Table D.2 Proposed Barrier Along Klong Tub Chang Bon

| | | |
|---|---|---|
| Barrier Type | : | Earth embankment with slope protection of Sodding |
| Height | : | 1.3 m |
| Width | : | 5.0 m |
| Slope | : | 1:2 |

## 2. PUMPING STATION

5 pumping stations; Lao, Huay Kwang, Bang Nang Chine, Ban Lai and Klet are proposed in the Feasibility Study. The pump capacity and operational water levels of these pumping stations resulted from hydraulic analysis are shown in the following table.

Table D.3 Proposed Pump Capacity and Design Water Level

(unit: m MSL)

| Pumping Station | | Operation L.W.L. | Discharge H.W.L. | Klong Bed Level |
|---|---|---|---|---|
| Huay Kwang | (3 $m^3/s$) | - 0.800 | +0.900 | -1.300 |
| Saen Sab | (9 $m^3/s$) | - 0.800 | +0.200 | -2.500 |
| Bang Nang Chine | (9 $m^3/s$) | - 0.800 | -0.180 | -2.430 |
| Ban Lai | (6 $m^3/s$) | - 0.800 | -0.165 | -2.500 |
| Klet | (9 $m^3/s$) | - 0.800 | -0.160 | -2.600 |

* *Water levels are indicated under the present condition of ground level*

Based on the result of hydraulic analysis, the facility planning of the pumping station is carried out and the proposed facilities are summarized in Table D.4. Maijor points considered for the planning are as follows:

(1) Equipment Type of Pump

In view point of the operational and functional conditions of pumps, existing pumping stations controlled by DDS and RID are classified into the following 3 types. (Refer to Table D.5)

a) Movable pump type (Capacity per unit: 0.01-2.00 $m^3/s$)

Only during raining season, this type of pump is installed in the pumpwell, therefore, this is of temporary nature, of the low cost and operation/maintenance easiness. Durable year of pump equipment is 7-10 years according to past experience.

b) Urgent pump type (Capacity per unit: 3.0 $m^3/s$)

In the urgent program in 1984, submersible pump having 3.0 $m^3/s$ capacity were adopted and constructed. Total pump capacity of 202 $m^3/s$ is for the Eastern Suburban Bangkok. The construction cost of this type is about one-fourth of the permanent type. Durable life of pump seems 7-15 years.

c) Permanent pump type (Capacity per unit: 5.0 $m^3/s$)

This type (mixed flow) of pump equipment was adopted for Rama IV and Padung krung Kasem pumping stations constructed in 1970 and 1972 respectively. Except engine trouble for the Rama IV pumping station, there has been no serious problem for operation/maintenance since their construction. Durable year is assumed approximately 20 years.

Taking the above existing conditions, construction cost, economic life, operation/maintenance easiness and etc. into consideration, the submersible pump of the urgent type is adopted. Major considerations for the selection of this type are as follows:

1) Construction cost is very low although economic life of submersible type is expected approximately 7-15 years.

2) To meet the site condition (difficulty of land acquisition).

3) Due to land subsidence at the site, the design of permanent type pump is rather difficult and such type of pump is very costly.

4) To harmonize with existing pumping station constructed by urgent program.

(2) Power Source of Pump Operation

As the alternatives of pump power source, electrical motor driven type and diesel engine driven type are studied. Comparing the both types, the electrical motor driven type is adopted taken into account the availability of electricity supply in Bangkok, operation and maintenance, the problems occured in the past.

(3) Number of Pump Units to be installed

In view of the pump operation and maintenance, the pump units installed in a station are proposed 2 to 3 units with discharge capacity of 1.5 $m^3/s$ to 3 $m^3/s$. Table D.4 shows the proposed capacity and unit for the 5 proposed stations.

(4) Automatic Screen

For the protection of the pump and maintaining the high discharge efficiency, automatic screen is proposed to be installed at the intake pit.

(5) Civil Works

In view of the weak subsoil conditions and land subsidence, pile foundation is planned to support the pump facilities. The piles have to be driven into the stiff clay layer, about 20 meters below ground surface. Moreover, against the differencial settlement due to the land subsidence and seepage failure caused by different water levels of up and down-streams, cut-off wall is planned to be provided.

Table D.4 Proposed Pumping Station

| Name | Capacity per set ($m^3/s$) | No. | Total Capacity ($m^3/s$) | Pump type |
|---|---|---|---|---|
| Bang Nang Chine | 3.0 | 3 | 9.0 | axial flow submersible |
| Ban Lai | 3.0 | 2 | 6.0 | " |
| Klet | 3.0 | 3 | 9.0 | " |
| Lao | 3.0 | 3 | 9.0 | " |
| Huay Kwang | 1.5 | 1 | 3.0 | " |

3. Gate

Existing gates are classified into wooden gate, sluice gate and swing gate. Swing gate in the past had some problems in operation and maintenance work and has not been constructed in recent years. Wooden gate used only for small size gate is low in construction cost but has short durability.

On the other hand, sluice gate has already been constructed in many sites and is reported to be functionarily satisfactory. Therefore, sluice gate is adopted. Location of proposed gates are shown in Fig. D.1 and D.5.

The standard gate width of 6.0 m is adopted and the gate leaf having roller is made of steel.

Proposed Gate

| Name of Gate | Width, Height of Gate (m) | No. | Gate Type | Klong Width (m) |
|---|---|---|---|---|
| Song | 6 x 5 | 1 | Sluice | 32.0 |
| Lolae | 6 x 6 | 1 | Sluice | 15.0 |
| Saen Saeb | 6 x 6 | 1 | Sluice | 42.0 |
| Phra Khanong | 6 x 6 | 1 | Sluice | 35.0 |

Table D.5 Existing Pump Controlled by DDS and RID

| Type of Pump (According to Function) | No. of Unit | Pump Size | Capacity per Unit | Maintenance Trouble |
|---|---|---|---|---|
| | Unit | mm | m3/s | |
| (1) Movable Type | 430 | ϕ 100 - ϕ 1,100 | 0.01 - 2.00 | There is no serious maintenance trouble for 30 units (ϕ600-ϕ1,000) of JICA Grant Aid Pumps in 1981.<br>Required over haul - 30 times/year among 230 submerged pump units<br>- 10 times/year among 200 diese pump units |
| (2) Pumps Installed by Urgent Programme (Submersible Type) | 118 | ϕ 1,200 | 3.00 | Operation/Maintenance trouble occured.<br>1) Upper bearing : for all units (118)<br>2) Moter Elect. Cable : 3 units (Phrakanong P.S.)<br>3) Bolt firing Motor : 1 units ( " )<br>4) Mechanical Seal<br>: 2 units among 6 units (Bang Oa P.S.)<br>: 2 " " 5 " (Bang Na P.S.)<br>: 2 " " 15 " (Phrakahanong P.S.)<br>: 2 " " 6 " (Sam Saen P.S.)<br>: 4 " " 13 " (P.S. Under RID) |
| (3) Permanent Type RamaIV Pumping Station (Vertical Mixed Flow) | 4 | ϕ 1,500 | 5.00 | Constructed in 1970<br>There is no serious problem except engine trouble (over haul) since several years ago. |
| (4) Permanent Type Padung Krung.Kasem Pumping Station (Horizontal Mixed Flow) | 5 | ϕ 1,500 | 5.00 | Constructed in 1972<br>There is no serious problem. |

## 4. Klong Improvement

Under the conditions of present klong network systems, hydrological and hydraulic analysis is carried out in Appendix C to evaluate the existing discharge and storage capacity of the klongs. As a result of the analysis, the necessary klong improvement is clarified in order to obtain the condition of almost no innundation in urbanized area for the design rainfall.

The improvement of the klongs is confined, in principle, to the existing klong right-of-way to avoid land acquisition as much as possible and two type (rectangular shape with retaining wall and trapezoidal shape with 1:2 slope) klong cross section are considered. Fig. D.6 shows flow chart of study on the klong improvement works.

Tables D.7 and D.8 summarize the klong improvement works, consisting of retaining wall and dreding. Main points considered for improvement planning are as follows:

1) Historically many houses have been constructed along the klong and it is practically difficult to widen the klong and to acquire the enough right of ways in the urbanized area owing to the social and economic impact. Therefore, the widening is confined to the existing klong and land acquisition for right-of-way is, in principle, limited.

   From the viewpoint of the klong improvement plan, however, it is desiable to set out the right of way in the both sides of klong for the maintenance of the klong and the emergency flood fighting.

   It is required to remove houses, illegally built within the right-of-way of klongs to avoid the disturbance of discharge and maintenance of klong.

2) As for the improvement planning in this stage, existing retaining walls are utilized as much as possible except timber wall and damaged or dangerous concrete wall. At the places needed dredging in front of existing retaining wall, the reconstruction is planned because of the structural weakness.

The proposed retaining wall having the rectangular section is classified as follows:

Table D.6 Classification of Retaining Wall Construction

| Classification | | Existing Retaining Wall | | Deepening |
|---|---|---|---|---|
| | | Type | Damage | |
| 1. | Utilizing Existing Wall | Conc. wall | Not damaged | Not planned |
| 2. | Reconstruction | Conc. wall | " | Planned |
| 2. | Reconstruction | Conc. wall | Damaged | - |
| 2. | Reconstruction | Timber wall | - | - |
| 3. | Construction | None of Wall | - | |

At present, in many places, due to siltation and dumped garbage the klong capacity is reduced. Therefore, it is required to dredge and clear up the klong. Considering the stability of retaining wall and embankment, however, it shall be carefull to lowering the klong bottom. Furthermore, remnant and superfluous structures have to be demolished and removed in order to maintain the proper function of the drainage system.

3) For the klongs which have or be able to acquire sufficient space, the trapezoidal section is adopted from the economical point of view.

For the strapezoidal section, three alternatives of typical sections are studied as shown in Fig.D.7 and the alternative A-2 is adopted which has sodding protection for the 1:2 side slope.

4) In case that the trapezoidal section can not be adopted because of difficulty in land acquisition, the rectangular section is adopted which requires the construction of retaining wall. For the design of retaining wall, several alternatives are studied i.e., concrete panel wall type, sheet pile type and gravity type as shown in Fig.D.7. And the concrete panel wall type and sheet pile type as shown in Fig.D.8 are adopted considering followings:

a) Concrete panel wall type

Under the soft soil conditions of the Bangkok clay, many types of retaining wall were constructed along the river and klongs. Among these types, the concrete panel wall type was adopted for the major part of the klong retaining wall.

Considering the past experience, construction cost and utilization of local materials, this concrete panel wall type is adopted in this project.

For the anchoring of this type, alternatives B-1 of Fig. D.7 (cantilever type) and B-4 (pile anchor type) are principally recommended taking into account the stability and reliability of the structure under the soft soil conditions. Bracing beam method (alternative B-2) is recommended for small klongs with width of less than 6 to 8 m. For the narrow places where anchoring in B-4 is difficult, batter pile method (alternative B-5) is recommendable although it is rather weak against land subsidence comparing with other types due to included batter pile.

b) Concrete sheet pile type

For the concrete panel wall type higher than 3.5 m sheet pile type is adopted due to stability problem.

For this type, alternatives as shown in Fig.D.7 are studied. From the view point of land acquisition, easiness of material purchase, construction cost, alternative C-1 of concrete sheet pile type is adopted. Anchoring is basically adopted same as the concrete panel wall type (B-4 type).

c) Gravity type

Gravity type has an advantage to the durability of the structure comparing with other types. However, since it will be costly type under the soft soil conditions, it is not recommendable in this study.

5) Drains

The project area is geometrically low and plain, and consequently gradient of drains to be installed is inevitably limited to lower values, 0.3% for instance. This brings the low flow velocity in the drains, and consequently sedimentation of of sand in the drains will occur. Thus the effective cross section of pipes will be largely reduced.

Furthermore, differential settlement of the pipes due to weak subsoils and land subsidence will promote sedimentation of sand by the change of gradience. Therefore, one of the most significant factors for the drain planning is to construct the firm foundation to avoid the differential settlement.

Considering above mentioned conditions, following 4 types of drain foundation are studied, and wooden ladder foundation and friction pile foundation are adopted for the drains

Typical sections for these types are shown in Fig. D.9.

1) Wooden Ladder Foundation

This method is to lay drains on the wooden ladder in order to distribute the loads, such as self weight of the pipe and weight of above soils, uniformly to the base ground. This foundation has been adopted, in the past for a long time, as a highly reliable pipe foundation in a weak subsoil.

2) Reinforced Concrete Panel Foundation

This foundation has been widely adopted in Thailand and its idea is fundamentally the same as wooden ladder foundation.

3) Soil Cement Foundation

This method is one of the subsoil improvement methods and is utilized as a pipe foundation. Improved subsoil is made by mixing the soil and cement at site in order to increase the strength of soils.

4) Friction Pile Foundation

For the construction of box culvert, friction pile foundation is preferable to be adopted preventing differential settlement of structure and subsoil.

For the installation of drains in case of crossing highway, horizontal jacking method is proposed at the crowded highway, where particularly open cut method is difficult to apply.

This method requires sufficient earth covering of min. 2.5 times of the pipe diameter, for avoiding the collapse of the ground surface. In this case manholes are to be installed on both sides of the road.

Standard cross sections of this method are shown in Fig.D.10.

Some of existing main and middle scale roads, which drain pipes with the diameter 600mm to 1500mm are installed, have been raised in elevation and ground elevation of these roads have become higher than the private land nearby.

In spite of the fact that, consequently, the storm water inlets of the drains installed on the road have been utilized only for drainage discharging on the road, existing drains from the private land are not fully fulfil the role.

The location and elevation of the inlet of the drain should be coodinated with the ground elevation of peripheral private land in order to discharge storm water smoothly on the both side of the road.

Table D.7 Summary of Proposed Retaining Wall and Dredging for Klong Improvement (1)

| Klong | Proposed Shape | Klong Length (m) | Retaining Wall Length (m) Exist. | Exist. Uti-lized | Re-const. | Const. | Dredging ($x10^3m^3$) | Land Acquisi-tion($m^2$) | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| Phra Khanong Polder (Priamary Facility) | | | | | | | | | |
| Phra Khanong | T,RC,RD | 7,600 | 5,360 | 810 | 1,980 | 3,010 | 74.7 | - | |
| | (T) | (3,900) | (2,620) | - | - | - | (38.1) | - | |
| | (R.C) | (2,000) | (1,440) | (810) | (680) | (2,610) | (12.5) | - | |
| | (R.D) | (1,700) | (1,300) | - | (1,300) | (400) | (24.1) | - | |
| | RC,RD | 3,600 | 1,490 | - | 1,490 | 2,100 | 91.9 | 1,100 | |
| Tan | (R.C) | (800) | (310) | - | (310) | (490) | (22.4) | - | |
| | (R.D) | (2,800) | (1,180) | - | (1,180) | (1,720) | (69.5) | (1,100) | |
| San Saeb | T,RC,RD | 7,400 | 7,980 | - | 6,940 | 4,260 | 186.1 | 11,700 | |
| | (T) | (1,800) | (1,060) | - | - | - | (47.9) | - | |
| | (R.C) | (1,600) | (1,860) | - | (1,860) | (1,340) | (38.0) | (1,500) | |
| | (R.D) | (4,000) | (5,060) | - | (5,080) | (2,920) | (100.2) | (10,200) | |
| Sub-Total (1) | | 18,600 | 14,830 | 810 | 10,410 | 9,380 | 352.7 | 12,800 | |
| | (T) | (5,700) | (3,680) | (-) | (-) | (-) | (86.0) | (-) | |
| | (R.C) | (4,400) | (3,610) | (810) | (2,850) | (4,440) | (72.9) | (1,500) | |
| | (R.D) | (8,500) | (7,540) | (-) | (7,560) | (4,940) | (193.8) | (11,300) | |
| Ramkhamhaeng Drainage Area | | | | | | | | | |
| Chit | R.A | 1,300 | - | - | - | 2,600 | 3.3 | - | |
| Gig | T,RA | 1,540 | 1,440 | 100 | 1,270 | 470 | 8.7 | - | |
| | (T) | (570) | - | - | - | - | (1.2) | | |
| | (RA) | (970) | (1,440) | (100) | (1,270) | (470) | (7.5) | | |
| Kacha | T,RA | 4,400 | 800 | - | 800 | 2,400 | 28.9 | - | |
| | (T) | (2,800) | - | - | - | - | (17.3) | | |
| | (RA) | (1,600) | (800) | - | (800) | (2,400) | (11.6) | | |
| Sub-Total (2) | | 7,240 | 2,240 | 100 | 2,070 | 5,470 | 40.9 | - | |
| | (T) | (3,370) | (-) | (-) | (-) | (-) | (18.5) | - | |
| | (RA) | (3,870) | (2,240) | (100) | (2,070) | (5,470) | (22.4) | - | |
| West Huay Kwang Drainage Area | | | | | | | | | |
| Sam Sen | T.RB | 6,200 | 3,300 | 2,600 | 500 | 1,300 | 20.0 | 2,700 | |
| | (T) | (5,100) | (2,400) | (2,200) | - | - | (12.5) | (2,700) | |
| | (RB) | (1,100) | (900) | (400) | (500) | (1,300) | (7.5) | - | |
| Lat Phrao | T | 5,470 | 1,000 | 600 | - | - | 140.4 | 1,920 | |
| Yai Soon | T | 1,600 | 200 | 200 | - | - | 4.4 | 2,800 | |
| Chao Khun Sing | T | 2,600 | 600 | 600 | - | - | 4.6 | 1,800 | |
| Sub-Total (3) | | 15,870 | 5,100 | 4,000 | 500 | 1,300 | 169.4 | 9,220 | |
| | (T) | (14,770) | (4,200) | (3,600) | - | - | (161.9) | (9,220) | |
| | (RB) | (1,100) | (900) | (400) | (500) | (1,300) | (7.5) | (0) | |

Table D.7 Summary of Proposed Retaining Wall and Dredging for Klong Improvement (2)

| Klong | Proposed Shape | Klong Length (m) | Retaining Wall Length (m) | | | | Dredging ($x10^3m^3$) | Land Acquisition ($m^2$) | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | | Exist. | Exist. Uti-lized | Re-const. | Const. | | | |
| Bang Na Polder | | | | | | | | | |
| Klet | R.A, RC | 6,200 | 0 | - | - | 12,400 | 113.3 | - | |
| | (R.A) | (2,700) | (0) | - | - | (5,400) | (66.1) | - | |
| | (R.C) | (3,500) | (0) | - | - | (7,000) | (47.2) | - | |
| Bang Na | T,RA,RC | 6,200 | 2,800 | 400 | 2,100 | 6,500 | 59.8 | 400 | |
| | (T) | (2,000) | (800) | (400) | - | - | (10.1) | - | |
| | (RA) | (600) | (0) | - | (0) | (1,200) | (4.6) | - | |
| | (RC) | (3,600) | (2,000) | - | (2,100) | (5,300) | (45.1) | (400) | |
| Ban Lai | T,RA | 3,500 | 0 | - | - | 6,000 | 35.5 | - | |
| | (T) | (400) | (0) | - | - | - | (0) | - | |
| | (RA) | (3,000) | (0) | - | - | (6,000) | (35.5) | - | |
| Kwang Bon | R.A | 2,600 | 0 | - | - | 5,200 | 20.2 | - | |
| Suan Aoi | T | 600 | 0 | - | - | - | 10.2 | - | |
| Kwang Lang | T | 1,000 | 0 | - | - | - | 6.7 | - | |
| Bang Ao | T,RA | 2,100 | 2,200 | 1,400 | 800 | 1,200 | 14.6 | - | |
| | (T) | (500) | (0) | - | - | - | (4.9) | - | |
| | (RA) | (1,600) | (2,200) | (1,400) | (800) | (1,200) | (9.7) | - | |
| Bang Nang Chine | T,RA | 3,860 | 3,840 | 2,240 | 600 | 3,480 | 17.4 | - | |
| | (T) | (600) | (0) | (0) | - | - | (1.6) | - | |
| | (RA) | (3,260) | (3,840) | (2,240) | (600) | (3,480) | (15.8) | - | |
| Bang Na-Trad Rd.K1 | T | 1,350 | - | - | - | - | 5.7 | - | |
| Bang Na-Trad Rd.K2 | T | 600 | - | - | - | - | 2.5 | - | |
| Bang Na-Trad Rd.K3 | T | 600 | - | - | - | - | 2.5 | - | |
| Bang Na Chak(1) | RA,RC | 2,350 | 600 | - | 600 | 4,100 | 27.1 | - | |
| | (RA) | (1,850) | (0) | - | - | (3,700) | (16.5) | - | |
| | (RC) | (500) | (600) | - | (600) | (400) | (10.6) | - | |
| Bang Na Chak(2) | R.A | 1,750 | - | - | - | 3,500 | 21.0 | - | |
| Sub-Total (4) | | 32,710 | 9,440 | 4,040 | 4,100 | 42,380 | 336.5 | 400 | |
| | (T) | (7,750) | (800) | (400) | (-) | (-) | (44.2) | (-) | |
| | (RA) | (17,360) | (5,040) | (3,640) | (1,400) | (29,680) | (189.4) | (-) | |
| | (RC) | (7,600) | (2,600) | (-) | (2,700) | (12,700) | (102.9) | (400) | |

Table D.7 Summary of Proposed Retaining Wall and Dredging for Klong Improvement (3)

| Klong | Proposed Shape | Klong Length (m) | Retaining Wall Length (m) Exist. | Exist. Utilized | Re-const. | Const. | Dredging ($x10^3m^3$) | Land Acquisition ($m^2$) | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| Bang Sue Drainage Area | | | | | | | | | |
| Bang Sue | T.RC.RD | 7,440 | 2,400 | 800 | 1,200 | 3,000 | 104.8 | 5,200 | |
| | (T) | (3,840) | (600) | (200) | - | - | (45.1) | (3,100) | |
| | (RC) | (2,600) | (1,400) | (600) | (800) | (2,400) | (38.1) | (1,300) | |
| | (RD) | (1,000) | (400) | - | (400) | (600) | (21.6) | (800) | |
| Ratchada Ditch | RA | 5,200 | - | - | - | 10,400 | 52.0 | - | |
| Kasesart | RA | 1,750 | - | - | - | 3,500 | 11.3 | - | |
| Lat Yao | RA | 2,150 | - | - | - | 4,300 | 3.2 | - | |
| Rhya Wake | RA | 2,000 | 500 | 500 | - | 3,500 | 13.2 | - | |
| Sub-Total (5) | | 18,540 | 2,900 | 1,300 | 1,200 | 24,700 | 184.5 | 5,200 | |
| | (T) | (3,840) | (600) | (200) | - | - | (45.1) | (3,100) | |
| | (RA) | (11,100) | (500) | (200) | (-) | (21,700) | (79.7) | (3,100) | |
| | (RC) | (2,600) | (1,400) | (600) | (800) | (2,400) | (38.1) | (1,300) | |
| | (RD) | (1,000) | (400) | (500) | (400) | (600) | (21.6) | (800) | |
| Total | | 92.96 | | | | 83.33 | 1,084.0 | 27,600 | |

Table D.8 Proposed Retaining Wall and Dredging for Klong Improvement (1)

| Klong | Block No. | Sta. No. | Length (m) | Proposed Section Shape | Proposed Retaining Wall Length (m) | | | | | | | | Dredging ($x10^3m^3$) | Land Acquisition ($m^2$) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Left Bank | | | | Right Bank | | | | | | |
| | | | | | Exist. | Exist. Utilized | Re-const. | Const. | Exist. | Exist. Utilized | Re-Const. | Const. | | | |
| Phra Khanong | 84 (1.5Km) | 0 | 0 | R | | | | | 0 | – | [illegible] | D 100 | 1.7 | | |
| | | 1 | 200 | R | | | | | 200 | – | D 200 | – | 3.4 | | |
| | | 2 | 200 | R | | | | | 200 | – | D 200 | – | 2.8 | | |
| | | 3 | 200 | R | | | | | 200 | – | D 200 | – | 2.0 | | |
| | | 4 | 200 | R | "City Core Project" | | | | 130 | – | D 130 | D 70 | 1.0 | | |
| | | 5 | 200 | R | | | | | 110 | – | D 110 | D 90 | 0.3 | | |
| | | 6 | 200 | R | | | | | 140 | – | D 140 | D 60 | 5.4 | | |
| | | 7 | 200 | R | | | | | 120 | – | D 120 | D 80 | 3.6 | | |
| | 83 (1.5Km) | 8 | 200 | R | | | | | 200 | – | D 200 | – | 3.9 | | |
| | | 9 | 200 | T | | | | | 170 | – | – | – | 1.4 | | |
| | | 10 | 200 | T | | | | | 200 | – | – | – | 0 | | |
| | | 11 | 200 | T | 100 | – | – | – | 100 | – | – | – | 1.0 | | |
| | | 12 | 200 | R | 160 | – | C 160 | C 40 | 140 | 140 | – | C 60 | 1.1 | | |
| | | 13 | 200 | R | 150 | 150 | – | C 150 | 200 | 200 | – | – | 0 | | |
| | | 14 | 200 | T | 140 | – | – | – | 130 | – | – | – | 2.2 | | |
| | | 15 | 200 | T | 100 | – | – | – | 200 | – | – | – | 1.6 | | |
| | 82 (1.5Km) | 16 | 200 | R | 0 | – | – | C 200 | 80 | – | C 80 | C 120 | 0.8 | | |
| | | 17 | 200 | T | 0 | – | – | – | 50 | – | – | – | 1.4 | | |
| | | 18 | 200 | T | 0 | – | – | – | 200 | – | – | – | 0.8 | | |
| | | 19 | 200 | T | 0 | – | – | – | 50 | – | – | – | 2.0 | | |
| | | 20 | 200 | R | 0 | – | – | C 200 | 50 | 50 | – | C 150 | 1.7 | | |
| | | 21 | 200 | T | 0 | – | – | – | 170 | – | – | – | 0.8 | | |
| | | 22 | 200 | T | 30 | – | – | – | 90 | – | – | – | 1.5 | | |
| | 81 (1.0Km) | 23 | 200 | R | 150 | – | C 200 | – | 200 | – | C 200 | – | 1.2 | | |
| | | 24 | 200 | T | 110 | – | – | – | 100 | – | – | – | 0.8 | | |
| | | 25 | 200 | T | 160 | – | – | – | 0 | – | – | – | 1.6 | | |
| | | 26 | 200 | T | 0 | – | – | – | 0 | – | – | – | 0.5 | | |
| | | 27 | 200 | R | 0 | – | – | C 200 | 0 | – | – | C 200 | 1.2 | | |
| | 80 (1.9Km) | 28 | 200 | R | 0 | – | – | C 200 | 40 | – | C 40 | C 160 | 1.7 | | |
| | | 29 | 200 | R | 150 | 150 | – | C 50 | 0 | – | – | C 200 | 2.7 | | |
| | | 30 | 200 | R | 20 | 20 | – | C 180 | 0 | – | – | C 200 | 2.7 | | |
| | | 31 | 200 | R | 0 | – | – | C 200 | 100 | 100 | – | C 100 | 1.6 | | |
| | | 32 | 200 | T | 80 | – | – | – | 0 | – | – | – | 3.2 | | |
| | | 33 | 200 | T | 0 | – | – | – | 0 | – | – | – | 3.2 | | |
| | | 34 | 200 | T | 10 | – | – | – | 0 | – | – | – | 3.8 | | |
| | | 35 | 200 | T | 200 | – | – | – | 10 | – | – | – | 2.4 | | |
| | | 36 | 200 | T | 70 | – | – | – | 20 | – | – | – | 1.4 | | |
| | | 37 | 200 | T | 70 | – | – | – | 60 | – | – | – | 1.8 | | |
| | | 38 | 200 | T | 0 | – | – | – | 0 | – | – | – | 3.3 | | |
| Sub-total (1) | | | 3,900 | T | 1,070 | – | – | – | 1,550 | – | – | – | 38.1 | | |
| (2) | | | 2,000 | R.C | 630 | 320 | 360 | 1,420 | 810 | 490 | 320 | 1,190 | 12.5 | | |
| (3) | | | 1,700 | R.D | 0 | [illegible] | – | – | 1,300 | [illegible] | 1,300 | 400 | 24.1 | | |

Table D.8 Proposed Retaining Wall and Dredging for Klong Improvement (2)

| Klong | Block No. | Sta. No.. | Length (m) | Proposed Section Shape | Proposed Retaining Wall Length (m) | | | | | | | | Dredging (x10$^3$m$^3$) | Land Acquisition (m$^2$) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Left Bank | | | | Right Bank | | | | | | |
| | | | | | Exist. | Exist. Uti-lized | Re-const. | Const. | Exist. | Exist. Uti-lized | Re-const. | Const. | | | |
| Ton | 77 | 0 | 0 | R | | | | | 0 | - | - | D 100 | 2.4 | | |
| | (2.0Km) | 1 | 200 | R | | | | | 50 | - | D 50 | D 150 | 5.6 | | |
| | | 2 | 200 | R | | | | | 30 | - | D 30 | D 170 | 5.6 | | |
| | | 3 | 200 | R | | | | | 30 | - | D 30 | D 170 | 2.9 | | |
| | | 4 | 200 | R | | | | | 0 | - | - | D 200 | 3.8 | | |
| | | 5 | 200 | R | | | | | 0 | - | - | D 200 | 5.8 | | |
| | | 6 | 200 | R | | | | | 0 | - | - | D 200 | 6.8 | | |
| | | 7 | 200 | R | | | | | 0 | - | - | D 200 | 5.4 | | |
| | | 8 | 200 | R | | | | | 0 | - | - | C 200 | 6.8 | | |
| | | 9 | 200 | R | "City Core Project" | | | | 200 | - | D 200 | - | 6.4 | 1,100 | |
| | | 10 | 200 | R | | | | | 90 | - | C 90 | C 110 | 5.4 | | |
| | 76 | 11 | 200 | R | | | | | 40 | - | C 40 | C 160 | 5.8 | | |
| | (1.6Km) | 12 | 200 | R | | | | | 180 | - | C 180 | C 20 | 4.4 | | |
| | | 13 | 200 | R | | | | | 200 | - | D 200 | - | 2.8 | | |
| | | 14 | 200 | R | | | | | 170 | - | D 170 | D 30 | 3.4 | | |
| | | 15 | 200 | R | | | | | 160 | - | D 160 | D 40 | 5.0 | | |
| | | 16 | 200 | R | | | | | 120 | - | D 120 | D 80 | 6.6 | | |
| | | 17 | 200 | R | | | | | 120 | - | D 120 | D 80 | 5.0 | | |
| | | 18 | 200 | R | | | | | 100 | - | D 100 | - | 2.0 | | |
| Sub-total | | | | | | | | | | | | | | | |
| (1) | | | 800 | R.C | - | - | - | - | 310 | - | 310 | 490 | 22.4 | - | |
| (2) | | | 2,800 | R.D | - | - | - | - | 1,180 | - | 1,180 | 1,620 | 69.5 | - | |
| TOTAL | | | 3,600 | | - | - | - | - | 1,490 | - | 1,490 | 2,110 | 91,9 | 1,100 | |

Table D.8 Proposed Retaining Wall and Dredging for Klong Improvement ( 3 )

| Klong | Block No. | Sta. No. | Length (m) | Proposed Section Shape | Proposed Retaining Wall Length (m) Left Bank Exist. | Left Bank Exist. Uti-lized | Left Bank Re-const. | Left Bank Const. | Right Bank Exist. | Right Bank Exist. Uti-lized | Right Bank Re-Const. | Right Bank Const. | Dredging ($x10^3m^3$) | Land Acquisi-tion ($m^2$) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Saen Saep | | 0 | 0 | R | 100 | - | D 100 | - | 100 | - | D 100 | - | 2.9 | | |
| | | 1 | 200 | R | 0 | - | - | D 200 | 70 | - | D 70 | D 130 | 9.8 | 2,000 | |
| | | 2 | 200 | R | 150 | - | D 150 | D 50 | 200 | - | D 200 | - | 5.2 | 1,300 | |
| | | 3 | 200 | R | 90 | - | D 90 | D 110 | 70 | - | D 70 | D 130 | 4.2 | | |
| | | 4 | 200 | R | 70 | - | C 70 | C 130 | 40 | - | C 40 | C 160 | 4.8 | | |
| | | 5 | 200 | R | 50 | - | D 50 | D 150 | 120 | - | D 120 | D 80 | 4.6 | | |
| | | 6 | 200 | T | 30 | - | - | - | 50 | - | - | - | 5.0 | | |
| | | 7 | 200 | R | 200 | - | C 200 | - | 50 | - | C 50 | C 150 | 4.8 | | |
| | | 8 | 200 | R | 200 | - | D 200 | - | 200 | - | D 200 | - | 5.6 | 900 | |
| | | 9 | 200 | R | 190 | - | D 190 | D 10 | 100 | - | D 100 | D 100 | 6.8 | 1,200 | |
| | | 10 | 200 | R | 120 | - | D 120 | D 80 | 90 | - | D 90 | D 110 | 6.8 | 1,200 | |
| | | 11 | 200 | T | 0 | - | - | - | 200 | - | - | - | 4.4 | | |
| | | 12 | 200 | R | 0 | - | - | D 200 | 150 | - | D 150 | D 50 | 5.6 | | |
| | | 13 | 200 | R | 0 | - | - | D 200 | 150 | - | D 150 | D 50 | 5.4 | 1,400 | |
| | | 14 | 200 | T | 0 | - | - | - | 200 | - | - | - | 4.8 | | |
| | | 15 | 200 | T | 60 | - | - | - | 120 | - | - | - | 4.6 | | |
| | | 16 | 200 | R | 120 | - | D 120 | D 80 | 170 | - | D 170 | D 30 | 5.3 | 900 | |
| | | 17 | 200 | R | 40 | - | D 40 | D 160 | 170 | - | D 170 | D 30 | 3.4 | | |
| | | 18 | 200 | R | 130 | - | D 130 | D 70 | 100 | - | D 100 | D 100 | 2.4 | | |
| | | 19 | 200 | R | 200 | - | D 200 | - | 200 | - | D 200 | - | 4.4 | | |
| | | 20 | 200 | T | 0 | - | - | - | 0 | - | - | - | 4.4 | | |
| | | 21 | 200 | T | 200 | - | - | - | 0 | - | - | - | 4.4 | | |
| | | 22 | 200 | T | 0 | - | - | - | 200 | - | - | - | 5.5 | | |
| | | 23 | 200 | R | 200 | - | D 200 | - | 0 | - | - | D 200 | 4.4 | | |
| | | 24 | 200 | R | 200 | - | D 200 | - | 200 | 0 | D 200 | - | 3.8 | | |
| | | 25 | 200 | R | 120 | - | D 120 | D 80 | 200 | - | D 200 | - | 3.8 | | |
| | | 26 | 200 | R | 130 | - | D 130 | D 70 | 130 | - | D 130 | D 70 | 5.2 | 1,300 | |
| | | 27 | 200 | R | 120 | - | D 120 | D 80 | 0 | - | - | D 200 | 4.6 | | |
| | | 28 | 200 | R | 0 | - | - | C 200 | 60 | - | C 60 | C 140 | 4.6 | | |
| | | 29 | 200 | R | 0 | - | - | C 200 | 20 | - | C 20 | C 180 | 4.6 | | |
| | | 30 | 200 | R | 100 | - | C 100 | C 100 | 120 | - | C 120 | C 80 | 4.6 | | |
| | | 31 | 200 | R | 200 | - | C 200 | - | 200 | - | C 200 | - | 3.8 | | |
| | | 32 | 200 | R | 200 | - | C 200 | - | 200 | - | C 200 | - | 6.8 | 1,500 | |
| | | 33 | 200 | R | 200 | - | C 200 | - | 200 | - | C 200 | C 200 | 4.0 | | |
| | | 34 | 200 | T | 0 | - | - | - | 0 | - | - | - | 5.8 | | |
| | | 35 | 200 | T | 0 | - | - | - | 0 | - | - | - | 9.0 | | |
| | | 36 | 200 | R | 200 | - | D 200 | - | 200 | - | D 200 | - | 3.8 | | |
| | | 37 | 200 | R | 0 | - | - | D 100 | 100 | - | D 100 | - | 2.2 | | |
| Sub-Total (1) | | | 1,800 | T | 290 | - | - | - | 770 | - | - | - | 47.9 | | |
| (2) | | | 1,600 | R.C | 970 | - | 970 | 630 | 890 | - | 890 | 710 | 38.0 | 1,500 | |
| (3) | | | 4,000 | R.D | 2,340 | - | 2,360 | 1,640 | 2,720 | - | 2,720 | 1,280 | 148.1 | 10,200 | |
| TOTAL | | | 7,400 | - | 3,600 | - | - | - | 4,380 | - | - | - | 186.1 | 11,700 | |

Table D.8 Proposed Retaining Wall and Dredging for Klong Improvement (4)

| Klong | Block No. | Sta. No.. | Length (m) | Proposed Section Shape | Proposed Retaining Wall Length (m) | | | | | | | | Dredging ($x10^3m^3$) | Land Acquisition ($m^2$) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Left Bank | | | | Right Bank | | | | | | |
| | | | | | Exist. | Exist. Uti-lized | Re-const. | Const. | Exist. | Exist. Uti-lized | Re-Const. | Const. | | | |
| Klet | 165 | 0 | | R | 0 | - | - | C 500 | 0 | - | - | C 500 | 9.4 | | Survey in M/P |
| | | 1 | 1,000 | R | 0 | - | - | C1,000 | 0 | - | - | C1,000 | 16.0 | | |
| | 166,167 | 2 | 1,000 | R | 0 | - | - | C1,000 | 0 | - | - | C1,000 | 18.7 | | |
| | 168 | 3 | 1,000 | R | 0 | - | - | C1,000 | 0 | - | - | C1,000 | 22.0 | | |
| | 169 | 4 | 1,000 | R | 0 | - | - | A1,000 | 0 | - | - | A1,000 | 20.0 | | |
| | 170 | 5 | 1,000 | R | 0 | - | - | A1,100 | 0 | - | - | A1,100 | 17.6 | | |
| | 171 | 6 | 1,200 | R | 0 | - | - | A 600 | 0 | - | - | A 600 | 9.6 | | |
| Sub-Total (1) | | | 2,700 | R.A | 0 | - | - | 2,700 | 0 | - | - | 2,700 | 66.1 | | |
| (2) | | | 3,500 | R.C | 0 | - | - | 3,500 | 0 | - | - | 3,500 | 47.2 | | |
| TOTAL | | | 6,200 | - | 0 | - | - | - | 0 | - | - | - | 113.3 | | |

Table D.8 Proposed Retaining Wall and Dredging for Klong Improvement (5)

| Klong | Block No. | Sta. No. | Length (m) | Proposed Section Shape | Proposed Retaining Wall Length (m) Left Bank Exist. | Exist. Uti-lized | Re-const. | Const. | Right Bank Exist. | Exist. Uti-lized | Re-Const. | Const. | Dredging ($x10^3 m^3$) | Land Acquisi-tion ($m^2$) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bang Na | 177 | 0 | 0 | R | 100 | - | C 200 | - | 100 | - | C 200 | - | 1.6 | | |
| | (1.0Km) | 1 | 200 | T | 200 | 200 | - | - | 0 | - | - | - | 2.0 | | |
| | | 2 | 200 | T | 200 | 200 | - | - | 0 | - | - | - | 1.3 | | |
| | | 3 | 200 | R | 0 | - | - | C 200 | 0 | - | - | C 200 | 2.6 | | |
| | | 4 | 200 | R | 0 | - | - | C 200 | 0 | - | - | C 200 | 2.8 | | |
| | | 5 | 200 | R | 0 | - | - | C 200 | 0 | - | - | C 200 | 2.2 | | |
| | 176 | 6 | 200 | R | 0 | - | - | C 200 | 200 | - | C 200 | - | 1.6 | | |
| | (1.1Km) | 7 | 200 | R | 0 | - | - | C 200 | 0 | - | - | C 200 | 3.0 | | |
| | | 8 | 200 | R | 0 | - | - | C 200 | 0 | - | - | C 200 | 3.4 | | |
| | | 9 | 200 | R | 0 | - | - | C 200 | 0 | - | - | C 200 | 2.2 | | |
| | | 10 | 200 | R | 200 | - | C 200 | - | 200 | - | C 200 | - | 1.8 | | |
| | 175 | 11 | 200 | R | 200 | - | C 200 | - | 0 | - | - | C 200 | 3.2 | | |
| | (1.1Km) | 12 | 200 | R | 200 | - | C 200 | - | 0 | - | - | C 200 | 2.7 | | |
| | | 13 | 200 | T | 200 | - | - | - | 0 | - | - | - | 2.2 | | |
| | | 14 | 200 | R | 200 | - | C 200 | - | 0 | - | - | C 200 | 2.1 | | |
| | | 15 | 200 | R | 0 | - | - | C 200 | 0 | - | - | C 200 | 2.4 | | |
| | | 16 | 200 | T | 0 | - | - | - | 0 | - | - | - | 1.8 | | |
| | 174 | 17 | 200 | T | 200 | - | - | - | 0 | - | - | - | 0 | | |
| | (1.0Km) | 18 | 200 | R | 0 | - | - | C 200 | 0 | - | - | C 200 | 2.1 | | |
| | | 19 | 200 | R | 0 | - | - | C 200 | 0 | - | - | C 200 | 2.8 | | |
| | | 20 | 200 | R | 200 | - | C 200 | - | 200 | - | C 200 | - | 2.4 | 400 | |
| | | 21 | 200 | R | 200 | - | C 200 | - | 0 | - | - | C 200 | 2.5 | | |
| | 173 | 22 | 200 | T | 0 | - | - | - | 0 | - | - | - | 1.7 | | |
| | (1.0Km) | 23 | 200 | T | 0 | - | - | - | 0 | - | - | - | 0.2 | | |
| | | 24 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 0.8 | | |
| | | 25 | 200 | T | 0 | - | - | - | 0 | - | - | - | 0.2 | | |
| | 172 | 26 | 200 | T | 0 | - | - | - | 0 | - | - | - | 0.7 | | |
| | (1.1Km) | 27 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.9 | | |
| | | 28 | 200 | T | 0 | - | - | - | 0 | - | - | - | 0 | | |
| | | 29 | 200 | R | 0 | - | - | C 200 | 0 | - | - | C 200 | 2.7 | | |
| | | 30 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.9 | | |
| | 172 | 31 | 200 | R | 0 | - | - | C 100 | 0 | - | - | C 100 | 1.0 | | |
| Sub-Total (1) | | | 2,000 | T | 800 | 400 | - | - | - | - | - | - | 10.1 | | |
| (2) | | | 600 | R.A | 0 | - | 0 | 600 | - | - | 0 | 600 | 4.6 | | |
| (3) | | | 3,600 | R.C | 1,300 | - | 1,400 | 2,300 | 700 | - | 800 | 2,900 | 45.1 | 400 | |
| TOTAL | | | 6,200 | - | 2,100 | 400 | - | - | 700 | - | - | - | 59.8 | 400 | |

Table D.8 Proposed Retaining Wall and Dredging for Klong Improvement (6)

| Klong | Block No. | Sta. No. | Length (m) | Proposed Section Shape | Proposed Retaining Wall Length (m) Left Bank Exist. | Left Bank Exist. Uti-lized | Left Bank Re-const. | Left Bank Const. | Right Bank Exist. | Right Bank Exist. Uti-lized | Right Bank Re-Const. | Right Bank Const. | Dredging ($x10^3m^3$) | Land Acquisi-tion ($m^2$) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kwang Bon-1 | 197 | 0 | 0 | R | 0 | - | - | A 100 | 0 | - | - | A 100 | 0.8 | | |
| | (0.6Km) | 1 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.2 | | |
| | | 2 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.8 | | |
| | | 3 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.2 | | |
| | 196 | 4 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.3 | | |
| Ban Lai-1 | (0.67Km) | 5 | 200 | R | 0 | - | - | A 100<br>A 100 | 0 | - | - | A 100<br>A 100 | 0.6<br>0.6 | 4 | |
| | | 6 | 200 | T | 0 | - | - | - | 0 | - | - | - | 0 | | |
| | 192 | 7 | 200 | T | 0 | - | - | - | 0 | - | - | - | 0 | | |
| | (0.53Km) | 8 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.3 | | |
| | | 9 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.3 | | |
| | 191 | 10 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 0.7 | | |
| | (0.69Km) | 11 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.2 | | |
| | | 12 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.0 | | |
| | | 13 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.6 | | |
| | 190 | 14 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 6.5 | | |
| | (0.91Km) | 15 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 2.0 | | |
| | | 16 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 2.3 | | |
| | | 17 | 200 | R | 0 | - | - | A 100 | 0 | - | - | A 100 | 0.9 | | |
| Sub-Total(Kwang Bon-1) | | | 1,000 | | | | | A1,000 | 0 | | | A1,000 | 7.5 | | |
| Sub-Total(Ban Lai-1) | | | 2,400 | - | 0 | - | - | A2,000 | 0 | - | - | A2,000 | 18.8 | | |
| Ban Lai-2 | | 1 | 0 | R | 0 | - | - | A 500 | 0 | - | - | A 500 | 10.1 | | Survey |
| | | 2 | 1,000 | R | 0 | - | - | A 500 | 0 | - | - | A 500 | 6.6 | | in M/P |
| Sub Total(Bang Lai-2) | | | 1,000 | - | 0 | - | - | A1,100 | 0 | - | - | A1, 00 | 16.7 | | |
| Kwang Bon-2 | 195 | 0 | 0 | R | 0 | - | - | A 100 | 0 | - | - | A 100 | 0.7 | | |
| | (0.8Km) | 1 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.4 | | |
| | | 2 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.6 | | |
| | | 3 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 0.8 | | |
| | | 4 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 2.4 | | |
| | 194 | 5 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.3 | | |
| | (0.8Km) | 6 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.3 | | |
| | | 7 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 2.3 | | |
| | | 8 | 200 | R | 0 | - | - | A 100 | 0 | - | - | A 100 | 0.9 | | |
| Sub Total(Kwang Bon-2) | | | 1,600 | - | 0 | - | - | A1,600 | | | | A1,600 | 12.7 | | |
| TOTAL(K.Kwang Bon,1+2) | | | 2,600 | R.A | 0 | - | - | 2,600 | 0 | - | - | 2,600 | 20.2 | | |
| Total (1) (K.Ban Lai) | | | 500 | T | 0 | - | - | - | 0 | - | - | - | 0 | | |
| Total (2) ( " ) | | | 3,000 | R.A | 0 | - | - | 3,000 | 0 | - | - | 3,000 | 35.5 | | |
| TOTAL (1)+(2) | | | 3,500 | | 0 | - | - | - | 0 | - | - | - | 35.5 | | |

Table D.8 Proposed Retaining Wall and Dredging for Klong Improvement ( 7)

| Klong | Block No. | Sta. No. | Length (m) | Proposed Section Shape | Proposed Retaining Wall Length (m) | | | | | | | | Dredging ($x10^3m^3$) | Land Acquisition ($m^2$) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Left Bank | | | | Right Bank | | | | | | |
| | | | | | Exist. | Exist. Utilized | Re-const. | Const. | Exist. | Exist. Utilized | Re-Const. | Const. | | | |
| Suan Aoi | 206 | 0 | 0 | T | 0 | – | – | – | 0 | – | – | – | – | | Survey in M/P |
| | (0.6Km) | 1 | 600 | T | 0 | – | – | – | 0 | – | – | – | 10.2 | | |
| Total | | | 600 | T | 0 | – | – | – | 0 | – | – | – | 10.2 | | |
| Kwang Lang | 207 | 0 | 0 | T | 0 | – | – | – | 0 | – | – | – | – | | Survey in M/T |
| | (1.0Km) | 1 | 1,000 | T | 0 | – | – | – | 0 | – | – | – | 6.7 | | |
| Total | | | 1,000 | T | 0 | – | – | – | 0 | – | – | – | 6.7 | | |

Table D.8 Proposed Retaining Wall and Dredging for Klong Improvement (8)

| Klong | Block No. | Sta. No. | Length (m) | Proposed Section Shape | Proposed Retaining Wall Length (m) Left Bank Exist. | Exist. Uti-lized | Re-const. | Const. | Right Bank Exist. | Exist. Uti-lized | Re-Const. | Const. | Dredging ($x10^3m^3$) | Land Acquisi-tion ($m^2$) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bang Ao-1 | 215 | 0 | 0 | T | 0 | - | - | - | 0 | - | - | - | 1.6 | | |
| | (1.0Km) | 1 | 200 | T | 0 | - | - | - | 0 | - | - | - | 3.3 | | |
| | | 2 | 200 | R | 200 | - | A 200 | - | 200 | - | A 200 | - | 1.7 | | |
| | | 3 | 200 | R | 200 | - | A 200 | - | 200 | | A 200 | - | 0.9 | | |
| | | 4 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 2.5 | | |
| | 214 | 6 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 2.0 | | |
| | (0.8Km) | 7 | 200 | T | 0 | - | - | - | 0 | - | - | - | 0.6 | | |
| | | 8 | 200 | R | 200 | 200 | - | - | 200 | 200 | - | - | - | | To be |
| | | 9 | 200 | R | 200 | 200 | - | - | 200 | 200 | - | - | - | | Construct- |
| | 213 | 10 | 200 | R | 200 | 200 | - | - | 200 | 200 | - | - | - | | ed in 1986 |
| Bang Nang Chine-1 | (0.4Km) | 11 | 200 | R | 100<br>100 | 100<br>100 | - | - | 100<br>100 | 100<br>100 | - | - | - | | |
| | | 12 | 200 | R | 200 | 200 | - | - | 200 | 200 | - | - | - | | |
| | 212 | 13 | 200 | R | 200 | 200 | - | - | 200 | 200 | - | - | - | | |
| | (0.76Km) | 14 | 160 | R | 60 | 60 | - | - | 60 | 60 | - | - | - | | |
| Sub-Total (Bang Ao-1) | | | 2,100 | - | 1,100 | 700 | A 400 | A 600 | 1,100 | 700 | A 400 | A 600 | 14.6 | | |
| Sub-Total (Bang Nang Chine-1) | | | 660 | - | 660 | 660 | - | - | 660 | 660 | - | - | - | | |
| Bang Na Chine-2 | 208 | 0 | 0 | R | 100 | 100 | - | - | 100 | 100 | - | - | 0.1 | | |
| | (1.0Km) | 1 | 200 | R | 200 | 200 | - | - | 200 | 200 | - | - | 1.2 | | |
| | | 2 | 200 | T | 0 | - | - | - | 0 | - | - | - | 0.6 | | |
| | | 3 | 200 | R | 200 | - | A 200 | - | 0 | - | - | A 200 | 3.6 | | |
| | | 4 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 2.0 | | |
| | | 5 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.8 | | |
| | 209 | 6 | 200 | R | 0 | - | - | A 200 | 0 | | - | A 200 | 1.0 | | |
| | (0.8Km) | 7 | 200 | T | 0 | - | - | - | 0 | - | - | - | 0 | | |
| | | 8 | 200 | T | 0 | - | - | - | 0 | - | - | - | 1.0 | | |
| | | 9 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 0.6 | | |
| | 210 | 10 | 200 | R | 150 | 150 | - | A 50 | 150 | 150 | - | A 50 | 0 | | |
| | (0.6Km) | 11 | 200 | R | 200 | - | - | A 200 | 200 | - | - | A 200 | 1.0 | | |
| | | 12 | 200 | R | 200 | - | - | A 200 | 200 | - | - | A 200 | 1.1 | | |
| | 211 | 13 | 200 | R | 200 | - | A 200 | - | 200 | - | A 200 | - | 0.8 | | |
| | (0.6Km) | 14 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.5 | | |
| | | 15 | 200 | R | 0 | - | - | A 190 | 10 | 10 | - | A 190 | 1.1 | | } To be Construct- |
| | 212 (0.76Km) | 16 | 200 | R | 100 | 100 | - | - | 100 | 100 | - | - | 0 | | ed in 1986 |
| Sub-Total (Bang Nang Chine-2) | | | 3,200 | | 1,360 | 560 | A 400 | A1,640 | 1,360 | 560 | A 200 | A1,840 | 17.4 | | |
| K. Bang Ao | | (1) | 500 | T | 0 | - | - | - | 0 | - | - | - | 4.9 | | |
| | | (2) | 1,600 | R.A | 1,100 | 700 | A 400 | A 600 | 1,100 | 700 | A 400 | A 600 | 9.7 | | |
| TOTAL | | | 2,100 | - | 1,100 | 700 | - | - | 1,100 | 700 | - | - | 14.6 | | |
| K. Bang Nang Chine | | (1) | 600 | T | 0 | 0 | - | - | 0 | 0 | - | - | 1.6 | | |
| | | (2) | 3,260 | R.A | 1,920 | 1,120 | A 400 | A1,640 | 1,920 | 1,120 | A 200 | A1,840 | 15.8 | | |
| TOTAL | | | 3,860 | - | 1,920 | 1,120 | - | - | 1,920 | 1,120 | - | - | 17.4 | | |

Table D.8 Proposed Retaining Wall and Dredging for Klong Improvement ( 9 )

| Klong | Block No. | Sta. No. | Length (m) | Proposed Section Shape | Proposed Retaining Wall Length (m) | | | | | | | | Dredging ($x10^3m^3$) | Land Acquisition ($m^2$) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Left Bank | | | | Right Bank | | | | | | |
| | | | | | Exist. | Exist. Uti-lized | Re-const. | Const. | Exist. | Exist. Uti-lized | Re-const. | Const. | | | |
| Jek | 227 | 0 | 0 | R | - | - | - | - | - | - | - | - | - | | |
| | (1.0Km) | 1 | 200 | R | 300 | 300 | | | 300 | 300 | - | - | 0 | | To be Constructed in 1986 |
| | | 2 | 200 | R | 200 | 200 | | | 200 | 200 | - | - | 0 | | |
| | | 3 | 200 | R | 200 | 200 | - | - | 200 | 200 | - | - | 0 | | |
| | | 4 | 200 | R | 200 | 200 | | | 200 | 200 | - | - | 0 | | |
| | | 5 | 200 | R | 200 | 200 | | | 200 | 200 | - | - | 0 | | |
| | 226 | 6 | 200 | R | 290 | 290 | | | 290 | 290 | - | - | 0 | | |
| | (0.58Km) | 7 | 380 | R | 190 | 190 | | | 190 | 190 | - | - | 0 | | |
| Total | | | 1,580 | - | 1,580 | 1,580 | - | - | 1,580 | 1,580 | - | - | 0 | | |
| Bang Chak(1) | 230 | 0 | 0 | R | - | - | - | - | - | - | - | - | - | | |
| | (1.0Km) | 1 | 200 | R | 300 | - | C 300 | - | 300 | - | C 300 | - | 4.9 | | |
| | | 2 | 200 | R | 0 | - | - | C 200 | 0 | - | - | - | 5.7 | | |
| | | 3 | 200 | R | 0 | - | - | A 200 | 0 | - | - | C 200 | 1.4 | | |
| | | 4 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 2.4 | | |
| | | 5 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 2.0 | | |
| | 229 | 6 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 2.0 | | |
| | (0.8Km) | 7 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.3 | | |
| | | 8 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.4 | | |
| | | 9 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 2.4 | | |
| | 228 | 10 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.6 | | |
| | (0.55Km) | 11 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.7 | | |
| | | 12 | 150 | R | 0 | - | - | A 50 | 0 | - | - | A 50 | 0.3 | | |
| Sub-Total (1) | | | 1,850 | R.A | - | - | - | 1,850 | - | - | - | 1,850 | 16.5 | | |
| (2) | | | 500 | R.C | 300 | - | 300 | 200 | 300 | - | 300 | 200 | 10.6 | | |
| TOTAL | | | 2,350 | - | 300 | - | - | - | 300 | - | - | - | 27.1 | | |
| Bang Chak (2) | 232 | 0 | 0 | R | 0 | - | - | A 425 | 0 | - | - | A 425 | 5.1 | | Survey in M/P |
| | | 1 | 850 | R | 0 | - | - | A 875 | 0 | - | - | A 875 | 10.5 | | |
| | 231 | 2 | 900 | R | 0 | - | - | A 450 | 0 | - | - | A 450 | 5.4 | | |
| TOTAL | | | 1,750 | R.A | 0 | - | - | A1,750 | 0 | - | - | A1,750 | 21.0 | | |

Table D.8 Proposed Retaining Wall and Dredging for Klong Improvement (10)

| Klong | Block No. | Sta. No. | Length (m) | Proposed Section Shape | Proposed Retaining Wall Length (m) Left Bank Exist. | Left Bank Exist. Uti-lized | Left Bank Re-const. | Left Bank Const. | Right Bank Exist. | Right Bank Exist. Uti-lized | Right Bank Re-const. | Right Bank Const. | Dredging ($x10^3m^3$) | Land Acquisi-tion ($m^2$) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gig | 145 | 0 | 0 | R | 100 | 100 | - | - | 100 | - | - | - | 0 | | |
| | (1.54Km) | 1 | 200 | R | 200 | - | A 200 | - | 200 | - | A 200 | - | 1.7 | | |
| | | 2 | 200 | R | 200 | - | A 200 | - | 200 | - | A 200 | - | 1.8 | | |
| | | 3 | 200 | R | 200 | - | A 200 | - | 0 | - | - | A 200 | 1.7 | | |
| | | 4 | 200 | T | 0 | - | - | - | 0 | - | - | - | 0.3 | | |
| | | 5 | 200 | R | 0 | - | - | A 270 | 270 | - | A 270 | - | 2.3 | | |
| | | 6 | 340 | T | 0 | - | - | - | 0 | - | - | - | 0.6 | | |
| | | 7 | 200 | T | 0 | - | - | - | 0 | - | - | - | 0.3 | | |
| Sub-Total (1) | | | 570 | T | - | - | - | - | - | - | - | - | 1.2 | | |
| (2) | | | 970 | R.A | 700 | 100 | 600 | 270 | 770 | - | 670 | 200 | 7.5 | | |
| TOTAL | | | 1,540 | | 700 | 100 | - | - | 770 | - | - | - | 8.7 | | |
| Kacha | 150 | 0 | 0 | T | 0 | - | - | - | 0 | - | - | - | 0.4 | | |
| | (1.0Km) | 1 | 200 | T | 0 | - | - | - | 0 | - | - | - | 0.6 | | |
| | | 2 | 200 | T | 0 | - | - | - | 0 | - | - | - | 0.8 | | |
| | | 3 | 200 | T | 0 | - | - | - | 0 | - | - | - | 0.3 | | |
| | | 4 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.6 | | |
| | | 5 | 200 | T | 0 | - | - | - | 0 | - | - | - | 0.9 | | |
| | 149 | 6 | 200 | T | 0 | - | - | - | 0 | - | - | - | 0 | | |
| | | 7 | 200 | T | 0 | - | - | - | 0 | - | - | - | 0.8 | | |
| | | 8 | 200 | T | 0 | - | - | - | 0 | - | - | - | 1.6 | | |
| | | 9 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 0.9 | | |
| | | 10 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.1 | | |
| | 148 | 11 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.1 | | |
| | (2.4Km) | 12 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 1.9 | | |
| | | 13 | 200 | R | 200 | - | A 200 | - | 200 | - | A 200 | - | 1.1 | | |
| | | 14 | 200 | R | 200 | - | A 200 | - | 200 | - | A 200 | - | 1.2 | | |
| | | 15 | 200 | T | 0 | - | - | - | 0 | - | - | - | 2.3 | | |
| | | 16 | 200 | R | 0 | - | - | A 200 | 0 | - | - | A 200 | 2.7 | | |
| | | 17 | 200 | T | 0 | - | - | - | 0 | - | - | - | 3.2 | | |
| | | 18 | 200 | T | 0 | - | - | - | 0 | - | - | - | 1.5 | | |
| | | 19 | 200 | T | 0 | - | - | - | 0 | - | - | - | 3.4 | | |
| | | 20 | 200 | T | 0 | - | - | - | 0 | - | - | - | 1.1 | | |
| | | 21 | 200 | T | 0 | - | - | - | 0 | - | - | - | 0 | | |
| | | 22 | 200 | T | 0 | - | - | - | 0 | - | - | - | 0.4 | | |
| Sub-Total (1) | | | 2,800 | T | - | - | - | - | - | - | - | - | 17.3 | | |
| (2) | | | 1,600 | R.A | 400 | - | 400 | 1,200 | 400 | - | 400 | 1,200 | 11.6 | | |
| TOTAL | | | 4,400 | | 400 | - | - | - | 400 | - | - | - | 28.9 | | |

Table D.8 Proposed Retaining Wall and Dredging for Klong Improvement (11)

| Klong | Block No. | Sta. No.. | Length (m) | Proposed Section Shape | Proposed Retaining Wall Length (m) Left Bank Exist. | Exist. Uti-lized | Re-const. | Const. | Right Bank Exist. | Exist. Uti-lized | Re-const. | Const. | Dredging ($x10^3m^3$) | Land Acquisi-tion ($m^2$) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lao | 96 | 0 | 100 | T | – | – | – | – | – | – | – | – | 0.1 | – | |
| | | 1 | 200 | T | – | – | – | – | – | – | – | – | 0.1 | – | |
| | | 2 | 200 | T | – | – | – | – | – | – | – | – | – | – | |
| | | 3 | 200 | T | – | – | – | – | 200 | 200 | – | – | 0.1 | – | |
| | | 4 | 200 | T | – | – | – | – | – | – | – | – | 0.4 | – | |
| | | 5 | 200 | T | – | – | – | – | 200 | 200 | – | – | – | – | |
| | | 6 | 200 | T | – | – | – | – | 200 | 200 | – | – | 0.2 | – | |
| | 95 | 7 | 200 | T | – | – | – | – | 200 | 200 | – | – | 0.2 | – | |
| | | 8 | 200 | T | – | – | – | – | 200 | 200 | – | – | 0.3 | – | |
| | | 9 | 200 | T | – | – | – | – | 200 | 200 | – | – | 0.3 | – | |
| | | 10 | 200 | T | – | – | – | – | – | – | – | – | 0.4 | – | |
| | | 11 | 200 | T | – | – | – | – | – | – | – | – | 0.2 | – | |
| | | 12 | 200 | T | – | – | – | – | – | – | – | – | 0.1 | – | |
| | 94 | 13 | 200 | T | – | – | – | – | – | – | – | – | 0.6 | 200 | |
| | | 14 | 200 | T | – | – | – | – | – | – | – | – | 0.8 | – | |
| | | 15 | 200 | T | – | – | – | – | – | – | – | – | 0.8 | – | |
| | | 16 | 200 | T | 200 | 200 | – | – | 200 | 200 | – | – | 0.4 | – | |
| | | 17 | 200 | T | – | – | – | – | – | – | – | – | 1.9 | 800 | |
| | 93 | 18 | 200 | T | – | – | – | – | 200 | – | – | – | 0.7 | 900 | |
| | | 19 | 200 | T | – | – | – | – | – | – | – | – | 1.2 | – | |
| | 93.92 | 20 | 200 | T | – | – | – | – | 200 | 200 | – | – | 1.8 | 400 | |
| | 92 | 21 | 200 | T | – | – | – | – | – | – | – | – | 0.3 | 400 | |
| | | 22 | 200 | T | – | – | – | – | – | – | – | – | 0.6 | – | |
| | 91 | 23 | 200 | T | – | – | – | – | – | – | – | – | 0.9 | – | |
| | | 24 | 200 | T | 200 | 200 | – | – | – | – | – | – | 0.1 | – | |
| | 91.90 | 25 | 200 | T | – | – | – | – | 200 | 200 | – | – | – | – | |
| | 90 | 26 | 200 | R | – | | | B 200 | – | – | – | B 200 | 2.1 | – | |
| | | 27 | 200 | R | – | | | B 200 | – | – | – | B 200 | 0.8 | – | |
| | | 28 | 200 | R | 200 | 200 | | – | 200 | 200 | – | – | 1.2 | – | |
| | | 29 | 200 | R | – | | | B 200 | – | – | – | B 200 | 2.1 | – | |
| | | 30 | 200 | R | 200 | – | B 200 | – | 200 | – | B 200 | – | 0.3 | – | |
| | | 31 | 100 | R | – | – | – | B 100 | 100 | – | B 100 | – | 1.0 | – | |
| Sub-Total (1) | | | 5,100 | T | 400 | 400 | – | – | 2,000 | 1,800 | – | – | 12.5 | 2,700 | |
| (2) | | | 1,100 | R | 400 | 200 | B 200 | B 700 | 500 | 200 | B 300 | B 600 | 7.5 | – | |
| TOTAL | | | 6,200 | | 800 | 600 | B 200 | B 700 | 2,500 | 2,000 | B 300 | B 600 | 20.0 | 2,700 | |

Table D.8 Proposed Retaining Wall and Dredging for Klong Improvement (12)

| Klong | Block No. | Sta. No. | Length (m) | Proposed Section Shape | Proposed Retaining Wall Length (m) | | | | | | | | Dredging ($x10^3 m^3$) | Land Acquisition ($m^2$) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Left Bank | | | | Right Bank | | | | | | |
| | | | | | Exist. | Exist. Uti-lized | Re-const. | Const. | Exist. | Exist. Uti-lized | Re-const. | Const. | | | |
| Lat Phrao | 89 | 0 | 100 | T | 100 | 100 | - | - | 100 | 100 | - | - | 6.3 | - | |
| | | 1 | 200 | T | 200 | - | - | - | - | - | - | - | 10.0 | 1,000 | |
| | | 2 | 200 | T | 200 | - | - | - | - | - | - | - | 9.1 | - | |
| | | 3 | 200 | T | - | - | - | - | - | - | - | - | 8.3 | - | |
| | | 4 | 200 | T | - | - | - | - | - | - | - | - | 6.8 | - | |
| | | 5 | 200 | T | - | - | - | - | - | - | - | - | 7.0 | - | |
| | | 6 | 200 | T | - | - | - | - | - | - | - | - | 6.8 | - | |
| | | 7 | 200 | T | - | - | - | - | - | - | - | - | 7.2 | - | |
| | | 8 | 200 | T | - | - | - | - | - | - | - | - | 7.9 | - | |
| | 88 | 9 | 200 | T | - | - | - | - | - | - | - | - | 4.8 | - | |
| | | 10 | 200 | T | - | - | - | - | - | - | - | - | 6.8 | - | |
| | 88.87 | 11 | 200 | T | - | - | - | - | - | - | - | - | 6.5 | - | |
| | | 12 | 200 | T | - | - | - | - | - | - | - | - | 4.5 | - | |
| | | 13 | 200 | T | 200 | 200 | - | - | 200 | 200 | - | - | 3.6 | - | |
| | | 14 | 200 | T | - | - | - | - | - | - | - | - | 4.3 | 360 | |
| | | 15 | 200 | T | - | - | - | - | - | - | - | - | 4.2 | - | |
| | | 16 | 200 | T | - | - | - | - | - | - | - | - | 3.9 | - | |
| | | 17 | 200 | T | - | - | - | - | - | - | - | - | 4.2 | - | |
| | | 18 | 200 | T | - | - | - | - | - | - | - | - | 4.0 | - | |
| | | 19 | 200 | T | - | - | - | - | - | - | - | - | 2.2 | - | |
| | | 20 | 200 | T | - | - | - | - | - | - | - | - | 1.4 | - | |
| | | 21 | 200 | T | - | - | - | - | - | - | - | - | 2.6 | 200 | |
| | - | 22 | 200 | T | - | - | - | - | - | - | - | - | 4.3 | 360 | |
| | - | 23 | 200 | T | - | - | - | - | - | - | - | - | 2.4 | - | |
| | - | 24 | 200 | T | - | - | - | - | - | - | - | - | 3.0 | - | |
| | - | 25 | 200 | T | - | - | - | - | - | - | - | - | 3.9 | - | |
| | - | 26 | 200 | T | - | - | - | - | - | - | - | - | 2.4 | - | |
| | - | 27 | 135 | T | - | - | - | - | - | - | - | - | 1.4 | - | |
| | - | 28 | 35 | T | - | - | - | - | - | - | - | - | 0.6 | - | |
| TOTAL | | | 5,470 | T | 700 | 300 | - | - | 300 | 300 | - | - | 140.4 | 1,920 | |

Table D.8 Proposed Retaining Wall and Dredging for Klong Improvement (13)

| Klong | Block No. | Sta. No. | Length (m) | Proposed Section Shape | Proposed Retaining Wall Length (m) | | | | | | | | Dredging ($x10^3m^3$) | Land Acquisition ($m^2$) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Left Bank | | | | Right Bank | | | | | | |
| | | | | | Exist. | Exist. Utilized | Re-const. | Const. | Exist. | Exist. Utilized | Re-const. | Const. | | | |
| Yai Soon | 139 | 0 | 100 | T | - | - | - | - | - | - | - | - | - | 200 | |
| | | 1 | 200 | T | - | - | - | - | - | - | - | - | 0.1 | - | |
| | | 2 | 200 | T | - | - | - | - | - | - | - | - | 1.3 | 300 | |
| | | 3 | 200 | T | - | - | - | - | - | - | - | - | 0.3 | 400 | |
| | | 4 | 200 | T | - | - | - | - | - | - | - | - | 0.2 | 400 | |
| | | 5 | 200 | T | - | - | - | - | 200 | 200 | - | - | 0.6 | - | |
| | | 6 | 200 | T | - | - | - | - | - | - | - | - | 0.2 | 400 | |
| | | 7 | 200 | T | - | - | - | - | - | - | - | - | 1.4 | 900 | |
| | | 8 | 100 | T | - | - | - | - | - | - | - | - | 0.3 | 200 | |
| TOTAL | | | 1,600 | T | - | - | - | - | 200 | 200 | - | - | 4.4 | 2,800 | |
| Chao Khunsing | 120 | 0 | 100 | - | - | - | - | - | - | - | - | - | - | - | |
| | | 1 | 200 | T | - | - | - | - | - | - | - | - | 0.0 | - | |
| | | 2 | 200 | T | - | - | - | - | - | - | - | - | 0.2 | - | |
| | | 3 | 200 | T | - | - | - | - | - | - | - | - | 0.2 | - | |
| | | 4 | 200 | T | - | - | - | - | - | - | - | - | 0.1 | - | |
| | 120,119 | 5 | 200 | T | - | - | - | - | - | - | - | - | 1.3 | 1,000 | |
| | 119 | 6 | 200 | T | - | - | - | - | - | - | - | - | 1.8 | 200 | |
| | | 7 | 200 | T | - | - | - | - | - | - | - | - | 0.6 | 600 | |
| | | 8 | 200 | T | - | - | - | - | 200 | 200 | - | - | 0.4 | - | |
| | | 9 | 200 | Exist. | - | - | - | - | - | - | - | - | - | - | |
| | 119,118 | 10 | 200 | " | - | - | - | - | - | - | - | - | - | - | |
| | 118 | 11 | 200 | " | - | - | - | - | - | - | - | - | - | - | |
| | | 12 | 200 | " | - | - | - | - | - | - | - | - | - | - | |
| | | 13 | 100 | " | 200 | 200 | - | - | 200 | 200 | - | - | - | - | |
| TOTAL | | | 2,600 | T | 200 | 200 | - | - | 400 | 400 | - | - | 4.6 | 1,800 | |

Table D.8 Proposed Retaining Wall and Dredging for Klong Improvement (14)

| Klong | Block No. | Sta. No.. | Length (m) | Proposed Section Shape | Proposed Retaining Wall Length (m) Left Bank Exist. | Left Bank Exist. Uti-lized | Left Bank Re-const. | Left Bank Const. | Right Bank Exist. | Right Bank Exist. Uti-lized | Right Bank Re-const. | Right Bank Const. | Dredging ($x10^3m^3$) | Land Acquisi-tion ($m^2$) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bang Sue | 16 | 0 | 100 | T | | | | | – | – | – | – | 2.3 | – | |
| | | 1 | 200 | T | | | | | 200 | – | – | – | 4.6 | 2,000 | |
| | | 2 | 200 | T | | | | | 200 | 200 | – | – | 2.2 | – | |
| | | 3 | 200 | T | | | | | – | – | – | – | 3.3 | – | |
| | | 4 | 200 | T | | | | | – | – | – | – | 2.6 | – | |
| | | 5 | 200 | T | | | | | – | – | – | – | 0.8 | – | |
| | | 6 | 200 | T | | | | | – | – | – | – | 1.3 | – | |
| | | 7 | 200 | R | | | | | 200 | – | D 200 | – | 2.7 | – | |
| | | 8 | 200 | R | | | | | 200 | – | D 200 | – | 3.9 | 400 | |
| | | 9 | 200 | R | | | | | – | – | – | D 200 | 5.3 | 400 | |
| | | 10 | 200 | R | | | | | – | – | – | D 200 | 4.9 | – | |
| | 15 | 11 | 200 | R | "City Core Project" | | | | – | – | – | D 200 | 4.8 | – | |
| | | 12 | 200 | T | | | | | – | – | – | – | 0.3 | – | |
| | | 13 | 200 | T | | | | | – | – | – | – | 2.4 | – | |
| | | 14 | 200 | T | | | | | – | – | – | – | 3.3 | – | |
| | | 15 | 200 | T | | | | | – | – | – | – | 3.1 | – | |
| | | 16 | 200 | T | | | | | – | – | – | – | 3.2 | – | |
| | 14 | 17 | 200 | R | | | | | – | – | – | C 200 | 4.1 | – | |
| | | 18 | 200 | R | | | | | 200 | – | C 200 | – | 4.1 | 900 | |
| | | 19 | 200 | R | | | | | 200 | – | C 200 | – | 2.7 | – | |
| | 13 | 20 | 200 | R | | | | | – | – | – | C 200 | 1.6 | – | |
| | | 21 | 200 | R | | | | | – | – | – | C 200 | 3.0 | – | |
| | | 22 | 200 | R | | | | | – | – | – | C 200 | 3.4 | 400 | |
| | 12 | 23 | 200 | R | 150 | 150 | – | – | 150 | 150 | – | – | – | – | To be con-constructed this year |
| | | 24 | 200 | R | 150 | 150 | – | – | 150 | 150 | – | – | – | – | |
| | | 25 | 200 | R | 200 | – | C 200 | – | – | – | – | C 200 | 3.4 | – | |
| | | 26 | 200 | R | 200 | – | C 200 | – | – | – | – | C 200 | 4.1 | – | |
| | | 27 | 200 | R | – | – | – | C 200 | – | – | – | C 200 | 3.2 | – | |
| | | 28 | 200 | R | – | – | – | C 200 | – | – | – | C 200 | 4.3 | – | |
| | | 29 | 200 | R | – | – | – | C 200 | – | – | – | C 200 | 4.2 | – | |
| | | 30 | 200 | T | – | – | – | – | – | – | – | – | 1.3 | – | |
| | | 31 | 200 | T | – | – | – | – | – | – | – | – | 1.7 | – | |
| | | 32 | 200 | T | – | – | – | – | – | – | – | – | 1.4 | – | |
| | | 33 | 200 | T | – | – | – | – | – | – | – | – | 1.6 | – | |
| | | 34 | 200 | T | – | – | – | – | – | – | – | – | 2.1 | – | |
| | | 35 | 200 | T | – | – | – | – | – | – | – | – | 2.7 | – | |
| | | 36 | 200 | T | – | – | – | – | – | – | – | – | 3.0 | 1,100 | |
| | | 37 | 100 | T | 200 | – | – | – | – | – | – | – | 1.9 | – | |
| | | 38 | 40 | T | – | – | – | – | – | – | – | – | – | – | |
| Sub-Total (1) | | | 3,840 | T | 200 | – | – | – | 400 | 200 | – | – | 45.1 | 3,100 | |
| Sub-Total (2) | | | 2,600 | R.C | 700 | 300 | C 400 | C 600 | 700 | 300 | C 400 | C1,800 | 38.1 | 1,300 | |
| Sub-Total (3) | | | 1,000 | R.D | – | – | – | – | 400 | – | D 400 | D 600 | 21.6 | 800 | |
| TOTAL | | | 7,440 | – | 900 | 300 | C 400 | C 600 | 1,500 | 500 | 800 | 2,400 | 104.8 | 5,200 | |

Table D.8 Proposed Retaining Wall and Dredging for Klong Improvement (15)

| Klong | Block No. | Sta. No.. | Length (m) | Proposed Section Shape | Proposed Retaining Wall Length (m) Left Bank Exist. | Exist. Uti-lized | Re-const. | Const. | Right Bank Exist. | Exist. Uti-lized | Re-const. | Const. | Dredging ($x10^3m^3$) | Land Acquisi-tion ($m^2$) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ratchada Ditch | 55 | 0 | 100 | R | - | - | - | 100 | - | - | - | 100 | 1.0 | - | |
| | | 1 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | | 2 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | | 3 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | | 4 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | | 5 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | | 6 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | | 7 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | | 8 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | | 9 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | | 10 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | | 11 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | | 12 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | | 13 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | | 14 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | | 15 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | 54 | 16 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | 54.53 | 17 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | 53 | 18 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | 53.52 | 19 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | 52 | 20 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | | 21 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | 51 | 22 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | | 23 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | | 24 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | | 25 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.0 | - | |
| | | 26 | 100 | R | - | - | - | 100 | - | - | - | 100 | 1.0 | - | |
| TOTAL | | | 5,200 | R | - | - | - | 5,200 | - | - | - | 5,200 | 52.0 | | |
| Kasesart | 45 | 0 | 100 | R | - | - | - | 100 | - | - | - | 100 | 0.1 | - | |
| | | 1 | 200 | R | - | - | - | 200 | - | - | - | 200 | 1.4 | - | |
| | | 2 | 200 | R | - | - | - | 200 | - | - | - | 200 | 1.5 | - | |
| | | 3 | 200 | R | - | - | - | 200 | - | - | - | 200 | 1.3 | - | |
| | | 4 | 200 | R | - | - | - | 200 | - | - | - | 200 | 1.2 | - | |
| | | 5 | 200 | R | - | - | - | 200 | - | - | - | 200 | 1.4 | - | |
| | | 6 | 200 | R | - | - | - | 200 | - | - | - | 200 | 1.4 | - | |
| | | 7 | 200 | R | - | - | - | 200 | - | - | - | 200 | 1.5 | - | |
| | | 8 | 250 | R | - | - | - | 250 | - | - | - | 250 | 1.1 | - | |
| TOTAL | | | 1,750 | R.A | - | - | - | A1,750 | - | - | - | A1,750 | 11.3 | - | |

Table D.8 Proposed Retaining Wall and Dredging for Klong Improvement (16)

| Klong | Block No. | Sta. No.. | Length (m) | Proposed Section Shape | Proposed Retaining Wall Length (m) | | | | | | | | Dredging ($x10^3m^3$) | Land Acquisition ($m^2$) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Left Bank | | | | Right Bank | | | | | | |
| | | | | | Exist. | Exist. Utilized | Re-const. | Const. | Exist. | Exist. Utilized | Re-const. | Const. | | | |
| Phya Wake | 58 | 0 | 100 | R | 100 | 100 | - | - | 100 | 100 | - | - | - | - | To be constructed in this year |
| | | 1 | 150 | R | 150 | 150 | - | - | 150 | 150 | - | - | - | - | |
| | | 2 | 250 | R | - | - | - | 250 | - | - | - | 250 | 0.4 | - | |
| | | 3 | 200 | R | - | - | - | 200 | - | - | - | 200 | 1.3 | - | |
| | | 4 | 200 | R | - | - | - | 200 | - | - | - | 200 | 1.3 | - | |
| | 58.57 | 5 | 200 | R | - | - | - | 200 | - | - | - | 200 | 1.3 | - | |
| | | 6 | 200 | R | - | - | - | 200 | - | - | - | 200 | 1.3 | - | |
| | | 7 | 200 | R | - | - | - | 200 | - | - | - | 200 | 1.3 | - | |
| | | 8 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.1 | - | |
| | | 9 | 200 | R | - | - | - | 200 | - | - | - | 200 | 2.1 | - | |
| | | 10 | 100 | R | - | - | - | 100 | - | - | - | 100 | 2.1 | - | |
| TOTAL | | | 2,000 | R | 250 | 250 | - | 1,750 | 250 | 250 | - | 1,750 | 13.2 | - | |
| Lat Yao | 49 | 0 | 100 | R | - | - | - | 100 | - | - | - | 100 | 0.1 | - | |
| | | 1 | 200 | R | - | - | - | 200 | - | - | - | 200 | 0.3 | - | |
| | | 2 | 200 | R | - | - | - | 200 | - | - | - | 200 | 0.3 | - | |
| | | 3 | 200 | R | - | - | - | 200 | - | - | - | 200 | 0.3 | - | |
| | | 4 | 200 | R | - | - | - | 200 | - | - | - | 200 | 0.3 | - | |
| | | 5 | 200 | R | - | - | - | 200 | - | - | - | 200 | 0.3 | - | |
| | | 6 | 200 | R | - | - | - | 200 | - | - | - | 200 | 0.3 | - | |
| | | 7 | 200 | R | - | - | - | 200 | - | - | - | 200 | 0.3 | - | |
| | 49.48 | 8 | 200 | R | - | - | - | 200 | - | - | - | 200 | 0.3 | - | |
| | 48 | 9 | 200 | R | - | - | - | 200 | - | - | - | 200 | 0.3 | - | |
| | | 10 | 200 | R | - | - | - | 200 | - | - | - | 200 | 0.3 | - | |
| | | 11 | 50 | R | - | - | - | 50 | - | - | - | 50 | 0.1 | - | |
| TOTAL | | | 2,150 | R | - | - | - | 2,150 | - | - | - | 2,150 | 3.2 | - | |

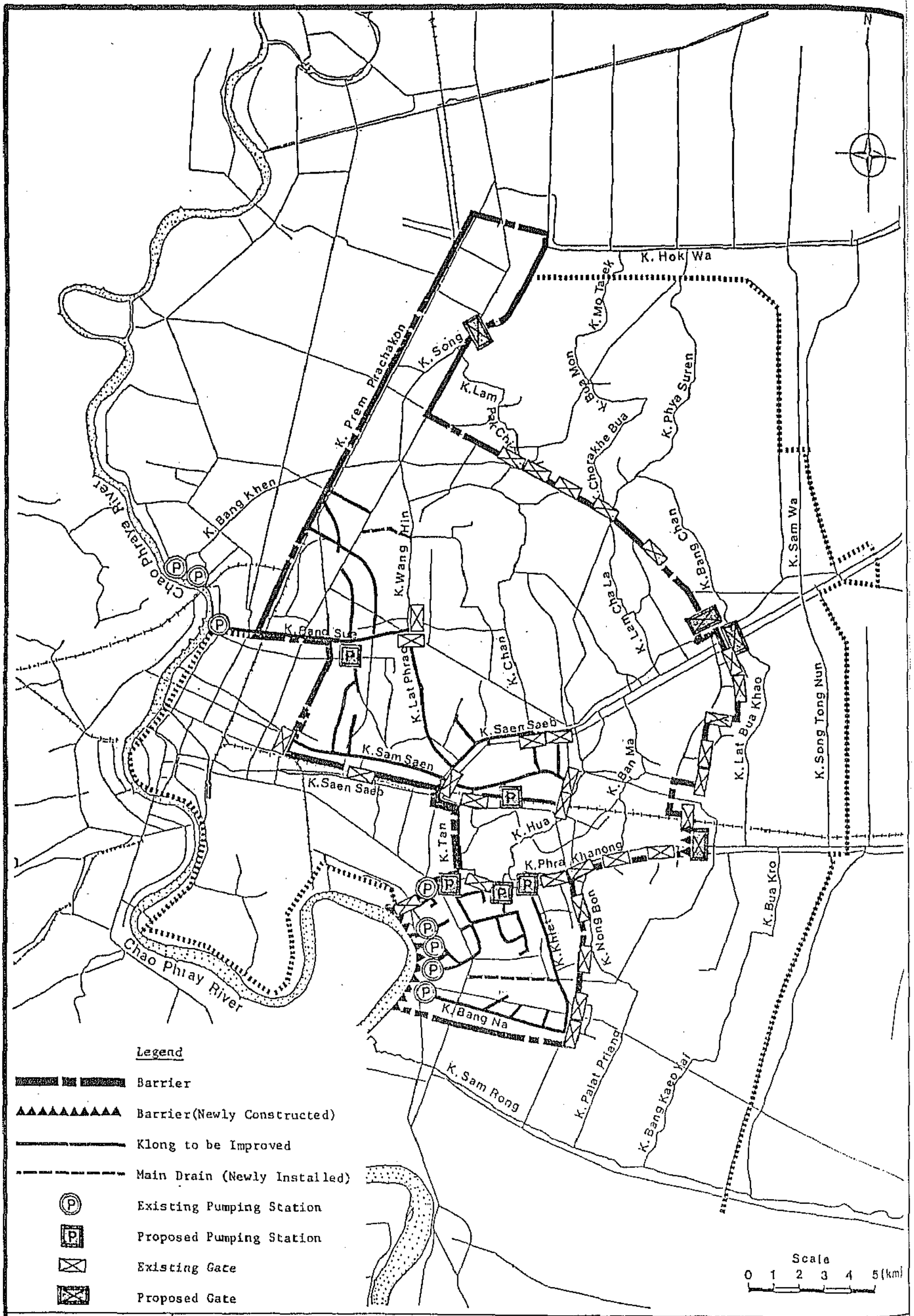



Fig. D.1 PROPOSED FACILITIES IN THE FEASIBILITY STUDY

**FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK**



JICA 2529B.E. 1986A.D.

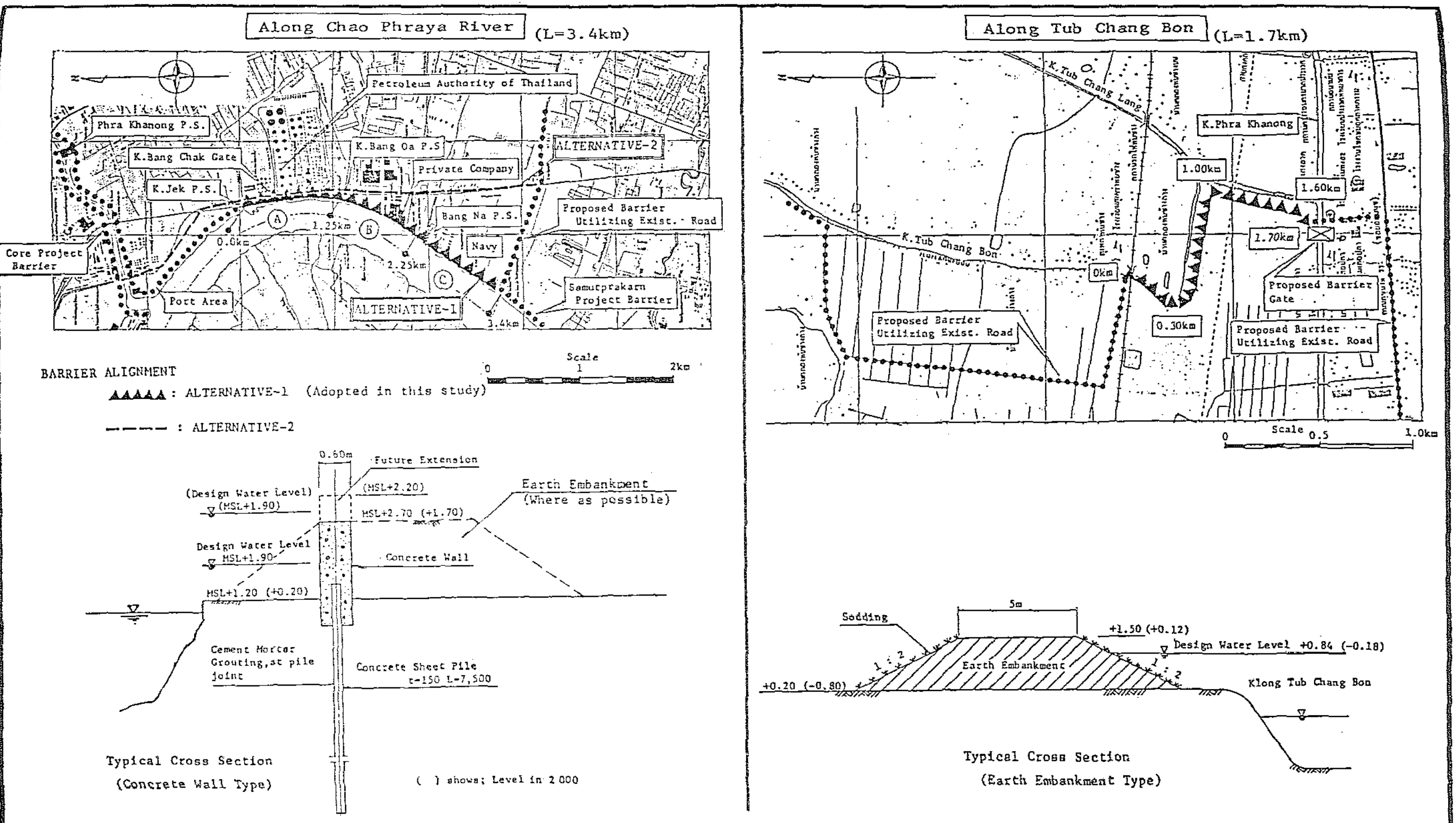



Fig. D.2 ALIGNMENT AND TYPICAL DESIGN OF FLOOD PROTECTION BARRIER

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2529B.E 1986A.D

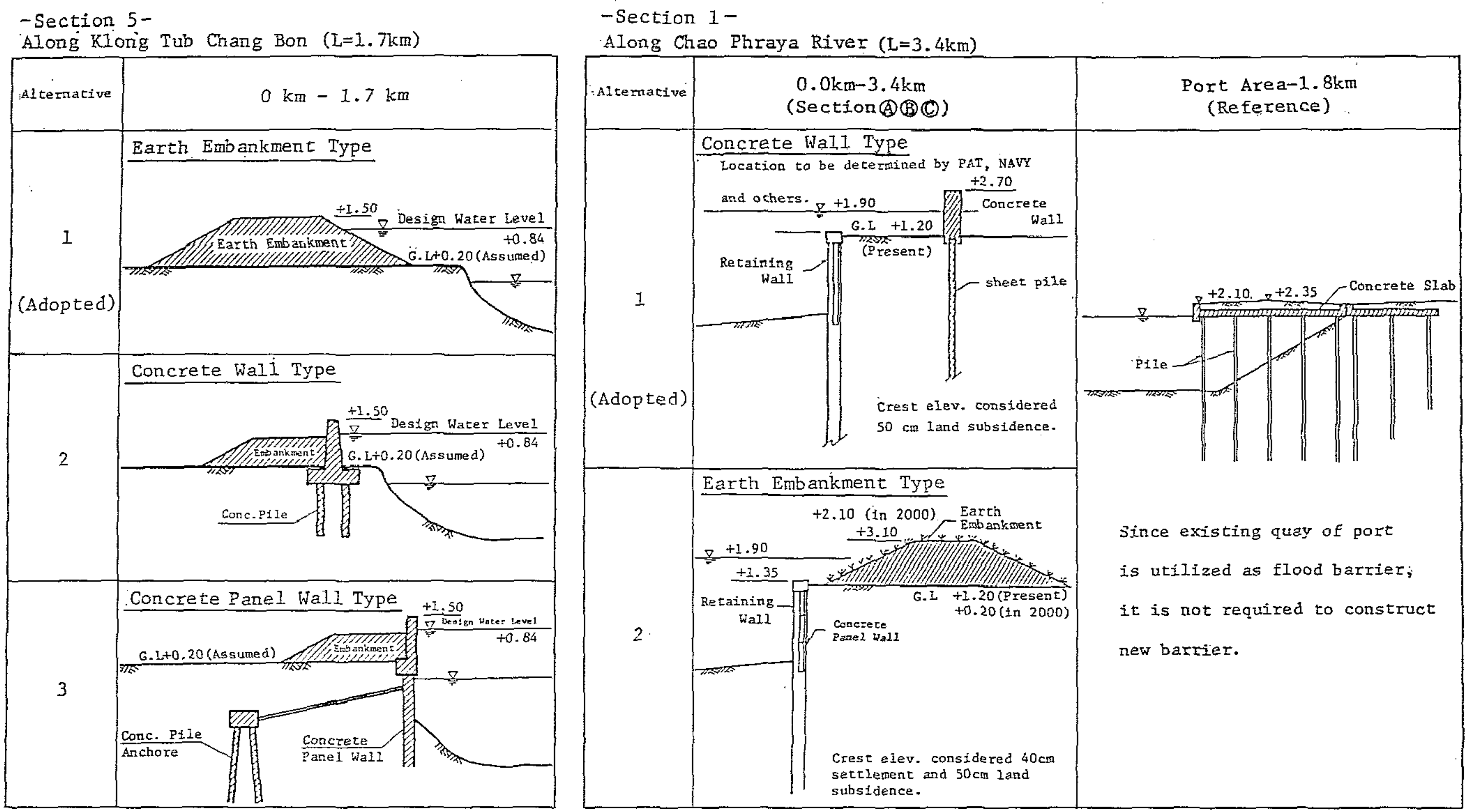
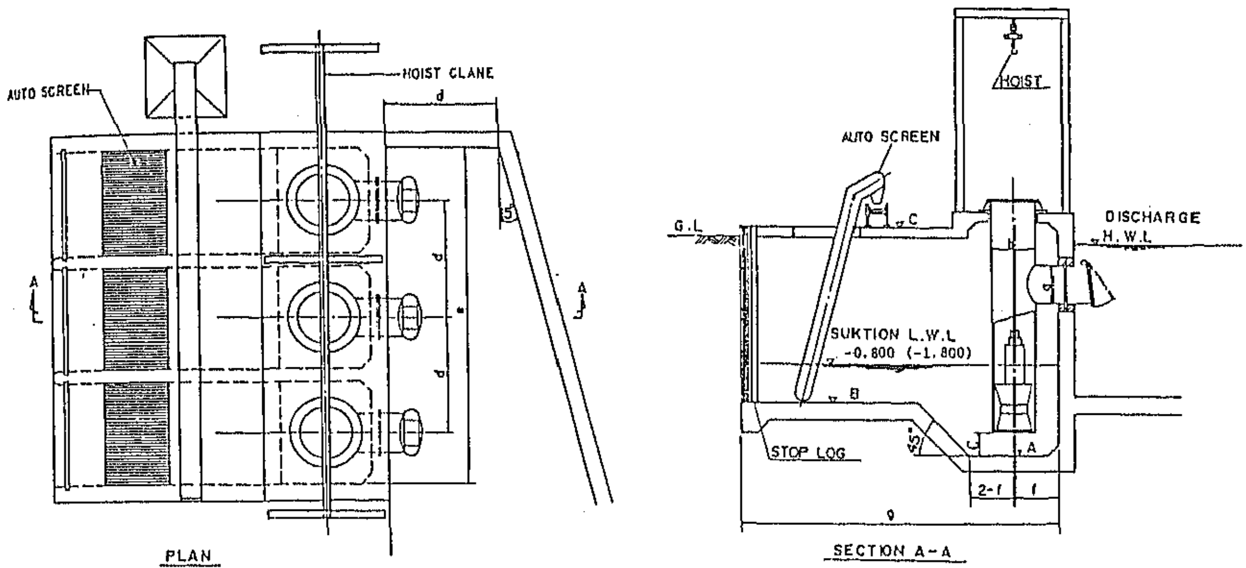



Fig. D.3 ALTERNATIVES FOR STUDY ON FLOOD PROTECTION BARRIER

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK




PLAN

SECTION A-A

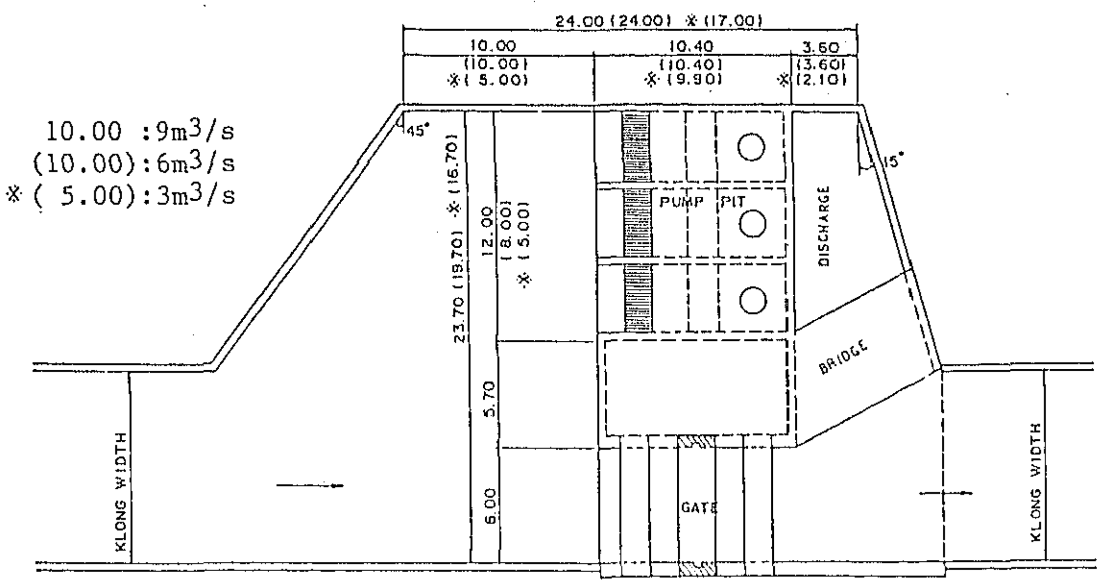



Table of Elevation and Dimension

[Unit:m MSL]

| NAME OF PUMPING STATION | NO. S OF PUMP | TOTAL CAPACITY | ELEVATION | | | | DIMENSION | | | | | | | DISCHARGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | G. L | A | B | C | a | b | c | d | e | f | g | ·HWL |
| K.BANG NA CHINE | 3 | 9 $m^3/s$ | +0.600 (-0.400) | -4.800 (-5.800) | -3.430 (-4.430) | +1.100 (+0.100) | 1.200 | 1.400 | 0.700 | 3.600 | 12.000 | 1.400 | 10.000 | -0.180 (-1.180) |
| K.KLET | 3 | 9 | +0.800 (-0.200) | -4.800 (-5.800) | -3.600 (-4.600) | +1.300 (+0.300) | " | " | " | " | " | " | " | -0.160 (-1.160) |
| K.SAEN SAB | 3 | 9 | +0.600 (-0.400) | -4.800 (-5.800) | -3.500 (-4.500) | +1.100 (+0.100) | " | " | " | " | " | " | " | +0.200 (-0.800) |
| K.BANG LAI | 2 | 6 $m^3/s$ | +0.700 (-0.300) | -4.800 (-5.800) | -3.500 (-4.500) | +1.200 (+0.200) | " | " | " | " | 8.000 | " | " | -0.165 (-1.165) |
| K.HUAY KWANG | 2 | 3 $m^3/s$ | +0.700 (0.000) | -3.600 (-4.300) | -2.000 (-2.700) | +1.500 (+0.800) | 0.700 | 0.900 | 0.450 | 2.100 | 5.000 | 1.200 | 9.500 | +0.900 (+0.200) |

0.700:Elevation at present (m MSL)

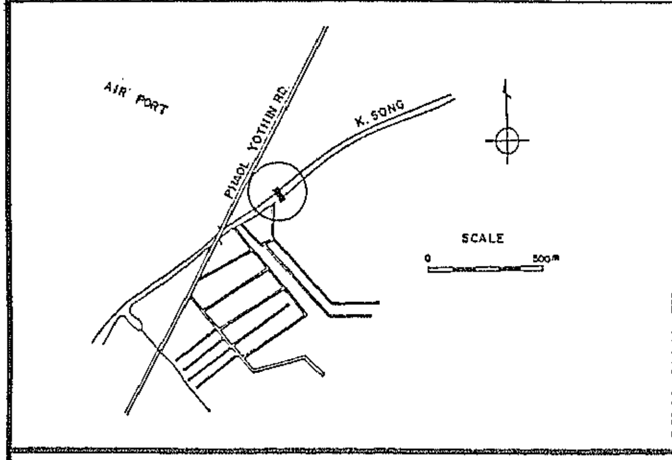
(-0.300):Elevation in 2000 (m MSL)

Fig. D.4 TYPICAL DESIGN OF PUMPING STATION

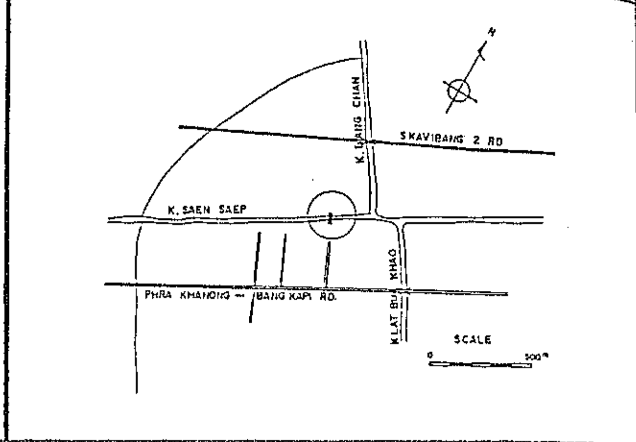
FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2529B.E 1986A.D

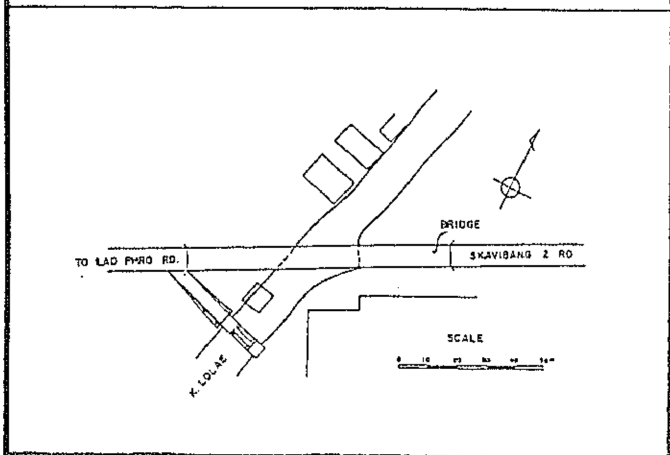
K. Song Gate



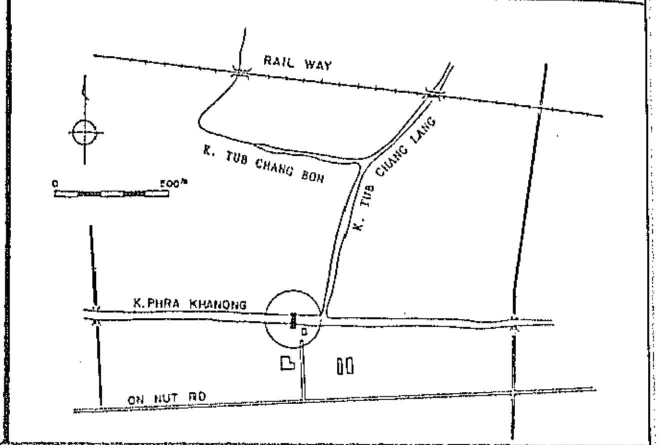

K. Saen Saeb

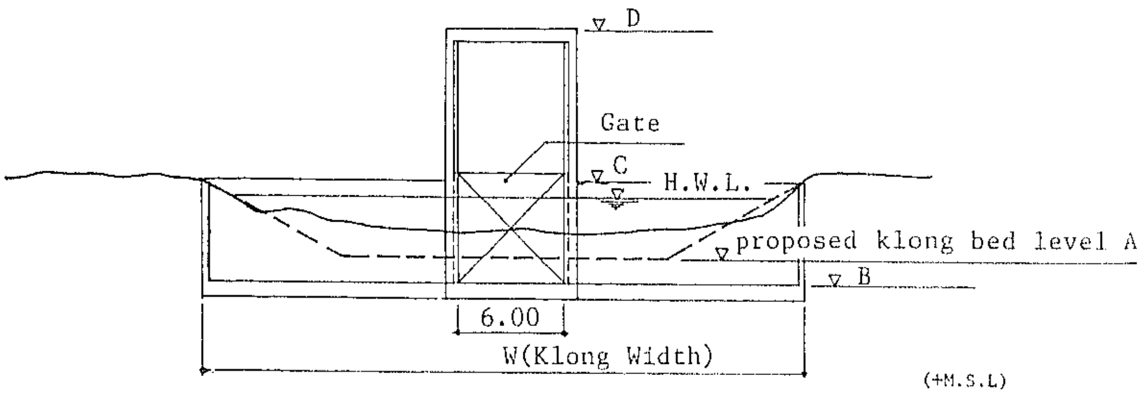



K. Lolae




K. Phra Khanong




(+M.S.L)

| Name of Gate | A | B | H.W.L | C | D | W |
|---|---|---|---|---|---|---|
| K.Song | - 2.48<br>(- 3.18) | - 3.50<br>(- 4.20) | + 1.27<br>(+ 0.57) | + 1.60<br>(+ 0.90) | +11.30<br>(+10.30) | 32.00 |
| K.Lolae | - 2.00<br>(- 3.00) | - 4.00<br>(- 5.00) | + 1.09<br>(+ 0.009) | + 1.400<br>(+ 0.400) | + 9.70<br>(+ 8.70) | 17.40 |
| K.Saen Saeb | - 2.95<br>(- 3.95) | - 4.00<br>(- 5.00) | + 1.09<br>(+ 0.09) | + 1.05<br>(+ 0.50) | +11.30<br>(+10.30) | 32.00 |
| K.Phra Khanong | - 3.22<br>(- 4.22) | - 4.50<br>- 5.50 | + 0.84<br>(- 0.16) | + 1.20<br>(+ 0.20) | + 9.70<br>(+ 8.70) | 35.00 |

(     ) : Elevation in 2000

Fig. D.5 LOCATION AND TYPICAL DESIGN OF PROPOSED GATES

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

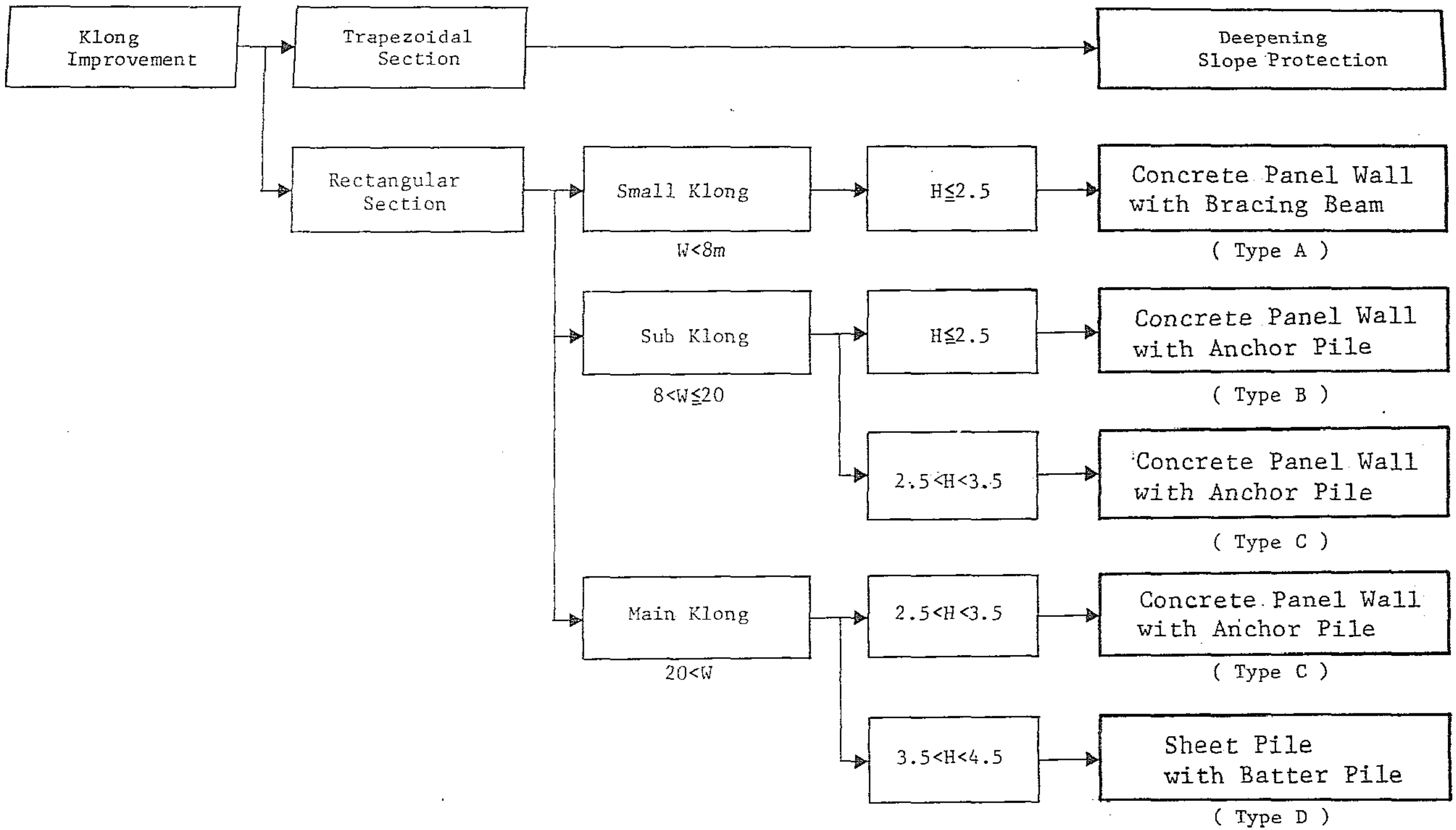



Fig. D.6 SELECTION OF RETAINING WALL TYPE

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

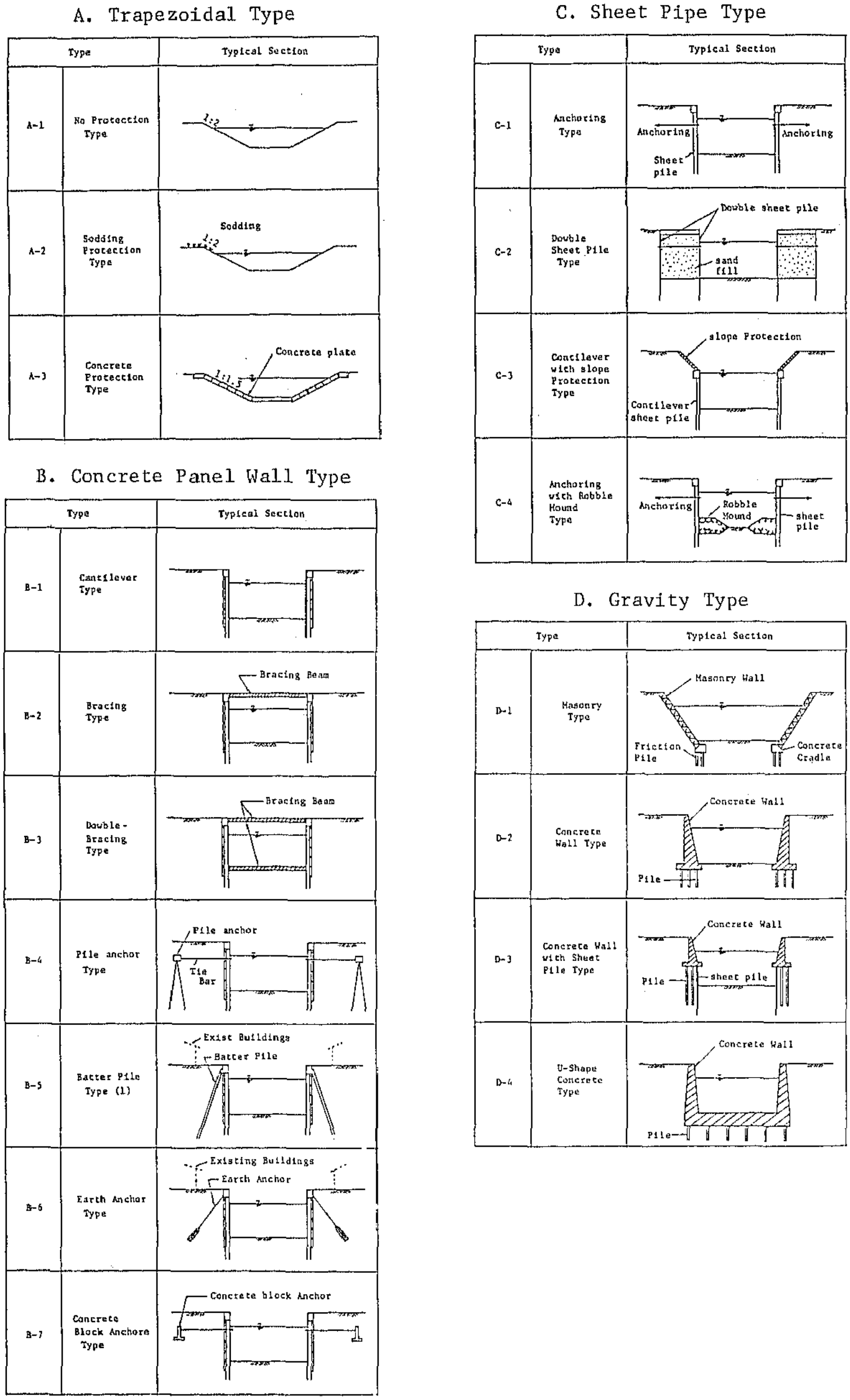
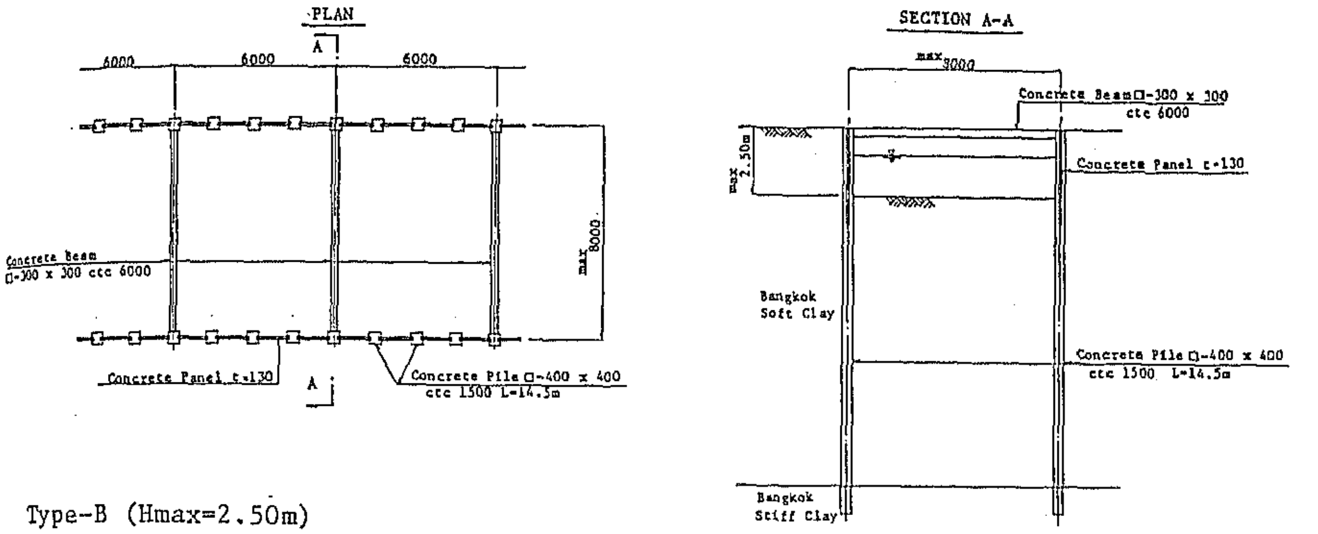



Fig. D.7 TYPICAL SECTION OF RETAINING WALL

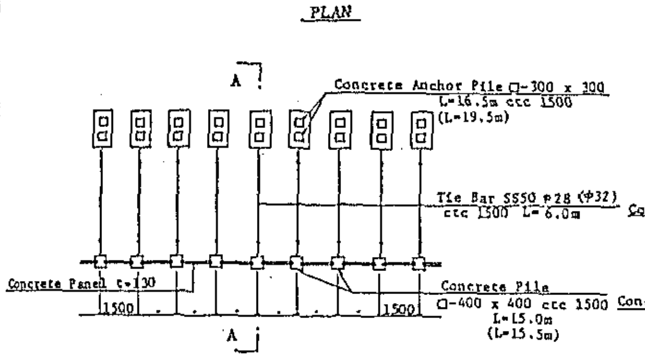
**FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK**

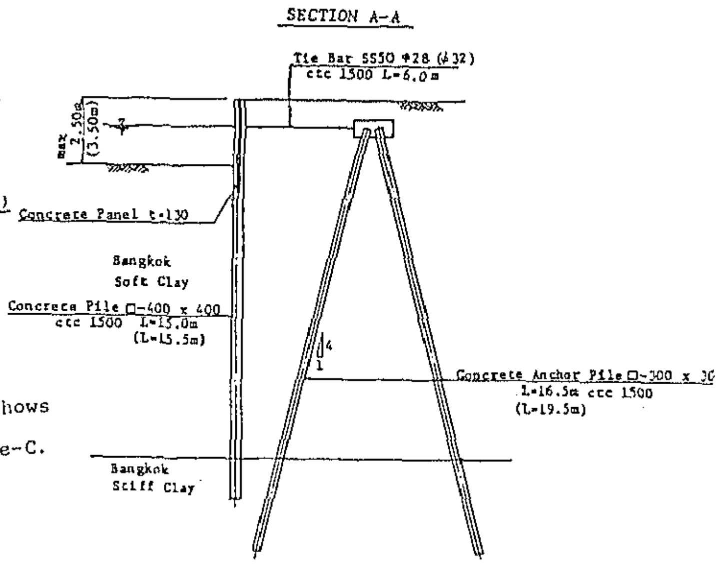
Type-A (Hmax=2.50m)




Type-B (Hmax=2.50m)

Type-C (Hmax=3.50m)




* Figure in parenthesis shows dimention of Type-C.

Type-D (Hmax=4.50m)

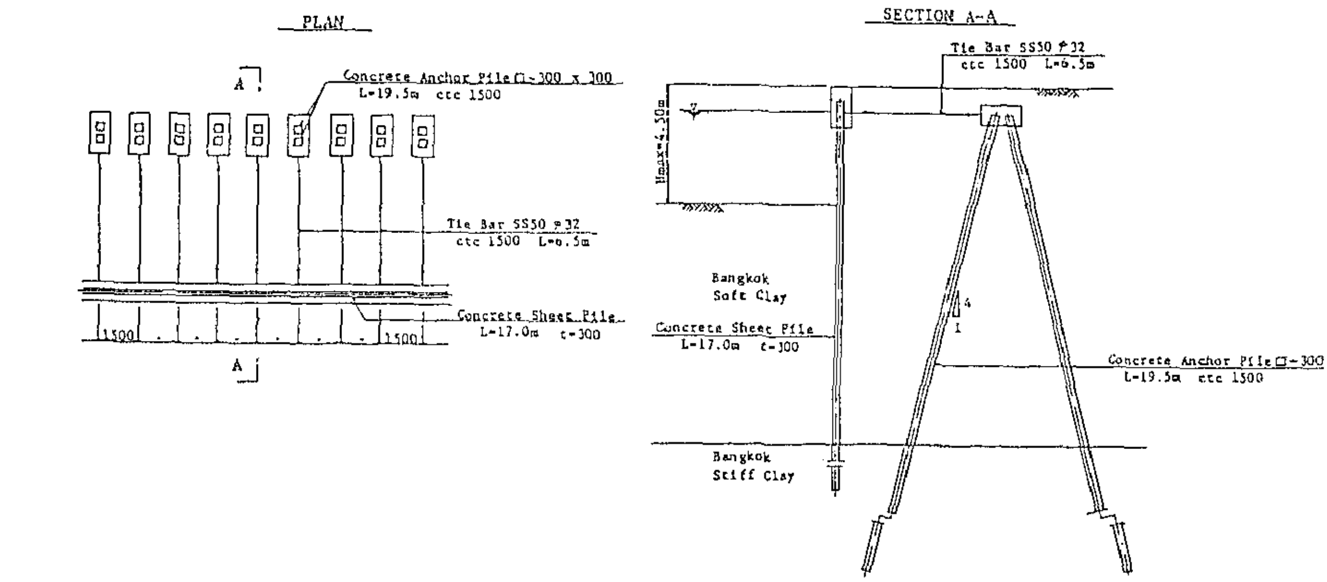


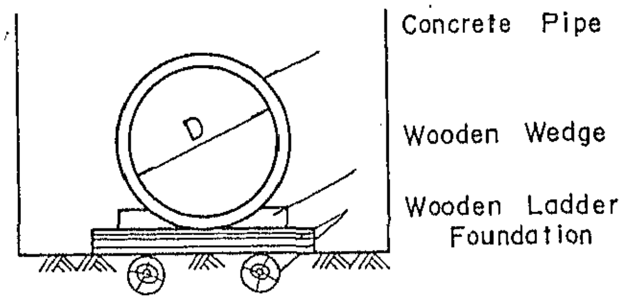

Fig. D.8 TYPICAL DESIGN OF RETAINING WALL

**FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK**

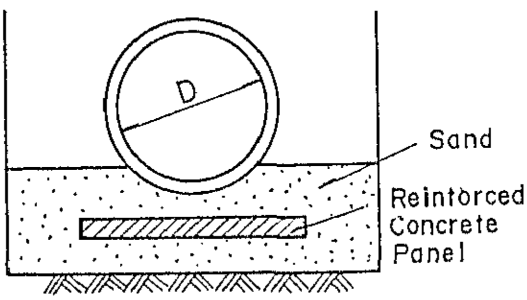


JICA 2529B.E 1986A.D

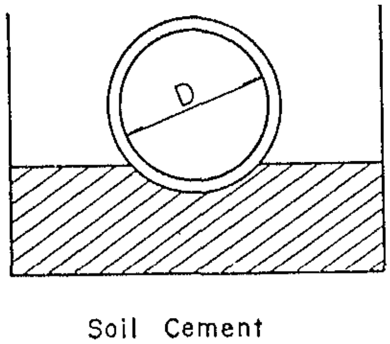
Type ( 1 ) Wooden Ladder Foundation




Type ( 2 ) Concrete panel Foundation




Type ( 3 ) Soil Cement Foudation




Type ( 4 ) Friction Pile Foundation

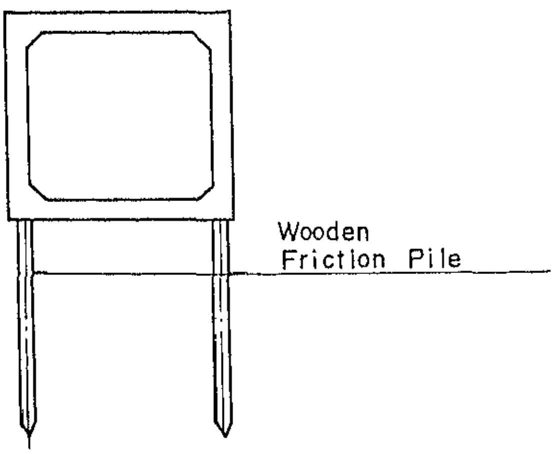
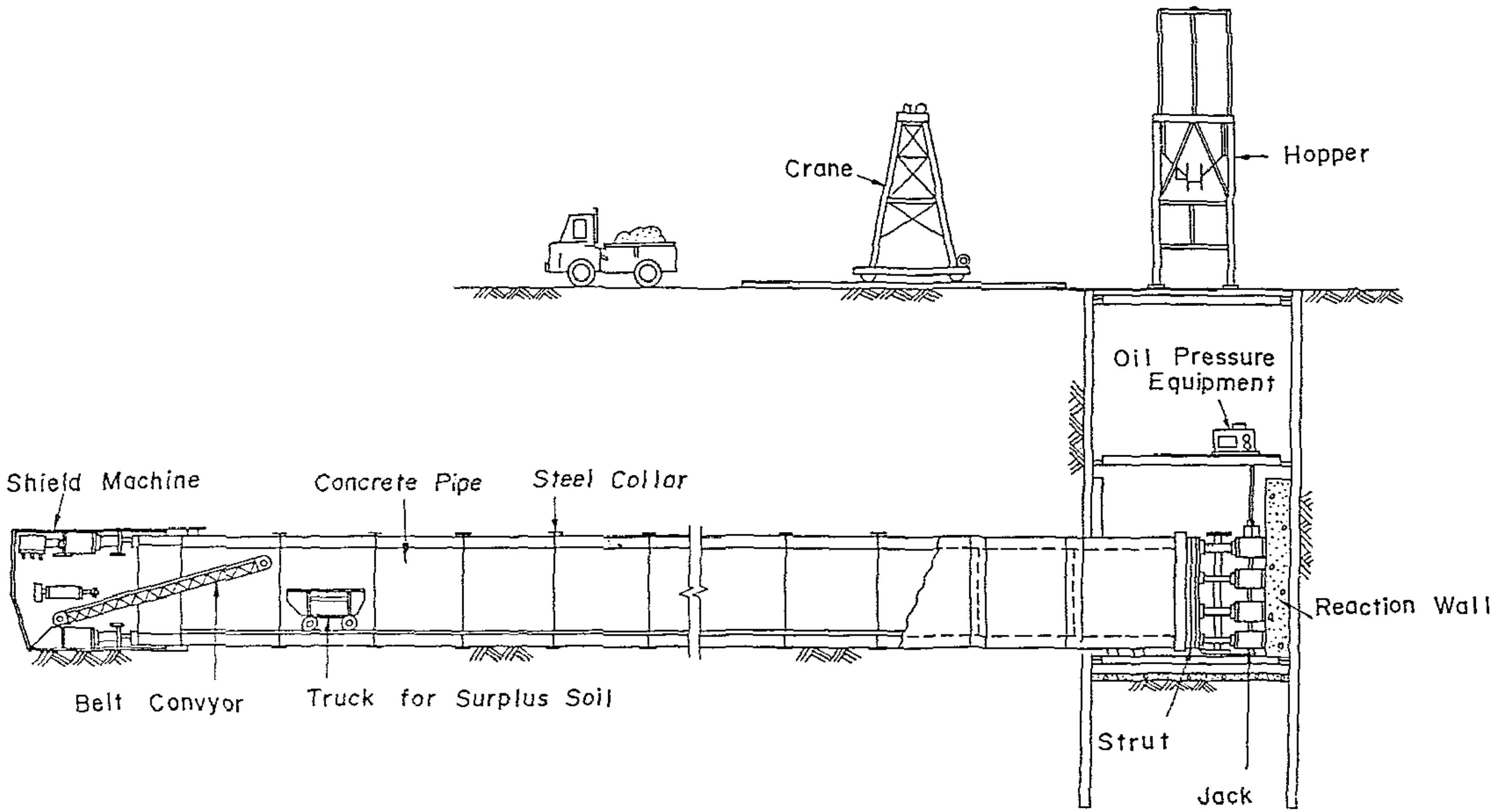



Fig. D.9 FOUNDATION FOR DRAIN

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK




| Fig. D.10 | JACKING METHOD FOR CONSTRUCTION OF DRAIN UNDER HIGHWAY |
|---|---|

**FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK**

# APPENDIX E

# PROJECT COST

# APPENDIX E PROJECT COST

## Table of Contents



## List of Tables

APPENDIX E PROJECT COST

## 1. General

Based on the facility plans, the costs of construction, land acquisition and operation maintenance were estimated. The estimation was conducted in accordance with the following conditions.

1) The estimates are made on the assumption that all construction works will be contracted to general contractors by internatioal tender.

2) The costs were computed under the economic conditions prevailing in Aug., 1985.

3) The cost was classified into foreign currncy and local currency portions.

Foreign currency and local currency portions were computed based on the follownig clasification.

The foreign currency portions consist of the costs of;

-- Imported equipment, materials and supplies;
-- Domestic materials of which the country is a net importer;
-- Wages of expatriate personnel;and
-- Overhead and profit of foreign firms.

The local currency portions include the costs of:

-- Domestic materials and supplies of which the country is a net exporter;
-- Wages of local personnel;
-- Overhead and profit of local firms;and
-- Taxes.

4) The unit cost of each work item is obtained by totaling the labour cost, equipment cost, material cost, etc.

5) Land acquisition cost are adopted 3,000 Baht/$m^2$ based on the unit cost of current data obtained by the real estate study report published by TISCO.

6) For all unit costs, a constant allowance of 30% for overhead and profit was added to the direct unit prices.

7) Contingency allowance was made of 9% of the total construction cost.

8) The engineering design and supervision fees etc. were assumed to be 4% of the construction cost.

9) Annual price escalation was considered 5% for both foreign and local currency. Based on the implementation schedule as described in Paragraph 6, total price escalation was taken 22.1% against 1985 construction costs.

Table E.1 Price Escalation Rate

| Year | Escalation | Const. Cost | |
|---|---|---|---|
| | | W/O Escal. | W/ Escal. |
| 1983 | 10.3 | 46 | 51 |
| 1988 | 15.8 | 825 | 955 |
| 1989 | 21.6 | 825 | 1,003 |
| 1990 | 27.6 | 805 | 1,027 |
| 1991 | 34.0 | 154 | 206 |
| Total | Ave. 22.1% | 2,655M฿ | 3,242M฿ |

2. Unit Cost

The unit cost by work items is calculated from the material cost, labour cost, equipment cost, etc. analyzing the data on the construction cost of recent similar projects such as the Urgent Project and the City Core Project as well as taking into consdieration the local conditions in Bangkok. The unit costs by items are as listed in Table E-6.
Table E-7 shows the summary of the breakdown of these components by each type of works.

3. Land Acquisition

Unit prices of 3,000 Baht/$m^2$ for land acquisition are obtained from the real estate study report published by TISCO. The breakdown of these costs by facilities is given in Table E-2.

4. Construction Cost

The construction cost estimates for the feasibility study have been based on the quantities calculated and on the unit costs for each work item. The summary of the cost is presented in Table E-2.

5. Operation and Maintenance Cost

The operation and maintenance costs comprised the cost of yearly operation and maintenance of klong, pumping station, gate, pipe/box culvert, barrier and flood control operation center. Routine operation and maintenance is confined to the costs of wage, electricity, cleaning and minor repairs.

(1) Wage
This includes the wage of operation for pumping station, gate facilities and services.

(2) Electricity Cost
This includes the cost of electricity for pumping station, gate facilities and services.

(3) Cleaning Cost

This includes the cost of cleaning the klongs, drainage pipe, and other services.

(4) Repair Cost

This includes the cost of facility repairs, painting of gate, pump and inspection of structures.

The operation and maintenance costs are summarized as follows;

| Items | | Cost | Quntity |
|---|---|---|---|
| (1) | Klong | 35.8 M฿ | 91.04 km |
| (2) | Pumping Station | 2.7 | 5 stations |
| (3) | Gate | 0.5 | 4 stations |
| (4) | Pipe and Box Culvert | 0.3 | 4.33 km |
| (5) | Barrier | 0.3 | 5.20 km |
| (6) | Flood control O.P center | 2.0 | 1 center |
| Total | | 41.6 M฿ | |

The result of the calculations mentioned above indicates that annual operation and maintenace cost per year amounts to approximately 1.83% of total construction cost.

## 5.1 Operation and Maintenance Cost - Klong Improvement

Operation and maintenance cost items for the klong improvement:

| | | | |
|---|---|---|---|
| (i) | Reparing cost of retaining wall | : | 101.51 km |
| (ii) | Dredging cost for siltation | : | 91.04 km |
| (iii) | Grass cutting cost | : | 40.29 km |
| (iv) | Garbage cleaning cost | : | 91.04 km |
| (v) | Repairing cost of earth embankment | : | 40.29 km |
| (vi) | Others | : | - |

(i) Repairing Cost of Retaining Wall

Reparing cost of retaining wall is assumed as 1.25% of construction cost under the consideration of site condition such as weak subsoil condition, accessibility to site etc.

1,789.3 M฿ x 1.25% = 22.3 M฿/Year

(ii) Dredging Cost for siltation

Dredging works for siltation will be done once per 10-years. Average dredging depth and width of klong are 0.20m and 20m.

101.51 km ÷ 10 year x 0.20m x 20m x 50 ฿ = 2.0 M฿/Year

(iii) Grass Cutting Cost

For the trapezoidal section of Klong, grass cutting works will be done with 10m avarage width along Klong, twice a year.

40.29 km x 10m x 2.2 ฿ x 2 times = 1.8 M฿

(85 ฿/day - 50 m2/day x 1.3 = 2.2 ฿/m2

(iv) Garbage Cleaning Cost

Garbage cleaning works including removal of water hyacinth will be done twice a year. It is assumed 30% of klong water surface will be covered by the hyacinth.

91.04 km x 20m x 5.5 x 2 x 0.3 = 6.0 M฿

(85 ฿/day ÷ 20 m2/day x 1.3 = 5.5)

(v) Reparing Cost of Slope for Trapezoidal Section

40.29 km x 10m x 1.1 ฿/m2 = 0.4 M฿

(1 m3 x 110 ฿/m3 - 100 m2 = 1.1 ฿/m2

(vi) Total Operation and Maintenance Cost for the Klong

| | | |
|---|---|---|
| i) | 22.3 | |
| ii) | 2.0 | |
| iii) | 1.8 | |
| iv) | 6.0 | |
| v) | 0.4 | |
| vi) | 3.3 | (10% of i) - v)] |

Total 35.8 M฿/Year (= 2% of 1,843.2 M฿)

5.2 Operation and Maintenance Cost-Pumping station (Const. Cost 123.3 MB)

Labour 2 Main/Place x 3000 ฿/M-M x 12 Month = 0.1 M฿

Electricity 500 hr/year 1 KWhr = 2 ฿

| | kw set | Electricity M฿ | Labour M฿ | Total M฿ |
|---|---|---|---|---|
| Bang Nang Chine ($Q=9m^3/s$) | 132 x 3 | 0.4 | 0.1 | 0.5 |
| Bang Lai (Q=6 " ) | 132 x 2 | 0.3 | 0.1 | 0.4 |
| Klet (Q=9 " ) | 132 x 3 | 0.4 | 0.1 | 0.5 |
| Lao (Q=9 " ) | 132 x 3 | 0.4 | 0.1 | 0.5 |
| Huay Kwang (Q=3 " ) | 55 x 2 | 0.1 | 0.1 | 0.2 |
| | | | | 2.1 M฿ |
| Reparing Cost | 123.3x0.005 | | | 0.6 M฿ |
| | | | | 2.7 M฿ |

5.3 Operation and Maintenance Cost-Gate Station (Const.Cost 48.2 M฿)

Labour 1 Man/Place x 3000 ฿/M-M x 12 Month = 0.05 M฿

| | KW | | hr | | time day | | day | | man | | | | M฿ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Electricity | 18.5 | x | 0.5 | x | 2 | x | 30 | x | 8 | x | 2 | = | 0.01 |

| | Electricity M฿ | Labour M฿ | Total M฿ |
|---|---|---|---|
| K.Song | 0.01 | 0.05 | 0.06 |
| K.Lolae | " | " | " |
| K.Saen Saeb | " | " | " |
| K.Phrakhanong | " | " | " |
| Repairing Cost | 48.2 x 0.005 | | 0.3 MB |

/

5.4 Operation and Maintenance Cost-Pipe & Box Culvert

(Const.Cost 147.6 M฿)

Cleaning (L = 4.3km V= 13,000 $m^3$)

| m3 | | year | | B/m3 | | M฿ |
|---|---|---|---|---|---|---|
| 13,000 | ÷ | 5 | x | 100 | = | 0.3 |

5.5 Operation and Maintenance Cost-Flood Protection Barrier

(1) Along Chao Phraya River (Concerete Wall Type-3.4 km)

0.5% of the construction cost is assumed

| M฿ | | | | M฿/year | |
|---|---|---|---|---|---|
| 40.3 | x | 0.5% | = | 0.2 | (0.5%) |

(2) Along Klong Tub Chang Bon

0.5% of the construction cost is assumed

| M฿ | | | | M฿ |
|---|---|---|---|---|
| 2.3 | x | 0.5% | = | 0.1 |

(3) Total Operation and Maintenance Cost for the Flood Protection Barrier

| | |
|---|---|
| i) | 0.2 |
| ii) | 0.1 |
| | M฿ |
| Total | 0.3 |

5.6 Operation and Maintenance Cost-Flood Control Operation Center

(1) Operator Salary
2 persons x 12 persons x 16,700 Ø ... 0.4 MØ

(2) Operating Expense
Telephone, Electric .................. 1.0 MØ

(3) Patroling Expence
Repairing, Patrol .................. 0.4 MØ

(4) Office Work Expence
Stationary, Others .................. 0.2 MØ

(5) Total O/M Cost for Flood Control Operation Center

| | |
|---|---|
| i) | 0.4 |
| ii) | 1.0 |
| iii) | 0.4 |
| iv) | 0.2 |
| Total | 2.0 MØ |

6. Implementation Schedule

The degree of flood flood protection should be upgraded stage by stage. The high priority measures is the exclusion of river overspill and overland flow from outside land. This suggests the early construction of a flood protection barrier, which would protect area from outside flooding and inland drainage facilities later or in parallel, depending on usefullness of the work.

The facilities for the Feasibility Study are ranked as shown in Fig. 5.6. The flood protection barrier and its gates are ranked as high priority. Then primary dranage facilities, which contribute to alleviate overall flooding are ranked at next priority generally, followed by secondary and tertiary drainage facilities. Effects of these facilities are shown in Appendix from which implementation order is decided.

Considering the time for preparation of detailed design and particularly financial procurement, construction can be started in 1988, one year later than the Master Plan proposal, and completed in 1991. The flood protection barrier, gates, pumping stations and control center are planned to be implemented in 1988. Construction of primary facilities are scheduled in 1988 and 1989, followed by secondary facilities in 1990 and tertiary facilities in 1991 as shown in Table E.8.

Table E.2 Summary of Construction Cost

(Million Baht)

| Facility | Description | Construction Cost | | | Land Acquision | Remarks |
|---|---|---|---|---|---|---|
| | | F/C | L/C | Total | | |
| A. Flood Barrier | | | | | | |
| 1. Chao Phraya River | L=3400m, H=1.5m | (50) 19.0 | (50) 19.0 | 38.0 | - | Conc.Wall |
| 2. K.Tub Chang Bon | L=1700m, H=1.3m | (25) 0.6 | (75) 1.7 | 2.3 | - | Enbankment |
| Sub-Total | | 19.6 | 20.7 | 40.3 | - | |
| B. Control Gate | H W No. | | | | | |
| 1. K.Song | 6x 6x 1 | (65) 7.7 | (35) 4.1 | 11.8 | - | |
| 2. K.Lolae | 6x 6x 1 | 6.4 | 3.5 | 9.9 | - | |
| 3. K.Saen Saep | 6x 7x 1 | 9.2 | 5.0 | 14.2 | - | |
| 4. K.Phrakhanong | 6x 6x 1 | 8.0 | 4.3 | 12.3 | - | |
| Sub-Total | | 31.3 | 16.9 | 48.2 | - | |
| C. Pumping Station | | | | | | |
| 1. Bang Nang Chine | $Q = 9\ m^3/s$ | (70) 19.8 | (30) 8.5 | 28.3 | 2.0 | |
| 2. Ban Lai | Q = 6 " | 15.4 | 6.6 | 22.0 | 0.9 | |
| 3. Klet | Q = 9 " | 19.2 | 8.2 | 27.4 | 0.9 | |
| 4. Saen Sab | Q = 9 " | 19.3 | 8.3 | 27.6 | 2.0 | |
| 5. Huay Kwang | Q = 3 " | 12.6 | 5.4 | 18.0 | 0.9 | |
| Sub-Total | $Q = 36\ m^3/s$ | 86.3 | 37.0 | 123.3 | 6.7 | |
| D. Klong Improvement | L=92.96 km | | | | | |
| 1. Retaing Wall | L=101.51 km | (45) 805.2 | (55) 984.1 | 1,789.3 | 82.9 | |
| 2. Dredging | $V=1,084,000m^3$ | (60) 32.3 | (40) 21.5 | 53.9 | - | |
| Sub-Total | | 834.5 | 1,005.7 | 1,843.2 | 82.9 | |
| E. Pipe/Box Culvert | L=4,330 m | (50) 73.8 | (50) 73.8 | 147.6 | - | |
| F. Flood Control Operation System | | 68.0 | | 68.0 | - | |
| Sub-Total (A-F) | | 1,116.5 | 1,154.1 | 2,270.6 | 89.6 | |
| G. Phisical Contingency | | 100.4 | 103.8 | 204.2 | - | |
| H. Engineering /Supervision | | 44.6 | 46.2 | 90.8 | - | |
| Sub-Total (A-H) | | 1,261.5 | 1,304.1 | 2,565.6 | 89.6 | Total 2,655.2 ฿ |
| I. Price Escalation | | 278.8 | 288.2 | 567.0 | 19.8 | |
| Total (A-I) | | 1,540.3 | 1,592.3 | 3,132.6 | 109.4 | Total 3,242 M฿ |

Table E-3(a) Construction Cost for Flood Protection Barrier

| Barrier | Unit | Quantity | Unit Cost (฿) | | | Construction Cost (M฿) | | | Land Ac |
|---|---|---|---|---|---|---|---|---|---|
| | | | F/C | L/C | Total | F/C | L/C | Total | |
| | | | 50 | 50 | | | | | |
| 1)Chao Phraya River | L.m | 3,400 | 5,600 | 5,600 | 11,200 | 19.0 | 19.0 | 38.0 | -- |
| | | | 25 | 75 | | | | | |
| 2)Tub Chang Bon | L.m | 1,700 | 340 | 1,010 | 1,350 | 0.6 | 1.7 | 2.3 | -- |
| Total | - | -- | - | -- | -- | 19.6 | 20.7 | 40.3 | -- |

Table E-3(b) Construction Cost for Control Gate

| Gate | Unit | Quantity | Unit Cost (M฿) | | | Construction Cost (M฿) | | | Land Ac |
|---|---|---|---|---|---|---|---|---|---|
| | | | F/C | L/C | Total | F/C | L/C | Total | |
| | | | | | | 65 | 35 | | |
| 1) K.Song | L.S | 1 | 7.7 | 4.1 | 11.8 | 7.7 | 4.1 | 11.8 | -- |
| -Civil | | | (3.5) | (3.1) | (6.6) | | | | |
| -Gate Leaf | | | (4.2) | (1.0) | (5.2) | | | | |
| | | | | | | 65 | 35 | | |
| 2) K.Lolae | L.S | 1 | 6.4 | 3.5 | 9.9 | 6.4 | 3.5 | 9.9 | -- |
| -Civil | | | (2.3) | (2.5) | (4.8) | | | | |
| -Gate Leaf | | | (4.1) | (1.0) | (5.1) | | | | |
| | | | | | | 65 | 35 | | |
| 3) K.Saen Saep | L.S | 1 | 9.2 | 5.0 | 14.2 | 9.2 | 5.0 | 14.2 | -- |
| -Civil | | | (4.2) | (3.8) | (8.0) | | | | |
| -Gate Leaf | | | (5.0) | (1.2) | (6.2) | | | | |
| | | | | | | 65 | 35 | | |
| 4) K.Phrakhanong | L.S | 1 | 8.0 | 4.3 | 12.3 | 8.0 | 4.3 | 12.3 | -- |
| -Civil | | | (3.7) | (3.2) | (6.9) | | | | |
| -Gate Leaf | | | (4.3) | (1.1) | (5.4) | | | | |
| | | | | | | 65 | 35 | | |
| Total | - | - | - | - | - | 31.3 | 16.9 | 48.2 | -- |

Table E.3(c) Construction Cost of Pumping Station

| Items | Bang Na Chine Pumping Station Construction Cost x10³฿ | | | K.Bang Lai Pumping Station Construction Cost x10³฿ | | | K.Klet Pumping Station Construction Cost x10³฿ | | | K.Saen Sab Pumping Station Construction Cost x10³฿ | | | K.Huay Kwang Pumping Station Construction Cost x10³฿ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F/C | L/C | Total | F/C | L/C | Total | F/C | L/C | Total | F/C | L/C | Total | F/C | L/C | Total |
| Civil works | 4,859 | 3,240 | 8,099 | 3,946 | 2,631 | 6,577 | 4,454 | 2,969 | 7,423 | 4,954 | 3,302 | 8,256 | 2,135 | 3,157 | 5,292 |
| Mecanical and electrical facilities | 8,991 | 2,248 | 11,239 | 6,045 | 1,151 | 7,556 | 8,991 | 2,248 | 11,239 | 8,991 | 2,248 | 11,239 | 4,396 | 1,099 | 5,495 |
| submarged pump | 132KW unit ∅1,200x3 | | ( 3,600) | 132KW unit ∅1,200x2 | | ( 2,400) | 132KW unit ∅1,200x3 | | ( 3,600) | 132KW unit ∅1,200x3 | | ( 3,600) | 55KW unit ∅ 700x2 | | ( 1,320) |
| discharge pipe | | | ( 219) | | | ( 146) | | | ( 219) | | | ( 219) | | | ( 58) |
| flap valve | | | ( 270) | | | ( 180) | | | ( 270) | | | ( 270) | | | ( 52) |
| oparation panel | | | ( 870) | | | ( 580) | | | ( 870) | | | ( 870) | | | ( 500) |
| hoist | | | ( 280) | | | ( 250) | | | ( 280) | | | ( 280) | | | ( 225) |
| auto screen | | | ( 6,000) | | | ( 4,000) | | | ( 6,000) | | | ( 6,000) | | | ( 3,340) |
| steel gate width; 6.0m (C.I.F) | 2,948 | 1,246 | 4,212 | 2,948 | 1,264 | 4,212 | 2,948 | 1,264 | 4,212 | 2,457 | 1,053 | 3,510 | 2,948 | 1,264 | 4,212 |
| Instration and miscellaneous works | 3,297 | 1,413 | 4,710 | 2,568 | 1,101 | 3,669 | 3,203 | 1,372 | 4,575 | 3,221 | 1,380 | 4,601 | 2,100 | 900 | 3,000 |
| total | 20,095 | 8,165 | 28,260 | 15,507 | 6,507 | 22,014 | 19,596 | 7,853 | 27,449 | 19,623 | 7,983 | 27,606 | 11,579 | 6,420 | 17,999 |

Table E.3(d) Construction Cost for Klong Improvement (1)

(Unit: Million Baht)

| Klong | Retaining Wall (฿) | | | | Dredging | Land Acquision | Remarks |
|---|---|---|---|---|---|---|---|
| | A | B | C | D | | | |
| **A. Main Klong** | | | | | | | |
| 1. Phra Khanong | - | - | 68.1 | 85.3 | 3.4 | - | |
| 2. Ton | - | - | 16.6 | 140.6 | 4.6 | 3.3 | |
| 3. Sean Seap | - | - | 66.2 | 401.6 | 9.3 | 35.1 | |
| Sub-Total | - | - | 150.9 | 627.5 | 17.3 | 38.4 | |
| **B. Bang Na Drainage Area** | | | | | | | |
| 1. Bang Na | 10.8 | - | 153.2 | - | 3.0 | 1.2 | |
| 2. Bang Nang Chine | 36.7 | - | - | - | 0.9 | - | |
| 3. Jek | 0 | - | - | - | 0 | - | |
| 4. Bang Oa | 18 | - | - | - | 0.7 | - | |
| 5. Bang Chak (1) | 33.3 | - | 20.7 | - | 1.4 | - | |
| 6. " " (2) | 31.5 | - | - | - | 1.1 | - | |
| 7. Kwang Bon | 46.8 | - | - | - | 1.0 | - | |
| Ban Lai | 54.0 | - | - | - | 1.8 | - | |
| 8. Suan Aoi | - | - | - | - | 0.5 | - | |
| 9. Kwang Lai | - | - | - | - | 0.3 | - | |
| 10. Bang Na-Trad (K1) | - | - | - | - | 0.3 | - | |
| 11. Bang Na-Trad (K2) | - | - | - | - | 0.1 | - | |
| 12. Bang Na-Trad (K3) | - | - | - | - | 0.1 | - | |
| 13. Klet | 48.6 | - | 144.9 | - | 5.7 | - | |
| Sub-Total | 279.7 | - | 318.8 | - | 16.9 | 1.2 | |
| **C. Rhamkhamhaeng Drainage Area** | | | | | | | |
| 1. Kacha | 28.8 | - | - | - | 1.4 | - | |
| 2. Gig | 15.7 | - | - | - | 0.4 | - | |
| 3. Chit | 23.4 | - | - | - | 0.2 | - | |
| Sub-Total | 67.9 | - | - | - | 2.0 | - | |

Table E.3(d) Construction Cost for Klong Improvement (2)

(Unit: Million Baht)

| Klong | Retaining Wall (฿) | | | | Dredging | Land | Remarks |
|---|---|---|---|---|---|---|---|
| | A | B | C | D | (฿) | Acquision | |
| D. West Huay Kwang Drainage Area | | | | | | | |
| 1. Sam Sen | - | 32.8 | - | - | 1.0 | 8.1 | |
| 2. Lat Phrao | - | - | - | - | 7.0 | 5.8 | |
| 3. Chao Khun Sing | - | - | - | - | 0.2 | 5.4 | |
| 4. Yai Soon | - | - | - | - | 0.2 | 8.4 | |
| 5. Huay Kwang | - | - | - | - | - | - | |
| 6. Nasong | - | - | - | - | - | - | |
| Sub-Total | - | 32.8 | - | - | 8.4 | 27.7 | |
| E. Bang Sue Drainage Area | | | | | | | |
| 1. Bang Sue | - | - | 66.2 | 50.2 | 5.2 | 15.6 | |
| 2. Ratchada Ditch | 93.6 | - | - | - | 2.6 | - | |
| 3. Kasesert | 31.5 | - | - | - | 0.6 | - | |
| 4. Lat Yao | 38.7 | - | - | - | 0.2 | - | |
| 5. Huay Kwang Bon | 31.5 | - | - | - | 0.7 | - | |
| Sub-Total | 195.3 | - | 66.2 | 50.2 | 9.3 | 15.6 | |
| Total | 542.9 | 32.8 | 535.9 | 677.7 | 53.9 | 82.9 | |
| | | | | 1,789.3 | | 1,926.1 | |

Total Cost of Retaining Wall 1,789.3

Table E-3(e) Construction Cost for Drain

| Location | Description | Unit | Length(m) | Construction (M฿) | | |
|---|---|---|---|---|---|---|
| | | | | F/C | L/C | Total |
| Bang Na Polder | | | | | | |
| 1. Cross of Bang Na-Trad Rd. | 2@B3x3 | L.m | 175 | 3.15 | 3.15 | 6.30 |
| 2. Cross of Highway | ϕ 2.5 | " | 35 | 3.60 | 3.60 | 7.20 |
| 3. Sukhumvit Soi 50 | B2.5x2.5 | " | 700 | 10.60 | 10.60 | 21.20 |
| 4. Connecting with K. Bang Jek and side ditch along Sukhumvit Soi 50 | B2.5x2.5 | " | 150 | 2.25 | 2.25 | 4.50 |
| Sub-Total | | | 1,060 | 19.60 | 19.60 | 39.20 |
| Ramkhamhaeng Polder | | | | | | |
| 5. From Ramkhamhaeng University to K. Saen Sep | ϕ 1.5 | L.m | 200 | 0.55 | 0.55 | 1.10 |
| Sub-Total | | | 200 | 0.55 | 0.55 | 1.10 |
| West Huay Khwang Drainage Area | | | | | | |
| 6. Highway Ditch | 2@B2x2 | L.m | 900 | 23.95 | 23.95 | 47.90 |
| Sub-Total | | | 900 | 23.95 | 23.95 | 47.90 |
| Bang Sue Drainage Area | | | | | | |
| 7. Sena Nichom Rd. | 1@B2x2 | L.m | 2,000 | 26.00 | 26.00 | 52.00 |
| 8. Ratchada Ditch | 2@B2x2 | " | 100 | 2.65 | 2.65 | 5.30 |
| 9. K. Lat Yao | 1@B2x3 | " | 70 | 1.05 | 1.05 | 2.10 |
| Sub-Total | | | 2,170 | 29.70 | 29.70 | 59.40 |
| Total (1-9) | | | 4,330 | 50<br>73.80 | 50<br>73.80 | 147.60 |

Table E.3(f) Construction Cost for Flood Control Operation Center

(unit: Thousand yen)

| Stage | Feasibility Stage | | | Future Stage | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Descriptions / Package | Priority Package | | | Second Package | | | Whole Package | | |
| | Unit | Amount | Remark | Unit | Amount | Remark | Unit | Amount | Remark |
| (1) MASTER STATION | | (325,900) | | | (409,000) | | | (439,000) | |
| 1. Host Computer | 1 set | 40,500 | Without Back up machine | 1 set | 81,000 | With Back up Machine | 1 set | 81,000 | |
| 2. Man-Machine sub-system Color Copier, 70"projector Mimic Panel, TV Camera, VTR Desk, etc | 1 unit | 76,000 | | 1 unit | 76,000 | | 1 unit | 76,000 | |
| 3. Communication sub-system | 1 unit | 60,000 | | 1 unit | 71,000 | | 1 unit | 71,000 | |
| 4. Application Soft Ware | 1 " | 100,000 | | 1 " | 120,000 | | 1 " | 150,000 | |
| 5. Power Supply System | 1 " | 39,400 | | 1 " | 50,000 | | 1 " | 50,000 | |
| 6. Cables | 1 " | 10,000 | | 1 " | 11,000 | | 1 " | 11,000 | |
| (2) SUB MASTER STATION | | | | | (297,500) | | | (476,000) | |
| 1. Computer system | | — | | 5 sets | 160,000 | | 8 sets | 256,000 | |
| 2. Application Soft Ware | | — | | 5 " | 100,000 | | 8 " | 160,000 | |
| 3. Power Supply System | | — | | 5 " | 25,000 | | 8 " | 40,000 | |
| 4. Cables | | — | | 5 " | 12,500 | | 8 " | 20,000 | |
| (3) OUT STATIONS | | (109,500) | | | (291,360) | | | (525,130) | |
| 1. OTU (STC-1000) | 15 sets | 33,750 | | 41 sets | 92,250 | | 75 sets | 168,750 | |
| 2. Cabinet | 15 sets | 14,400 | | 41 " | 39,360 | | 75 " | 72,000 | |
| 3. Water Level Gage | 28 " | 25,200 | | 69 " | 62,100 | | 119 " | 107,100 | |
| 4. Rainfall Gage | 13 " | 3,250 | | 31 " | 7,750 | | 61 " | 15,250 | |
| 5. OTU Soft Ware | 15 " | 4,500 | | 41 " | 12,300 | | 75 " | 32,500 | |
| 6. Cable | 1 unit | 8,600 | | 1 unit | 24,600 | | 1 unit | 34,530 | |
| 7. Modification of Existing panel | 1 " | 4,800 | | 1 " | 12,000 | | 1 " | 20,000 | |
| 8. DC Battery charger | 15 " | 15,000 | | 41 " | 41,000 | | 75 " | 75,000 | |
| (4) OUT For RID, MD EGAT PA | | | | | (52,000) | | | (91,000) | |
| 1. OTU and Cabinet | | — | | 4 sets | 32,000 | | 7 sets | 56,000 | |
| 2. OTU Soft Ware | | — | | 4 " | 16,000 | | 7 " | 28,000 | |
| 3. DC Battery charge | | — | | 4 " | 4,000 | | 7 " | 7,000 | |
| (5) OTHERS | | (190,200) | | | (453,500) | | | (656,930) | |
| 1. Master Station Installation | | 12,000 | | 1 unit | 17,000 | | 1 unit | 20,000 | |
| 2. Sub-Master Installation | | — | | 1 " | 20,000 | | 1 " | 35,000 | |
| 3. OTU Installation | | 20,000 | | 1 " | 67,500 | | 1 " | 118,130 | |
| 4. Site Testing | | 60,000 | | 1 " | 160,000 | | 1 " | 180,000 | |
| 5. Spare Parts | | 30,000 | | 1 " | 42,000 | | 1 " | 76,800 | |
| 6. Test Equipments | | 15,000 | | 1 " | 15,000 | | 1 " | 20,000 | |
| 7. OTU House | | 15,000 | | 1 " | 41,000 | | 1 " | 72,000 | |
| 8. TOT Telephone Line | | 9,200 | | 1 " | 25,000 | | 1 " | 45,000 | |
| 9. One year Maintenance | | 9,000 | | 1 " | 30,000 | | 1 " | 40,000 | |
| 10. Operation Training | | 20,000 | | 1 " | 36,000 | | 1 " | 50,000 | |
| (6) Total of Initial Cost | ¥ 625,600 thousand yen<br>॥<br>68 Million ฿ | | | ¥ 1,503,360 thousand yen<br>॥<br>158 Million ฿ | | | ¥ 2,188,060 thousand yen<br>॥<br>235 Million ฿ | | |
| (7) Operation & Maintenance | | | | | | | | | |
| 1. Salary of Operator | 2 Memb. | 0.40 M฿ | | 3 Memb. | 0.60 M฿ | | 3 Memb. | 0.60 M฿ | |
| 2. Operating Expense (TOT, EGAT, ETC) | 1 " | 1.00 M฿ | | 1 unit | 3.10 M฿ | | 1 unit | 3.90 M฿ | |
| 3. Patroling Expense | 1 " | 0.30 M฿ | | 1 " | 0.80 M฿ | | 1 " | 1.00 M฿ | |
| 4. Office Work Expense | 1 " | 0.20 M฿ | | 1 " | 0.50 M฿ | | 1 " | 0.50 M฿ | |
| TOTAL | | 2 Million ฿ / year | | | 5 Million ฿ / year | | | 6 Million ฿ / year | |

Table E.4 Labour Wage

| Type of Labour | Labour Wage per Day (฿) |
|---|---|
| Unskilled Labour | 85 |
| Mason | 120 - 140 |
| Bar Bender | 85 - 120 |
| Concretor | 100 - 140 |
| Asphalter | 100 - 130 |
| Carpenter | 100 - 180 |
| Painter | 120 - 150 |
| Welder | 130 - 150 |
| Foreman | 300 - 400 |
| Chief Forman | 350 - 600 |
| Car Driver | 100 - 150 |
| Equipment Operator | 200 - 250 |
| Boat Crew (low) | 90 - 290 |
| " (middle) | 120 - 430 |
| " (high) | 400 |

Table E.5 Material Price (1)

| Item | Description | Unit | Price (฿) | Foregin (%) | Local (%) |
|---|---|---|---|---|---|
| ready mixed concrete | 100kg/cm$^2$ | m$^3$ | 1,000 | 35 | 65 |
| " " " | 160 " | " | 1,150 | 35 | 65 |
| " " " | 210 " | " | 1.300 | 35 | 65 |
| cement | portland | t | 1,640 | 40 | 60 |
| sand | use of concrete | m$^3$ | 140 | 30 | 70 |
| " | " backfill | " | 110 | 30 | 70 |
| laterite | | " | 110 | 30 | 70 |
| riprap | 50-150mm | " | 170 | 30 | 70 |
| crusher-run | 0- 40 " | " | 140 | 30 | 70 |
| deformed bar S D 30 | 13mm & below | t | 9,500 | 70 | 30 |
| " | 16 " & over | " | 8,900 | 70 | 30 |
| sheet pile | | t | 9,620 | 70 | 30 |
| H-shaped Steel | H-300x300 | " | 9,200 | 70 | 30 |
| Soft wood | | m$^3$ | 5,500 | 20 | 80 |
| hard wood | | " | 11,000 | 20 | 80 |
| Wooden pile | ϕ 75mm x 3m | ea. | 32 | 20 | 80 |
| " " | ϕ100mm x 4m | " | 59 | 20 | 80 |
| " " | ϕ125mm x 5m | " | 100 | 20 | 80 |
| " " | ϕ150mm x 6m | " | 180 | 20 | 80 |
| gasoline | | L | 12 | 80 | 20 |
| diesel oil | | " | 7 | 80 | 20 |
| light oil | | " | 7 | 80 | 20 |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Table E.5 Material Price (2)

| Item | Description | Unit | Price (฿) | Foregin (%) | Local (%) |
|---|---|---|---|---|---|
| R.C.Pile | □ 200mm x 200mm x 10m | ec. | 1,180 | 40 | 60 |
| | " x 12 | " | 1,416 | " | " |
| | " x 15 | " | 1,920 | " | " |
| | " x 20 | " | 3,260 | " | " |
| | □ 300 x 300 x 10 | " | 2,520 | " | " |
| | " x 12 | " | 3,024 | " | " |
| | " x 15 | " | 4,140 | " | " |
| | " x 20 | " | 6,140 | " | " |
| | □ 350 x 350 x 10 | " | 3,430 | " | " |
| | " x 12 | " | 4,120 | " | " |
| | " x 15 | " | 5,150 | " | " |
| | " x 20 | " | 6,860 | " | " |
| | □ 450 x 450 x 10 | " | 6,240 | " | " |
| | " x 12 | " | 7,490 | " | " |
| | " x 15 | " | 9,360 | " | " |
| | " x 20 | " | 12,480 | " | " |
| R.C.Pile | ϕ 600mm x 1m | " | 275 | " | " |
| | ϕ 700 x " | " | 370 | " | " |
| | ϕ 800 x " | " | 450 | " | " |
| | ϕ 1000 x " | " | 700 | " | " |
| | ϕ 1200 x " | " | 925 | " | " |
| | ϕ 1500 x " | " | 1,500 | " | " |
| R.C.Box Culbert | □ 2.0m x 2.0m x 1m | " | 12,700 | " | " |
| | 2.5 x 2.5 x 1 | " | 15,800 | " | " |
| | 3.0 x 3.0 x 1 | " | 20,500 | " | " |
| | 3.5 x 3.5 x 1 | " | 25,900 | " | " |
| | | | | | |
| | | | | | |

Table E.6 Unit Price ( 1 )

| Item | Description | Unit | Price (฿) | Foregin (%) | Local (%) |
|---|---|---|---|---|---|
| concrete work | 100 $kg/cm^2$ | $m^3$ | 1,650 | 25 | 75 |
| | 160 " | " | 1,800 | 25 | 75 |
| | 210 " | " | 1,950 | 25 | 75 |
| steel bar bending | 13 mm & below | " | 14,750 | 45 | 55 |
| | 16 mm & over | " | 14,430 | 45 | 55 |
| forming | steel | $m^2$ | 190 | 45 | 55 |
| | wooden | " | 290 | 10 | 90 |
| hydraulic crane | 10 t | day | 2,300 | 95 | 5 |
| | 20 | " | 4,500 | " | " |
| | 35 | " | 7,500 | " | " |
| | 45 | " | 8,500 | " | " |
| | 80 | " | 23,000 | " | " |
| truck crane | 35 t | " | 7,000 | " | " |
| | 45 | " | 10,000 | " | " |
| | 70 | " | 20,000 | " | " |
| | 80 | " | 25,000 | " | " |
| back hoe | 0.3 $m^3$ | " | 2,700 | " | " |
| | 0.6 | " | 3,000 | " | " |
| | 0.9 | " | 3,500 | " | " |
| dump truck | 6 t | " | 800 | 90 | 10 |
| | 8 t | " | 1,600 | " | " |
| | 10 t | " | 1,800 | " | " |
| pile driver | drop hammer | " | 2,000 | " | " |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Table E.6 Unit Price ( 2 )

| Item | Description | Unit | Price (฿) | Foregin (%) | Local |
|---|---|---|---|---|---|
| excavation | baek hoe 0.35 $m^3$ | $m^3$ | 85 | 60 | 40 |
| " | " 0.60 $m^3$ | " | 72 | 60 | 40 |
| " | man power | " | 43 | 0 | 100 |
| back filling | back hoe 0.35 $m^3$ | " | 102 | 80 | 20 |
| | " 0.60 $m^3$ | " | 80 | 80 | 20 |
| | man power | " | 20 | 0 | 100 |
| Sheet pile driving | L = 3.5 m | m | 600 | 85 | 15 |
| | 5.0 | " | 790 | " | " |
| | 6.0 | " | 910 | " | " |
| | 8.0 | " | 2,310 | " | " |
| | 10.0 | " | 2,640 | " | " |
| | 12.0 | " | 3,150 | " | " |
| | 15.0 | " | 3,830 | " | " |
| wooden pile driving | L = 3.0 m | ec. | 55 | 15 | 85 |
| | 4.0 | " | 70 | " | " |
| | 5.0 | " | 90 | " | " |
| | 6.0 | " | 110 | " | " |
| concrete pile driving | L =10.0 | " | 780 | 85 | 15 |
| | 11.0 | " | 840 | " | " |
| | 12.0 | " | 900 | " | " |
| | 13.0 | " | 950 | " | " |
| | 14.0 | " | 970 | " | " |
| | 15.0 | " | 1,010 | " | " |
| attaching & Dettaching of steel | truck crane 16 t | t | 1,290 | 75 | 25 |
| concrete pipe lying | ϕ 800 mm | m | 210 | 80 | 20 |
| | ϕ 1,000 | " | 250 | " | " |
| | ϕ 1,200 | " | 280 | " | " |
| | ϕ 1,500 | " | 310 | " | " |

Table E.6 Unit Price ( 3 )

| Item | Description | Unit | Price (฿) | Foregin (%) | Local (%) |
|---|---|---|---|---|---|
| wooden ladder foundation | ϕ 800-1,000 mm | m | 190 | 20 | 80 |
| | ϕ 1,200 | " | 240 | " | " |
| | ϕ 1,500 | " | 360 | " | " |
| box culvert lying | 2,000 x 2,000 | " | 1,010 | 75 | 25 |
| | 2,500 x 2,500 | " | 1,350 | " | " |
| | 3,000 x 3,000 | " | 1,800 | " | " |
| | 3,500 x 3,500 | " | 2,250 | " | " |

Table E.7 Unit Construction Cost (1)

Flood Barrier - Concrete Wall (For 1.0 L.M

| Item | Unit | Unit Cost | | | Quantity | Construction Cost | | |
|---|---|---|---|---|---|---|---|---|
| | | Total | F/C | L/C | | F/C | L/C | Total |
| A. Concrete Wall | | | | | | | | |
| 1. Concrete | $m^3$ | 1,950 | 25 | 75 | 0.7 | 341 | 1,024 | 1,365 |
| 2. Re-Bar | Kg | 14.4 | 45 | 55 | 105.0 | 680 | 832 | 1,512 |
| 3. Form | $m^2$ | 190 | 45 | 55 | 3.6 | 308 | 376 | 684 |
| 4. Leveling Conc | $m^3$ | 1,650 | 25 | 75 | 0.1 | 41 | 124 | 165 |
| Sub-Total | | | 37 | 63 | | 1,370 | 2,356 | 3,726 |
| | | | | | | | | |
| B. Sheet Pile | (L=7.5$^m$, □150 x 500) | | | | | | | |
| 1. Material | Piece | 1,650 | 40 | 60 | 2.0 | 1,320 | 1,980 | 3,300 |
| 2. Driving | " | 1,140 | 85 | 15 | 2.0 | 1,938 | 342 | 2,280 |
| Sub-Total | | | 58 | 42 | | 3,258 | 2,322 | 5,580 |
| | | | | | | | | |
| C. Grauting | place | 440 | 29 | 71 | 2.0 | 255 | 625 | 880 |
| | | | | | | | | |
| D. Miscellaneous | L.S. | 1,019 | 48 | 52 | 1.0 | 489 | 530 | 1,019 |
| Total | | | | | | 5,372 | 5,833 | 11,205 |
| | | | | | | | | |
| | | | | | | | | 11,205 ¥/L.M |

Table E.7 Unit Construction Cost (2)

Flood Barrier - Embankment (For 1.0 L.M.)

| Item | Unit | Unit Cost Total | Unit Cost F/C | Unit Cost L/C | Quantity | Construction Cost F/C | Construction Cost L/C | Construction Cost Total |
|---|---|---|---|---|---|---|---|---|
| ·Embankment | $m^3$ | 110 | 30 | 70 | 9.9 | 327 | 762 | 1,089 |
| ·Sodding | $m^2$ | 20 | 0 | 100 | 6.0 | — | 120 | 120 |
| ·Miscellaneous | L.S. | 36 | 27 | 73 | 1.0 | 10 | 26 | 36 |
| Total | | | 27 | 73 | | 337 | 908 | 1,245 |

Table E.7 Unit Construction Cost (3)

Retaining Wall - Type A (For 6 L.M.)

| Item | Unit | Unit Cost |  |  | Quantity | Construction Cost (฿) |  |  |
|---|---|---|---|---|---|---|---|---|
|  |  | Total | F/C | L/C |  | F/C | L/C | Total |
| A. Cap Beam |  |  |  |  |  |  |  |  |
| 1. Concrete | $m^3$ | 1,950.0 | 25 | 75 | 1.6 | 780 | 2,340 | 3,120 |
| 2. Re-Bar | Kg | 14.4 | 45 | 55 | 240.0 | 1,555 | 1,901 | 3,456 |
| 3. Form | $m^2$ | 190.0 | 45 | 55 | 9.0 | 770 | 940 | 1,710 |
| Sub-Total |  |  | 37 | 63 |  | 3,105 | 5,181 | 8,286 |
| B. Bracing Beam |  |  |  |  |  |  |  |  |
| 1. Concrete | $m^3$ | 1,950.0 | 25 | 75 | 0.4 | 195 | 585 | 780 |
| 2. Re-Bar | Kg | 14.4 | 45 | 55 | 60.0 | 389 | 475 | 864 |
| 3. Form | $m^2$ | 190.0 | 45 | 55 | 2.4 | 205 | 251 | 456 |
| 4. Installation | L.S. | 480.0 | 75 | 25 | 1.0 | 360 | 120 | 480 |
| Sub-Total |  |  | 45 | 55 |  | 1,149 | 1,431 | 2,580 |
| C. Concrete Panel |  |  |  |  |  |  |  |  |
| 1. Concrete | $m^3$ | 1,950.0 | 25 | 75 | 1.9 | 926 | 2,779 | 3,705 |
| 2. Re-Bar | Kg | 14.4 | 45 | 55 | 285.0 | 1,847 | 2,257 | 4,410 |
| 3. Form | $m^2$ | 190.0 | 45 | 55 | 2.0 | 171 | 209 | 380 |
| 4. Installation | L.S. | 2,280.0 | 75 | 25 | 1.0 | 1,710 | 570 | 2,280 |
| Sub-Total |  |  | 44 | 56 |  | 4,654 | 5,815 | 10,469 |
| D. King Pile (L=14.5$^m$, 中.40 x .40) |  |  |  |  |  |  |  |  |
| 1. Material | Piece | 6,820.0 | 40 | 60 | 4.0 | 10,912 | 16,368 | 27,28 |
| 2. Driving | " | 990.0 | 85 | 15 | 4.0 | 3,366 | 594 | 3,96 |
| Sub-Total |  |  | 46 | 54 |  | 14,278 | 16,962 | 31,24 |
| E. Miscellaneous | L.S. | 1,580.0 | 44 | 56 | 1.0 | 695 | 885 | 1,58 |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| Total |  |  | 44 | 56 |  | 23,881 | 30,274 | 54,15 |
|  |  |  |  |  |  |  |  |  |
|  |  | (54,155 ÷ 6.0 = 9,026) |  |  |  |  |  | 9,0 |
|  |  |  |  |  |  |  |  |  |

Table E.7

# Unit Construction Cost (4)

## Retaining Wall - Type B

(For 6 L.M.)

| Item | Unit | Unit Cost Total | Unit Cost F/C | Unit Cost L/C | Quantity | Construction Cost F/C | Construction Cost L/C | Construction Cost Total |
|---|---|---|---|---|---|---|---|---|
| A. Cap Beam | | | | | | | | |
| 1. Concrete | $m^3$ | 1,950 | 25 | 75 | 1.6 | 780 | 2,340 | 3,120 |
| 2. Re-Bar | Kg | 14.4 | 45 | 55 | 240.0 | 1,555 | 1,901 | 3,456 |
| 3. Form | $m^2$ | 190 | 45 | 55 | 9.0 | 770 | 940 | 1,710 |
| Sub-Total | | | 37 | 63 | | 3,105 | 5,181 | 8,286 |
| B. Concrete Panel | | | | | | | | |
| 1. Concrete | $m^3$ | 1,950 | 25 | 75 | 1.9 | 926 | 2,779 | 3,705 |
| 2. Re-Bar | Kg | 14.4 | 45 | 55 | 285.0 | 1,847 | 2,257 | 4,104 |
| 3. Form | $m^2$ | 190 | 45 | 55 | 2.0 | 171 | 209 | 380 |
| 4. Installation | L.S. | 2,280 | 75 | 25 | 1.0 | 1,710 | 570 | 2,280 |
| Sub-Total | | | 44 | 56 | | 4,654 | 5,815 | 10,469 |
| C. King Pile (L=14.5$^m$, ⌀ 0.40 x 0.40) | | | | | | | | |
| 1. Material | Piece | 6,820 | 40 | 60 | 4.0 | 10,912 | 16,368 | 27,280 |
| 2. Driving | " | 990 | 85 | 15 | 4.0 | 3,366 | 594 | 3,960 |
| Sub-Total | | | 46 | 54 | | 14,278 | 16,962 | 31,240 |
| D. Anchor | | | | | | | | |
| 1. Concrete | $m^3$ | 1,950 | 25 | 75 | 1.3 | 634 | 1,901 | 2,535 |
| 2. Re-Bar | Kg | 14.4 | 45 | 55 | 195.0 | 1,264 | 1,544 | 2,808 |
| 3. Form | $m^2$ | 190 | 45 | 55 | 7.0 | 599 | 731 | 1,330 |
| 4. Leveling Conc. | | | 25 | 75 | 0.2 | 82 | 248 | 330 |
| 5. Tie-Bar | set | 1,100 | 45 | 55 | 4.0 | 1,980 | 2,420 | 4,400 |
| 6. Batter Pile (L=16.5$^m$, ⌀ 0.30 x 0.30) | | | | | | | | |
| · Material | Piece | 4,740 | 40 | 60 | 8.0 | 15,168 | 22,752 | 37,920 |
| · Driving | " | 1,040 | 85 | 15 | 8.0 | 7,072 | 1,248 | 8,320 |
| Sub-Total | | | 46 | 54 | | 26,799 | 30,844 | 57,643 |
| E. Miscellaneous | L.S. | 1,580 | | | 1.0 | 711 | 869 | 1,580 |
| Total | | | 45 | 55 | | 49,547 | 59,671 | 109,218 |
| | | (109,218 ÷ 6.0 = 18,203) | | | | | | 18,203 B/m |

Table E.7 Unit Construction Cost (5)

Retaining Wall - Type C (For 6 L.M.)

| Item | Unit | Unit Cost Total | F/C | L/C | Quantity | Construction Cost F/C | L/C | Total |
|---|---|---|---|---|---|---|---|---|
| A. Cap Beam | | | | | | | | |
| 1. Concrete | $m^3$ | 1,950 | 25 | 75 | 1.6 | 780 | 2,340 | 3,120 |
| 2. Re-Bar | Kg | 14.4 | 45 | 55 | 240.0 | 1,555 | 1,901 | 3,456 |
| 3. Form | $m^2$ | 190 | 45 | 55 | 9.0 | 770 | 940 | 1,710 |
| Sub-Total | | | 37 | 63 | | 3,105 | 5,181 | 8,286 |
| B. Concrete Panel | | | | | | | | |
| 1. Concrete | $m^3$ | 1,950 | 25 | 75 | 2.5 | 1,219 | 3,656 | 4,875 |
| 2. Re-Bar | Kg | 14.4 | 45 | 55 | 375.0 | 2,430 | 2,970 | 5,400 |
| 3. Form | $m^2$ | 190 | 45 | 55 | 2.5 | 214 | 261 | 475 |
| 4. Installation | L.S. | 3,000 | 75 | 25 | 1.0 | 2,250 | 750 | 3,000 |
| Sub-Total | | | 44 | 56 | | 6,113 | 7,637 | 13,750 |
| C. King Pile (L=15.0, ⌀ 0.40 x 0.40) | | | | | | | | |
| 1. Material | Piece | 7,050 | 40 | 60 | 4.0 | 11,280 | 16,920 | 28,200 |
| 2. Driving | " | 1,010 | 85 | 15 | 4.0 | 3,434 | 606 | 4,040 |
| Sub-Total | | | 46 | 54 | | 14,714 | 17,526 | 32,240 |
| D. Anchor | | | | | | | | |
| 1. Concrete | $m^3$ | 1,950 | 25 | 75 | 1.3 | 634 | 1,901 | 2,535 |
| 2. Re-Bar | Kg | 14.4 | 45 | 55 | 195.0 | 1,264 | 1,544 | 2,808 |
| 3. Form | $m^2$ | 190 | 45 | 55 | 7.0 | 599 | 731 | 1,330 |
| 4. Leveling Conc. | $m^3$ | 1,650 | 25 | 75 | 0.2 | 82 | 248 | 330 |
| 5. Tie-Bar | set | 1,100 | 45 | 55 | 4.0 | 1,980 | 2,420 | 4,400 |
| 6. Batter Pile (L=19.5$^m$, □300 x 300) | | | | | | | | |
| · Material | Piece | 5,940 | 40 | 60 | 8.0 | 19,008 | 28,512 | 47,520 |
| · Driving | " | 1,090 | 85 | 15 | 8.0 | 7,412 | 1,308 | 8,720 |
| Sub-Total | | | 46 | 54 | | 30,979 | 36,664 | 67,643 |
| E. Miscellaneous | L.S. | 2,440 | 45 | 55 | 1.0 | 1,098 | 1,342 | 2,440 |
| Total | | | 45 | 55 | | 56,009 | 68,350 | 124,359 |
| | | (124,359 ÷ 6 = 20,727) | | | | | | 20,727 |

Table E.7

## Unit Construction Cost (6)

Retaining Wall - Type D (For 1.5 L.M.)

| Item | Unit | Unit Cost Total | F/C | L/C | Quantity | Construction Cost F/C | L/C | Total |
|---|---|---|---|---|---|---|---|---|
| A. Cap Beam | | | | | | | | |
| 1. Concrete | $m^3$ | 1,950 | 25 | 75 | 0.4 | 195 | 585 | 780 |
| 2. Re-Bar | Kg | 14.4 | 45 | 55 | 60.0 | 389 | 475 | 864 |
| 3. Form | $m^2$ | 190 | 45 | 55 | 1.8 | 154 | 188 | 342 |
| Sub-Total | | | 37 | 63 | | 738 | 1,248 | 1,986 |
| B. Conc.Sheet Pile | (L=17.0m, 0.30 x 0.50) | | | | | | | |
| 1. Material | Piece | 7,860 | 40 | 60 | 3.0 | 9,432 | 14,148 | 23,580 |
| 2. Driving | " | 4,410 | 85 | 15 | 3.0 | 11,246 | 1,984 | 13,230 |
| Sub-Total | | | | | | 20,678 | 16,132 | 36,810 |
| C. Anchor | | | | | | | | |
| 1. Concrete | $m^3$ | 1,950 | 25 | 75 | 0.3 | 146 | 439 | 585 |
| 2. Re-Bar | Kg | 14.4 | 45 | 55 | 45.0 | 292 | 356 | 648 |
| 3. Form | $m^2$ | 190 | 45 | 55 | 3.2 | 274 | 334 | 608 |
| 4. Leveling Conc | $m^3$ | 1,650 | 25 | 75 | 0.1 | 41 | 124 | 165 |
| 5. Tie-Bar | set | 1,420 | 45 | 55 | 1.0 | 639 | 781 | 1,420 |
| 6. Batter Pile | (L=20.0m, □0.30 x 0.30) | | | | | | | |
| · Material | Piece | 6,140 | 40 | 60 | 2.0 | 4,912 | 7,368 | 12,280 |
| · Driving | " | 1,100 | 85 | 15 | 2.0 | 1,870 | 330 | 2,200 |
| Sub-Total | | | 46 | 54 | | 8,174 | 9,732 | 17,906 |
| D. Grauting | place | 440 | 25 | 75 | 3.0 | 330 | 990 | 1,320 |
| E. Miscellaneous | L.S. | 17,400 | 52 | 48 | 1.0 | 9,048 | 8,352 | 17,400 |
| Total | | | 52 | 48 | | 38,968 | 36,454 | 75,422 |
| | | | | | | | | |
| | | (75,422 ÷ 1.5 = 50,281) | | | | | | 50,200 ₱/m |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

Table E.8 Implementation Schedule

| Item / Year | Total | 1987 | 1988 | 1989 | 1990 | 1991 | |
|---|---|---|---|---|---|---|---|
| Flood Barrier (km) | 6.2 | - | 6.2 | - | - | - | |
| Gate (place) | 4 | - | 4 | - | - | - | |
| Pumping Station (station) | 5 | - | 5 | - | - | - | |
| Klong Improvement (km) | | | | | | | |
| Trunk Klongs | 26.0 | - | 18.6 | 7.4 | - | - | |
| Other Klongs | 66.9 | - | - | 14.5 | 33.6 | 18.8 | See Table |
| Drain Improvement (km) | 4.3 | - | - | 0.0 | 3.2 | 1.1 | See Table |
| Flood Control Operation Center (set) | 1 | - | 1 | - | - | - | |
| Detailed Design | 1 | 1 | - | - | - | - | |
| Project Cost (million Baht at 1985 price) | 2,655 | 46 | 825 | 825 | 805 | 154 | |
| Foreign Portion | 1,261 | 23 | 450 | 353 | 372 | 63 | |
| Local Portion | 1,394 | 23 | 375 | 472 | 433 | 91 | |

Table E.9 Klong Improvement

(Uint: meter)

| Year | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|
| Phra Khanong Polder | 3,600 Tan<br>7,600 Phra Khanong | 7,400 Saen Saep | | |
| Bang Na Polder | | 6,200 Bang Na<br>2,100 Bang Oa | 3,860 Bang Na Jen<br>3,500 Bang Lai | 600 Suan Aoi<br>1,000 Kwang Lai |
| | | | 2,600 Kwang Bon<br>2,350 Bang Chak 1<br>1,750 Bang Chak 2<br>6,200 Klet | 1,350 Bang Na Trad(k1)<br>600 Bang Na Trad(k2)<br>600 Bang Na Trad(k3) |
| Ramkhamhaeng Polder | | | 4,400 Kacha | 1,540 Jik<br>1,300 Chit |
| West Huay Kwang Drainage Area | | 6,200 Sam Sen | | 5,470 Lat Phrao<br>1,600 Yai Soon<br>2,600 Chao Khun Sing |
| Bang Sue Polder | 7,440 Bang Sue | | 5,200 Ratchada<br>1,750 Kasesert<br>2,000 Phya Wake | 2,150 Lat Yao |
| Total | 18,640 | 21,900 | 33,610 | 18,810 |
| Construction Cost (million Baht) | 440.2 | 696.6 | 611.7 | 87.3 |

Table E.10 Implementation Schedule (Drain)

(Unit: meter)

| Year | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|
| Bang Na Polder | | 35 Cross of Highway | | 175 Cross of Bang Na Trad Road<br>700 Sukhumvit Soi 50<br>150 Klong Jek to Sukumvit Soi 50 |
| Ramkhamhaeng Polder | | | 200 University to Klong Saen Saep | |
| West Huay Kwang Drainage Area | | | 900 Highway Ditch | |
| Bang Sue Polder | | | 100 Ratchada<br>2,000 Sena Nichom | 70 Lat Yao |
| Total | 0 | 35 | 3,200 | 1,095 |
| Cost (million Baht) | | 7.2 | 106.3 | 34.1 |

# APPENDIX F

# FLOOD PLAIN MANAGEMENT

# APPENDIX F FLOOD PLAIN MANAGEMENT



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# APPENDIX F FLOOD PLAIN MANAGEMENT

"Flood plain management" or "non-structural measures" is much required in Lower Chao Phraya Plain, including eastern suburban Bangkok, in addition to the proposed structural measures. Experiences in such countries as United States, Australia and Japan have shown that the combination can be highly effective and cost less than structural measures alone.

## 1. Necessity of Flood Plain Management

### 1.1 Causes of Flood and Flood Damage

The causes of flood are heavy rainfall and high tide/high water levels of the Chao Phraya river. The floods used to bring no substantial damages for the residents living in stilt-elevated houses and relying on boat transportation through an extensive network of klongs (canals).

Modernization of life-style and rapid urbanization has, however, changed the susceptibility to damage by seasonal floods as indicated rising damage of the severe floods which have hit Bangkok since the 1950s, that is, houses have been recently built on elevated-land in order not to suffer flood damage, resulting in loss of natural retention area/capacity and increase of run-off discharge.

Furthermore, provision of infrastructure could not keep pace with rapid urbanization. Water supply system was not an exception. Groundwater abstraction increased particularly in pipe-water unserviced eastern suburbs and Samut Prakan Province, resulting in severe land subsidence. The center of land subsidence is located in eastern suburbs and Samut Prakan Provicne.

This land subsidence has greatly aggravated the flood problem. Firstly, much flood water in the vast, flat Lower Chao Phraya Plain inflows easily into the depressed eastern suburbs. Secondly, the inflowed water is difficult to be drained out into the Chao Phraya river because water levels of the river during end of rainy season, exceed occasionally subsided ground elevations. These phenomena as shown in Fig. F.1. increased so that flood problem became serious recently like 1980 and 1983 floodings.

## 1.2 Role of Flood Plain Management

On the occasion of 1983 flooding, urgent (structural) measures have been provided. If the proposed high-standard structural measures are provided in the eastern suburbs, although it will take a long time, flooding problems will be resolved to much extent. Nevertheless, residual flooding problems will still remain for a smaller segment of the community because of drainage difficulty in the very flat eastern suburbs.

Consequently, comprehensive flood damage mitigation plan, consisting of both structural and non-structural measures, should be adopted to solve flood problems in the eastern suburbs.

Flood damage mitigation plan consists of structural and non-structural measures as illustrated in Table F.1. and Fig. F.1.

Since few non-structural measures have been introduced as urgent measures much effort of their introduction will be required. Their objecitives are to:

- ensure, through appropriate zoning, the usage of flood prone land is compatible with the degree of the flood hazard;

- implement a management plan aimed at:

  - containing the problem by development and building controls;
  - reducing the extent and severity of the hazard by removal of development from the flood plain (as well as by structural measures);
  - ensuring adequate flood warning procedures.

Particularly, as demand of land in eastern suburbs is growing at the highest rate (discussed in section 2.3), non-structural measures are considered effective not to increase flood damage.

More importantly, they tend to pass the burden of costs from the public at large to those who reap the advantages of flood plain location because flood protection responsibility is shared between the governments (on structural measures) and those who live in the eastern suburbs (on non-structural measures) on the other hand, their execution requires a strong leadership and public support. This matter is discussed in section 3.

Table F.1.

Concept of Comprehensive Flood Damage Mitigation Plan

| | | |
|---|---|---|
| Reason | Difficulty in Provision of Drainage Facilities | |
| Component | Structural Measures | Non-Structural Measures |
| Objective | REDUCTION OF FLOOD | REDUCTION OF FLOOD DAMAGE |
| | .To block inflow from outer area<br>.To increase drainage capacity | .To prohibit flood-prone area from urban development<br>.To guide urban development to flood-free area |
| Measures | .Polder dyke and gate<br>.Pumping station<br>.Klong and pipe improvement | .Land use guidance according to flood risk<br>.Flood proofing |
| | Retention area (pond) | Retention basin |

## 2. Zoning Regulation

### 2.1 General

Eastern suburbs is generally divided into two zones as shown in Fig. F.2 from the view point of flood portection; One is flood protection area and another is retarding area. Flood protection area is defined as the existing urbanized area and promoting urbanization area where both structural and non-structural measures are provided. Feasibility Study area (same as the Master Plan area) falls in this category. On the other hand, retarding area is defined as an agricultural area and prohibiting urbanization area. Eastern part of the Preliminary Study Area (between the Feasibility Study area and the Green Belt area) as well as the Green Belt area falls in this category. Appropriate measures for each area is shown in Table F.2 which intend land use to comply with flood risk in each area.

However, there are a variety of factors to be considered in zoning decisions in more detail. Many of these factors are be in conflict. In order to encourage the wisest land use coping with the flooding situation, the flood risk evaluation, is explained, followed by the required land size for future urbanization.

### 2.2 Flood Risk Evaluation

Preparation of flood risk mapping in eastern suburbs has just started in this study and we have prepared maps, though preliminarily.

Table F.2 Concept of Zoning Regulations

| Classification | Urban Development | Scope of Area | Measures |
|---|---|---|---|
| Protection Area | Urbanized Area<br>Promoting Urbanization Area | A* | To form a polder<br>To improve drainage capacity<br>To make retention pond, compensating retention area lost with urban development<br>Prohibition of ground water withdrawal<br>To improve surface water supply system<br>Provision of Infranstructure |
| Retarding Area | Prohibiting Urbanization Area | B** | To adjust drainage condition for agriculture and open space<br>Prohibition of landfill<br>To encourage flood-proofing<br>Prohibition of Infrastructure Provision |

* Master Plan and Feasibility Study Areas

** East half of eastern suburban Bangkok between Green Belt and Master Plan Areas

### 2.2.1 Past Flood Data

Flood areas of 1983 flooding have been prepared as shown in Fig. F.3 by the National Statistical office through the direct interviews. As heavy rainfall continued to fall during August and October, entire Lower Chao Phraya Plain suffered from flooding. In the depressed eastern suburbs, collecting much rainwater from the neighboring areas, flooding lasted one to four months. Flooding started in late August and ended in early December (See Figs. F.4 and F.5 which were surveyed by our team). These figures reveal that southern and eastern parts of eastern suburbs suffered more from flooding.

After this flooding, dyke and gates along the border of the eastern suburbs with the Green Belt Area have been constructed or installed as the urgent measures in order to block inflow from the outer area into the inner area. As a result, type of flooding has changed from long-duration, large-area one to short-duration, small area one. Our study team surveyed flooded areas after the urgent measures, as shown in Fig. F.6.

### 2.2.2 Topography

Topographical maps of scales 1:20,000 and 1:50,000 are available for the eastern suburbs. However the maps were prepared in 1969 and 1974 respectively when severe land subsidence did not take place and the contour intervals are 20 meters with supplementary lines of 10 meters. Therefore, spot levelling surveys were conducted through the Preliminary Study, Master Plan and Feasibility Study by our study team in order to grasp the topographic terrain of the very flat eastern suburbs.

Based on these surveys, topographic map is prepared as shown in Fig. F.7.

This map reveals that;

(1) urbanized areas are higher by 50 to 100 cm than the neighboring non-urbanized areas, which are original swamp lands, and

(2) southern part (downstream of Klong Phra Khanong) is the lowest in topography due to land subsidence.

Land subsidence can be stopped when groundwater pumping up is limited to an appropriate amount. Such measures as reducing pumping up and extension of surface water service area have been already planned. However, as it will take a time to stop land subsidence even after those measures, 70 to 100 cm land subsidence is estimated to occur by the year 2000 according to AIT study. Figs. F.7 and F.8 show progression of land subsidence and estimated ground elevation in 2000 respectively.

### 2.2.3 Morphology

The Study Area is located in the vast Chao Phraya delta, with ground elevation of less than 2.5 m MSL. For example, ground elevation in Ayutthaya, 100 km off from the river mouth is only 2 m MSL. As the delta is very flat, water coming down from the upstream spread and is accumulated, reaching 50 to 100 cm high during rainy season. On the other hand, during dry season accumulated water is gradually flown downstream and is heavily evaporated, resulting in like desert.

However, in this vast, flat delta, there is slightly difference in vulnerability to flooding. Extensive klong (canal) network has been developed in the Study Area, densely in southeastern part and sparsely in western part of the Study Area as shown in Figs. F.9 and F.10.

This map is reproduced from 1910 map of the Royal Thai Survey Department, and superimposed with the existing contour lines. This may indicate that southeastern part is vulnerable to flooding through klongs from upstream of the delta.

On the other hand, northern part (Bang Kapi district) seems a backswamp portion of the Chao Phraya river. Because of physiographic position, water accumulates here by the inflow from the surrounding area and stays for a prolonged period. LANDSAT imagery clearly reveals that this part holds water for a much longer period than its eastern and western neighbors.

### 2.2.4 Estimation of Flood Area

Storage basin model (Bi-dimensional model) has been developed in order to examine an approximate flooding status and to identify the poor drainage areas. The eastern suburbs (the Preliminary Study Area of 501 $km^2$ plus other area of 104 $km^2$) is divided into 9 basins. Details are expalined in Appendix H of the Master Plan.

Using this model, flood areas are estimated for a 5-years frequency rainfall under the condition of the execution of 1984 urgent measures, presenting in Figs. F.11 and F.12.

## 2.3 Urbanization

Required urbanized areas in future is an important factor for delineating sound land use pattern, in addition to flood risk mapping. Therefore, to begin with, urbanization trend is explained, followed by estimation of future population and urbanized area.

### 2.3.1 Urbanization Trend

The city's population increased slowly to reach 890,000 in 1937 and one million in 1953. As shown in Fig. F.14, growth since then has been extremely rapid as a consequence primarily of high fertility and migration rates. Population has increased during the period 1937-1983 by more than 500 percent to its current total of more than 5 million. Even more dramatically, the urbanized area has increased to 300-500 square kilometers.

Bangkok is concluding a period of high rates of growth of population and entering a period of more moderate rates of growth which will, however, continue to yield large absolute increases in population. The urbanized area has also been expanding rapidly but would in the future grow more slowly.

2.3.2 Development Patterns

Between 1968 and 1979, residential area which constitutes large part of the urbanized area in the BMA increased from 41.5 to 114.3 square kilometers, an annual growth rate of 11%, higher than the rate of population growth. This high rate of consumption of land is due to both the increase in population and the relocation of population from high density areas to areas of lower densities.

Most of paddy land in east side of Chao Phraya River in Bangkok had been bought by absentee landlords and speculators whereas rather small land holdings of the orchard belt in the Thonburi have continued to belong to a large number of owner-occupiers. Although increases in residential use occured in all directions, the main thrust of expansion was in the direction of Bang Kapi, Bang Khen, and Min Buri in the north, Muang Samut Prakan and Phra Khanong to the south and east of the Bangkok.

The development pattern has been virtually unplanned. To a great extent the conversion of paddy land at the urban fringe were made along major roads, with very little attention to secondary and lower roads, resulting in ribbon development. From the standpoint of private developers and their customers, this ribbon development has been economical because the cost of the far flung infrastructure necessary has, for the most part, not been borne by them. Roads built for the purpose of connecting Bangkok with distant places made an unintended ribbon of development and large vacant areas remain among thin ribbons of development along major roads.

### 2.3.3 Population Projection

The future population in BMA was estimated in the Master Plan study based on the following four data (see Appendix E of Master Plan):

(1) Projection based on regression curve

(2) Estimated figures of "Population projections for Thailand, whole Kingdom and Regions, National Statistical Office".

(3) Estimated figures of "The General Plan of Bangkok Metropolis and its Vicinity, 2000, DTCP", and

(4) Estimated figures of "The Research Center of Chulalongkorn University".

Results of these projections vary from 7,260,000 to 7,800,000 in the year 2000. It is considered reasonable to adopt 7,700,000 as the medium projected population. This figure coincides with that of Bangkok Metropolitan Region Development Study (Table 2.1 of interim report, August 1985).

This study also projects populations in each district. Populations in four districts in eastern suburbs, i.e., Huay Kwang, Bang Khen, Bang Kapi and Phra Khanong grow at the highest rate among BMA as shown in Table F.3.

Table F.3 Population Projection in Four Districts

| Name of Districts | Population: 1000's | | |
|---|---|---|---|
| | 1980 | 1985 | 2000 |
| Huay Kwang | 192 | 233 | 359 |
| Phra Khanong | 498 | 587 | 840 |
| Bang Khen | 367 | 492 | 809 |
| Bang Kapi | 244 | 377 | 710 |
| Total | 1,301 | 1,689 | 2,718 |

As the Feasibility Study Area do not cover the whole four districts, population in the Areas was projected in the Master Plan as shown in Table F.4.

Table F.4 Population Projection in the Study Area

| Area | Population : 1000's | | |
|---|---|---|---|
| | 1980 | 1990 | 2000 |
| Fesibility Study Area and Master Plan Area | 1,060 | 1,660 | 2,350 |
| Preliminary Study Area | 1,160 | 1,790 | 2,500 |

### 2.3.4 Future Land Demand

Future urbanized areas are estimated from the Development Policy (See Appendix E of Master Plan) and the projected population.

In order to project the future urbanized area in the Master Plan Area in the year 2000, the urbanized area in the Preliminary Study Area is first estimated. The following two methods are adopted to estimate the future urbanized area in the Preliminary Study Area:

(1) Study of the relationship between the existing population density and the proportion of built-up area.

(2) The trend of urbanized areas from 1960 to 1980.
Results of these projections are summarized in Appendix E of Master Plan.

It is considered reasonable to adopt 230 $km^2$ as the projected urbanized area for the Preliminary Study Area.

On the other hand, the future urbanized area in the Master Plan Area is estimated as follows:

(1) Present urbanized area in the outside of the Master Plan Area which included in the Urban Control Area (retarding area from viewpoints of flood protection) is 14 $km^2$.

(2) The outside of Master Plan Area should not be developed till 2000 by the definition of Urban Control Area.

(3) According to these measures, the future urbanized area in the outer Master Plan Area will be reserved as 14 $km^2$ in 2000.

(4) 216 $km^2$ (230 $km^2$-14 $km^2$) is adopted for the future urbanized area in the Master Plan Area in 2000.

3. Implementation Procedure of Non-Structural Measures

Zoning regulations are the most effective measures but their enforcement is considered difficult. The management of existing properties at flood risk area is a more difficult problem in terms of the social and economic consequences to affected property owners. A good and sound communication needs to be established between management authorities and local communities if the social and economic controls are to be dealt with in rational and equitable fashion.

Fortunately, as inter-governmental coordination and cooperation for flood protection has become easy through the recently set up national-committee, zoning control as well might become possible in near future.

On the other hand, enforcement of zoning regulations will take a considerable time to reach decision of zoning because of time-consuming preparation of more precise flood risk mapping, getting concensus from the residents. Therefore, even during preparation of zoning regulations, other alternate non-structural measures, which are considered applicable at an early stage, are necessary to be applied in order not to increase flood damage (which is explained in section 3.2).

## 3.1 Present Stage of the Greater Bangkok Plan

History of city planning, which should be the base of zoning regulations, is reviewed here.

Planning commenced in 1959 both in terms of national economic planning and comprehensive city planning. The Greater Bangkok Plan which has since been referred to as the Litchfield Plan was presented in 1960. At the same time (in 1961/1962), the Department of Town and Country Planning (DTCP) was established as a central city planning agency. The Department has since been in charge of updating and revising the Greater Bangkok Plan. However, the Plan was never officially adopted.

Since 1975, Thailand has had a new Town Planning Act which superseded the one of 1952. The stipulation of the law required a new revision of the Plan, especially with respect to procedures of submission, public inspection, and approval. So the DTCP began working on the second revision, called the Greater Bangkok Plan 2000, which was also prepared in connection with the objectives of the Fourth National Economic and Social Development Plan (1977-1981). The proposed land use pattern showed a marked shift away from the previous plans: from the concentric pattern to a polycentric development pattern.

Although this Plan was neither adopted, as a result of coordination among the NESDB, the DTCP and the BMA, the present metropolitan development concept comprises three levels: