CHAPTER 6

DETAILED DESIGN

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6.1 General

(1) Division of Urban Drainage System Improvement

The Urban Drainage System Improvement is divided into three sub-components, namely (a) Semarang River Drainage System Improvement, (b) Asin River Drainage System Improvement and (c) Bandarharjo Drainage System Improvement.

Among this areas, (a) Semarang River drainage area is a gravity drainage area where stormwater can be drained by gravity and (b) Asin River drainage area and (c) Bandarharjo drainage area are pump drainage areas where stormwater shall be drained by pumps because of low ground elevation. The areas of each drainage area is 6.220 km^2, 4.430 km^2 and 2.185 km^2 respectively. (refer to Fig. 6.1.1)

(2) Design Criteria

For the detailed design of facilities, "Design Criteria" (Interim Report (4) Volume III) was principally applied. Those criteria not included in the report will be specifically described in the succeeding each sections hereinafter.

(3) Geological Condition of the Area

The geological condition of the area is characterized by the upper layer of very soft alluvial clay with N values between 0 to 20 and hard fluvium clay layer with N values larger than 50 beneath the alluvial layer.

The depth of very soft clay layer ranges between 20 m to 25 m from the ground surface. The bottom of the hard clay layer was not confirmed in the study.

The longitudinal geological profile along Semarang, Asin and Baru rivers are show in Figs. 6.1.2 to 6.1.4.

(4) Topographical Information

The detailed design of drainage channel improvement and drainage facilities is performed based on the topographical survey result conducted in 1997 as a part of the Study.

(5) Design Discharge

The design discharges of the target drainage channels with the return period of 5-year are shown in Fig. 6.1.5.

6.2 Semarang River Drainage System Improvement (Package 1)

6.2.1 Work Items

There are following facilities to be designed in Semarang River Drainage System Improvement. (refer to Fig. 6.2.1)

(a) Semarang River Improvement

- Dredging/Excavation of Channel : V=58,409 m^3 (L=5,866 m)
- Raising of Existing Dike : L=7,206 m
- Secondary channel outlet closures : 56 places

(b) Renovation of Inspection Road : L=11,737 m

6.2.2 Semarang River Improvement

(1) Channel Alignment

Alignment of Semarang River basically follows the existing alignment. (refer to Fig. 6.2.2)

(2) Longitudinal Profile

Design longitudinal profile of Semarang River is almost same profile as desinged in Urban V. (refer to Fig. 6.2.3)

(3) Cross Section and Bank Protection

Design Cross Section of Semarang River basically applied the design cross section designed in Urban V. Design cross sections from No. 45 to No. 90 are trapezoidal cross section without revetment. From No. 90 to No. 241+13, the design cross sections are rectangular with existing wet masonry revetment. (refer to Fig. 6.2.4)

Seismic design of the existing revetment structure along Semarang River has been checked according to the design criteria formulated in the Study. The structure has enough safety against the design earthquake. The detailed calculation is shown in

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According to the geological investigation by boring and laboratory test, soil composing the ground of the area is fine soil with D_{50}=0.005~0.006 mm and does not have the property to be liquefied by earthquake (0.02 mm < D_{50} < 2.0 mm). Therefore, there is no fear of liquefaction of the ground in the area.

(4) Dike Raising

Non-uniform steady flow calculation was made with the new channel alignment, channel sections and the design discharge. The calculation result is shown in Fig. 6.2.5.

Existing dike along Semarang River is to be raised in order to obtain enough freeboard against the design high water level of Semarang River. Structure and location of dike raising is shown in Fig. 6.2.6. The total length of dike raising is about 7,206 m.

(5) Closing of Secondary Channel Outlets

Along the lower reaches of Semarang River downstream from the Sta. No. 141, all the secondary channel outlets connected to Semarang River is to be closed, as the design high water level is higher than the ground elevation of the hinter land. The closed secondary channels should be rerouted into the pump drainage system. The closing works will be done in this project. However, rerouting of those secondary channel systems will be planned and executed in SSUDP by Semarang Municipal Government before the completion of the Project. Locations of the outlets to be closed and typical closing methods are shown in Fig. 6.2.7.

6.2.3 Related Structures

(1) Renovation of Inspection Road

Presently, Semarang River is equipped with Inspection roads on both sides in almost all stretches except the lower reaches from North Ring Road. However, the pavement are deteriorated in many parts. Therefore, together with the river improvement, the inspection road is to be renovated by overlaying concrete blocks. Location of renovation of the existing inspection road is shown in Fig.6.2.8. Along Semarang River, it stretches from Tugu Muda down to No.45 on both sides of the channel. The design elevation of the inspection road along Semarang River basically follows the existing ground level considering smooth connection with the existing municipal roads.

Fig. 6.2.8 shows the standard cross section of the inspection road.

(2) Existing Bridges

There are twenty-two (22) existing bridges across Semarang River, of which twelve (12) do not have enough space between the bottom of the girders and the design high water level.

However, raising of those bridges are not included in the Project, as reconstruction of bridges in this area causes serious problem in urban traffic. It is proposed here that in future those bridges should be raised together with road renovation or urban renewal project. Table 6.2.1 shows the amount of required raising for each bridge.

6.3 Asin River Drainage System Improvement (Package 2)

6.3.1 Work Items

There are following facilities to be designed in Asin Drainage System Improvement.(refer to Fig. 6.3.1)

(1) Semarang River Improvement (L=1,375 m)

- Excavation of Semarang River Channel : V=36,475 m^3
- Construction of Revetment : L=719 m
- Dike Raising : L=228 m

(2) Asin River Improvement (L= 1,165 m)

- Excavation of Asin River Channel : V=31,770 m^3
- Reconstruction of Revetment : L=1,165 m for both sides
- Relocation of Semarang River : L=408 m (excavation volume=21,187 m^3)
- Reconstruction of Bridges : L=20.0 m, two bridges
- Box Culvert : W=3.5 m, H=2.0 m, L=194 m
- Miscellaneous Works : (1) Reconstruction of water pipe, telephone line conduit across Asin River
  (2) Tree planting
  (3) Supplying maintenance equipment

(3) Asin Pumping Station

- Pump (Installed Capacity) : Q=9.0 m^3/s

- Number of Unit : 3 units
- Pumping Station : reinforced concrete, 11.0 m × 35.0 m
- Piers and Foundation of Gate : reinforced concrete, 11.6 m × 12.0 m
- Bridge : L=20.0 m
- Pump Control Building, Management Office, Garage, Staff House

(4) Asin Pumping Station Gate : W=4.00 m, H=3.46 m × U =2 gates

(5) Asin Retarding Pond : A=1.6 ha (Capacity V=24,000 m³)

(6) Construction and Renovation of Inspection Road : L=4,483 m

6.3.2 Semarang River Improvement

(1) Alignment of Semarang River

Alignment of Semarang River basically follows the existing alignment except a part where the river to be relocated . The purpose of this channel relocation is to create a space for Asin Retarding Pond. At the relocation part, design alignment is made to attain a smooth flow of flood discharge. The bending point is shifted around 200 m toward downstream keeping the upper and lower river courses as they are. (refer to Fig. 6.3.2)

(2) Longitudinal Profile

Design longitudinal profile of Semarang River is almost the same as designed in Urban V. (refer to Fig. 6.2.3)

(3) Cross Section

Design cross sections of Semarang River basically applied the cross sections that designed in Urban V. Design cross sections downstream from Sta. No.45 to the river mouth (Sta. No.0), including relocation part, are designed as trapezoidal cross section. The sediment between the existing riverbed and the design riverbed shall be dredged. (refer to Fig. 6.3.3)

(4) Revetment

Inclined type revetment (Type A-1) is applied for curve section of Semarang River between Station SMR-45 and North Ring Road Bridge for protection against the erosion. Structure of this revetment is wet masonry as shown in Fig. 6.3.4. The toe of the wet masonry is supported by cobble stone filling and log piles.

Concrete sheet pile (Type-C) revetment is applied for transition section between the new Semarang River and the old Semarang River. The reason of this is easiness of river course transformation during construction.

(5) Dike Raising

Existing dike along Semarang River is to be raised in order to obtain enough freeboard against the design high water level of Semarang River.

(6) Inspection Road

As for the reaches from No.45 to the river mouth (No. 0), new inspection road are constructed except the left bank lower reaches from the North Ring Road, where land reclamation is not completed.

6.3.3 Asin River Improvement

(1) Alignment of Asin River

Design alignment of Asin River follows existing alignment. Only the uppermost stretches of the channel is to be changed into box culvert, as it is difficult to widen the channel because of land acquisition problem. (refer to Fig. 6.3.5)

(2) Longitudinal Profile

Asin River has a dual function of a river channel and a retarding pond. It has to have a capacity to accommodate the design discharge ($Q=35\ m^3/s$). At the same time the river is required to have a enough storage capacity for a retarding pond ($v=28,000m^3$).

Therefore, the riverbed was designed as flat while the design high water level is determined by non-uniform flow calculation with design discharge.

Fig. 6.3.6 shows the longitudinal profile of Asin River.

(3) Cross Section

Design cross section is a composite trapezoidal shape (refer to Fig. 6.3.7). The lower channel will function as a channel to accommodate maximum capacity of pump so that storage volume of the retarding pond is maintained until the inflow discharge exceeds the pump capacity.

(4) Revetment

Inclined type of revetment is being proposed in order to reduce cost and also to cope with very soft foundation soil in the area. Structural detail is shown in Fig. 6.3.8.

Type B revetment is applied for the higher channel and Type A-2 revetment is applied for the lower channel. In the neighborhood of the Asin Pumping Station, Type C (concrete sheet pile) revetment is applied in order to form a rectangular channel section.

(5) Reconstruction of Bridges

(a) General

There are two bridges to be reconstructed in Asin River Improvement. (refer to Fig. 2.1.12)

The features of the bridges to be reconstructed are shown in the table below.

Bridge Name	Span Length (m)	Bridge Length (m)	Effective Width (m)	Total Width (m)	Load
Asin No.1 Bridge	20.0	21.86	9.60	10.20	vehicle
Asin No.2 Bridge	20.0	21.83	8.25	8.85	vehicle

The geology of the site along Asin River is composed of 20 m to 25 m thick alluvial clay and fluvial clay/sand layer exists below it, both of which are of the Quaternary Period. The alluvial clay is very soft, where the N values range between 0 and 10, while the fluvial clay/sand is hard , where the N values are mostly over 40. Therefore, the fluvial layer is selected as the bearing layer of the foundation piles.

According to the boring investigation in the Urban Drainage System Improvement Area, the fluvial clay/sand layer has a mild slope toward Java Sea and the depth of it become deeper toward downstream. For the design of foundation pile, the boring data of DB 3, which is located closest to the sea and the hard clay layer is deepest, shall be utilized.

(b) Asin No. 1 Bridge

Type of Superstructure

As the bridge length is longer than 20 m, PC type girder is selected (refer to Table 6.3.1).

Design Criteria

The design criteria for the bridge design are stated in the Interim Report (4) Vol. III "Design Criteria".

For seismic load, following coefficient is adopted.

$$Teq = Kh \cdot I \cdot Wr$$

where,

Teq : total base shear force in the direction being considered (kN)

Kh : coefficient of horizontal seismic loading

$$Kh = C \cdot S$$

where,

C : base shear coefficient for the appropriate zone, period and side condition (=0.15 for zone 4)

S : structure type factor (=1.3 for PC type)

I : safety factor of importance of structure (= 1.0 for road bridge)

Wr : total nominal weight of structure object to seismic acceleration (kN)

Therefore,

$$Teq = 0.15 \times 1.5 \times 1.0 \times Wr = 0.2Wr$$

Pile Foundation Design

For foundation pile PC pile with diameters of 350 mm to 600 mm were compared and 500mm was selected as the most economical diameter. (refer to Table 6.3.2)

Design Result

Design result is shown in Fig. 6.3.9.

(c) Asin No.2 Bridge

Type of Superstructure

As the bridge length is longer than 20 m , PC type girder is selected.

Design Criteria

The design criteria for the bridge are stated in the Design Criteria Report.

For seismic load, following coefficient was adopted.

Teq= $0.15 \times 1.5 \times 1.0 \times Wr = 0.2Wr$

Pile Foundation Design

For foundation pile PC pile with diameters of 350 mm to 600 mm were compared and 500 mm was selected as the most economical diameter.

Design Result

Design result is shown in Fig. 6.3.10.

(7) Improvement of Uppermost Stretches of Asin River

The uppermost stretches of Asin River is improved by constructing a box culvert under a street.

(a) Drainage Area

Location and drainage area of the Uppermost Stretches of Asin River is shown in Fig. 6.3.11. The drainage area is 0.135 km^2.

(b) Design Discharge

The design discharge is calculated as follows;

$$Q = 0.2778 \times Cs \times C \times I \times A$$

where,

Q : peak discharge (m^3/s)

I : average intensity of rainfall (133 mm/hr, L=1,100 m)

A : catchment area (0.135 km^2)

C : run-off coefficient (=0.65)

Cs : storage coefficient (=0.8)

therefore, Q is given as follows.

$Q = 2.6$ m^3/s

(c) Longitudinal Profile and Alignment

The channel is embedded under JL. Hasanudin with minimum earth coverage of 0.5 m. The design water level at the inlet is designed as EL.-0.15 m , 0.3 m lower than the existing ground elevation at the point (EL.+0.15 m). The water level at the outlet is designed as EL.-0.417 m taking the design high water level of Asin River.

The alignment of channel is designed to connect the inlet and outlet in the shortest distance with the length of 194.09 m. Curvatures with radius 25 m and 10 m are applied for bending in order to reduce loss of energy. Considering open cut excavation without using steel sheet pile false work, distance from the houses are kept as long as 5 m.

Fig. 6.3.12 shows the alignment, the longitudinal profile and cross sections of Asin Box Culvert.

(d) Cross Section

Cross section is designed as follows;

- The inner section has a enough space for maintenance, the inner height shall be 2.0 m as the minimum requirement for maintenance.

- The width of the culvert shall be equivalent or larger the connected secondary channel (W=3.5 m) to attain a smooth inflow.

As the result, the design cross section is 3.5 m (width) and 2.0 m (height).

(e) Discharge Capacity

Discharge capacity is calculated as follows;

$$Q = A \times 1/n \times R^{2/3} \times I^{1/2}$$

where,

Q	: discharge capacity (m^3/s)
A	: area of flow (m^2) ($3.5\ m \times 1.0\ m = 3.5\ m^2$)
n	: manning coefficient (=0.015)
R	: hydraulic radius ($=A/S=3.5/(1.0 \times 2+3.5)=0.093$ m)
I	: water surface slope (=0.267 m/ 194 m = 0.00138)

Therefore,

$$Q = 7.0 \times (1/0.015) \times 0.093^{2/3} \times 0.00138^{1/2}$$

$= 3.6\ m^3/s > 2.6\ m^3/s$

As the cross section is decided from the requirement of maintenance purpose, the discharge capacity is larger than the design discharge.

(f) Location of Manholes

Manholes are installed for maintenance purpose and the location of manholes are show in Fig. 6.3.12. The interval of manhole is 10.0 m based on the discussion with Semarang City.

(g) Detailed Design of Structure

Detailed design of structure is shown on Fig. 6.3.13.

(7) Miscellaneous Works

In the course of channel improvement of Asin River, some structures should be removed or reconstructed. Those structures are as follows and their locations are indicated in Fig. 6.3.14.

(a) Structures to be demolished

There are six (6) small pumping facilities along Asin River, which have been installed by an private association of residents of Tanah Mas Estate. According to the discussion with Tanah Mas Estate, those pumps are to be removed and to be handed over to the association, as they will not be used after the completion of Asin Pumping Station.

(b) Structures to be reconstructed

There are two water pipes crossing over Asin River under the ownership of PDAM. The structures will be reconstructed to have enough freeboard with the channel improvement. The detailed design of reconstruction is presented in Fig 6.3.15.

There is also a rectangular steel duct containing telephone lines near No.2 Bridge under the ownership of TELKOM. The structure will be reconstructed to have enough freeboard with the channel improvement. Only substructure are reconstructed and the existing super structures are reutilized. The detailed design of reconstruction is presented in Fig. 6.3.16.

There are six secondary channel outlets to be reconstructed along Asin River. Presently, these outlets are connected to the small pumping stations which are to be demolished in this project. Therefore, these outlets should be reconstructed in order to attain smooth collection of rainwater into Asin River. The structure of the outlets are wet stone masonry and the dimensions are proposed to accomplish smooth connection with existing secondary channels.

(8) Inspection Road

The design concept of inspection road for Asin River is to overlay concrete bricks over the existing pavement. Fig. 6.3.17 shows the location of the inspection road and standard cross section of the road. The design elevation of the road is determined as the same as the existing ground elevation.

6.3.4 Asin Pumping Station

The purpose of Asin Pumping Station is to drain out the inland stormwater in Asin Drainage Area to Semarang River and to prevent inundation of the area. The system is composed of Asin Pumping Station and Asin Retarding Pond (refer to Fig. 6.3.18). The pump keeps the water level of both Asin River and Asin Retarding pond low during rainy season and allows gravity drainage of stormwater in the area into Asin River. The main facilities of the pumping station are composed of pumps, screens and gate.

(1) Pump

(a) Design Capacity of Pump

The design capacity of the pump is the same as the Definitive Plan as follows;

- Total Design Discharge : 8.86 m^3/s
- Installed Capacity : 3.00 m^3/s/unit
- Number of Pumps : 3 units

(b) Size of Screw Pump

Three units of screw pump with the diameter of 3.0 m are proposed. Nominal installed capacity of three sets is 9.0 m^3/s which satisfies the design capacity.

(c) Pump Combination

Reduction of operation cost especially the electric power charge of pumping station is essential to attain low operation cost.

For Asin Pumping Station, three alternative plans were studied in terms of operation cost.

Alternative-1

Three units of main pumps are connected to a generator driven by a diesel engine and they are manually operated to discharge floodwater in the rainy season. An additional small pump is installed as a daily wastewater drainage system operated automatically by electric power supplied by the PLN.

Alternative-2

Only one main pump is connected to power supply from PLN and the others are connected and operated by a generator driven by a diesel engine.

The first main pump will be automatically operated throughout a year by water level to drain stormwater and the daily wastewater and the other two main pumps will be manually operated only during rainy season to drain floodwater.

Alternative-3

Three units of main pumps are directly driven by diesel engines and are manually operated during rainy season. For daily wastewater drainage, an auxiliary small pump which will be automatically operated throughout a year by the power of the PLN is provided.

The operation cost of each alternative is estimated as shown in the following table.

Comparison of Annual Operation Cost

	Operation	Yearly Energy Cost	Comparison
Alternative-1	3-main pumps operated by diesel engine generator 1,000 kVA, 350 hr/year 1-aux. pump 18 kW operated by PLN power, 3,650 hr/year	Fuel cost Rp. 45,478,000. Elec. Power cost Rp. 11,104,000. Total Rp. 56,582,000.	132 %
Alternative-2	2-main pumps operated by diesel engine generator 800 kVA 350 hr/year 1-main pump of 240 kW operated by PLN power, 600 hr/year	Fuel cost Rp. 76,320,000. Elec. Power cost Rp. 36,382,000. Total Rp. 112,702,000.	262 %

Alternative-3	3-main pumps operated by each 350 hp diesel engine 3x350=1,050 hr/year 1-aux. Pump 18 kW operated by PLN power, 3,650 hr/year	Fuel cost Rp. 31,834,000. Elec. Power cost Rp. 11,104,000. Total Rp. 42,938,000	100 %

Resulting from the comparison of operation cost, Alternative-3 is cheapest. The electricity for the Pump Control Building, Management Office, Garage and Staff House is provided by PLN system.

Fig. 6.3.19 shows the screw pump and Fig. 6.3.20 shows the Auxiliary Pump.

(d) Screen

A large amount of garbage exists in drainage channels. In design of pumping stations, a simple screen with 20 centimeter of interval is to be installed to catch only large trashes. Smaller trashes should be collected after pumped out into Semarang River or Harbor area. A motor boat is included in the Project as "Supplying Maintenance Equipment" in Package 2 in order to fulfill that purpose. Collected trashes should be hauled and treated in a proper treatment plant.

(e) Composition of Equipment of Asin Pumping Station

The designed main equipment is listed as follows.

- Main Pumps

  Diesel engine driven Screw pump

Drainage capacity	:	3.0 m^3/s
Total Head	:	5.1 m
Number of Unit	:	3 units

- Diesel Engine Units

Purpose	:	Screw pump drive
Type	:	Radiator cooled indoor type
Capacity	:	325 hp
Starting system	:	Batteries
Number of Unit	:	3 units

- Auxiliary Drainage Pump

Type	:	Submersible motor driven drainage pump
Drainage quantity	:	0.1 m^3/s
Head	:	6 m
Motor capacity	:	18 Kw
Number of Unit	:	2 units (One unit is for standby)

- Diesel Engine Driven Generator Unit

Type	:	Indoor use radiator cooled type
Capacity	:	30 kW
Operation	:	Manual (Operation panel self-contained)
Starting method	:	Batteries (Self contained)
Number of unit	:	1 unit

- Electric panel

Type : Indoor use, metal clad type

Composed with;

2-kWh meter and distribution panels, 1-motor control panel, 1 water level indication and alarm panel and 1-battery charger panel

The design drawings of electricity system and fuel supply system are shown in Figs. 6.3.21 to 6.3.23.

(2) Structure of Pumping Station

(a) Dimension of the Structure

The purpose of the pumping station with the area of 655 m^2 is to accommodate the screw pumps, engines, gear system, control panel, generators, inspection bridges and inspection paths.

Fig. 6.3.24 shows the schematic layout of the pumping station structure.

Structure Component

As the screw shaft is sustained by the top bearing and the bottom bearing, it is necessary to place it on one concrete structure. Therefore, the whole pumping station is divided into three concrete structures, namely "Front Structure", "Main Structure" and "Pump Control Building".

(b) Design Criteria

Load Condition

As load conditions, normal condition and earthquake condition are considered for the structural analysis of the structure and foundation piles. A case when stop logs are closed for repairing pumps and the pump system is not operated, is checked as a critical case against buoyancy and water pressure in flow direction.

Load Combination

Load combination for stability analysis is tabulated in Table 6.3.3.

Stability Condition

For stability analysis, two factors are considered. The one is stability of pile foundation and the other is safety against uplift described in the Design Criteria.

(c) Geological Condition

Boring data of DB 3 are utilized for pile foundation design as the closest boring location to the site. According to the data in boring DB 3, the pile foundation is designed taking the following N values for each depth.

EL. 0 m ~ EL. -15 m	: N = 5
EL.-15 m ~ EL.-25 m	: N = 10
EL.-25 m	: N = 50

(d) Pile Foundation Design

Design of pile foundation was made according to the Design Criteria.

The diameter of the pile is determined as D = 500 mm after a comparative study. A pre-stressed concrete pile is selected, because a reinforced concrete pile has less resistance against lateral force and a steel pipe pile is more costly than a pre-stressed concrete pile. The bearing layer is set at fluvial clay below EL. -25 m and the elevation of the pile tip is set as EL. -26 m as 2D deeper than the surface of the bearing layer. The result of pile foundation design calculation is shown in Table 6.3.4 the results of structural design are shown in Figs. 6.3.25 and 6.3.26.

(e) Reinforcing Bar Arrangement

Design of reinforcing bar arrangement is made based on the Design Criteria. For the reinforcing concrete, following materials are to be applied.

Concrete;	: Type C1 (K-225)
Reinforcing bar	: SIIU-30

The principles of bar arrangement are as follows;

- Concept of minimum concrete cover follows the Design Criteria
- The main bars were arranged outside of the distribution bars

Reinforcing bar arrangement is shown in Fig. 6.3.27.

(3) Asin Pumping Station Bridge

Type of Superstructure

As the bridge length is longer than 20 m , PC type girder is selected.

Design Criteria

The design criteria for the bridge are stated in the Design Criteria Report.

For seismic load, following coefficient is adopted.

$Teq= 0.15 \times 1.5 \times 1.0 \times Wr= 0.2Wr$

Pile Foundation Design

For foundation pile PC pile with diameters of 350 mm to 600 mm were compared and 500 mm was selected as the most economical diameter.

Design Result

Design result is shown in Fig. 6.3.28.

(4) Buildings

(a) General

For the operation and maintenance of Asin Pumping Station, buildings are planned beside the pumping station, which consists of a pump control building and other related buildings.

(b) Design Criteria

Number of Personnel

Based on the discussion with Semarang Municipal Office, which will operate and maintain the pumping station, staff of three (3) person, will be engaged to operate and maintain the pumping station.

Stuctural Design Criteria

The structural design criteria is described in Vol. III "Design Criteria" in the Interim Report (4).

(c) Proposed Buildings

The Asin Pumping Station Complex consists of four (4) buildings whose outlines are presented in the table below.

No.	Building Name	Structure	Total Floor Area (m^2)
1	Pump Control Building	Concrete	193.30
2	Management Office	Concrete	121.00
3	Garage	Concrete	199.00
4	Staff house	Concrete	44.64

(d) Conceptual Design

Seven design alternatives of roof-style, such as a gable roof, a gable roof, a square hipped roof, a rectangular hipped roof, a monitor roof and a doom roof, were proposed and were discussed with Semarang City.

In the discussion, a roof-style of mixture of a Java-style and a Japanese-style was selected.

(e) Design of Buildings

The layout and architectural design of the proposed buildings are shown in Figs 6.3.29 to 6.3.33.

6.3.5 Asin Pumping Station Gate

(1) Gate

The function of Asin Pumping Station Gate is to act as a dike when the water level of

Semarang River is higher than that of Asin River. When the water level of Semarang River is lower than the water level of Asin River, the gate is opened and the water stored is released into Semarang River by gravity. The facilities involved are main gate, hoisting system, stop log, piers, pile foundation and inspection bridge.

(a) Proposed Asin Pumping Station Gate

General plan and section of piers and foundation structure are shown in Figs. 6.3.34 and 6.3.35.

(b) Top Elevation of the Gate

As the gate acts as a part of the dike of Semarang River, the top elevation of the gate should be identical to that of the dike at the point. The top elevation of the dike of Semarang River is EL. 1.05 m {EL 0.45 m (H.W.L) + 0.60 m (freeboard)}. Therefore, the top elevation of the gate should be EL. 1.05m

(c) Elevation of the Gate Slab

The bottom elevation of the gate is made as low as the Semarang River bed. Therefore, the bottom elevation of the gate should be EL. -2.41m.

(d) Height of the Gate

According to (i) and (ii) the height of the gate becomes 3.46m

(e) Design Water Level of Semarang River Side

The design high water level of Semarang River Side is set at EL+0.45m from hydraulic calculation when a design flood (Q=65 m^3/s) discharges.

(f) Design Water Level of Asin River Side

D.L.W.L. (EL. -2.7 m) of Asin River is lower than the elevation (EL. -2.4 m) of the gate slab. For designing of gate leaf, water level of Asin River side is set as EL. -2.41 m as same as bottom elevation of the gate.

(g) Load Condition

Both normal and seismic conditions with the hydrostatic load of EL. 0.45 m at Semarang River side and EL. -2.41 m at Asin river side have been considered for the design.

For hydrodynamic load, it is described in the Interim Report (4) Vol. III "Design Criteria".

(h) Results of Gate Mechanical Design

General structure of the gate mechanical and detail of gate leaf are shown in Figs 6.3.36 and 6.3.37.

(i) Power Supply to the Gate

The gate lifting hoist is operated by electric motor. In order to save the operation cost, a diesel engine driven generator will supply electricity for this equipment. The capacity of the generator is designed to satisfy automatic trash screens and belt conveyor operation in future.

(2) Piers and Foundation of Gate

(a) Stability Analysis

Dimensions of the gate

Dimension of the piers and foundation structures are shown in Fig 6.3.34.

Conditions of Stability Analysis

Stability analysis is done under both normal and seismic conditions (2 cases and 2 directions) at the time of maintenance as summarized below:

- One gate is opened with maintenance equipment on the O/M bridge considering critical eccentric loading.
- Design water level at Asin River is EL. -2.41 m.
- Design water level at Semarang River is EL. 0.45 m.
- Stop logs are used for maintenance. (This case is more critical than the case when the main gate is closed because water weight on the slab is smaller)

Pile Foundation

For stability of the gate structure against horizontal and vertical forces, pre-stressed concrete pile foundation is applied because the surface layer of alluvium clay does not have enough bearing capacity with spread foundation for the structure. Bearing layer for pile foundation has been set at the fluvial clay with N-values over 50 below EL. -25.0 m.

Result of pile analysis is shown in Table 6.3.5.

(b) Stress Analysis

Conditions of Stress Analysis

- Seismic Status	: Normal	
	: Earthquake	
- Direction of Calculation	: Flow Direction	(X direction)
	: Gate Axis Direction	(Z direction)
- Gate condition	: Full open	
	: Full close	
	: Left side open	
	: Right side open	

The total number of cases for stress analysis is sixteen (16).

Arrangement of Reinforcing Bar

Based on the results of stress analysis, reinforcing bar arrangements have been decided. The idea of reinforcing bar arrangement follows the Design Criteria. Reinforcing bar arrangement is shown in Fig. 6.3.38.

6.3.6 Asin Retarding Pond

Asin Retarding Pond is located at the confluence of Semarang River and Asin River. The water level of the pond is kept as EL. –2.5 m during rainy season and it can store 24,000 m³ of storm water. The area of the pond is 1.6 ha with water depth of 1.5 m. A part of the land created for the Asin Retarding Pond by the relocation of Semarang River shall be reclaimed as a land for compensation, namely the land to which those three houses will be relocated from the Asin Pumping Station area.

The general plan and section and the types of revetment to be used for the Asin Retarding Pond are shown in Fig. 6.3.39.

6.3.7 Other Works

(1) Tree Planting

Along Asin River, trees are proposed to be planted to enhance a favorable environmental condition.

(2) Supplying Maintenance Equipment

In order to accomplish better maintenance of facilities the following equipment are to be supplied in this project.

Name	Capacity	Purpose
Backhoe	0.35 m^3	dredging, garbage collection
Dump Truck	8 t	hauling of sediment & garbage
Truck Crane	2.2 t	lifting of stoplog and lid of manhole
Garbage Container	6 m^3	garbage collection

6.4 Bandarharjo Drainage System Improvement

6.4.1 Work Items

There are following facilities to be designed in Bandarharjo Drainage System Improvement. (refer to Fig. 6.4.1)

(1) Baru River Improvement (L=1,071 m)

- Excavation of Baru River Channel : V= 25,390 m^3
- Reconstruction of Revetment : L= 903 m for both sides
- Closing of existing diversion gate from Semarang River

(2) Baru Pumping Station

- Design Discharge : Q=4.37 m^3/s
- Installed Capacity : Q=4.6 m^3/s (2.3 m^3/s x 2 units)
- Pump House : reinforced concrete, 11.0 m × 35.0 m
- Piers and Foundation of Gate : reinforced concrete, 6.0 m × 12.0 m
- Pump Control Building, Management Office, Garage, Staff House

(3) Baru Pumping Station Gate : W = 4.0 m, H = 3.25 m × 1 gates

(4) Baru Retarding Pond : A = 0.9 ha (capacity V=9,000 m^3)

(5) Secondary Channel

Bandarharjo West Secondary Channel (open channel, W=2.2 m, H=2.4 m, L=577 m)

Bandarharjo East Secondary Channel (box culvert, W=2 m, H=2 m, L=123 m).

In Bandarharjo Drainage System Improvement, an additional dike for boundary is included in the construction package, although the design of it is excluded from this Study.

(6) Renovation of Inspection Road (L=3,000 m)

6.4.2 Baru River Improvement

(1) Alignment of Baru River

Alignment of Baru River follows the existing alignment of the river. (refer to Fig. 6.4.2)

(2) Longitudinal Profile

Riverbed elevation and High Water Level of the river was designed as a retarding pond as no design discharge is allocated. (refer to Fig. 6.4.3)

(3) Cross Section

The cross section was designed as composite trapezoidal shape (refer to Fig. 6.4.4). The lower channel will function as a channel to accommodate maximum capacity of pump so that volume of the retarding pond is maintained until the inflow discharge exceeds the pump capacity.

The crown elevation of bank protection work of both sides of the river are proposed to be the average existing ground elevation along the river, namely EL.+0.3m on the right and EL. +0.2m on the left. As the design high water level is EL. –0.9 m for Baru River, the free boards are 1.2 m and 1.1 m respectively.

(4) Revetment

For the revetment inclined type (Type A-3) of revetment is proposed in order to cope with the very soft soil foundation and to reduce the construction cost.

In the neighborhood of the Pumping Station, concrete sheet pile (Type C) of revetment is applied.

(a) Inclined Type Revetment

The structure of inclined type (Type A-3) of revetment is of wet stone masonry as shown in Fig. 6.4.5. The toe of the wet masonry is supported by cobble filling.

(b) Pre-stressed Concrete Sheet Pile Wall

Self sustainable concrete sheet pile wall is applied in the vicinity of the pumping station where vertical wall is necessary. Pre-fabricated pre-stressed concrete sheet pile with 22 cm in thickness and 11 m to 13 m in length is applied for a vertical wall. (refer to Fig. 6.4.6)

Design of concrete sheet pile is as follows;

- Safety factor against overturning
  - Normal condition : Fs > 1.2
  - Earthquake condition : Fs >1.0
- Load to be considered
  - Earth pressure and hydro pressure
- Property of soil
  - Angle of internal friction : ϕ =22.5°
  - Cohesion : c = 4.1 t/m^2
  - Unit saturated weight : Wsub = 0.8 t/m^3
- Result of analysis

Type	Bank top elevation	Bank bottom elevation	Pile bottom elevation	Pile length
C-1	EL.+0.85 m	EL.-3.7 m	EL.-9.15 m	10 m
C-2	EL.+1.2 m	EL.-3.4 m	EL.-11.8 m	13 m
C-3	EL.+0.30 m	EL.-3.4 m	EL.-10.70 m	11 m

(5) Closing Structure of Baru River

An existing water gate located at the upstream end of Baru River shall be demolished and closing dike is constructed based on the requirement of the Semarang Port Authority and the agreement of Semarang Municipal Office.

The closing work is proposed to be done by placing concrete wall at the existing gate with the thickness to stand the hydrostatic pressure. Fig. 6.4.7 shows the structure of closing wall.

(6) Inspection Road

Inspection roads involved in Bandaraharjo Drainage System Improvement are as follows;

(a) Inspection road along Baru River : L=1,640 m, W=7.0 m
(Renovation of existing InspectionRoad)

(b) Inspection road along Bandarharjo West Secondary Channel
: L=577 m, W=6.0 m

(c) Inspection road around Baru Retarding Pond : L=520 m, W=6.0 m

(d) Inspection road along Baru Conveyance Channel : L=263 m, W=6.0 m

For (b), (c) and (d) above, the width of the roads of 6 m consisting of 1 m shoulder on one side and 5 m pavement. This is because of constraints of land and existence of the shoulder of the North Ring Road on one side of the Inspection Road. For (b), (c) and (d) above, the land for the inspection roads should be acquired together with the land for channel and retarding pond.

(7) Related Structures

(a) Pedestrian Bridge

There is one pedestrian bridge across Baru River. The structure itself is not touched by the project and the abutments and two piers are protected in the work of channel excavation and revetment construction. The protection is to be made by new wet stone masonry.

(b) Reconstruction of Secondary Channel Outlet

There are four secondary channel outlets along Baru River. One of which is reconstructed as the Bandarharjo East Secondary Channel as the present outlet is downstream from Baru Pumping Station. As for the other three, only the outlet structures are reconstructed together with the revetment works as they are located upstream of the pumping station.

6.4.3 Baru Pumping Station

The purpose of Baru Pumping Station is to drain out the inland stormwater in Bandarharjo Drainage Area and to prevent inundation of the area. The system is composed of Baru Pumping Station, Baru River improvement as a retarding pond, Baru Retarding Pond and Baru Conveyance Channel. The pump keeps the water level of both Baru River and Baru Retarding Pond low during rainy season and allow gravity drainage of storm water in the area into the retarding pond. Fig 6.4.8 shows the layout of Baru Pumping Station.

(1) Pump

(a) Design Capacity of Pump

The design capacity of the pump is as follows;

- Total Design Discharge : 4.37 m^3/s
- Installed Capacity : 2.30 m^3/s/unit
- Number of Pumps : 2 units

(b) Size of Screw Pump

The size of the screw is 2.6m. The nominal discharge capacity of two sets are 4.6 m^3/s and satisfies the design capacity.

(c) Combination of Power Supply

Three alternative plans for power supply are studied in terms of construction and operation costs.

Alternative-1

Two units of main pumps are connected to generators driven by a diesel engine and they are manually operated to discharge flood water in rainy seasons and an additional small pump is installed for a daily waste water drainage operated automatically by electric power supplied by PLN.

Alternative-2

Only one main pump is connected to power supply from PLN and the other is connected to and operated by a generator driven by a diesel engine.

The first one will be automatically operated throughout a year by water level to drain storm water and the daily waste water and the other will be manually operated during only rainy season to drain storm water.

Alternative-3

Two units of main pumps are driven by diesel engines and are manually operated rainy flood seasons. For daily wastewater drainage, an auxiliary small pump, which will be automatically operated throughout a year by the power of the PLN, is provided.

The operation cost of each alternative is estimated as shown in the following table.

Comparison of Energy Cost per Year

Alternatives	Operation	Annual Energy Cost	Comparison
Alternative-1	2 main pumps operated by diesel engine generator 800 kVA, 350 hr/year 1 aux. pump of 13 kW operated by PLN power, 3,650 hr/year	Fuel cost R_p 36,383,000. Elec. power cost R_p 8,020,000. Total R_p 44,403,000.	152 %
Alternative-2	1 main pumps operated by diesel engine generator 500 kVA 350 hr/year 1 main pump of 240 kW operated by PLN power 600 hr/year	Fuel cost R_p 24,255,000. Elec. power cost R_p 76,320,000 Total R_p 100,575,000.	344 %
Alternative-3	2 main pumps operated by each 350 hp diesel engine 2x350=750 hr/year 1 aux. pump of 13 kW operated by PLN power 3,650 hr/year	Fuel cost R_p 21,223,000 Elec. power cost R_p 8,020,000 Total R_p 29,243,000	100 %

Resulting from the comparison of operation cost, Alternative-3 is cheapest. The electricity for the Control Office, Management Office, Garage and Staff House is provided by PLN system.

Fig. 6.4.9 shows the screw pump and Fig. 6.4.10 shows the Auxiliary Pump.

(d) Screen

Simple screen is proposed mainly for safety purpose.

(e) Composition of Equipment of Baru Pumping Station

The designed main equipment on this stage is listed as follows.

- Main Pumps

  Diesel Engine Driven Screw Pump
  Drainage Capacity : 2.3 m^3/s/unit
  Total Head : 5.0 m
  Number of Unit : 2 units

- Diesel Engine Unit

  Purpose : Screw pump drive

Type:	: Radiator cooled indoor type
Capacity	: 267 hp
Starting system	: Batteries
Number of Unit	: 2 units

- Auxiliary Drainage Pump

Type	: Submersible Motor Driven Drainage Pump
Drainage Capacity	: 0.07 m^3/s
Head	: 6 m
Motor capacity	: 13 kW
Number of Unit	: 2 units (one unit is for standby)

- Diesel Engine Driven Generator Unit

Type	: Indoor use radiator cooled type
Capacity	: 25 kW
Operation	: Manual (Operation panel self contained)
Starting method	: Batteries (Self contained)
Number of unit	: 1 unit

- Electric Panel

Type	: Indoor use metal clad type

Composed with;

2 kWh meter and distribution panels, 1 Motor control panel, 1 Water level indication and alarm panel and 1 Battery charger panel

The design of electricity system is shown in Figs. 6.4.11 to 6.4.14.

(3) Pumping Station

(a) Dimension of the Structure

The purpose of the pump house with the area of 475 m^2 is to accommodate the screw pumps, engines, gear system, control panel, generators, trash screens belt conveyers, inspection bridges and inspection paths.

Fig. 6.4.15 shows the schematic layout of the pumping station.

Structure Component

As the screw shaft is sustained by the top bearing and the bottom bearing, it is necessary to place it on one concrete structure. Therefore, the whole pump house is divided into three concrete structures, namely "Front Structure", "Main Structure" and "Pump Control Building".

"Main Structure" is divided into three components, namely A, B, and C. Although, it is a continuous concrete structure, stability and safety against uplift are checked for each component.

(b) Design Criteria

Seismic Load Condition

For seismic status, normal condition and earthquake condition were considered. One case when both stop logs are closed and the pump system is not operated and another case when the stop logs are open and the pump system is operated.

Load to be considered

Load combination for stability analysis is tabulated in Table 6.3.3.

Stability Condition

Two factors were considered, one is stability of pile foundation and safety the other is against uplift described in the Design Criteria.

(c) Geological Condition

Geological condition is the same as Asin Pumping Station.

(d) Pile Foundation Design

Design of pile foundation was made according to the Design Criteria.

The diameter of the pile was determined as D=500 mm after a comparative study. The bearing layer was set as EL. -25 m and the bottom elevation of the pile was set as EL. -26 m as 2D deeper than the surface of the bearing layer.

The result of pile foundation design calculation is shown in Table 6.4.1.

The results of structural design and pile foundation design are shown in Figs. 6.4.16 and 6.4.17.

(e) Reinforcing Bar Arrangement

Design of reinforcing bar arrangement was made based on the Design Criteria. For the reinforcing concrete, following materials are to be applied.

Concrete; : Type C1 (K-225)

Reinforcing bar : SHU-30

The principles of bar arrangement are as follows;

- Concept of minimum concrete cover follows the Design Criteria
- The main bars were arranged outside of the distribution bars

Reinforcing bar arrangement is shown in Fig. 6.4.18.

(4) Buildings

(a) General

For the operation and maintenance of Baru Pumping Station, buildings are planned beside the pumping station which consists of a Pump Control House and other related buildings.

(b) Design Criteria

Number of Staff

Based on the discussion with Semarang Municipal Office which will operate and maintain the pumping station, a staff of three (3) persons will be engaged to operate and maintain the pumping station.

Structural Design Criteria

The structural design criteria is described in Vol. III "Design Criteria" in the Interim Report (4).

(c) Proposed Buildings

The operation / management office compound for Baru Pumping Station consists of four (4) buildings whose outlines are presented in the table below.

No.	Building Name	Structure	Total Floor Area (m^2)
1	Pump Control Building	Concrete	155.80
2	Control Office	Concrete	121.00
3	Garage	Concrete	199.00
4	Staff house	Concrete	44.64

(d) Conceptual Design

Seven design alternatives of roof-style, such as a gable roof, a gable roof, a square hipped roof, a rectangular hipped roof, a monitor roof and a doom roof, were proposed and were discussed with Semarang City.

In the discussion, a roof-style of mixture of a Java-style and a Japanese-style was selected.

(e) Design of Buildings

The layout and architectural design of the proposed buildings are shown in Figs 6.4.19 to 6.4.23.

6.4.4 Baru Pumping Station Gate

The Baru Pumping Station Gate is proposed to protect high tide. However, when water level of Baru River is higher than the tide, the gate is opened to drain stormwater by gravity.

The facilities involved are main gate, hoisting system, stop log, piers, pile foundation and inspection bridge.

(1) Gate

(a) Top Elevation of the Gate

As the gate acts as a tidal barrier, the top elevation of the gate should be identical to that of the tidal dike. The top elevation of the tidal dike is EL.+0.45.m (H.H.W.L.) + 0.4.m (freeboard) = EL. +0.85 m. Therefore, the top elevation of the gate should be EL.+0.85 m

(b) Bottom Elevation of the Gate

Both L.W.L. in Baru Retarding Pond and design riverbed of Baru River are EL. -2.40 m. Therefore, the bottom elevation of the gate should be EL.-2.40 m.

(c) Height of the Gate

According to (a) and (b), the height of the gate is 3.25 m.

(d) Design Tide Level

The design tide level is assumed as EL.+0.25 m (W.H.W.L.) + 0.1 m (hydraulic gradient) = EL.+0.35 m, and so is the design water level upstream.

(e) Design Water Level of Baru River Side

The design water level for the gate is the Design Low Water Level of Baru River, namely EL.-2.40 m.

(f) Load Condition

Both normal and seismic conditions with the hydraulic static load of EL. +0.35 m at sea side and EL. -2.40 m at Baru River side have been considered for the design.

For hydrodynamic load, the Design Criteria is applied.

(g) Results of Gate Design

General structure of the gate is shown in Figs. 6.4.24 and 6.4.25.

(h) Power Supply of Gate

A diesel engine driven generator unit is adopted to supply power to the gate hoist.

(2) Piers and Foundation of Gate

(a) Stability Analysis

Dimensions of the gate:

Dimensions of the piers and foundation structures are shown in Fig.6.4.26 and Fig. 6.4.27.

Conditions of Stability Analysis

Stability analysis was done under both normal and seismic conditions (2 cases and 2 directions) at the time of maintenance as summarized below:

- Gate is opened with maintenance equipment on the inspection bridge.
- Design water level at Baru River is EL. –2.4 m.
- Design water level at Sea side is EL.+0.35 m.
- Stop logs are used for maintenance. (This case is more critical than the case when the main gate is closed because water weight on the slab is smaller)

Results of Stability Analysis

Under both normal and seismic conditions, stability against overturning is confirmed with assumed dimension. For stability against sliding and bearing, pre-stressed concrete pile foundation is proposed. According to the geological survey data, bearing layer for pile foundation has been set at EL. –25.0 m, which is a fluvial hard clay with N values over 50.

The result of pile analysis is shown in Table 6.4.2.

(b) Stress Analysis

Conditions of Stress Analysis

Conditions of stress analysis are as follows;

- Seismic Status: Normal, Earthquake
- Direction of Calculation
  - Flow Direction (X direction)
  - Gate Axis Direction (Z direction)
- Gate condition: Open, Close

The total number of cases for stress analysis is eight (8).

Arrangement of Reinforcing Bar

Based on the results of stress analysis, reinforcing bar arrangements have been designed. The idea of reinforcing bar arrangement followed to the Design Criteria.

(c) Proposed Piers and Foundation Structure

General plan and section of the piers and foundation structure are shown in Figs. 6.4.26 and 6.4.27. and reinforcing bar arrangement is shown in Fig. 6.4.28.

6.4.5 Baru Retarding Pond

The function of Baru Retarding Pond is to store storm water collected from Bandarharjo West Drainage Area temporarily and to reduce the pump capacity. The water level of the pond is kept as low as EL.-1.9 m during rainy season and it can store 8,000 m^3 of storm water. The area of the pond is 0.8 ha with water depth of 1.0 m.

(1) Plan

The location of the Baru Retarding Pond is the same as the Definitive Plan. Detailed plan was made taking into account the inspection road design, location of existing high voltage electric pole, right of way of the North Ring Road. The location and plan of the pond is shown in Fig. 6.4.29.

(2) Elevation

The cross section of the pond is designed taking into account the design low water level (EL. –1.9 m) and the existing ground elevation in the area.

(3) Bank Protection

For the protection of the pond bank, inclined type of revetment is applied which is the same as for Baru River. The material of revetment is wet stone masonry and revetment structure is shown in Fig. 6.4.30.

(4) Inspection Road

Inspection road is designed around the retarding pond (refer to Fig. 6.4.29). The relationship between the location of the inspection road and the right of way of the North Ring Road is shown in Fig. 6.4.31.

6.4.6 Baru Conveyance Channel

The purpose of Baru Conveyance Channel is to connect Baru Retarding Pond with Baru Pumping Station and convey water in the pond to be pumped out by the pump and keep the water level of the pond low.

(1) Location

The location of Baru Conveyance Channel is shown in Fig. 6.4.32.

(2) Design Discharge

The design discharge of the Baru Conveyance Channel (Q_{BC}) is determined by allocating the design discharge of Baru Pumping Station (Q_{BP}) with the ratio of the drainage area of Bandarharjo West Drainage Area (A_{BW}) to the drainage area of Bandarharjo Drainage Area as a whole (A_B).

$$Q_{BC} = Q_{BP} \times A_{BW}/A_B$$

where,

Q_{BP} = 4.37 m³/s

A_{BW} = 0.580 km^2

A_B = 2.185 km^2

Therefore, the design discharge for the Baru Conveyance Channel is,

$Q_{BC} = 4.37 \times 0.580/2.185 = 1.16\ m^3/s$

(3) Alignment and Longitudinal Profile

The design longitudinal profile of the channel is determined by the design water levels of both the Baru Retarding Pond and Baru River.

- Design low water level of Baru Retarding Pond : EL.-1.90 m
- Design low water level of Baru River : EL.-2.40 m

The alignment of the channel is designed to connect the retarding pond and Baru River in the shortest distance. The location along the North Ring Road was discussed with BINA MARGA office and decided as follows. In Type B the structure is constructed inside the right of way of BINA MARGA (refer to Fig. 6.4.33).

Type	Distance from Retarding Pond	Location
A	0 m to 263 m, 646 m to 692 m	Outside of ROW of BINAMARGA
B	263 m to 646 m	Inside of ROW of BINAMARGA

Based on the discussion with BINA MARGA, the top elevation of the structure of Type-B should be at least 1.5m below the road surface. For the bending of the channel, curvature with the radius of 10.0 m was applied in order to attain to reduce the bending energy loss.

(4) Design Cross Section

The design cross section of the channel is determined from the view point of the maintenance of the channel. For the maintenance purpose, the minimum requirement of the inner height and inner width are 2.0 m respectively. Longitudinal profile and cross section are shown in Fig. 6.4.34.

(5) Discharge Capacity

Discharge capacity is calculated as follows;

$Q = A \times 1/n \times R^{2/3} \times I^{1/2}$

where,

Q : discharge capacity (m^3/s)

A : area of flow (m^2) (2.0 m × 0.7 m = 1.4 m^2)

n : manning coefficient (=0.015)

R : hydraulic radius (=A/S=1.4/(0.7×2+2)=0.412 m)

I : water surface slope (=0.5 m/ 692 m = 0.0007225)

therefore

$$Q = 1.4 \times 1/0.015 \times 0.412^{2/3} \times 0.0007225^{1/2}$$
$$= 1.4\ m^3/s > 1.2\ m^3/s$$

(6) Installation of Manhole

Manholes are installed with the interval length of 10.0 m for maintenance purpose. Location of manholes is indicated in Fig. 6.4.34.

(7) Detailed Design of Structure

For bar arrangement, the following basic ideas are applied;

- Minimum cover follows the Design Criteria
- The main bar is arranged outside of distribution bar
- The amount of area of distribution bar is more than 30 % of the one of main bar

Figs. 6.4.35 and 6.4.36 show bar arrangement for standard section and manhole.

6.4.7 Bandarharjo Secondary Channels

(1) Bandarharjo West Secondary Channel

The purpose of Bandarharjo Secondary Channel is to collect storm water in the west part of West Bandarharjo Drainage Area after the completion of Baru Retarding Pond. Presently, a small ditch of a limited capacity exists along the North Ring Road. Bandarharjo West Secondary Channel will function to collect the storm water and bring it to Baru Retarding Pond to assist the function of Baru Retarding Pond.

(a) Location

The location of the Bandarharjo West Secondary Channel with the length of 577 m is shown in Fig. 6.4.32. It is a secondary channel along the North Ring Road.

(b) Drainage Area

The drainage area of the channel is 0.075 km^2 as shown in Fig. 6.4.37.

(c) Design Discharge

The design discharge of the channel is calculated by the drainage area and the longest channel connected, as follows;

$$Q = 0.2778 \times Cs \times C \times I \times A$$

where,

Q : peak discharge (m^3/s)

I: average intensity of rainfall (166 mm/hr)

A : catchment area (0.075 km^2)

C : run-off coefficient (=0.65)

Cs : storage coefficient (=0.8)

therefore,

$Q = 2.0\ m^3/s$

(d) Design Profile and Plan

The design profile of the channel is designed as follows;

- Existing ground level along the channel : average EL.+0.5 m
- Design water level at the inlet : EL. - 0.5 m
- Design water level at the outlet : EL. - 0.9 m

(high water level of Baru Retarding Pond)

- Bottom elevation of the channel uppermost reach : - 2.0 m
- Bottom elevation of the channel lowermost reach : - 2.2 m
- Channel bed slope : I = 0.00351

Fig. 6.4.38 shows the profile and plan.

(e) Design Cross Section

Design cross section is shown in Fig. 6.4.38. The width of the channel is 2.2 m and the depth varies from 2.4 m to 2.7 m.

(f) Discharge Capacity

Discharge capacity of the channel is calculated as follows;

$$Q = A \times 1/n \times R^{2/3} \times I^{1/2}$$

where,

Q : discharge capacity (m^3/s)

A : area of flow (m^2) (2.2 m $\times$ 1.5 m=3.3 m^2)

n : manning coefficient (=0.015)

R : hydraulic radius (=A/S=3.3/(1.5×2+2.2)=0.63 m)

I : water surface slope (=0.4 m/ 577 m = 0.000693)

therefore,

$$Q = 3.3 \times 1/0.015 \times 0.63^{2/3} \times 0.000693^{1/2}$$
$$= 4.3\ m^3/s > 2.0\ m^3/s$$

(g) Structure Design

The structure is wet masonry.

(2) Bandarharjo East Secondary Channel

Presently, a secondary channel is connected to Baru River just upstream from the North Ring Road. After the construction of Baru Pumping Station, the outlet of the secondary channel should be relocated to upstream from the Pumping Station so that the downstream water level becomes low enough to drain the discharge.

(a) Location

Fig. 6.4.39 shows the location of the Bandarharjo East Secondary Channel. Because of the constraints of land, the structure should be a box culvert.

The inlet of the channel is connected to the existing secondary channel and the outlet of the channel is connected to Baru River upstream from the Pumping Station.

(b) Drainage Area

The drainage area for the Bandarharjo East Secondary Channel is 0.856 km^2 as shown in Fig. 6.4.40.

(c) Design Discharge

The design discharge for the channel is calculated from the catchement area and the length of the channel connected as follows;

$$Q = 0.2778 \times Cs \times C \times I \times A$$

where,

Q : peak discharge (m^3/s)

I : average intensity of rainfall (82.4 mm/hr)

A : catchment area (0.856 km^2)

C : run-off coefficient (=0.65)

Cs : storage coefficient (=0.8)

therefore,

$Q = 10.2\ m^3/s$

(d) Alignment and Profile

The design alignment and profile of channel are as follows;

- The alignment is shown in Fig. 6.4.39. The profile is shown in Fig. 6.4.41. The total length of the channel is 123 m.

- The design water level at the uppermost end of channel : EL.-0.51m (+0.3m (ground elevation) - 0.4 m (freeboard) - 0.41 m (inflow loss))

- The design water level at the lowermost end of channel : EL.-0.90 m (=design high water level of Baru River)

- The bottom elevation of the uppermost end of channel : EL.-2.46 m

- The bottom elevation of the lowermost end of channel : EL.-2.80 m (Design riverbed of Baru River is EL.-3.40 m)

(e) Design Cross Section

The design cross section of the channel is determined as follows;

- The section should accommodate the design discharge
- The channel should have a larger width than the inlet channel
- The inner height of the culvert is larger than 2.0 m for maintenance purpose

Therefore, the final design is 2.0 m in height and 2.0 m in width

(f) Discharge Capacity

$$Q = A \times 1/n \times R^{2/3} \times I^{1/2}$$

where,

Q : discharge capacity (m^3/s)

A : area of flow (m^2) (2.0 m $\times$ 1.95 m=3.9 m^2)

n : Manning coefficient (=0.015)

R : hydraulic radius (=A/S=3.9/(1.95$\times$2+2)=0.736 m)

I : water surface slope (=0.39 m / 123 m = 0.00317)

therefore,

$$Q = 3.9 \times 1/0.015 \times 0.736^{2/3} \times 0.00317^{1/2}$$
$$= 11.9 \text{ m}^3/\text{s} > 10.2 \text{ m}^3/\text{s}$$

(g) Structural Design

The structure design of the box culvert is the same as the Baru Conveyance Channel as the inner section is the same.

The location and the structure of manholes is the same as the Type-A of Baru Conveyance Channel.

6.4.8 Other Works

(1) Tree Planting

Along Baru River, trees are proposed to be planted to enhance a favorable environmental conditions.

(2) Supply Maintenance Equipment

Same equipment are supplied as Asin River Drainage System Improvement.

6.5 Compensation

For the works of urban drainage system improvement, 4.8 ha of land acquisition is acquired as follows:

- Asin Pumping Station	900 m²
- Asin Retarding Pond	24,000 m²
- Baru Retarding Pond	15,000 m²
- Baru Conveyance Channel	1,600 m²
- Bandarharjo West Secondary Channel	5,770 m²
total	47,270 m²

Three houses are to be relocated for Asin Pumping Station.

The land belongs to the Semarang Harbor Authority. Presently the area is unused and change of land use into drainage facilities were approved by the Mayor of Semarang City. As to the house evacuation, three (3) house are to be excavated and the land for relocation is to be prepared in the construction of Asin Retarding Pond.

6.6 Treatment Method of Dredged Material

River bed deposit of Semarang, Asin and Baru rivers contain significant amount of heavy metals and when the deposit are excavated or dredged, it should be treated before handling to the spoil bank. In this study period, leaching test of heavy metals in the sediment have been performed in order to decide the treatment method more precisely. The result of leaching test is shown in CHAPTER 3.

The result shows the following points;

(a) Leaching test shows that there is a possibility of contamination of groundwater by alkyl mercury which is leached out from the deposit with an amount exceeding Japanese standard.

(b) By mixing with not less than 7 % of cement against the dry weight of the dredged material, the amount of alkyl mercury leached out cannot be detected.

(c) Regarding other kinds of heavy metals, the amount of leaching is insignificant without any treatment.

Based on the result, the treatment method is designed and will be clearly stated in the technical specifications of the construction works as follows;

(a) The material to be treated is all river bed deposit excavated or dredged from the existing channels of Semarang, Asin and Baru rivers,

(b) The dredged material shall be deposited in a certain designated area for treatment, and

(c) The dredged material shall be mixed with cement with a content of not less than 7 % of the deposit material in dry state.

If the unit weight of the wet material is assumed as 1.5 t/m^3 and water content of the wet material is assumed to be 70%, 7 % of the weight of the dry material becomes 70 kg per 1 m^3 of material.

TABLES

CHAPTER 6
DETAILED DESIGN

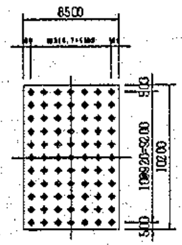
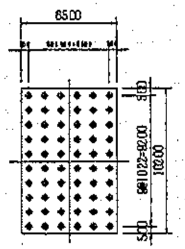
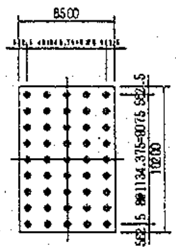
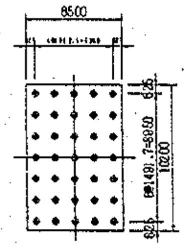
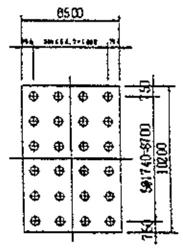
Table 6.2.1 REQUIRED AMOUNT OF BRIDGE RAISING ACROSS SEMARANG RIVER (No.0 - No.241+13)

No.	Location	Name of Street	Bottom of g;Girde	Design High Water	Freeboard		Amount to be Raised
			(EL m)	(EL m)	(m)		(m)
1	SMC-21+23	JL.Serskko Usmam Janatin	1.90	0.406	1.49		0.00
2	SMC-53+17	-	0.56	0.484	0.08	not enough	0.52
3	SMC-69+14	-	0.27	0.518	-0.25	not enough	0.85
4	SMC-90+11	-	1.68	0.564	1.12		0.00
5	SMC-106+13	Railway	-0.06	0.610	-0.67	not enough	1.07
6	SMC-115+14	JL.Mputantular	0.73	0.655	0.08	not enough	0.32
7	SMC-116+8	JL.Suprapto	0.89	0.659	0.23	not enough	0.17
8	SMC-121+3	-	0.60	0.682	-0.08	not enough	0.48
9	SMC-126+17	JL.Agus Salim	1.19	0.709	0.48		0.00
10	SMC-137+14	JL.Gong Gong	0.46	0.780	-0.32	not enough	0.72
11	SMC-142+23	JL.Pekajan	1.05	0.866	0.18	not enough	0.22
12	SMC-156+17	-	1.23	1.135	0.09	not enough	0.31
13	SMC-161	JL.Kimangun Sarkoro	2.32	1.230	1.09		0.00
14	SMC-168+7	JL.Sebandaran	1.77	1.356	0.41		0.00
15	SMC-183	JL.Wot Gandul	1.64	1.626	0.01	not enough	0.39
16	SMC-195+17	JL.Gajah Mada	2.85	1.859	0.99		0.00
17	SMC-211	JL.Tamrin	1.14	2.110	-0.97	not enough	1.37
18	SMC-215+22	-	2.65	2.227	0.42		0.00
19	SMC-225+10	JL.Pekenden	3.25	2.499	0.75		0.00
20	SMC-235+24	-	2.84	2.790	0.05	not enough	0.35

Table 6.3.1 COMPARISON OF BRIDGE TYPES

Material	Type of Bridge	Span Length (m) 10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	200
Rein-forced Concrete	Simple T girder																
	Hollow Slab																
	Rigid Frame																
——	Hollow slab																
Pre-stressed Concrete	Simple I-girder																
	Simple T-girder																
	simple box-girder																
	Continuous box girder																
	Box girder with hinge																
	Continuous rigid frame																
Steel Bridge	Simple composite girder																
	Simple box girder																
	Continuous box girder																
	truss girder																

Table 6.3.2 PILE FOUNDATION COMPARISON FOR BRIDGE

CASE		CASE1	CASE2	CASE3	CASE4	CASE5
SEISMIC CASE		φ350 	φ400 	φ450 	φ500 	φ600 
PILE TYPE		DRIVEN PC PILES 77×φ350	DRIVEN PC PILES 60×φ400	DRIVEN PC PILES 45×φ450	DRIVEN PC PILES 35×φ500	DRIVEN PC PILES 24×φ600
PILE TYPE	m	18	18	18	18	18
DISPLACEMENT	cm	0.253	0.278	0.326	0.371	0.446
ALLOWABLE DISPLACEMENT	cm	1.500	1.500	1.500	1.500	1.500
AXIAL LOAD	tf	25.924	33.223	43.861	57.445	83.238
ALLOWABLE AXIAL LOAD	tf	104.000	123.000	141.000	161.000	200.000
AXIAL PULL-OUT LOAD	tf	—	—	—	—	—
ALLOWABLE AXIAL PULL-OUT CAPACITY	tf	—	—	—	—	—
COMPRESSIVE STRESS OF CONCRETE	tf/m^2	181.2<255	178.1<255	193<255	188<255	190.6<255
TENSION OF CONCRETE	tf/m^2	-29.4>-30	-28.5>-30	-21.9>-30	-28.2>-30	-25>-30
COST	(relative ratio)	1.240	1.185	1.040	1.000	1.087
EVALUATION		▲	△	○	◎	○

DIAMETERS	mm	φ350	φ400	φ450	φ500	φ600
NUMBER		77	60	45	35	24
TOTAL LENGTH	m	1386	1080	810	630	432
PRICE	1000YEN/m	5.3	6.5	7.6	9.4	14.9
TOTAL COST	1000YEN	7345.8	7020	6156	5922	6436.8

NOTE:
1. Type B driven PC-Piles are used in comparison.
2. The costs used of PC-Piles are the local costs of Japan.

Table 6.3.3 COMBINATION OF LOADS

load name	normal condition		earthquake condition	
	stoplog open	stoplog closed	stoplog open	stoplog closed
weight of pumping station concrete	X	X	X	X
weight of bridge	X	X	X	X
weight of machine	X	X	X	X
weight of pump control building	X	X	X	X
weight of water	X		X	
uplift	X	X	X	X
driving force of screw	X		X	
hydrostatic pressure	X	X	X	X
earth pressure	X	X	X	X
inertia for pumping station concrete			X	X
inertia for bridge			X	X
inertia for machine			X	X
inertia for pump control building			X	X
hydrodynamic pressure			X	

Table 6.3.4 PILE FOUNDATION ANALYSIS (ASIN PUMPING STATION)

structure name			Front Structure	Main Structure A	Main Structure C	Pump Control Building
	item	allowable stress				
		kg/cm^2	kg/cm^2	kg/cm^2	kg/cm^2	kg/cm^2
normal condition	compressive stress of concrete	166.0	77.6	81.7	100.9	64.0
	tensile stress of concrete	0.0	18.8	26.6	86.7	64.0
	tensile stress of PC cable	8,700	8,240	8,202	7,918	8,038
earthquake condition	compressive stress of concrete	250.0	121.8	141.8	202.1	98.2
	tensile stress of concrete	−30.0	−18.0	−20.9	−15.6	32.3
	tensile stress of PC cable	8,700	8,391	8,396	8,348	8,169

Table 6.3.5 PILE FOUNDATION ANALYSIS (ASIN PUMPING STATION GATE)

Driving Force and Moment

	flow direction			gate axis direction			
	V	H	M	V	H	M	total H
Normal Condition	792.40	-102.81	-362.1	792.40	40.67	207.0	110.56
Earthquake(gate axis direction)	785.26	-86.99	-245.5	785.26	158.69	626.5	180.97
Earthquake(flow direction)	790.40	-198.38	-622.4	790.40	29.13	192.9	200.51

Calculated Stress of Pile

	item	allowable stress	stress
		kg/cm^2	kg/cm^2
normal condition	compressive stress of	166.0	130.7
	tensile stress of concrete	0.0	5
	tensile stress of PC cable	8,700	8,287
earthquake condition	compressive stress of	250.0	164.8
	tensile stress of concrete	-30.0	-29.2
	tensile stress of PC cable	8,700	8,635

Table 6.4.1 PILE FOUNDATION ANALYSIS (BARU PUMPING STATION)

structure name			Front Structure	Main Structure A	Main Structure C	Pump Control Building
	item	allowable stress	6*8	6*7	4*7	3*4
		kg/cm^2	kg/cm^2	kg/cm^2	kg/cm^2	kg/cm^2
normal condition	compressive stress of concrete	166.0	79.4	84.8	113.5	64.0
	tensile stress of concrete	0.0	26.6	92	68.6	64.0
	tensile stress of PC cable	8,700	8,203	8,176	7,996	8,038
earthquake condition	compressive stress of concrete	250.0	137.6	146.3	191.4	98.2
	tensile stress of concrete	-30.0	-29.9	-21.1	-13.1	32.3
	tensile stress of PC cable	8,700	8,440	8,396	8,341	8,169

Table6.4.2 PILE FOUNDATION ANALYSIS (BARU PUMPING STATION GATE)

Driving Force and Moment

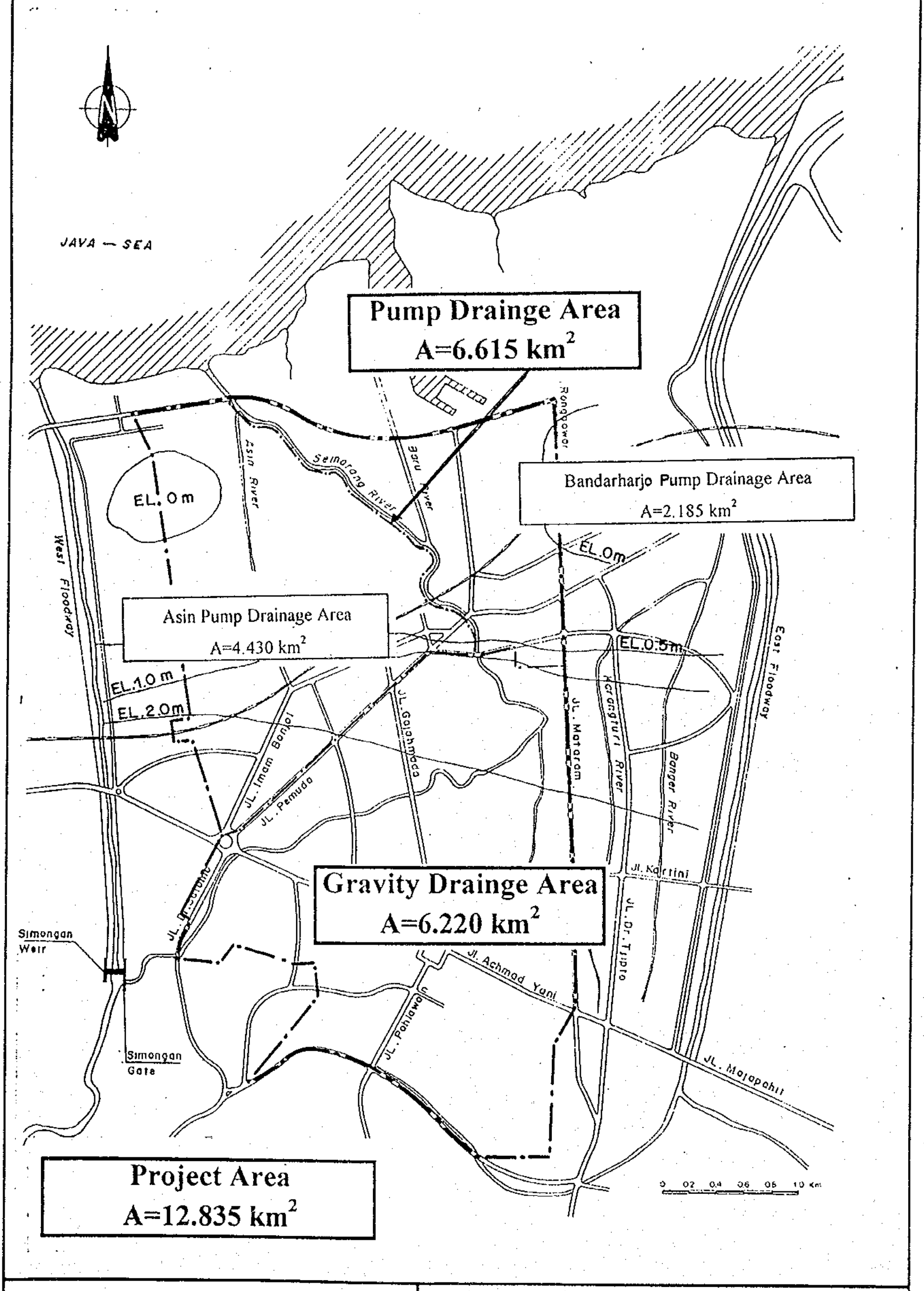
	flow direction			gate axis direction			
	V	H	M	V	H	M	total H
Normal Condition	361.55	-53.74	-136.4	361.55	33.88	49.4	63.53
Earthquake(gate axis direction)	355.57	-44.65	73.1	355.57	86.15	263.0	100.81
Earthquake(flow direction)	359.73	-99.22	-275.9	359.73	23.57	32.9	101.98

Calculated Stress of Pile

	item	allowable stress	stress
		kg/cm^2	kg/cm^2
normal condition	compressive stress of	166.0	129.4
	tensile stress of concrete	0.0	13.8
	tensile stress of PC cable	8,700	8,245
earthquake condition	compressive stress of	250.0	151.6
	tensile stress of concrete	-30.0	-8.5
	tensile stress of PC cable	8,700	8,342

FIGURES

CHAPTER 6
DETAILED DESIGN



THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA

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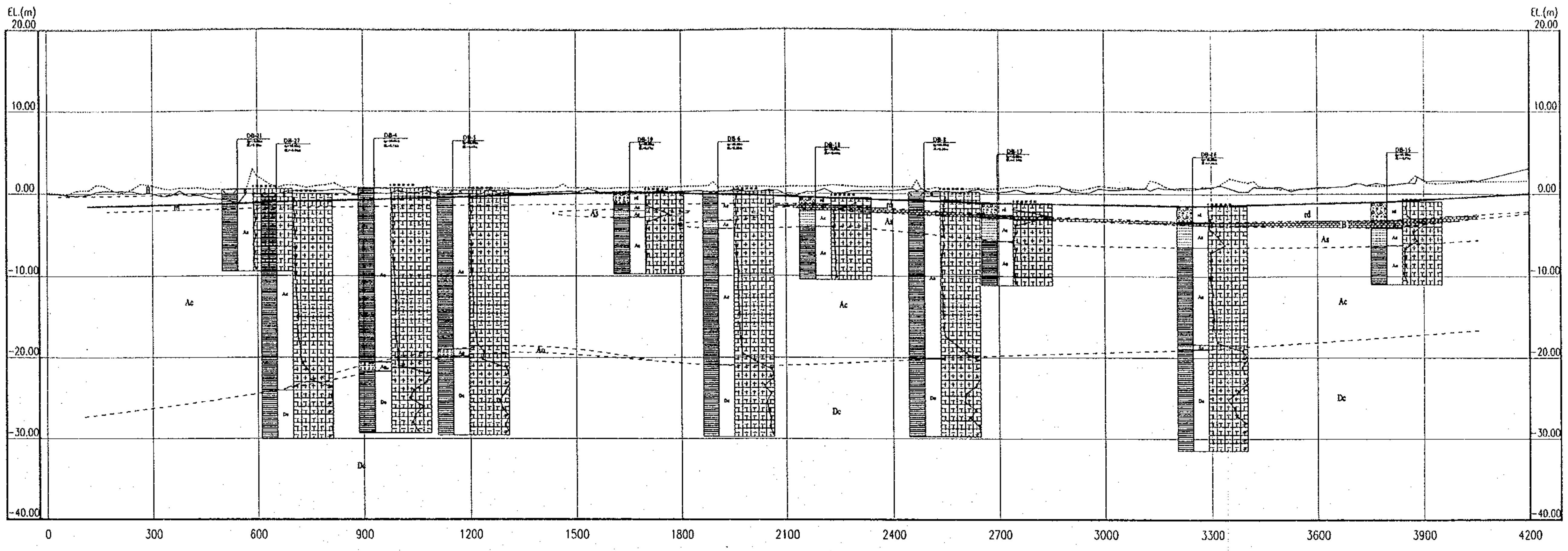
Fig. 6.1.1

STUDY AREA FOR URBAN DRAINAGE SYSTEM IMPROVEMENT

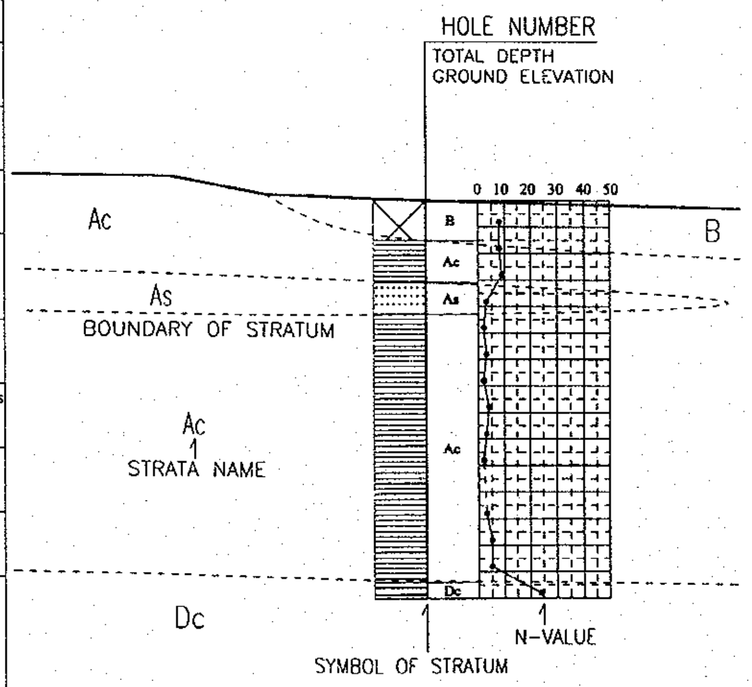


LEGEND

(Geological Strata)

Age			Formation and Strata Name	Symbol	Description
Quaternary	Holocene		Embankment	B	It consists of embankment, filled soil and refuse, and composed of clay, silt, sand and gravel.
			Riverbed deposit	rd	It consists of sand and gravel mainly at the upstream area of Simongang Weir. But it consists of sand and clay mainly at the downstream area.
			Alluvium	Ac	It consists of clay and sandy clay, and shows gray. The sediments are very soft, and contain fragments of shell.
				As	It consists of fine grain sand and middle grain sand mainly, and contains the intercalated clay and silt generally. At the downstream area of Simongan Weir, it contains organic materials and fragments of shell.
				Ao	It consists of organic clay and organic fine grain sand mainly, but continuity as a stratum is poor.
	Pleistocene		Diluvium	Dc	It consists of hard clay, and contains coral limestone partly. The surface part of this stratum is oxidized characteristically, and shows dark brown.
				Ds	It consists of sand mainly, and grain size of sand is from fine to coarse. And it contains many gravel, but diameter of gravel is smaller than 3cm generally.
				Dg	It consists of gravel and clay. The quality of clay is same as Dc stratum, and diameter of gravel is smaller than 20cm.
Tertiary-Quaternary	Pliocene-Pleistocene	Damar	Sedimentary Rock Unit	Da	It consists of alternation of conglomerate, sandstone and siltstone mainly, and contains mafic tuff partly. Sandstone and siltstone have tuffaceous quality, and the change of grain size of sandstone is big. The matrix of conglomerate consists of same material of sandstone. The gravel of conglomerate consists of andesite and pumice, and diameter of gravel is smaller than 20cm.
			Pyroclastic Rock Unit	Dp	It consists of volcanic breccia and mafic tuff mainly, and alternation is forming. The volcanic breccia contains fragments of andesite and pumice, and matrix consists of mafic tuff.

(DESCRIPTION ON THE DRAWING)



(SYMBOLS OF SOILS AND ROCKS AT CORE)

	B	Embankment
	rd	River Deposit
	Ac	Clay
	As	Sand
	Ao	Organic Clay
	Dc	Hard Clay
	Ds	Sand
	Dg	Gravel
	Da	Sedimentary Rock
	Dp	Pyroclastic Rock

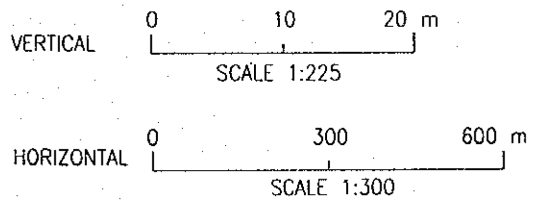


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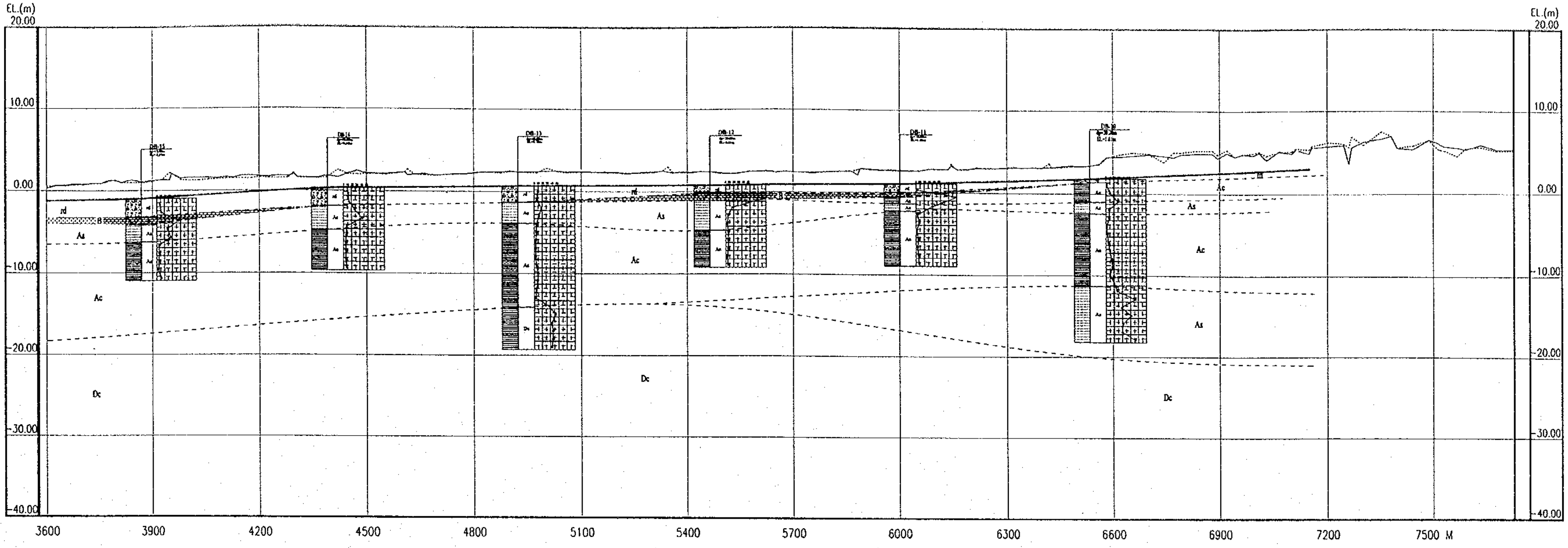
Fig. 6.1.2 (1/2)

GEOLOGICAL PROFILE OF SEMARANG RIVER LONGITUDINAL SECTION

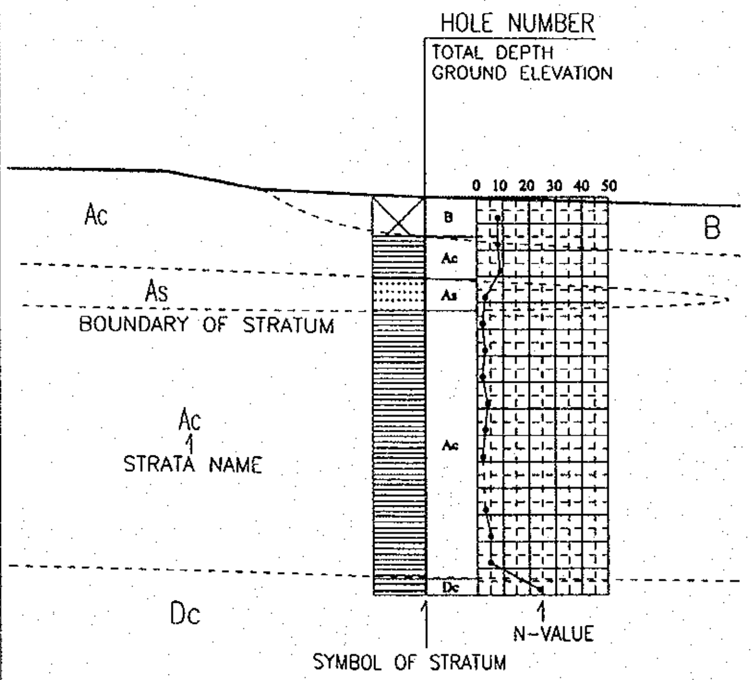


LEGEND

(Geological Strata)

Age			Formation and Strata Name	Symbol	Description
Quaternary	Holocene -50.00		Embankment	B	It consists of embankment, filled soil and refuse, and composed of clay, silt, sand and gravel.
			Riverbed deposit	rd	It consists of sand and gravel mainly at the upstream area of Simongang Weir. But it consists of sand and clay mainly at the downstream area.
			Alluvium	Ac	It consists of clay and sandy clay, and shows gray. The sediments are very soft, and contain fragments of shell.
				As	It consists of fine grain sand and middle grain sand mainly, and contains the intercalated clay and silt generally. At the downstream area of Simongan Weir, it contains organic materials and fragments of shell.
				Ao	It consists of organic clay and organic fine grain sand mainly, but continuity as a stratum is poor.
	Pleistocene		Diluvium	Dc	It consists of hard clay, and contains coral limestone partly. The surface part of this stratum is oxidized characteristically, and shows dark brown.
				Ds	It consists of sand mainly, and grain size of sand is from fine to coarse. And it contains many gravel, but diameter of gravel is smaller than 3cm generally.
				Dg	It consists of gravel and clay. The quality of clay is same as Dc stratum, and diameter of gravel is smaller than 20cm.
Tertiary–Quaternary	Pliocene–Pleistocene	Damar	Sedimentary Rock Unit	Da	It consists of alternation of conglomerate, sandstone and siltstone mainly, and contains mafic tuff partly. Sandstone and siltstone have tuffaceous quality, and the change of grain size of sandstone is big. The matrix of conglomerate consists of same material of sandstone. The gravel of conglomerate consists of andesite and pumice, and diameter of gravel is smaller than 20cm.
			Pyroclastic Rock Unit	Dp	It consists of volcanic breccia and mafic tuff mainly, and alternation is forming. The volcanic breccia contains fragments of andesite and pumice, and matrix consists of mafic tuff.

(DESCRIPTION ON THE DRAWING)



(SYMBOLS OF SOILS AND ROCKS AT CORE)

	B	Embankment
	rd	River Deposit
	Ac	Clay
	As	Sand
	Ao	Organic Clay
	Dc	Hard Clay
	Ds	Sand
	Dg	Gravel
	Da	Sedimentary Rock
	Dp	Pyroclastic Rock

VERTICAL 0 10 20 m SCALE 1:225

HORIZONTAL 0 300 600 m SCALE 1:300

THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA

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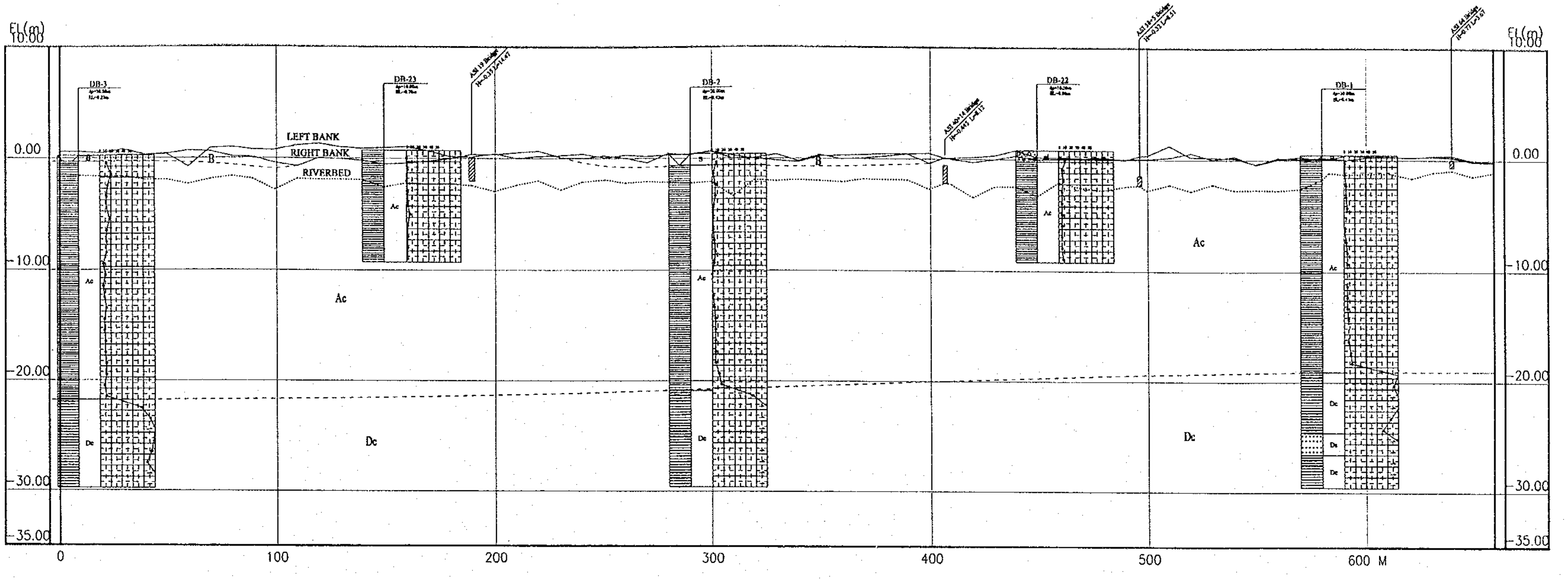
Fig. 6.1.2 (2/2)

GEOLOGICAL PROFILE OF SEMARANG RIVER LONGITUDINAL SECTION

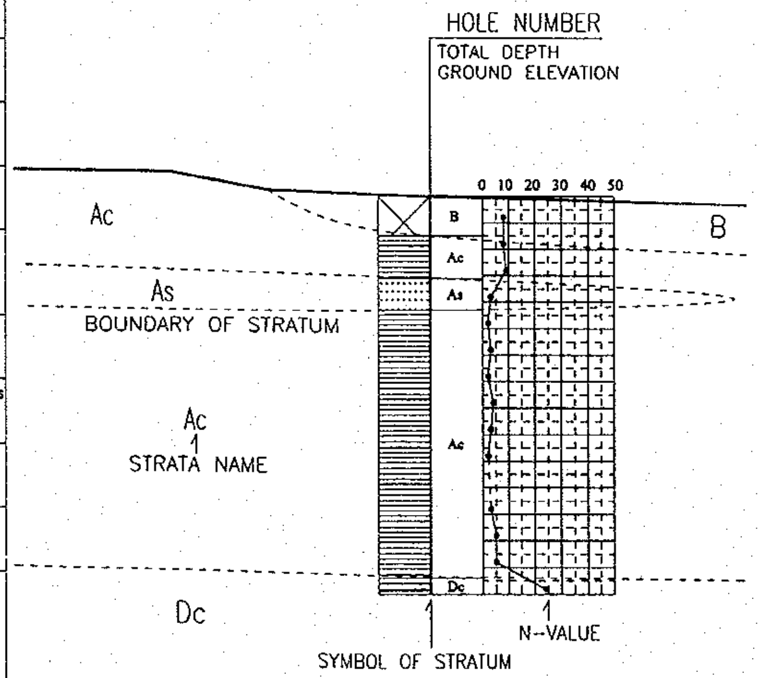


LEGEND

(Geological Strata)

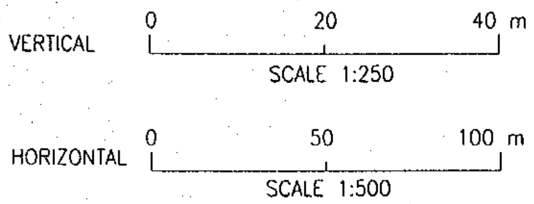
Age			Formation and Strata Name	Symbol	Description
Quaternary	Holocene -50.00		Embankment	B	It consists of embankment, filled soil and refuse, and composed of clay, silt, sand and gravel.
			Riverbed deposit	rd	It consists of sand and gravel mainly at the upstream area of Simongang Weir. But it consists of sand and clay mainly at the downstream area.
			Alluvium	Ac	It consists of clay and sandy clay, and shows gray. The sediments are very soft, and contain fragments of shell.
				As	It consists of fine grain sand and middle grain sand mainly, and contains the intercalated clay and silt generally. At the downstream area of Simongan Weir, it contains organic materials and fragments of shell.
				Ao	It consists of organic clay and organic fine grain sand mainly, but continuity as a stratum is poor.
	Pleistocene		Diluvium	Dc	It consists of hard clay, and contains coral limestone partly. The surface part of this stratum is oxidized characteristically, and shows dark brown.
				Ds	It consists of sand mainly, and grain size of sand is from fine to coarse. And it contains many gravel, but diameter of gravel is smaller than 3cm generally.
				Dg	It consists of gravel and clay. The quality of clay is same as Dc stratum, and diameter of gravel is smaller than 20cm.
Tertiary-Quaternary	Pliocene-Pleistocene	Damar	Sedimentary Rock Unit	Da	It consists of alternation of conglomerate, sandstone and siltstone mainly, and contains mafic tuff partly. Sandstone and siltstone have tuffaceous quality, and the change of grain size of sandstone is big. The matrix of conglomerate consists of same material of sandstone. The gravel of conglomerate consists of andesite and pumice, and diameter of gravel is smaller than 20cm.
			Pyroclastic Rock Unit	Dp	It consists of volcanic breccia and mafic tuff mainly, and alternation is forming. The volcanic breccia contains fragments of andesite and pumice, and matrix consists of mafic tuff.

(DESCRIPTION ON THE DRAWING)



(SYMBOLS OF SOILS AND ROCKS AT CORE)

B	Embankment
rd	River Deposit
Ac	Clay
As	Sand
Ao	Organic Clay
Dc	Hard Clay
Ds	Sand
Dg	Gravel
Da	Sedimentary Rock
Dp	Pyroclastic Rock

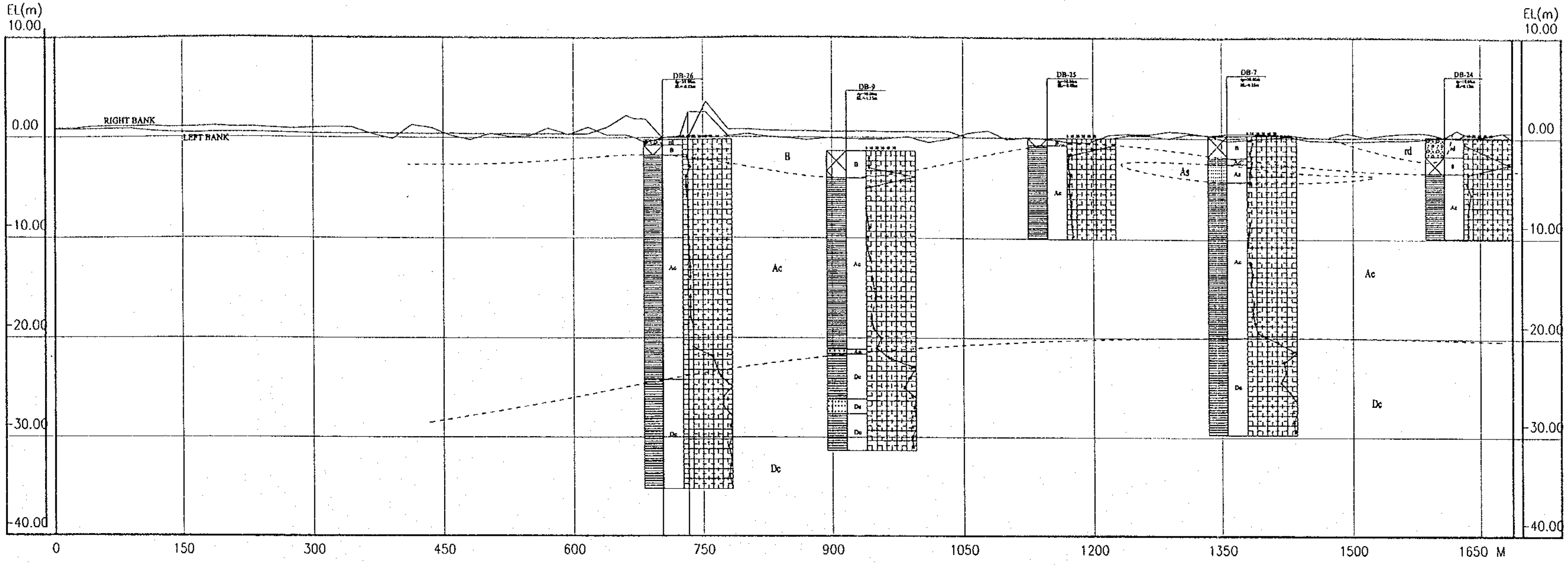


THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 6.1.3

GEOLOGICAL PROFILE OF ASIN RIVER LONGITUDINAL SECTION

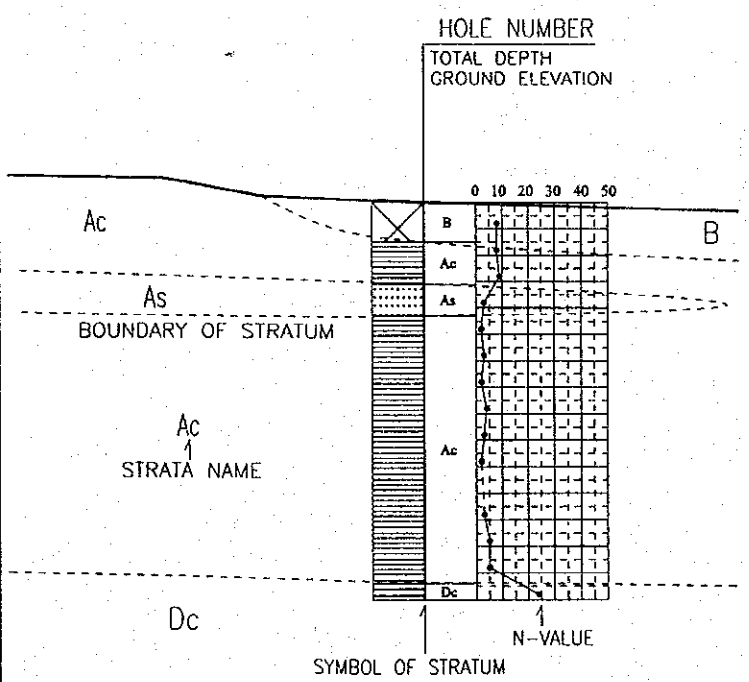


LEGEND

(Geological Strata)

Age			Formation and Strata Name	Symbol	Description
Quaternary	Holocene -50.00		Embankment	B	It consists of embankment, filled soil and refuse, and composed of clay, silt, sand and gravel.
			Riverbed deposit	rd	It consists of sand and gravel mainly at the upstream area of Simongang Weir. But it consists of sand and clay mainly at the downstream area.
			Alluvium	Ac	It consists of clay and sandy clay, and shows gray. The sediments are very soft, and contain fragments of shell.
				As	It consists of fine grain sand and middle grain sand mainly, and contains the intercalated clay and silt generally. At the downstream area of Simongan Weir, it contains organic materials and fragments of shell.
				Ao	It consists of organic clay and organic fine grain sand mainly, but continuity as a stratum is poor.
	Pleistocene		Diluvium	Dc	It consists of hard clay, and contains coral limestone partly. The surface part of this stratum is oxidized characteristically, and shows dark brown.
				Ds	It consists of sand mainly, and grain size of sand is from fine to coarse. And it contains many gravel, but diameter of gravel is smaller than 3cm generally.
				Dg	It consists of gravel and clay. The quality of clay is same as Dc stratum, and diameter of gravel is smaller than 20cm.
Tertiary–Quaternary	Pliocene–Pleistocene	Damar	Sedimentary Rock Unit	Da	It consists of alternation of conglomerate, sandstone and siltstone mainly, and contains mafic tuff partly. Sandstone and siltstone have tuffaceous quality, and the change of grain size of sandstone is big. The matrix of conglomerate consists of same material of sandstone. The gravel of conglomerate consists of andesite and pumice, and diameter of gravel is smaller than 20cm.
			Pyroclastic Rock Unit	Dp	It consists of volcanic breccia and mafic tuff mainly, and alternation is forming. The volcanic breccia contains fragments of andesite and pumice, and matrix consists of mafic tuff.

(DESCRIPTION ON THE DRAWING)



(SYMBOLS OF SOILS AND ROCKS AT CORE)

Symbol	
B	Embankment
rd	River Deposit
Ac	Clay
As	Sand
Ao	Organic Clay
Dc	Hard Clay
Ds	Sand
Dg	Gravel
Da	Sedimentary Rock
Dp	Pyroclastic Rock

VERTICAL 0 10 20 m SCALE 1:225

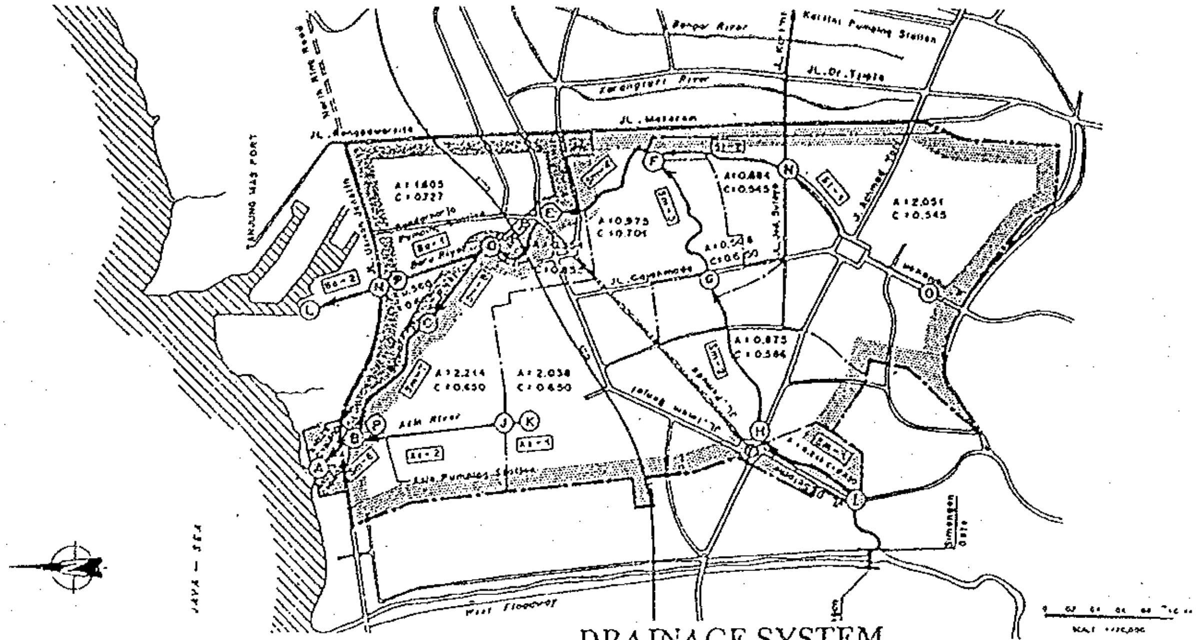
HORIZONTAL 0 150 300 m SCALE 1:300

THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA

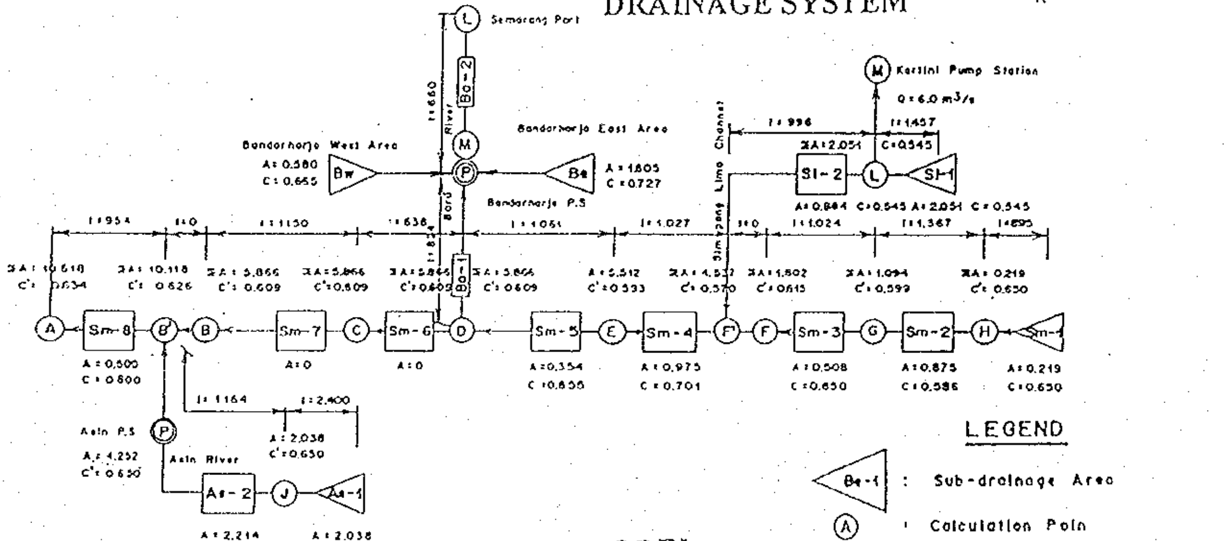
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 6.1.4

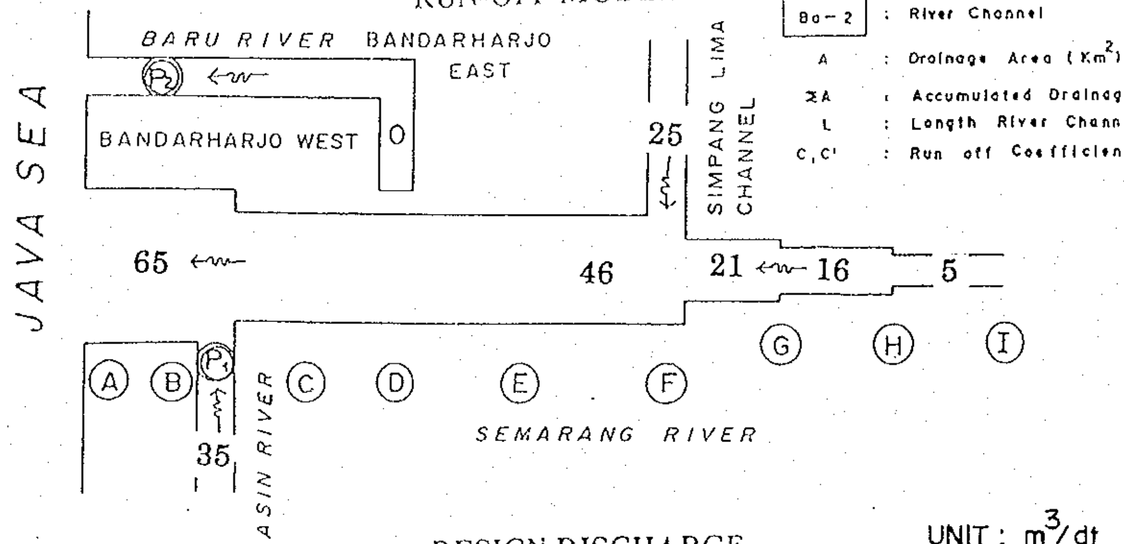
GEOLOGICAL PROFILE OF BARU RIVER LONGITUDINAL SECTION



DRAINAGE SYSTEM

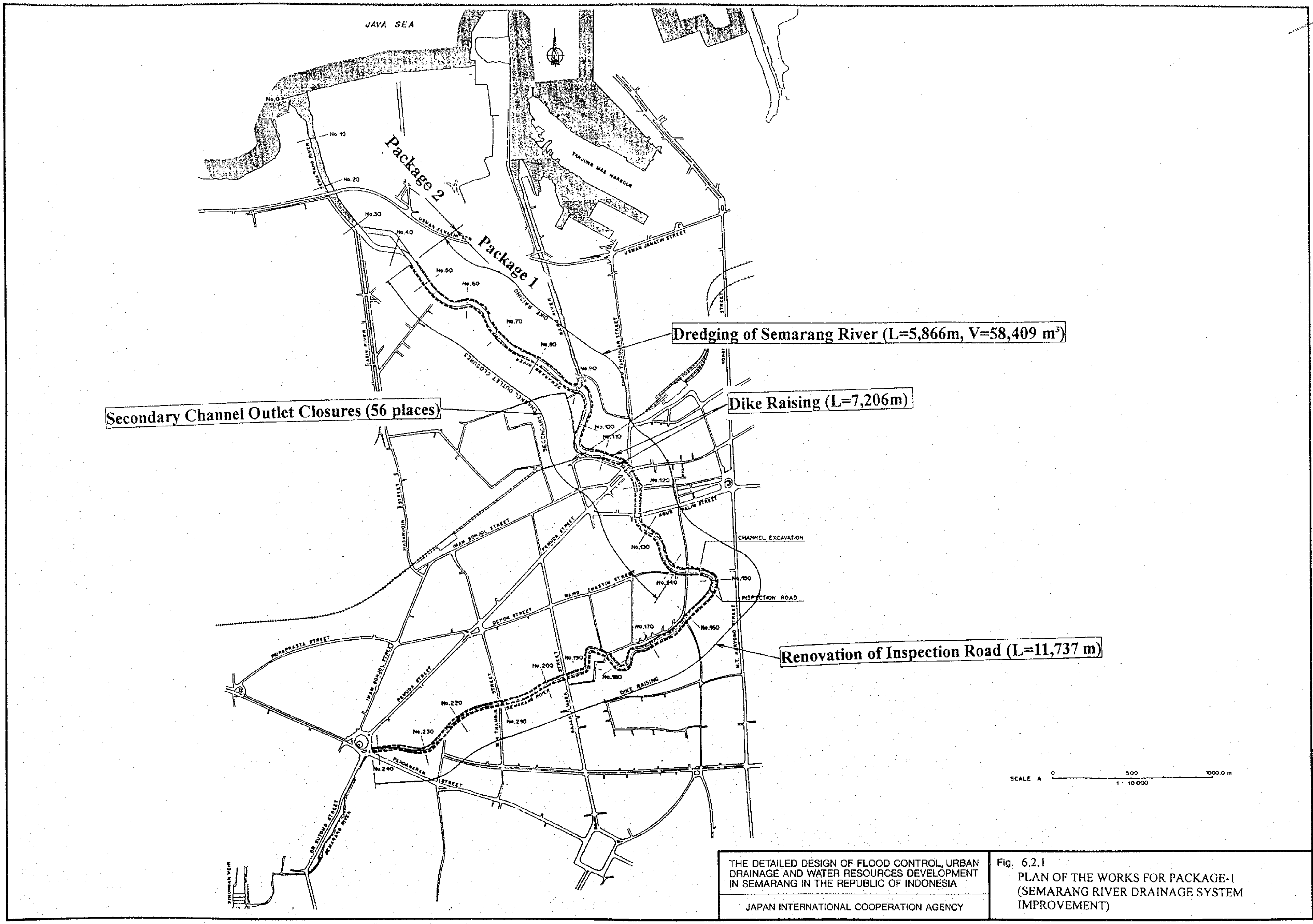


RUN-OFF MODEL



DESIGN DISCHARGE

THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA	Fig. 6.1.5
JAPAN INTERNATIONAL COOPERATION AGENCY	DESIGN DISCHARGE OF THE MAIN CHANNELS



THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA	Fig. 6.2.1 PLAN OF THE WORKS FOR PACKAGE-1 (SEMARANG RIVER DRAINAGE SYSTEM IMPROVEMENT)
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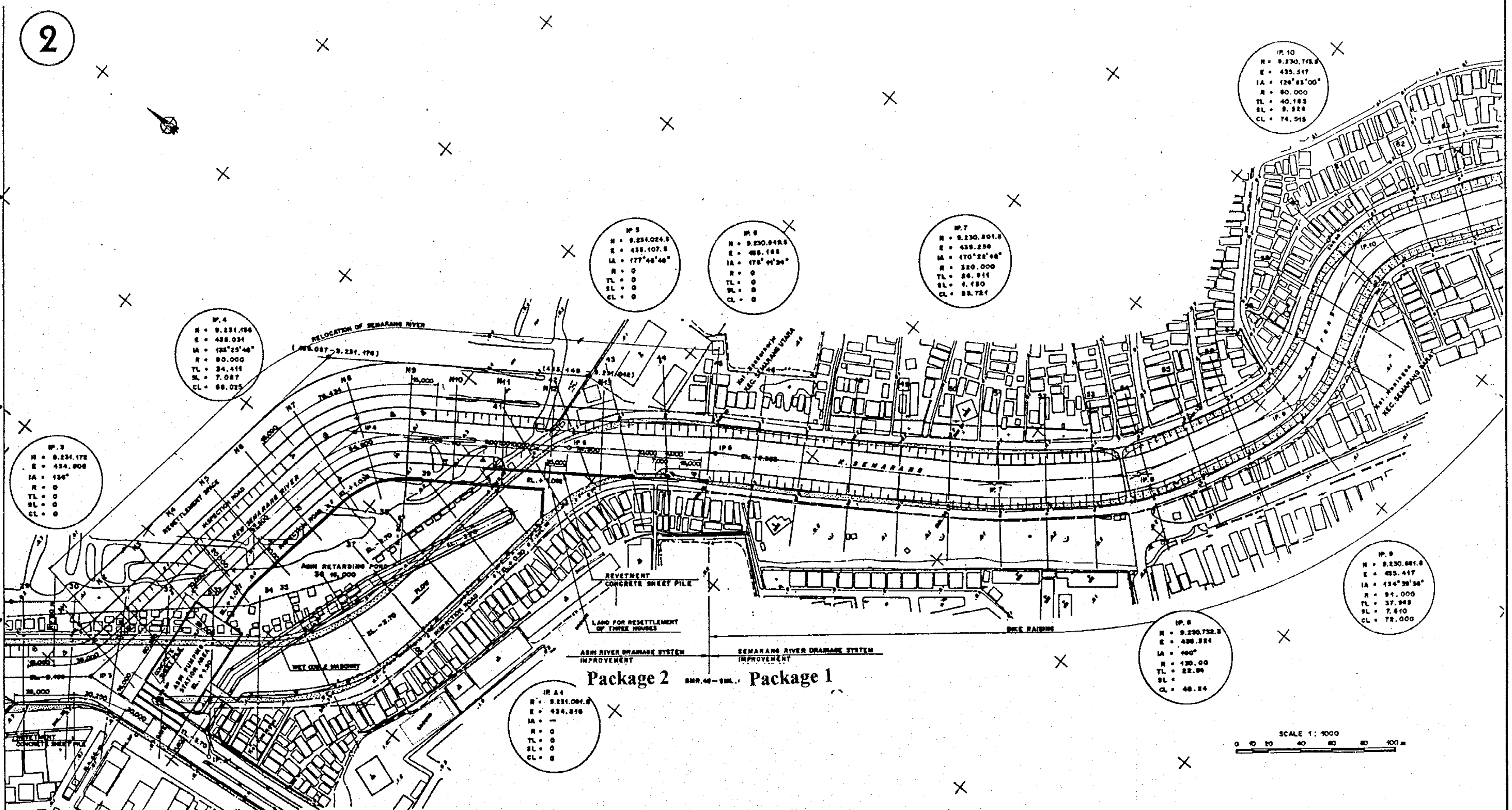

FOR REFERENCE

NAME	NORTHING	EASTING	ELEVATION
SML-30	9,231,172.815	434,784.882	1.386
SML-40	9,231,008.007	435,048.892	0.215
SML-50	9,230,844.120	435,228.466	0.185
SML-60	9,230,688.278	435,502.471	0.371

FOR REFERENCE

NAME	NORTHING	EASTING	ELEVATION
SMR-30	9,231,196.299	434,817.849	0.142
SMR-40	9,231,042.832	435,057.323	0.183
SMR-50	9,230,840.222	435,262.880	0.298
SMR-60	9,230,729.544	435,505.821	0.434

THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA

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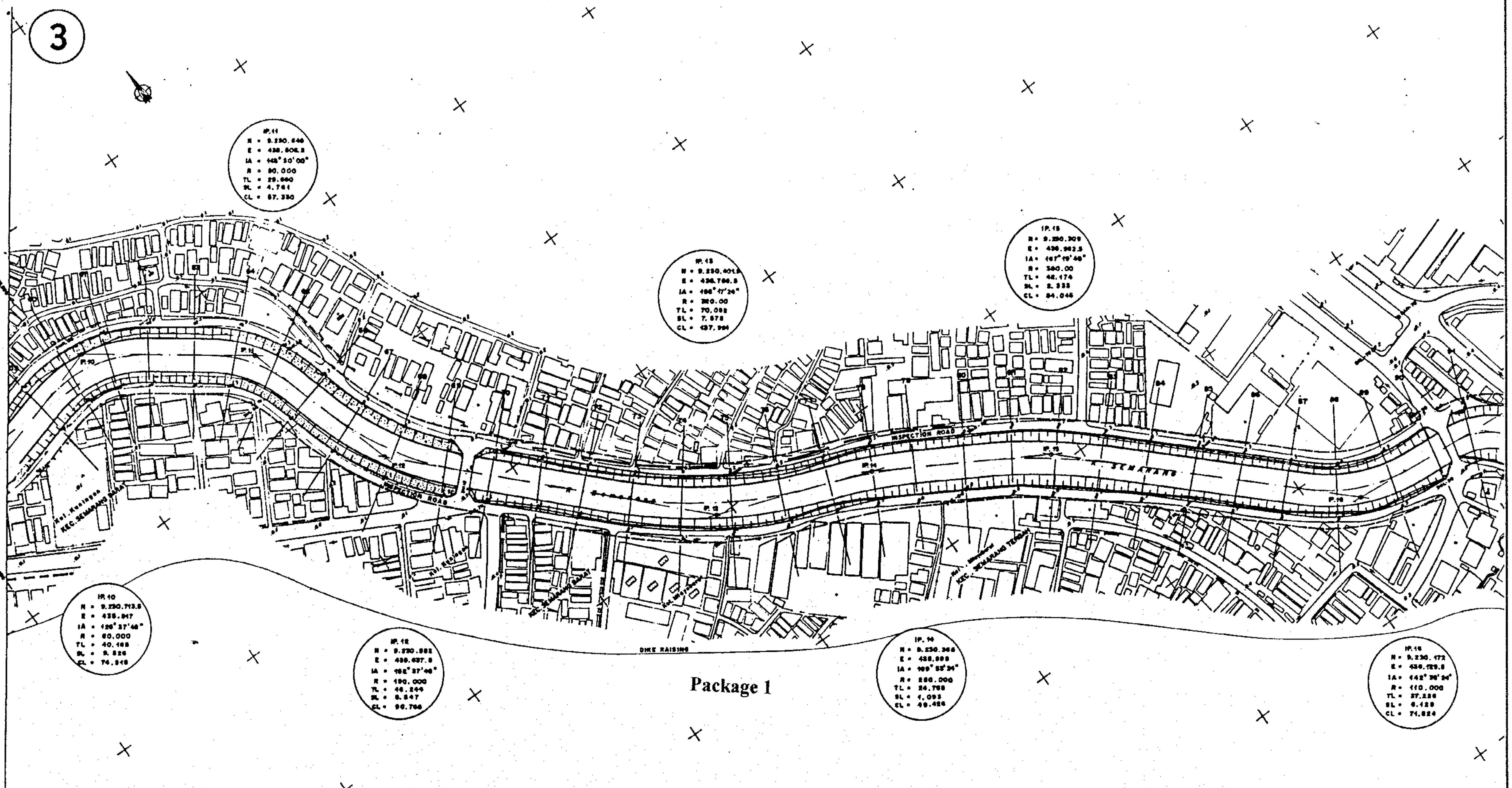
Fig. 6.2.2 (1/7)

SEMARANG RIVER PLAN (1/7)



FOR REFERENCE

NAME	NORTHING	EASTING	ELEVATION
SML-60	9,230,669.278	425,502.471	0.371
BM - 12	-	-	1.456
SML-70	9,230,492.374	425,673.811	0.349
SML-80	9,230,322.322	425,926.379	0.777
SML-90	9,230,151.674	426,179.376	0.914

FOR REFERENCE

NAME	NORTHING	EASTING	ELEVATION
SMR-60	9,230,729.344	425,505.521	0.434
SMR-70	9,230,513.946	425,695.944	0.246
SMR-80	9,230,350.797	425,944.230	0.470
SMR-90	9,230,190.877	426,186.284	0.500

THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 6.2.2 (2/7)

SEMARANG RIVER PLAN (2/7)