Mekong River consist of following component works in general:

- 1) Foot protection works: To protect bank slope and its foundation works from the riverbed scour, flexibly adjusting to the riverbed changes.
- 2) Foundation works: To support slope protection works, firmly fixing the foot of slope.
- 3) Lower slope protection works: To protect lower part of slope (the most erosion-vulnerable part of slope) by covering the slope surface.
- 4) Upper slope protection works: To protect upper part of slope from erosion due to attacks of flood flows and floating materials by covering the slope surface.

Various types of works can be conceived for the bank protection. Advisable measures for the Mekong River around Vientiane City are listed below.

- 1) Foot Protection Works
 - Groyne works: Rip-rap/wooden-pile groins
 - Gabion works
 - Soda mattress works
 - Rip-rap work
- 2) Foundation Works
 - Pile works
 - Frame works filled with rip-rap
 - Rip-rap work
- 3) Lower Slope Protection Works
 - Gabion works
 - Rip-rap work
 - Cobble stone with willow branch works
 - Soda mattress
 - Sand bag works
 - Step works with willow
 - Willow planting
- 4) Upper Slope Protection Works
 - Gabion works
 - Cobble stone with willow branch works
 - Sand bag works
 - Step works with grass cover

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. The riverbanks of the Mekong River in the Study Area were classified as follows:

- 1) Clifty Riverbanks:
 - Type-C1: Silty sand
 - Type-C2: Silty sand on loose gravel layer
 - Type-C3: Silty sand on consolidated gravel layer
- 2) Mild-slope Riverbanks: Type-M

Types of riverbank and advisable combinations of the component works for the bank protection are summarized in Table 2.1 for reference. The types of works and their coping measures are not limited to those mentioned in the Table 2.1, and they should be improved and developed based on the monitoring results of the works constructed. The higher safety level of works requires in general more construction materials and funds. Considering the effective use of limited fund, it is also advisable to construct small-scale works of lower safety initially, and reinforce the works stage-wise depending on the requirement of the monitoring results.

Table 2.1 Types of Riverbank and Protection Measures

Items	Type-C1 bank	Type-C2 banks	Type-C3 bank	Type-M bank
Physical Conditions				
Shape of bank	Cliffy bank	Cliffy bank	Cliffy bank	Mild-slope 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	Silty sand deposit
River flows	Facing or contacting to the main flow of the Mekong R.	Facing or contacting to the main flow of the Mekong R.	Facing or contacting to the main flow of the Mekong R.	Not directly 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.	Failure of riverbank due to pore pressure during recession period of high water and erosion of bank slope due to river flows.
Typical Riverbanks in Study Area	- Upstream reaches of Ice Factory B.P. - Ban Hom	- Hatdokkeo B.P. to Bo O B.P. - Wat Muangva B.P. to Sibounheuan B.P.	- Ban Dongphosi to Sithantai, though Type-C2 banks are found in places.	- Chinaimo sluice to Phanman B.P. - Other riverbanks adjacent to the cliffy banks (Type-C1/C2)
Coping Measures	- To protect foot of bank-slope from scour. - To protect bank-slope from erosion. - To reduce flow velocity near riverbank.	- 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.	- To consolidate toe of bank-slope. - To stabilize bank-slope - To reduce flow velocity near riverbank
Advisable Component Works				
Foot protection works (FP)	- Rip-rap groin work - Soda mattress work - Rip-rap work	- Rip-rap groin work - Gabion work - Soda mattress work - Rip-rap work	- Rip-rap groin work - Gabion work - Soda mattress work - Rip-rap work	- Rip-rap groin work - Pile groin work - Gabion work - Soda mattress work - Rip-rap work
Foundation works (F)	- Frame work filled w/rip-rap - Rip-rap work	- Frame work filled w/rip-rap - Rip-rap work	- Frame work filled w/rip-rap - Rip-rap work	- Pile work - Frame work filled w/rip-rap
Lower slope protection works (LS)	- Gabion work - Rip-rap work - Cobble with willow branch work - Soda mattress work - Willow work	- Gabion work - Rip-rap work - Cobble with willow branch work - Soda mattress work - Willow work	- Gabion work - Rip-rap work - Cobble with willow branch work - Soda mattress work - Willow work	- Gabion work - Rip-rap work - Cobble with willow branch work - Sand bag work - Step work with willow planting
Upper slope protection works (US)	- Gabion work - Cobble with willow branch work - Sand bag work	- Gabion work - Cobble with willow branch work - Sand bag work	- Gabion work - Cobble with willow branch work - Sand bag work	- Gabion work - Cobble with willow branch work - Sand bag work - Step work with grass-cover
Advisable Protection Works				
Important protection sites of higher safety	- Soda mattress (FP) + Rip-rap (F) + Cobble w/willow branch (LS & US)	- Soda mattress (FP) + Rip-rap (F) + Cobble w/willow branch (LS & US)	- Soda mattress (FP) + Rip-rap (F) + Cobble w/willow branch (LS & US)	- Soda mattress (FP) + Rip-rap (F) + Cobble w/willow branch (LS & US) - Pile groin (FP) + Pile (F) + Step work w/willow (LS) + Step work w/grass (US)
Other protection sites	- Soda mattress (FP) + Rip-rap (F) + Cobble w/willow branch (LS)	- Soda mattress (FP) + Rip-rap (F) + Cobble w/willow branch (LS)	- Rip-rap groin (FP)	- Pile (F) + Step work w/willow (LS) + Step work w/grass (US)

2.4 Artificial Impacts

As to the bank protection, physical bank conditions and works to be implemented would be the primary factors. In addition to these, reduction of harmful artificial impacts to the banks is also important issue to be considered for the conservation of riverbanks, especially in densely populated urban area. The following are the artificial impacts conceivable around Vientiane City:

- 1) Activities by Local Residents:
 - Cultivation of bank slope
 - Construction of houses/buildings on the riverbank and bank slope
 - Dumping garbage and other solid wastes in the river and bank slope
 - Mooring boats and fish cages at riverbank
- 2) Activities by Private Firms:
 - Sand and gravel mining from riverbed
 - Dredging riverbed for land reclamation
- 3) Public Works:
 - Construction of structures across the river such as bridge, cable, etc
 - River works by the governments of Lao PDR and Thailand as well

These activities could be harmful to the conservation of riverbanks if they are left uncontrolled. These activities should be regulated or coordinated by the government agencies in charge, so as not to damage or adversely influence the riverbanks and bank protection works.

Sand and gravel mining which are now implemented in places on both sides of the Mekong River by Lao PDR and Thailand should also be regulated. The gravels on the riverbed of the Mekong are the deposit of Glacier Age and little supply from the upstream reaches is expected under the present flow conditions. Increase of gravel mining will thus lead to lowering of riverbed during flood season. While the lowering riverbed is expected to stabilize the river course, it may put the riverbanks and the bank protection works in danger deepening the foot of bank slope. Quantities and sites of gravel mining should be investigated and regulated based on the data from both Lao PDR and Thailand.

3 SELECTION OF OBJECTIVE BANKS FOR PROTECTION

3.1 Principles for Bank Protection

- 1) Bank protection is planned for the riverbanks which are now suffering from erosion, since the changes in plan-form are small in the past.
- 2) Bank erosions in the reaches from KM-1562 (Tha Khek) to KM-1574 (Bo 0) are closely related with the evolution of islands called as Don Tam and Don Khieonoi. In other word, the changes of riverbank may influence the evolution of islands. This should be considered in selecting the type of works.
- 3) The cliffy riverbanks are now suffering from erosion and are anticipated to suffer from active erosion sooner or later. Erosions of the cliffy banks are of large scale and the sites extend to wide stretch. The stretch of cliffy bank should be protected by the structural measures.
- 4) The mild-slope riverbanks are not suffering from active erosions of river flows, but subject to slope failures due to excess pore pressure during the recession period of flood and harmful activities on riverbanks. The failures, however, are not large in scale, and seem local and intermittent. Considering these, the coping measures to the mild-slope riverbanks should be taken locally by the direct beneficiaries depending on their safety levels required.
- 5) As for the mild-slope riverbanks in the community, an approach by involvement of community people could be considered. In this approach, government shall (1) organize the local community for bank protection activities; (2) train local community leaders; (3) provide guidance, data and information required, (4) coordination with relevant communities and government agencies, and (5) any other assistance necessary for the activities by the community people. The protection measures to be carried out by the local community would be stabilization of bank slope by vegetation and step works and simple works for sure-footing. These activities involving the local people are expected to enhance the people's concerns and understanding on the functions and importance of the bank protection works as well.

3.2 Criteria and Procedures for Selection

Bank protection budget of Lao PDR 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 three stages of screenings based on general bank conditions, vulnerability to erosion, and social importance as follows:

- 1) Initial Screening Based on General Bank Conditions:
 - Cliffy bank (1A)
 - Mild-slope bank (1B)
 - Bank with sand-bar/island (1C)
 - Bank with exposed rocks (1D)
 - Bank with protection works (1E)

- 2) Secondary Screening Based on Vulnerability to Erosion:
 - Active river shifting (2A)
 - Recent active erosion (2B)
 - Out-curved bank (2C)
 - Close to main flow (2D)
 - Bank with little vegetation (2E)
- 3) Tertiary Screening Based on Social Importance:
 - Settlements including road on bank (3A)
 - Public roads on bank (3B)
 - Temples on bank (3C)

Riverbanks from Thadeua to Wat Thampha (59.24 km in total) are subject to the initial screening. The riverbanks passed for the initial screening are subject to the secondary screening, and the highest priority sites are selected from those passed for the initial and the secondary screenings.

Hydrographic maps prepared in 1995/96 based on aerial photos taken in 1991/92 were used as base map for screening works. KM-posts shown on the maps were also used to indicate the locations of riverbank, and the distances between the KM-posts were measured on the map. Relationship between the KM-post and cumulative distance from Thadeua (from the lower end of the bank protection works) is shown in Table 3.1. In the table, distributions of riverbank types are also shown using the KM-posts and distance from Thadeua.

For the screening purpose, the left riverbank in the Study Area were divided into numerous segments of 10-m long each, and respective evaluation items were marked for every segment riverbanks based on the study results made so far and supplementary field survey results.

Figure 3.1 is the summary of riverbank conditions evaluated for the items mentioned above, and the location of KM-posts and other major objects are shown more specifically in figure 3.2. The distributions of types of riverbank are also shown in the figure. Table 3.2 is a summary table of existing bank protection works. Locations of the existing works were measured at field by a portable GPS-set.

Results of marking for respective evaluation items are summarized in Table 3.3. Screenings were made based on the table.

Table 3.1 KM-Post and Distribution of Types of Bank

KM-post	Distance		Location	Distance from Thadeua (km)	Bank length by types				Notes
	Between posts (km)	From KM-1540 (km)			From Thadeua (km)	Cliffy bank (km)	Mild-slope bank (km)	Bank w/bars (km)	
1540	-	0.000	KM-1547 + 1.83	0.00	1.84				L. end of Thadeua BP U. end of Wat Chabtrong BP L. end of Wat Muang Wa BP U. end of Lao Liao Port Wat Thampha
1541	1.498	1.498	KM-1550 + 0.10	1.84	7.51				
1545	4.963	6.461	KM-1555 + 1.28	9.35					
1547	2.151	8.612	KM-1555 + 2.00	10.07		6.47			
Thadeua	1.825	10.437	KM-1561 + 1.41	16.54					
1549	0.462	10.899	KM-1563 + 1.15	18.16					
1550	1.278	12.177	KM-1565 + 1.30	20.77					
1551	1.214	13.391	KM-1565 + 2.59	22.06					
1553	2.222	15.613	KM-1569 + 0.57	25.49					
1555	2.897	18.510	KM-1571 + 0.00	26.88	5.12				
1557	2.797	21.307	KM-1575 + 0.94	32.00					
1559	2.002	23.309	KM-1581 + 0.42	37.02		4.99			
1560	1.044	24.353	KM-1585 + 0.96	42.01					
1561	1.214	25.567	KM-1587 + 1.80	44.86	3.94				
1563	1.882	27.449	KM-1591 + 1.34	48.80					
1565	2.456	29.905	KM-1593 + 0.56	50.69					
1567	2.727	32.632	KM-1595 + 0.54	52.69					
1569	2.726	35.358	KM-1595 + 1.56	53.71					
1570	0.895	36.253	KM-1597 + 0.71	55.34			1.63		
1571	1.065	37.318	KM-1599 + 1.18	58.41			0.83		
1573	2.300	39.618	KM-1600 + 0.77	59.24					
1575	1.874	41.492							
1577	1.925	43.417							
1579	1.895	45.312							
1580	0.852	46.164							
1581	0.874	47.038							
1583	2.222	49.260							
1585	2.229	51.489							
1587	2.010	53.499							
1589	1.931	55.430							
1590	1.406	56.836							
1591	1.065	57.901							
1593	2.662	60.563							
1595	2.024	62.587							
1597	2.477	65.064							
1599	2.599	67.663							
1600	1.243	68.906							
W.Thampha	0.923	69.829							
			Total	59.24	19.18	20.71	16.89	2.46	

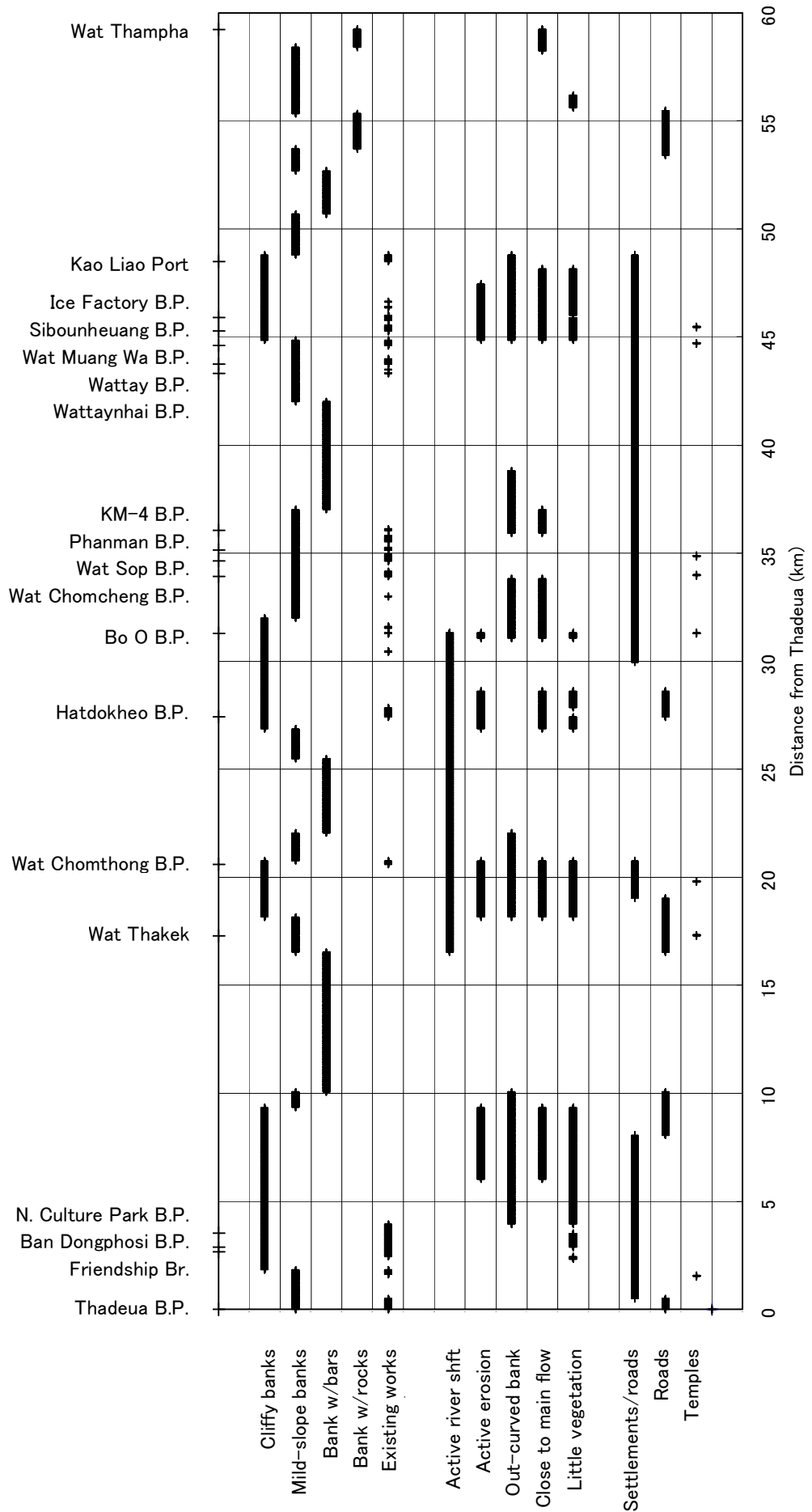
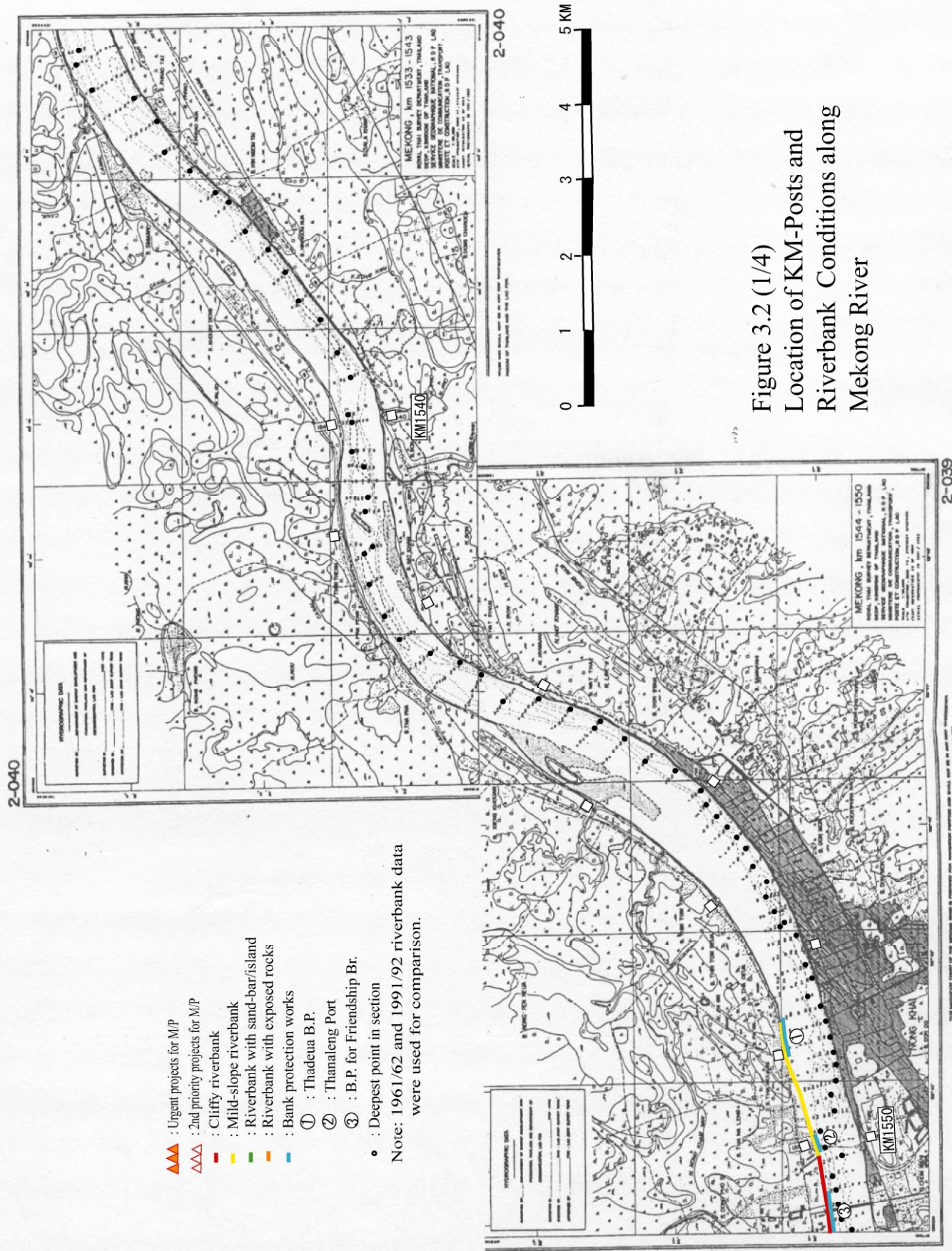


Figure 3.1 Summary of Riverbank Conditions



- ▲▲▲ : Urgent projects for M/P
- ▲▲▲ : 2nd priority projects for M/P
- ▲▲▲ : Cliffy riverbank
- : Mild-slope riverbank
- : Riverbank with sand-bar/island
- : Riverbank with exposed rocks
- : Bank protection works
- ① : Thadeua B.P.
- ② : Thanaleng Port
- ③ : B.P. for Friendship Br.
- : Deepest point in section

Note: 1961/62 and 1991/92 riverbank data were used for comparison.

Figure 3.2 (1/4)
 Location of KM-Posts and
 Riverbank Conditions along
 Mekong River

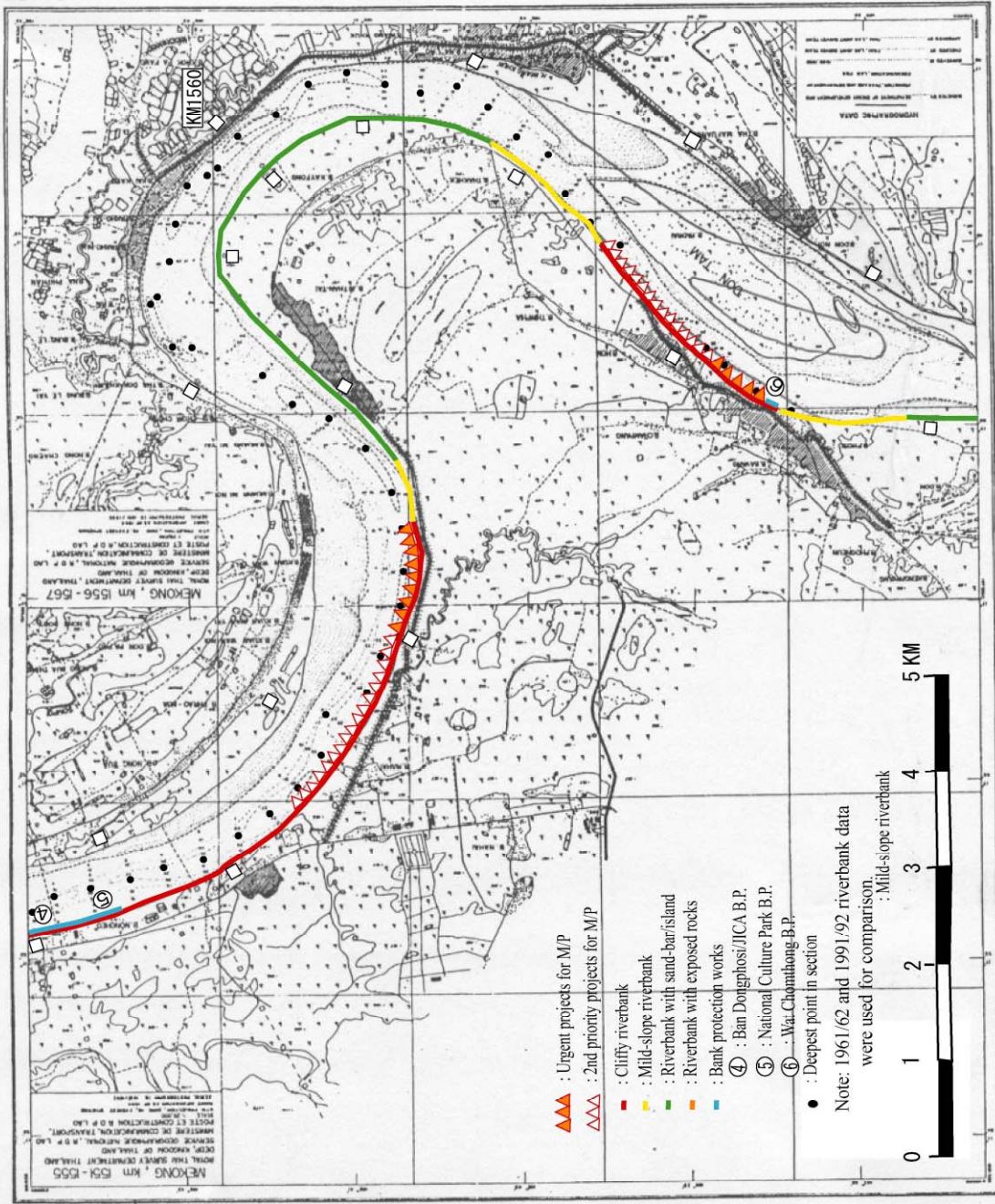
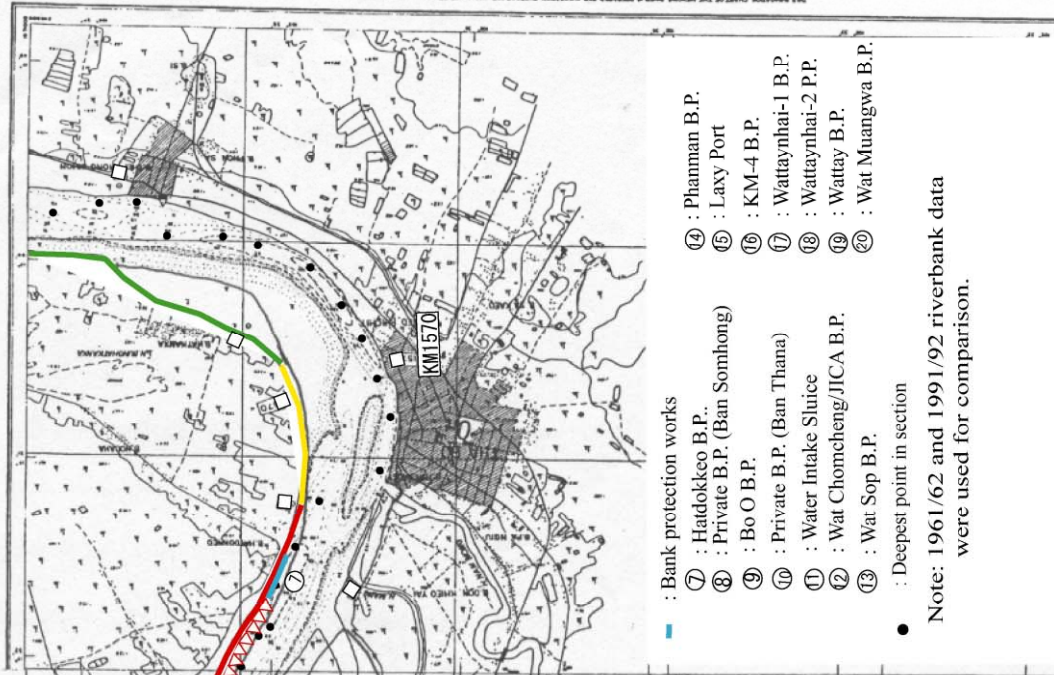


Figure 3.2(2/4) Location of KM-Posts and Riverbank Conditions along Mekong River

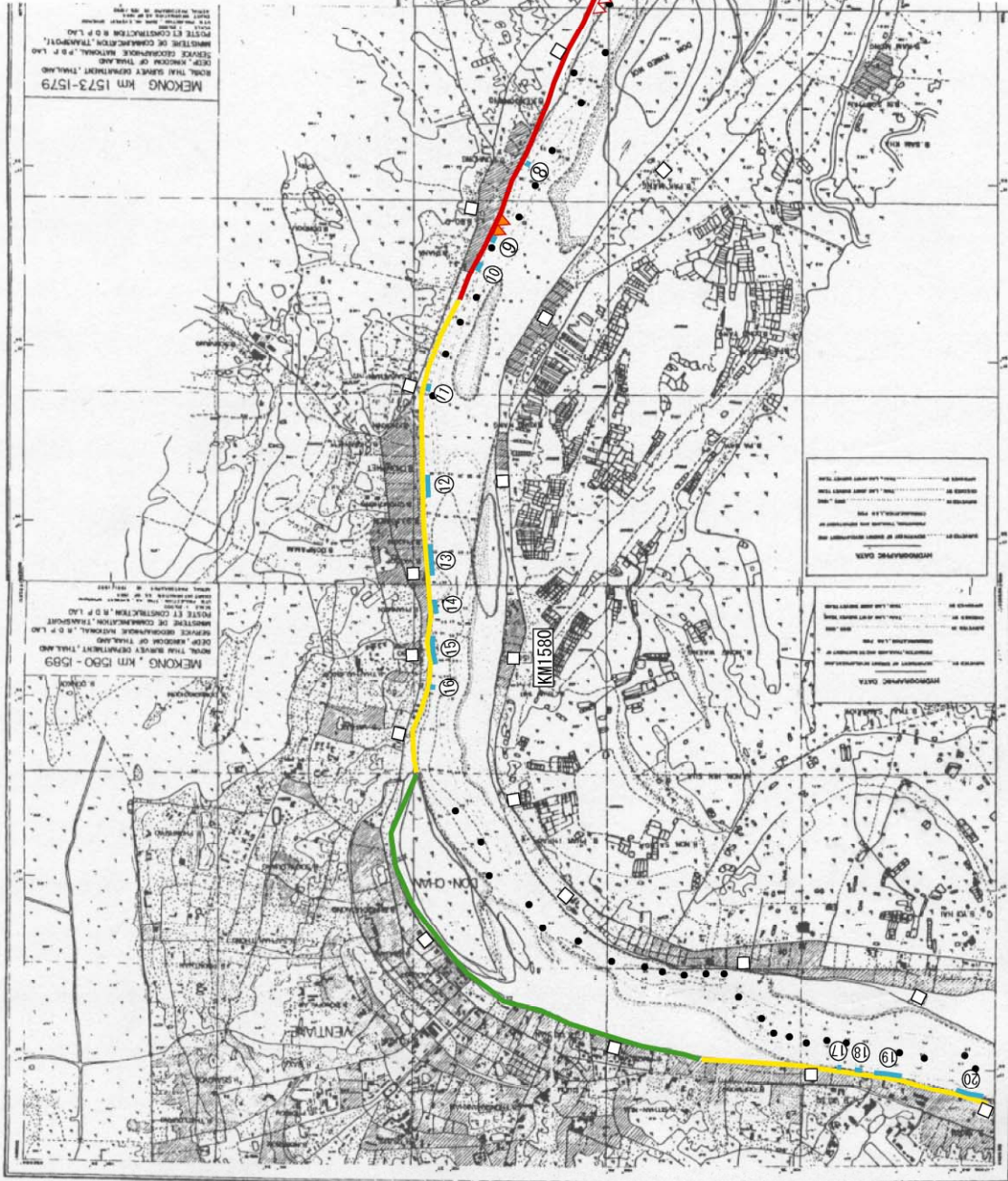


- ▲ : Urgent projects for M/P
- ▲▲ : 2nd priority projects for M/P
- ▲▲▲ : Clifty riverbank
- : Mild-slope riverbank
- : Riverbank with sand-bar/island
- : Riverbank with exposed rocks

- ⑦ : Haidokko B.P.
- ⑧ : Private B.P. (Ban Somhong)
- ⑨ : Bo O B.P.
- ⑩ : Private B.P. (Ban Thana)
- ⑪ : Water Intake Sluice
- ⑫ : Wat Chomcheng/JICA B.P.
- ⑬ : Wat Sop B.P.
- ⑭ : Phanman B.P.
- ⑮ : Laxy Port
- ⑯ : KM-4 B.P.
- ⑰ : Wattaynai-1 B.P.
- ⑱ : Wattaynai-2 P.P.
- ⑲ : Wattay B.P.
- ⑳ : Wat Muangwa B.P.

● : Deepest point in section

Note: 1961/62 and 1991/92 riverbank data were used for comparison.



- ▲ : Urgent projects for M/P
- ▲▲ : 2nd priority projects for M/P
- ▲▲▲ : Clifty riverbank
- : Mild-slope riverbank
- : Riverbank with sand-bar/island
- : Riverbank with exposed rocks

- ⑦ : Haidokko B.P.
- ⑧ : Private B.P. (Ban Somhong)
- ⑨ : Bo O B.P.
- ⑩ : Private B.P. (Ban Thana)
- ⑪ : Water Intake Sluice
- ⑫ : Wat Chomcheng/JICA B.P.
- ⑬ : Wat Sop B.P.
- ⑭ : Phanman B.P.
- ⑮ : Laxy Port
- ⑯ : KM-4 B.P.
- ⑰ : Wattaynai-1 B.P.
- ⑱ : Wattaynai-2 P.P.
- ⑲ : Wattay B.P.
- ⑳ : Wat Muangwa B.P.

● : Deepest point in section

Note: 1961/62 and 1991/92 riverbank data were used for comparison.

Figure 3.2 (3/4) Location of KM-Posts and Riverbank Conditions along Mekong River

- ▲▲▲ : Urgent projects for M/P
- ▲▲▲ : 2nd priority projects for M/P
- : Cliffy riverbank
- : Mild-slope riverbank
- : Riverbank with sand-bar/island
- : Riverbank with exposed rocks
- : Bank protection works

- ① : Sibounheuang/JICA B.P.
- ② : Sibounheuang/IDI B.P.
- ③ : Sibounheuang B.P.
- ④ : B.P. for Water Intake Tower
- ⑤ : Private B.P. (Ice Factory)
- ⑥ : Private B.P. (Ban Sibounheuang)
- ⑦ : Private B.P. (Mekong Breeze H.)
- ⑧ : Kaoliao Port

● : Deepest point in section
 Note: 1961/62 and 1991/92 riverbank data were used for comparison.

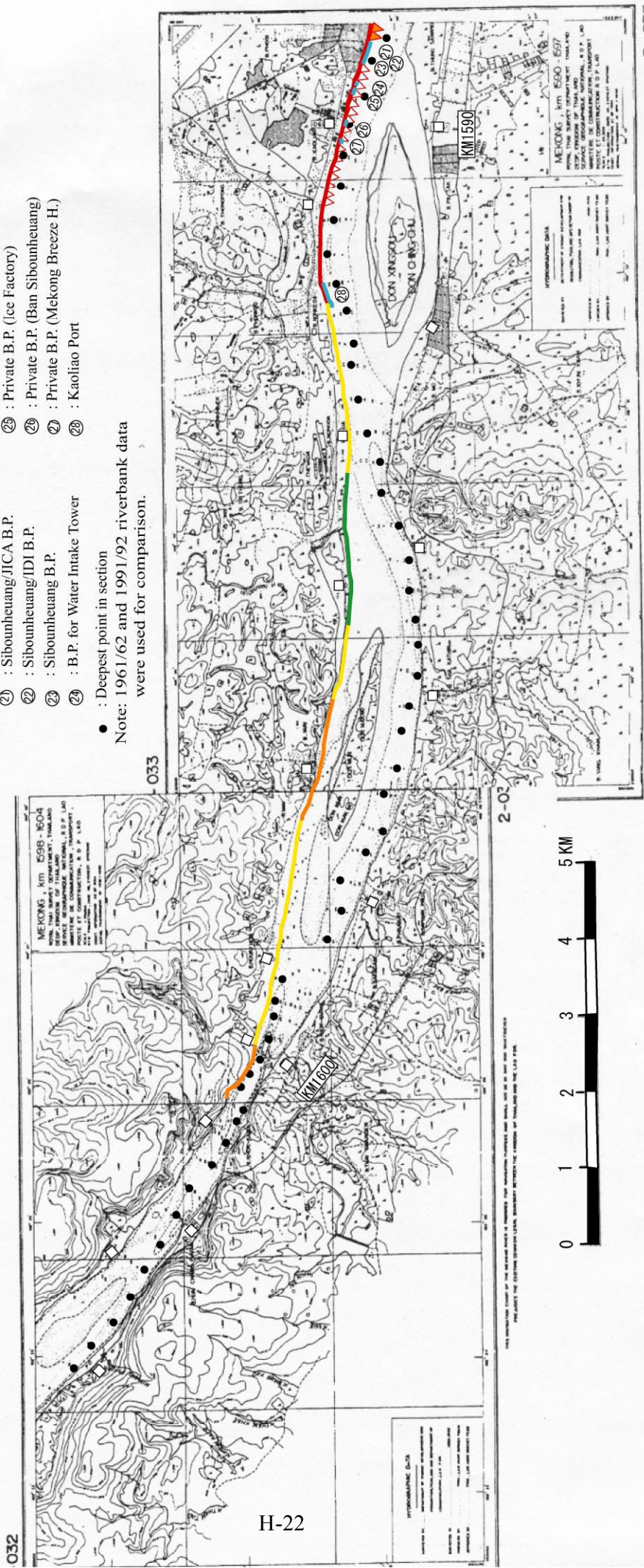


Figure 3.2 (4/4) Location of KM-Posts and Riverbank Conditions along Mekong River

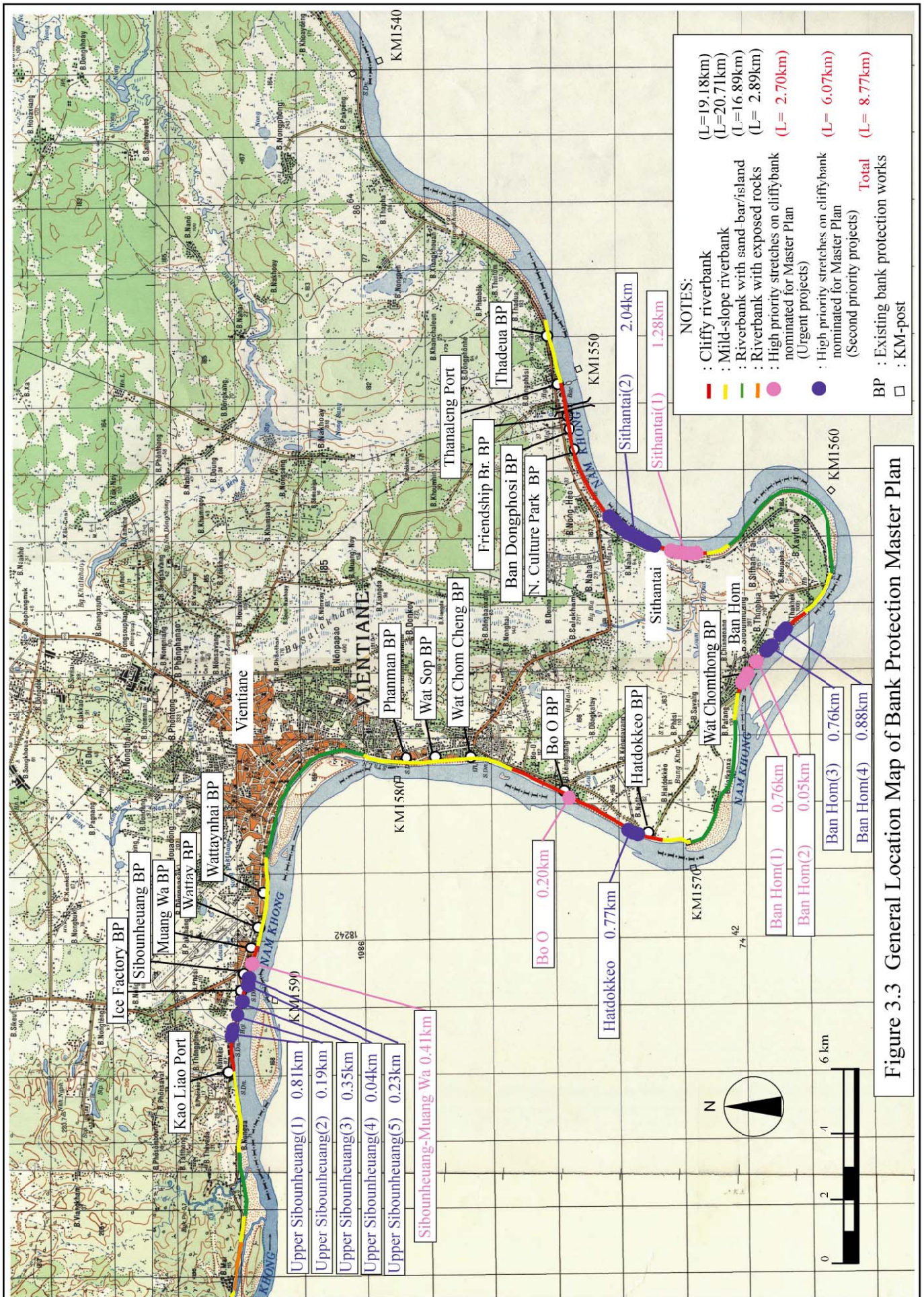


Figure 3.3 General Location Map of Bank Protection Master Plan

Table 3.2 (1/3) Existing Riverbank Protection Works (Thadeua – Wat Thampha)

(As of January, 2004)

No.	Facility	Location	Constructed Year	Length (m)	Type	Condition	Source of Fund	Remark
1	DCTPC B.P. (Thadeua)	0.00 km to 0.50 km At L.end N 17° 53.327, E 102° 44.291	1989/90 1992/93	500	Gabion w/ Reno mattress on the lower and upper slopes	Good w/sedimentation and vegetation	MRC/ Australia	1989/90: 250m 1992/93: 250m
2	Thanaleng Port	1.63 km to 1.84 km At L.end N 17° 53.072, E 102° 43.419		210	Concrete works w/rip-rap	Minor damages at the foot of slope.	-	
3	B.P. for Friendship Br. (Thanaleng)	2.45 km to 2.88 km At L.end N 17° 52.996, E 102° 42.935	1993/94	430	Reno mattress on the slope	Good w/sedimentation and vegetation	Australia	
4	JICA Pilot B.P. (Ban Dongphosi)	2.88 km to 3.53 km At L.end N 17° 52.957, E 102° 42.713	2002	650	Foot protection by soda mattress and slope protection by cobble stones w/willow branch	Good	JICA	
5	B.P. for National Culture Park	3.53 km to 3.95 km At L.end N 17° 52.889, E 102° 42.360	1996/97 1997/98	420	Gabion wall and slope protection works by gabion w/Reno mattress	Good	National budget	1996/97: 420m(lower slope) 1997/98: 400m(upper slope)
6	DCTPC B.P. (Wat Chomthong)	20.61 km to 20.77 km At 65m u/s of L.end N 17° 50.014, E 102° 38.232	2003	160	Rip-rap works on the lower slope	Good	Private	
7	DCTPC B.P. (Hatdokkae)	27.42 km to 27.85 km N 17° 51.559, E 102° 35.742 at L.end	1996/97 2000	430	Gabion w/Reno mattress on the slope	Severe scouring at the foot of bank protection works	EU	1996/97: 30m 2000: 400m
8	Private B.P. (Ban Somhong)	30.43 km to 30.48 km N 17° 53.024, E 102° 36.423 at L.end	1998	50	Wet masonry	Slope works under repair	Private	
9	DCTPC B.P. (Bo O)	31.27 km to 31.33 km N 17° 53.393, E 102° 36.615 at L.end	2003	60	Rip-rap works for the protection of foot of slope	Good	National budget	

(Remarks)

1. L.end/U.end: GPS–Coordinates of existing works at the lower/upper end of structure
 2. B.P.: Bankprotection works, MRC: Mekong River Committee
 3. Length of structures: Based on data from MCTPC and DCTPD and field measurements by portable distance meter
- DCTPC(m): 3,135
 JICA and ID(m): 1,125
 Private(m): 345
 Other works(m): 905
 (Total in m) 5,510

Table 3.2 (2/3) Existing Riverbank Protection Works (Thadeua – Wat Thampha)

(As of January, 2004)

No.	Facility	Location	Constructed Year	Length (m)	Type	Condition	Source of Fund	Remark
10	Private B.P. (Ban Thana)	31.53 km to 31.62 km N 17°53.616, E 102°36.713 at U. end	2003	90	Gabion wall and slope protection works by gabion w/Reno mattress	Good	Private	
11	Water intake sluice (Chinaimo)	32.98 km to 33.01 km N 17°45.291, E 102°37.007 at L. end		30	Concrete sluice for water intake	Good	-	
12	JICA Pilot B.P. (Wat Chom Cheng)	33.92 km to 34.16 km N 17°54.835, E 102°36.990 at 60m u/s of L. end	2002	240	Wooden pile groins (6) w/soda mattress	Good	JICA	
13	DCTPC B.P. (Wat Sop)	34.63 km to 34.95 km N 17°55.417, E 102°36.953 at 5m d/s of U. end	1997/98	320	Gabion works w/Reno mattress on the slope	Good	R.Korea and Australia	
14	DCTPC B.P. (Phanman)	35.13 km to 35.28 km N 17°55.499, E 102°36.942 at L. end	2000	150	Gabion w/Reno mattress on the slope and rip-rap w/dumped rocks at the toe	Good	National budget	
15	Laxy Port (KM-4)	35.52 km to 35.81 km N 17°55.702, E 102°36.929 at L. end		285	Concrete works for port	Minor damages at the foot of slope.	-	Constructed by the aid of Japan
16	DCTPC B.P. (KM-4)	36.05 km to 36.12 km N 17°55.997, E 102°36.947 at L. end	2003	70	Gabion works w/Reno mattress for upper slope and rip-rap works for lower slope	Good	National budget	Near residences of Vice-Minister
17	DCTPC B.P. (Wattaynhai-1)	43.31 km to 43.35 km N 17°58.089, E 102°34.470 at L. end	2003	35	Rip-rap works on the slopes	Good	National budget	
18	DCTPC B.P. (Wattaynhai-2)	43.49 km to 43.51 km N 17°58.104, E 102°34.389 at L. end	2003	20	Rip-rap works on the slopes	Good	National budget	

(Remarks)

1. L. end/U. end: GPS-Coordinates of existing works at the lower/upper end of structure
 2. B.P.: Bankprotection works, MRC: Mekong River Committee
 3. Length of structures: Based on data from MCTPC and DCTPD and field measurements by portable distance meter
- DCTPC(m): 3,135
 JICA and ID(m): 1,125
 Private(m): 345
 Other works(m): 905
 (Total in m) 5,510

Table 3.2 (3/3) Existing Riverbank Protection Works (Thadeua – Wat Thampha)

(As of January, 2004)

No.	Facility	Location	Constructed Year	Length (m)	Type	Condition	Source of Fund	Remark
19	DCTPC B.P. (Wattay)	43.74 km to 43.99 km N 17°58.118, E 102°34.278 at L.end	1995/96	250	Gabion wall and slope protection works by gabion w/Reno mattress	Good	MRC/ Australia	
20	DCTPC B.P. (Wat Muangwa)	44.61 km to 44.86 km N 17°58.220, E 102°33.678 at U.end	1996/97	250	Gabion wall and slope protection works by gabion w/Reno mattress	Good w/sedimentation	MRC/ Australia	
21	JICA Pilot B.P. (Sibounheang)	45.27 km to 45.43 km N 17°58.279, E 102°33.460 at L.end	2002	155	Protection of lower slope by cobble stone with willow branch works and foot protection by soda mattress	Good	JICA	Adjacent to IDI site
22	IDI Pilot B.P. (Sibounheang)	45.43 km to 45.51 km N 17°58.304, E 102°33.370 at L.end	2001	80	Gabion wall w/rip-rap works and foundation w/soda mattress works	Good w/sedimentation	IDI-Japan	
23	DCTPC B.P. (Sibounheang)	45.51 km to 45.55 km N 17°58.314, E 102°33.328 at L.end	2002	40	Sand bag worksfor upper slope and rip- rap works for lower slope	Good	National budget	
24	B.P. for Water Intake Tower	45.78 km to 45.86 km N 17°58.351, E 102°33.183 at L.end		80	Bank protection works by concrete blocks and gabion for intake tower		-	Tower was constructed by the aid of Japan.
25	Private B.P. (Ice Factory)	45.90 km to 46.01 km N 17°58.380, E 102°33.092 at L.end	1995	110	Gabion wall and slope protection works by gabion w/Reno mattress	Good	Private	
26	Private B.P. (Ban Sibounheang)	46.36 km to 46.42 km N 17°58.450, E 102°32.856 at L.end	2003	55	Gabion wall and slope protection works by gabion w/Reno mattress	Good	Private	
27	Private B.P. (Mekong Breeze H.)	46.61 km to 46.65 km N 17°58.489, E 102°32.684 at L.end	2002	40	Rip-rap works	Good	Private	
28	Kao Liao Port	48.50 km to 48.80 km N 17°58.590, E 102°31.648 at L..end	1990 1997	300	Concrete, masonry and rip-rap works	Minor damage at the foot of slope.	-	1997: Repaired by DCTPC

(Remarks)

1. L.end/U.end: GPS—Coordinates of existing works at the lower/upper end of structure
2. B.P.: Bankprotection works, MRC: Mekong River Committee
3. Length of structures: Based on data from MCTPC and DCTPD and field measurements by portable distance meter

DCTPC(m): 3,135
 JICA and IDI(m): 1125
 Private(m): 345
 Other works(m): 905
 (Total in m) 5,510

Table 3.3 (1/4) Selection of Priority Sites for Bank Protection Works

Distance (km)	Initial screening					Secondary screening					Tertiary screening			Stretch length (km)	2005/6 -2009/10	2010/11 -2019/20	Location (KM-post)	High Priority Stretches nominated for M/P	Remarks
	1A	1B	1C	1D	1E	2A	2B	2C	2D	2E	3A	3B	3C						
0.00	1				1							1		0			KM- 1547 + 1.83 km		Thadeua BP
0.50	1				0						1		0				KM- 1549 + 0.04 km		Wat
1.53	1				0						1		0				KM- 1549 + 1.07 km		
1.58	1				0						1		0				KM- 1549 + 1.12 km		
1.63	1				1						1		0				KM- 1549 + 1.17 km		Thanaleng Port
1.84	1				1						1		0				KM- 1550 + 0.10 km		
2.34	1				1						1		0				KM- 1550 + 0.60 km		Friendship Br.BP
2.45	1				1						1		0				KM- 1550 + 0.71 km		Friendship Br.
2.66	1				1						1		0				KM- 1550 + 0.92 km		BanDongphosi BP
2.88	1				1						1		0				KM- 1550 + 1.14 km		N.Culture Park BP
3.53	1				1						1		0				KM- 1551 + 0.58 km		
3.95	1				1						1		0				KM- 1551 + 1.00 km		
6.03	1				1						1		1				KM- 1553 + 0.85 km	Sithantai (2)	
8.07	1				1						1		1				KM- 1555	Sithantai (1)	
9.35	1				0						1		0				KM- 1555 + 1.28 km		
10.07	1				0						1		0				KM- 1555 + 2.00 km		
16.54	1				0						1		0				KM- 1561 + 1.41 km		
17.28	1				0						1		1				KM- 1563 + 0.27 km		Wat Thakek
17.33	1				0						1		0				KM- 1563 + 0.32 km		
18.16	1				1						1		1				KM- 1563 + 1.15 km	Ban Hom (4)	
19.04	1				1						1		1				KM- 1563 + 2.03 km	Ban Hom (3)	
19.80	1				1						1		1				KM- 1565 + 0.33 km	Ban Hom (2)	Wat Tong That
19.85	1				1						1		1				KM- 1565 + 0.38 km	Ban Hom (1)	
20.61	1				1						1		0				KM- 1565 + 1.14 km		Wat Chomthong BP
20.77	1				0						1		0				KM- 1565 + 1.30 km		
22.06	1				0						1		0				KM- 1565 + 2.59 km		

(NOTES)

1. Initial screening: General bank conditions

- 1A: Cliffy bank
- 1B: Mild-slope bank
- 1C: Bank w/bars
- 1D: Bank w/rocks
- 1E: Bank w/protection works

2. Secondary screening: Vulnerability to erosion:

- 2A: Active river shifting
- 2B: Recent active erosion
- 2C: Out-curved bank
- 2D: Close to main flow
- 2E: Bank w/little vegetation

3. Tertiary screening: Social importance:

- 3A: Settlements (incl. roads)
- 3B: Roads
- 3C: Temples

* Riverbank marked as "1" passed the screening and that marked as "0" was screened out.

Table 3.3 (2/4) Selection of Priority Sites for Bank Protection Works

Distance (km)	Initial screening					Secondary screening					Tertiary screening			Stretch length (km)	2005/6 -2009/10	2010/11 -2019/20	Location (KM-post)	High Priority Stretches nominated for M/P	Remarks
	1A	1B	1C	1D	1E	2A	2B	2C	2D	2E	3A	3B	3C						
25.49	1				0	1								0			KM- 1569 + 0.57 km		
26.88	1	1			1	1	1	1	1	1				0			KM- 1571 + 0.54 km		Hatdokka BP
27.42	1				0	1	1	1	1	1		1		0			KM- 1571 + 0.97 km		
27.85	1	1			1	1	1	1	1	1		1		1			KM- 1571 + 1.74 km		
28.62	1	1			0	1								0			KM- 1573 + 0.78 km		
29.96	1				0	1								0			KM- 1573 + 1.25 km		Ban Somhong BP
30.43	1				0	1								0			KM- 1573 + 1.30 km		
30.48	1	1			1	1	1	1	1	1				0			KM- 1575 + 0.01 km		
31.07	1	1			1	1	1	1	1	1				1			KM- 1575 + 0.21 km		Bo O
31.27	1				0	1	1	1	1	1				0			KM- 1575 + 0.22 km		Bo O BP
31.28	1				0	1	1	1	1	1		1		0			KM- 1575 + 0.27 km		Wat Bo O
31.33	1	1			1	1	1	1	1	1				0			KM- 1575 + 0.47 km		Ban Thana BP
31.53	1				0	1	1	1	1	1				0			KM- 1575 + 0.56 km		
31.62	1	1			1	1	1	1	1	1				0			KM- 1575 + 0.94 km		
32.00					0	1	1	1	1	1				0			KM- 1577		Chinamo Sluice
32.98	1				0	1	1	1	1	1				0			KM- 1577 + 0.03 km		
33.01	1				0	1	1	1	1	1				0			KM- 1577 + 0.85 km		
33.83	1				0	1	1	1	1	1				0			KM- 1577 + 0.94 km		
33.92	1				0	1	1	1	1	1				0			KM- 1577 + 0.98 km		
33.96	1				0	1	1	1	1	1		1		0			KM- 1577 + 1.03 km		
34.01	1				0	1	1	1	1	1				0			KM- 1577 + 1.18 km		
34.16	1				0	1	1	1	1	1				0			KM- 1577 + 1.65 km		Wat Chomcheng BP
34.63	1				0	1	1	1	1	1				0			KM- 1577 + 1.87 km		Wat Chomcheng
34.85	1				0	1	1	1	1	1		1		0			KM- 1579 + 0.02 km		Wat Sop BP
34.90	1				0	1	1	1	1	1				0			KM- 1579 + 0.07 km		Wat Sop
34.95	1				0	1	1	1	1	1				0					

(NOTES)

1. Initial screening: General bank conditions

- 1A: Clifty bank
- 1B: Mild-slope bank
- 1C: Bank w/bars
- 1D: Bank w/rocks
- 1E: Bank w/protection works

2. Secondary screening: Vulnerability to erosion:

- 2A: Active river shifting
- 2B: Recent active erosion
- 2C: Out-curved bank
- 2D: Close to main flow
- 2E: Bank w/little vegetation

3. Tertiary screening: Social importance:

- 3A: Settlements (incl. roads)
- 3B: Roads
- 3C: Temples

* Riverbank marked as "1" passed the screening and that marked as "0" was screened out.

Table 3.3 (3/4) Selection of Priority Sites for Bank Protection Works

Distance (km)	Initial screening					Secondary screening					Tertiary screening			Stretch length (km)	2005/6 -2009/10	2010/11 -2019/20	Location (KM-post)	High Priority Stretches nominated for M/P	Remarks
	1A	1B	1C	1D	1E	2A	2B	2C	2D	2E	3A	3B	3C						
35.13	1										0	1	0	0	0.15			KM- 1579 + 0.25 km	Phanman BP
35.28	1										0	1	0	0	0.24			KM- 1579 + 0.40 km	Laxy Port
35.52	1										0	1	0	0	0.29			KM- 1579 + 0.64 km	
35.81	1										0	1	0	0	0.12			KM- 1580 + 0.08 km	
35.93	1							1	1		0	1	0	0	0.12			KM- 1580 + 0.20 km	
36.05	1							1	1		0	1	0	0	0.07			KM- 1580 + 0.32 km	
36.12	1							1	1		0	1	0	0	0.90			KM- 1580 + 0.39 km	
37.02	1							1			0	1	0	0	1.80			KM- 1581 + 0.42 km	KM-4 BP
38.82	1										0	1	0	0	3.19			KM- 1583	
42.01	1										0	1	0	0	1.30			KM- 1585 + 0.96 km	Wattaynhai-1 BP
43.31	1										0	1	0	0	0.04			KM- 1587 + 0.25 km	
43.35	1										0	1	0	0	0.14			KM- 1587 + 0.29 km	
43.49	1										0	1	0	0	0.02			KM- 1587 + 0.43 km	Wattaynhai-2 BP
43.51	1										0	1	0	0	0.23			KM- 1587 + 0.45 km	
43.74	1										0	1	0	0	0.25			KM- 1587 + 0.68 km	Wattay BP
43.99	1										0	1	0	0	0.62			KM- 1587 + 0.93 km	
44.61	1										0	1	0	0	0.07			KM- 1587 + 1.55 km	Wat Muang Wa BP
44.68	1										0	1	0	0	0.05			KM- 1587 + 1.62 km	Wat Muang Wa
44.73	1										0	1	0	0	0.13			KM- 1587 + 1.67 km	
44.86	1							1	1	1	1	1	1	1	0.41	0.00		KM- 1587 + 1.80 km	Sibounheuang-Muang Wa
45.27	1							1	1	1	0	1	0	0	0.16			KM- 1589 + 0.28 km	Sibounheuang BP: JICA
45.43	1							1	1	1	0	1	0	0	0.01			KM- 1589 + 0.44 km	Sibounheuang BP: IDI
45.44	1							1	1	1	0	1	0	1	0.05			KM- 1589 + 0.45 km	Wat Sibounheuang
45.49	1							1	1	1	0	1	0	0	0.02			KM- 1589 + 0.50 km	
45.51	1							1	1	1	0	1	0	0	0.04			KM- 1589 + 0.52 km	Sibounheuang BP
45.55	1							1	1	1	1	1	1	1	0.23	0.23		KM- 1589 + 0.56 km	Upper Sibounheuang (5)

(NOTES)

1. Initial screening: General bank conditions

- 1A: Clifty bank
- 1B: Mild-slope bank
- 1C: Bank w/bars
- 1D: Bank w/rocks
- 1E: Bank w/protection works

2. Secondary screening: Vulnerability to erosion:

- 2A: Active river shifting
- 2B: Recent active erosion
- 2C: Out-curved bank
- 2D: Close to main flow
- 2E: Bank w/little vegetation

3. Tertiary screening: Social importance:

- 3A: Settlements (incl. roads)
- 3B: Roads
- 3C: Temples

* Riverbank marked as "1" passed the screening and that marked as "0" was screened out.

3.3 Screening and Selected Riverbanks

3.3.1 Initial Screening

Riverbanks Requiring Works: As discussed in the previous sub-section, the cliffy riverbanks (19.18 km) need to be protected by the government. The mild-slope riverbanks (20.71 km) will be conserved with an approach by people's involvement. The riverbanks with sand-bar/island and exposed rock (19.35 km) would not require specific bank protection works. Stretches of the cliffy riverbank are listed below.

- 1) B. Dongphosi - B. Sithantai: 7.51 km
(From KM-1550 + 0.10 km to KM-1555 + 1.28 km)
- 2) Ban Hom: 2.61 km
(From KM-1563 + 1.15 km to KM-1565 + 1.30 km)
- 3) B. Hatdokkeo – u/s Bo O: 5.12 km
(From KM-1571 + 0.00 km to KM-1575 + 0.94 km)
- 4) Muang Wa – Kao Liao Port: 3.94 km
(From KM-1587 + 1.80 km to KM-1591 + 1.34 km)

Existing Works: Out of the total riverbank length of 59.24 km, a total length of 5.51 km has already been protected by protection works and other structures of port and water intake. These existing works are listed in Table 3.1 and summarized below.

1) Bank protection works	
Work of GOL:	3.135 km (1.540 km)
Pilot works by IDI & JICA:	1.125 km (0.885 km)
Private works:	0.345 km (0.345 km)
2) Other works (ports & intakes):	0.905 km (0.380 km)
Total	5.510 km (3.150 km)

In the above table, length in () shows the total length of existing work located in the stretches of the cliffy riverbank.

Result of Initial Screening: A total of 16.03 km of cliffy riverbanks has passed the initial screening, eliminating the total length of existing works (3.15 km) as follows (Table 3.3):

	Cliffy bank	Existing work	Passed (1)
1) B. Dongphosi - B. Sithantai:	7.51 km	1.50 km	6.01 km
2) B. Hom:	2.61 km	0.16 km	2.45 km
3) B. Hatdokkeo - Bo O:	5.12 km	0.63 km	4.49 km
4) Muang Wa - Kao Liao Port:	3.94 km	0.86 km	3.07 km
Total	(19.18 km)	(3.15 km)	(16.03 km)

3.3.2 Secondary Screening

Evaluation: The riverbanks were evaluated from various evaluation items regarding the vulnerability to erosion. The following five items were taken up for the evaluation:

Active river shifting

- 1) Recent active erosion
- 2) Out-curved bank
- 3) Close to main flow
- 4) Bank with little vegetation

According to the marking result for each segment riverbank, the riverbanks which meet with more than four items were considered to pass the tertiary screening, and those less than three items were screened out.

Result of Secondary Screening: A total of 9.31 km riverbank has passed the secondary screening as follows (Table 3.3):

	Cliffy bank	Passed (2)
1) B. Dongphosi - B. Sithantai:	7.51 km	3.32 km
2) B. Hom:	2.61 km	2.45 km
3) B. Hatdokkeo - Bo O:	5.12 km	1.51 km
4) Muang Wa - Kao Liao Port:	3.94 km	2.03 km
Total	(19.18 km)	(9.31 km)

3.3.3 Tertiary Screening

Evaluation: The erosion vulnerable riverbanks of 9.31 km are further subject to screening from the aspect of social importance. The evaluation items of this aspect are whether the settlements or public roads are located within the damageable distance or not. If yes, the bank should be given higher priority for protection.

Result of Tertiary Screening: A total of 8.77 km of critical banks were finally selected as a result of tertiary screening as follows (Table 3.3):

	Cliffy bank	Passed (3)
1) B. Dongphosi - B. Sithantai:	7.51 km	3.32 km
2) B. Hom:	2.61 km	2.45 km
3) B. Hatdokkeo - Bo O:	5.12 km	0.97 km
4) Muang Wa - Kao Liao Port:	3.94 km	2.03 km
Total	(19.18 km)	(8.77 km)

3.4 Arrangements for Implementation

Selected Priority Sties: Trough a series of screenings, the following riverbanks were selected for high priority stretches nominated for the Master Plan(Table 3.4):

Table 3.4 High Priority Stretches nominated for Master Plan

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

Locations of these riverbanks are shown in Figure 3.2, and they are also schematically presented in Figure 3.3. The MCTPC/DCTPC conducted surveys and/or design by themselves for some portions of the bank around Vientiane City as shown in Table 1.1. The sites selected for the Master Plan covers all the sites subjected to the survey/design by the MCTPC/DCTPC.

Arrangements for Implementation: For the implementation of the works by the year 2020, the high priority stretches were divided into two project groups, i.e., Urgent Projects to be implemented immediately and Second Priority Projects to be implemented after the completion of the Urgent Projects.

The riverbanks extending 2.70 km in total were tentatively proposed as the Urgent Projects as shown in Table 3.5.

Table 3.5 Urgent Projects for Immediate Implementation

Site Name	Location by KM post	Urgent Projects	Length (meter)
Sithantai	From KM-1555+0.00km To KM-1555+1.28km	Sithantai (1)	1,280
Ban Hom	From KM-1565+0.33km To KM-1565+1.14km	Ban Hom (1) Ban Hom (2)	760 50
Bo O	From KM-1575+0.01km To KM-1575+0.21km	Bo O	200
Sibounheuang - Muang Wa	From KM-1587+1.80km To KM-1589+0.28km	Sibounheuang - Muang Wa	410
Total			2,700

These sites were selected considering seriousness of bank erosion and possible damage under the present river conditions. The work sites for the respective year should be specified according to the urgency of work implementation of the works judging from the current site conditions as follows:

- Sites where serious bank-erosion damages took place during these flood seasons,
- Sites where important building and/or facilities were newly constructed on the erosion-vulnerable bank, and
- Sites, which are anticipated to induce serious erosion damages in near future.

Riverbanks for the Second Priority Projects are estimated to be 6.07 km in total. Completion of these works is targeted by the year of 2020, but would be subject to change mainly due to the progress of works and the fund available for the work in future.

3.5 Repair of Existing Bank Protection Works

Aside from the bank protection works to be constructed newly, maintenance activities and/or rehabilitation works for the existing works and those to be constructed are also important to sustain the bank protection function.

At present, existing bank protection works at Hatdokkeo and National Culture Park are damaged at their foot. Especially the damages of bank protection works at Hatdokkeo are serious, though they are partly repaired by rip-rap works.