

Chapter 6

CONVEYANCE SEWER

CONSTRUCTION

(PACKAGE C, D & E)

CHAPTER 6 CONVEYANCE SEWER CONSTRUCTION (PACKAGE C, D & E)

6.1 General

The wastewater treatment plant (WWTP) will be constructed in Binh Chanh District and at a distance of approximately 3.53 km from the intermediate pumping station (IWPS). Thus, the conveyance sewer is required to transmit the wastewater from the IWPS to the WWTP.

6.2 Scope of Project

This project consists of the construction of the conveyance sewer and the inspection/maintenance road.

Conveyance sewer construction comprises the construction of approximately 3,535 m of double-cell (each 1,300 mm (W) x 1,200 mm (H)) reinforced concrete sewer supported on timber piles and concrete piles between the proposed intermediate wastewater pumping station and the proposed wastewater treatment plant. The sewer includes a siphon, comprising two (2) pipes with a diameter of 1,200 mm conduits to be constructed by pipe jacking, where it passes beneath the Tac Ben Ro Canal. The location of the conveyance sewer construction is shown in Fig. 6.1.

The inspection and maintenance road is installed along the conveyance sewer route. The road reaches the WWTP with a bridge over the Tac Ben Ro Canal.

In consideration of the good interface with the construction of intermediate pumping station and wastewater treatment plant, the construction of conveyance sewer is divided into two (3) portions and is included in Package C, D and E.

Package C : Between IWPS and the connection with Don Dieu road, L = 242 m

Package D : Between the connection with Don Dieu road and the maintenance chamber installed before the Tac Ben Lo Canal, L = 3,003 m

Package E : Between the maintenance chamber installed before the Tac Ben Lo Canal and the inflow pumping station at WWTP, L = 289 m

6.3 Applicable Code and Criteria

There has been no change in applying the following codes and standards since Basic Design.

- 1) Vietnamese Standard (TCVN)
- 2) Design Criteria of Exterior and Project Drainage Networks No. 20 TCN-51-84, Ministry of Construction

- 3) Sewerage Facilities Planning and Design Manual, Japan Sewerage Works Agency Standards (JSWAS), 1994
- 4) Japanese Industrial Standard (JIS)
- 5) Reinforced Concrete Sewer Pipe, Japan Sewerage Works Agency Standards (JSWAS), 1987
- 6) Reinforced Concrete Pipe Jacking Sewer Pipe, Japan Sewerage Works Agency Standards (JSWAS), 1999
- 7) American Society for Testing and Materials (ASTM)
- 8) American Association of State High Way and Transportation Officials (AASHTO)

6.4 Design Condition and Criteria

Design Flow	: 192,000 m ³ /day (2.222 m ³ /s), i.e., hourly maximum Flow (1.4 times of daily average dry weather flow in year 2010) plus groundwater infiltration (10% of daily average dry weather flow)
Flow system	: Gravitation
Flow equation	: Manning equation, $n = 0.013$
Minimum velocity	: 0.7 m/s
Gradient	: 0.5 ‰
Minimum earth covering	: 1.2 m
Manhole interval	: 100 m

6.5 Design of Conveyance Sewer

6.5.1 Soil and Groundwater Conditions

The soil investigation was carried out in eleven (11) places along the conveyance sewer line in the JICA M/P and F/S Study and the this study. The both data was analyzed and compiled in this study.

The geologic profile along the conveyance sewer line is presented in Fig. 6.2. The profile shows that the very soft organic clay (OH) lies with a thickness ranging from 2 m to 28 m and 15 m thick on average beneath the conveyance line. The groundwater level ranges from GL-0.5 m to GL-1.3 m.

The average value of soil property data was analyzed as listed below:

Natural moisture content	$w = 82.48 \%$
Natural unit weight	$\gamma = 1.489 \text{ g/cm}^3$
Void ratio	$e_0 = 2.170$
Unconfined compressive strength	$q_u = 0.118 \text{ kg/cm}^2$
Compression index	$C_c = 0.807$
Coefficient of consolidation	$C_v = 3.16 \times 10^{-4} \text{ cm}^2/\text{s}$
Preconsolidation pressure	$P_c = 0.445$
Coefficient of volume compressibility	$m_v = 1.21 \times 10^{-5} \text{ cm}^2/\text{g}$

Standard Penetration Test $N = 0 - 2$

6.5.2 Box Culvert and Manholes

A double-cell (each 1200 mm x 1300 mm) reinforced concrete box culvert is proposed and the typical plan and section is shown in Fig. 6.3 and the longitudinal profile is presented in Fig. 6.4. The box culvert has a joint with a water stop and elastic filler at each 30 m and is installed in-situ.

Manhole is designed at an interval of 100 m and the bending for each cell as shown in Fig. 6.3. Total number of manhole amounts to 78.

6.5.3 Earth Work for Trench Excavation

Required trench width for proper installation of the box culvert is determined to be 5.2 m. A stability analysis of sliding based on the soil properties, two (2) types of shoring are proposed for trench excavation according to the excavation depth and the thickness of the very soft organic clay (OH) layer. A safety factor against sliding of 1.25 is adopted.

In case that the thickness of the OH layer is smaller than approximately 12 m, the maximum excavation depth of 4 m from the existing ground level with timber wall is proposed. Conversely, if the thickness is greater than 13 m, braced sheeting is proposed as retaining wall. The portion of two (2) types is shown in Fig. 6.2.

The detailed design of retaining wall is described as below:

(1) Timber Wall

Timber wall is proposed to maintain the stability of the trench wall for the 1st portion between manholes no. CM1 (i.e., the outlet of IWPS) and CM16 with a distance of 1,345 m. Timber wall of 300 mm wide and 30 mm thick, timber wailing of 120 mm wide and 60 mm thick and timber brace of 120 mm wide and 60 mm thick are used. The timber wailing is designed to be driven into 0.5 m below the bottom of trench and the timber struts are designed to be longitudinally spaced at 3 m center-to-center. The typical plan and section of timber wall are shown in Fig. 6.5.

(2) Braced Sheet piling

Steel sheet piling is proposed for the 2nd portion between manholes no. CM16 and CM41 (i.e., the inlet of WWTP) with a distance of 2,075 m. Sheet pile of FSP-2 type with a total length of 12.2 m is used. The driven length of the sheet pile below the bottom level of the trench is computed based on the conditions that the wall yields laterally, by (i) sliding sideways or (ii) rotating about the bottom of the wall.

Two (2) stages of struts with H-shape are longitudinally spaced in at 3.5 m center-to-center and two (2) stages of wale with H-shape are horizontally spaced at 1.7 m

center-to-center. The typical plan and section of timber wall are shown in Fig. 6.5.

6.5.4 Foundation

The landuse of the area where the conveyance sewer is proposed is a paddy field at present and will be developed as residential area. According to the PCHCM's policy of development, this area will be filled up to GL+2.0 m.

Based on the soil property as mentioned-above, settlement of unconsolidated soft clay layer is computed at approximately 28 cm in 50 years. The conveyance sewer is gravity flow system and the designed longitudinal profile should be maintained to keep a steady flow. Consequently, two (2) types of timber and concrete piling are proposed as a foundation.

(1) Timber Piling

Timber piling is designed as end-gearing piles for the 1st portion between manholes no. CM1 (i.e., the outlet of IWPS) and CM16. The timber piles with a diameter of 80 – 100 mm and a length of 4.5 m are used 25 piles per m² to support the box culvert. Bearing capacity of timber pile was calculated and the safety factor is estimated at about 1.4.

(2) Concrete Piling

The stiff clay layer is deeper than the length of timber pile along the 2nd portion between manholes no. CM16 and CM41 (i.e., the inlet of WWTP). Therefore, precast reinforced concrete piles are designed as end-gearing piles. The piles are driven into the stiff clay layer ranging from 17 m to 30 m deep beneath the datum. The concrete piles are 300 mm x 300 mm and are connected into the slab of the box culvert with 2 m center-to-center spacing of piles.

6.6 Design of Pipe Jacking

The length of this section is 115.5 m and the bottom level of the Tac Ben Ro Canal is EL-5.3 m. Design high water level and design low water level of the canal are estimated at EL+1.65 m and EL-2.0 m, respectively.

From technical and economical points of view, Pipe Jacking Method is proposed for crossing of the Tac Ben Lo Canal between manhole no. CM38 and CM39.

According to “ the Design Criteria of Exterior and Project Drainage Networks No. 20 TCN-51-84, Ministry of Construction ”, two (2) lines are proposed in parallel. The reinforced jacking pipes with a diameter of Ø1200 mm are designed to be vertically installed at a distance of 2.17 m from the bottom level (EL-5.3 m) of the canal to the crown of the pipes. The two (2) pipes are spaced horizontally at the same distance of 2.16 m between the outsides of two (2) pipes. The distance is determined as 1.5 times of the external diameter of the pipe.

At the locations of the manhole no. CM38 and CM39, launching and reception shafts for pipe jacking work will be constructed, respectively. The proposed temporary structure is presented in Fig. 6.6. Because of the soil conditions, soil improvement is adopted to the bottom area (length : 8.4 m x width : 9.84 m) of the shafts with a depth of 3 m.

6.7 Design of Maintenance Chamber

The maintenance chambers are designed to be installed at the both side of Ø1200 mm pipe after the completion of pipe installation by pipe jacking. The structure design of the maintenance chamber is presented in Fig. 6.7.

Debris collection sumps at the bottom are provided at the drop and riser of the siphon. Before the drop and riser stop logs are installed for maintenance purpose.

6.8 Design of Inspection/Maintenance Road

Inspection/maintenance road is designed on the conveyance sewer. The total length of inspection/maintenance road is approximately 2,967 m. Three (3) types of inspection/maintenance road section are designed as shown in Fig. 6.8.

6.9 Bill of Quantity

The quantities of major works item are as listed below. Details of Bill of Quantities of Conveyance Sewer Construction Project are compiled in Design Report.

Item	Unit	Quantity
Timber Piling (80 – 100 mm dia. X 4500 mm)	m	101,890
Reinforced Concrete Piling (300 mm x 300 mm)	m	68,050
Excavation	m ³	64,570
Backfill	m ³	87,550
Road Works	m ²	19,450
Concrete	m ³	8,350
Steel Reinforcement	tone	560

6.10 Construction Plan and Schedule

This section deals with construction plan and schedule of the conveyance sewer construction.

6.10.1 Basic Condition

For preparation of construction plan and schedule, the following consideration has been taken as a basic concept of construction works.

(1) Scope of Work

The construction work consists of the following main construction component and quantities of main works are presented in the table above.

- (a) Construction of Conveyance Sewer (Total length = 6,535 m = 3,419 m + 116 m)
 - Open Cut : 3,419 m
 - Pipe Jacking : 116 m x 2 lines
- (c) Construction of Manhole (39 places)
- (d) Construction of Maintenance Chamber (2 places)
- (2) Other Conditions

- (a) Model of Construction

The construction shall be carried out by sufficient contractor(s) selected through the international bidding (ICB).

- (b) Availability of Construction Plant and Equipment

The major construction works shall be conducted by applying heavy equipment, which are mostly supplied locally, due to limited construction period and keeping good quality of construction.

- (c) Construction Materials

Most of basic construction materials could be considered available in this country. Some particular processed materials (steel sheet pile, H-type steel beam, mechanical and electrical equipment and etc.) are to be procured from outside.

- (d) Pattern of Construction Method

Main work comprises of trench excavation and backfilling, concrete work and pipe jacking work.

6.10.2 Major Works of the Construction

Major works of conveyance sewer construction consists of the followings:

- (1) Temporary Road Construction

Prior to construction of conveyance sewer, a temporary road shall be constructed along the conveyance sewer route. The width of the road is designed at 6 m of crushed stone surface on the laterite road base between Don Dieu road, which will be extended to the prison in Nha Be District, and Chanh Hung road.

The temporary access road will be constructed from the proposed Chanh Hung road to the proposed bridge crossing the Tac Ben Ro River. The width of the road is designed at 6 m of crushed stone surface on the laterite road base with a total length of 464 m. This road will be used for construction of maintenance chambers.

(2) Pilling work

Timber pilling work is carried out for the section specified in section 6.5.4 Foundation and timber piles shall be driven by manpower.

Reinforced concrete pilling work is carried out for the section specified in section 6.5.4 Foundation and concrete pile of 300 mm × 300 mm shall be driven by diesel hammer.

(3) Excavation and shoring works for trench

Excavation shall be conducted by backhoe because excavation depth is smaller than 6.0 m.

Timber sheeting or continuous sheet piling with H-type steel bracing shall be used according to the excavation depth and the soil conditions of the site as described in section 6.5.3. Timber pile shall be driven into the required depth by manpower and sheet piles shall be driven into the required depth by vibro hammer. Excavation shall be limited to 0.5 m below at each strut level.

The excavated soil is directly loaded to dump track by excavators and is transported to the proposed dumping site.

The trenches should be dewatered for concrete placement and pipe laying, and they should be kept continuously dewatered for as long as necessary. Dewatering shall be executed by sump drainage method.

(4) Construction of Box Culvert by Open Cut Method

Box culvert construction consists of the following works.

(a) Sand backfilling

Sand backfill of 200 mm thick shall be executed at the bottom of the culvert. Sand backfilling shall be carried out with the yellow sand and by tamper.

(b) Concrete work

Ready mixed concrete, which is produced in a factory and transported to the site by truck with agitator, shall be used for the concrete culvert structures. The concrete shall be placed to the required position by concrete pumping.

(5) Excavation and shoring works for shafts

Prior to excavation, soil improvement work shall be executed below the bottom of shaft with depths ranging from 2.0 m by cement-mixing method.

The excavation faces of launching and receiving sides of shaft shall be improved by cement-mixing method at the same time. The improvement area is shown below;

Width (m)	Length (m)		Height (m)
	Launching	Reception	
3.5	3.2	5.5	4.0

Excavation works shall be conducted in the same manner as trench described in (1)
Excavation and shoring works for trench

(6) Installation of pipe by Pipe Jacking Method

Construction plan of pipe jacking work is described as shown in Fig. 4.10, Chapter 4 of Main Report, Vol. II. On the ground, a space of lubricant equipment, grouting equipment, muck tank crane genetor, power pack, control cabin, stock yard for pipe, transportation and other minor works is required at the launching shaft, has been carefully considered to determine the locations of the shaft.

(7) Concrete work for maintenance chambers

Ready mixed concrete, which is produced in a factory and transported to the site by truck with agitator, shall be used for all concrete structures. The concrete shall be placed to the required position by crane with bucket.

(8) Backfill work

Backfilling should proceed immediately on curing of trench-made joints and after the concrete cradle, or other structures gain sufficient strength to withstand loads without damage. Backfilling shall be executed with the black sand up to the road sub-grade level.

(9) Removal of struts and sheet pile for shoring

Struts shall be removed when backfilling reaches the strut levels. After backfilling complete to road sub-grade, sheet piles shall be carefully drawn without losing the surrounding ground.

6.10.3 Construction Schedule

To consider the construction conditions, such as possible working area, working items, applicable construction machines and numbers, construction period for each works are expected as following:

(1) Preparatory Work	2 Months
(2) Temporary Road Construction	3 months
(3) Piling Work	4 months
(4) Conveyance Sewer by Open Cut Method	12 Months
(5) Permanent Road Construction	3 Months
(7) Cleaning and Handing Over	1 Month

Construction schedule of the conveyance sewer is shown in Table 6.1.

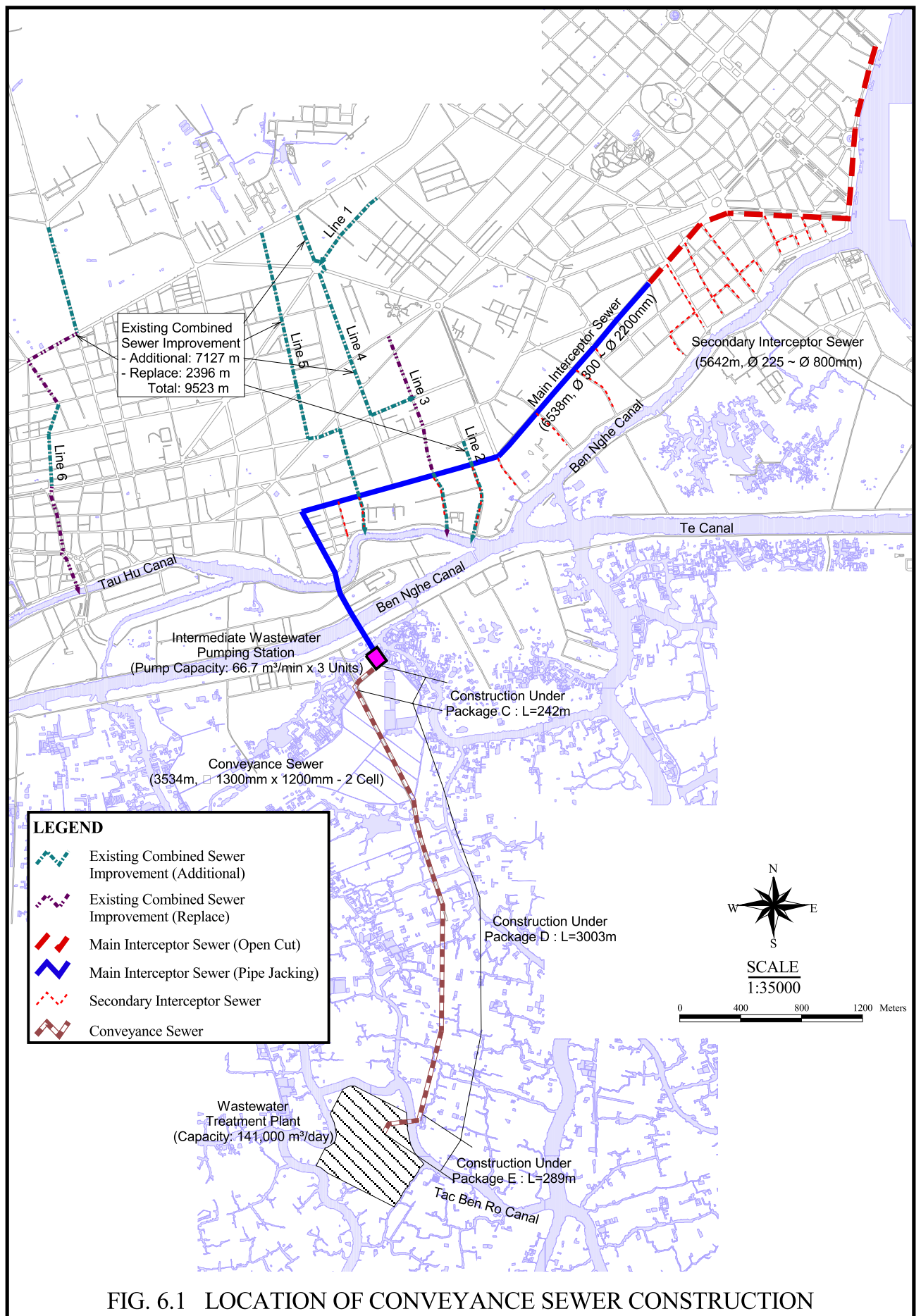


FIG. 6.1 LOCATION OF CONVEYANCE SEWER CONSTRUCTION

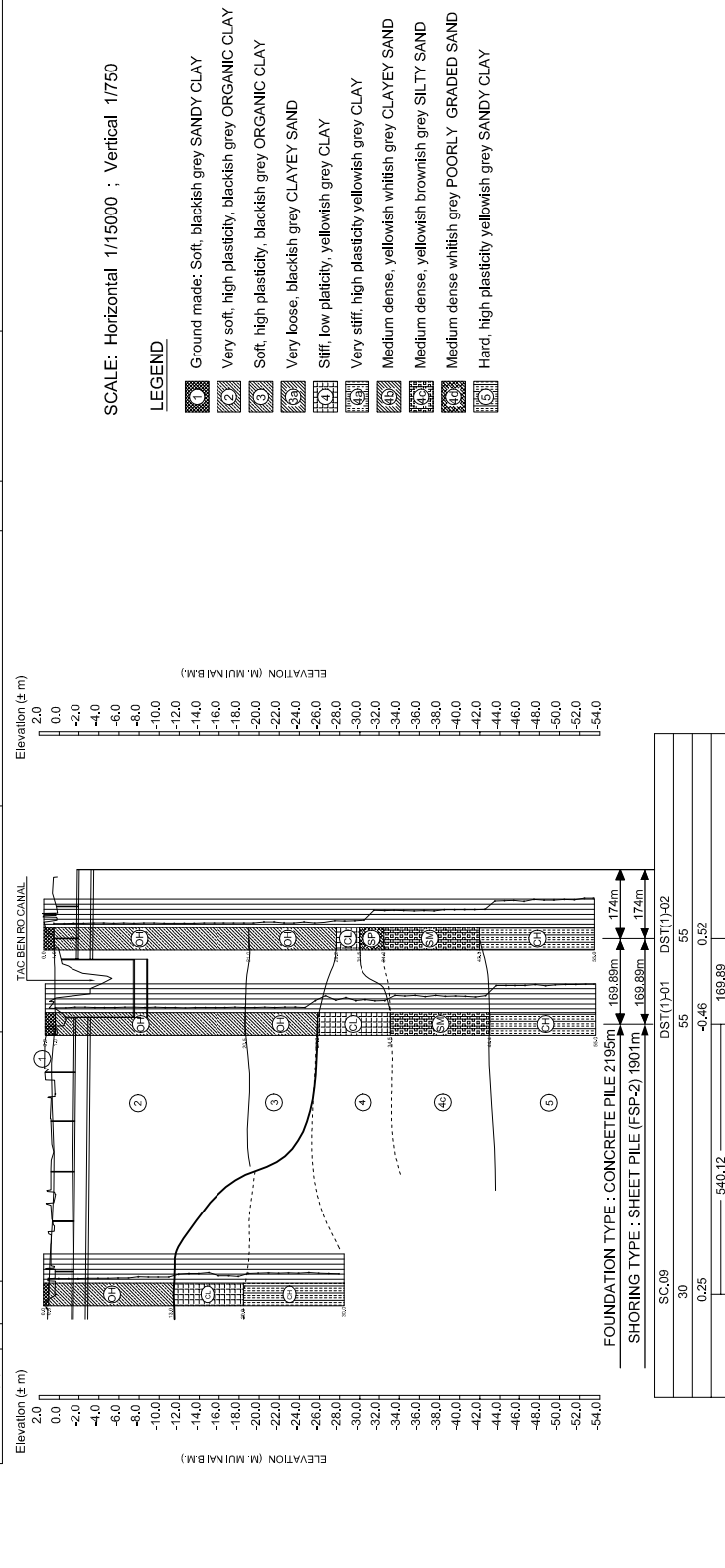
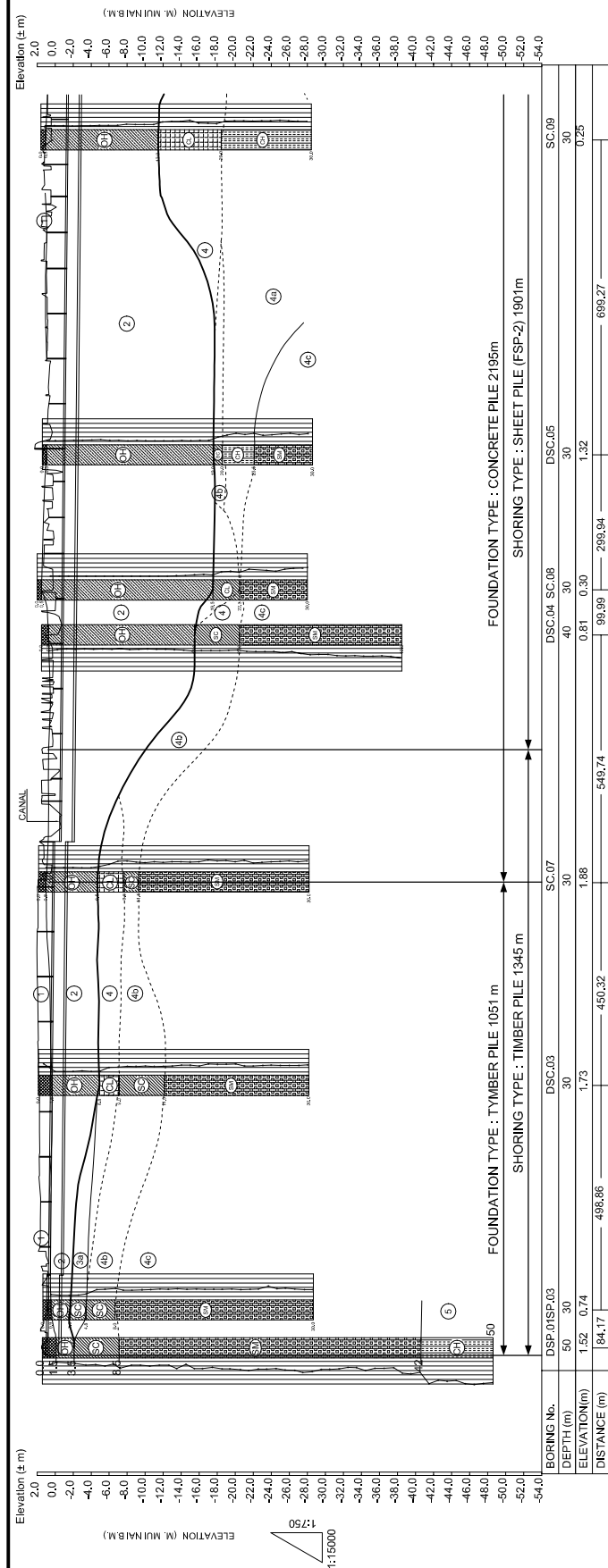
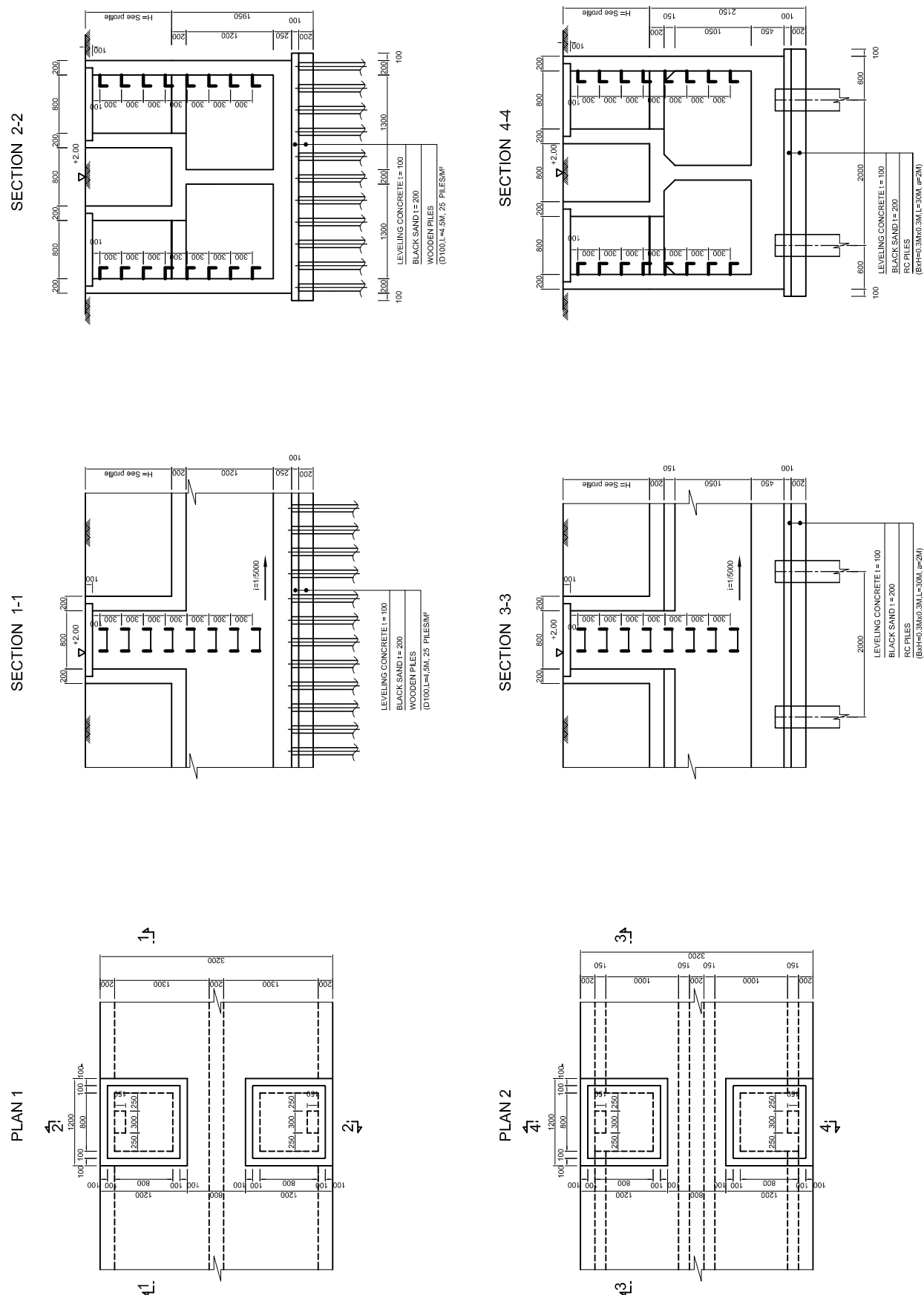
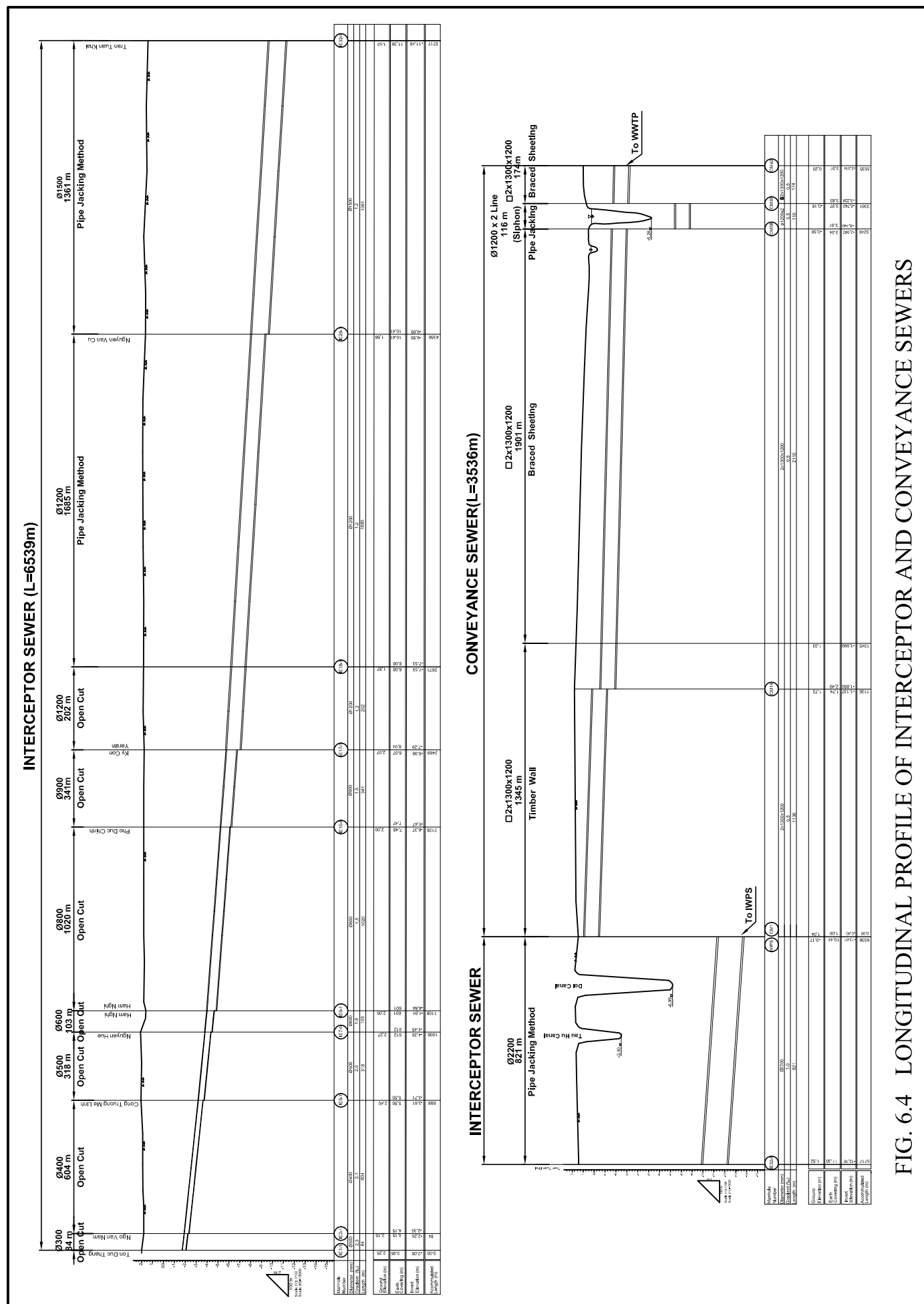
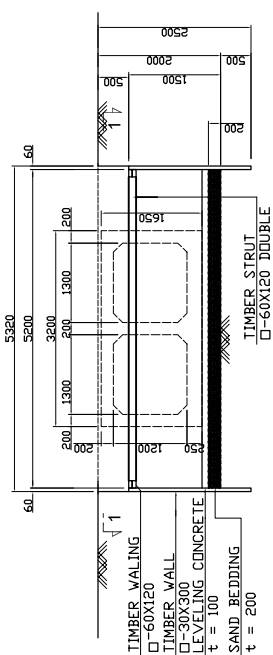
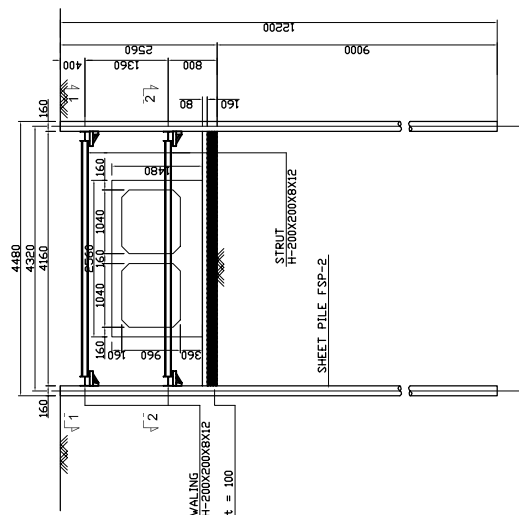


FIG. 6.2 GEOLOGIC PROFILE ALONG CONVEYANCE SEWER LINE

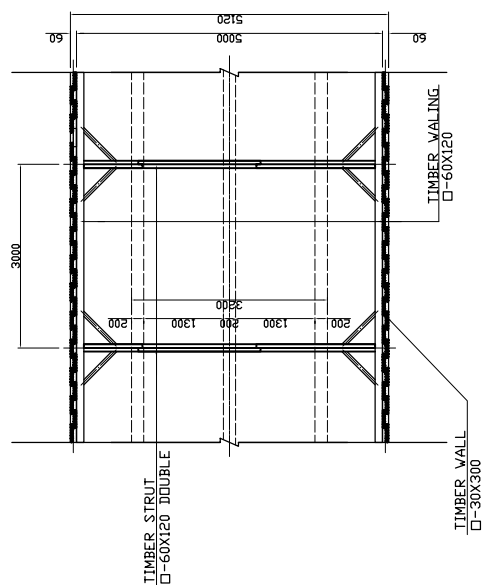




TIMBER WALL SECTION
LINE NUMBER CM1 ~ CM16



SECTION B-B



SECTION 1-1

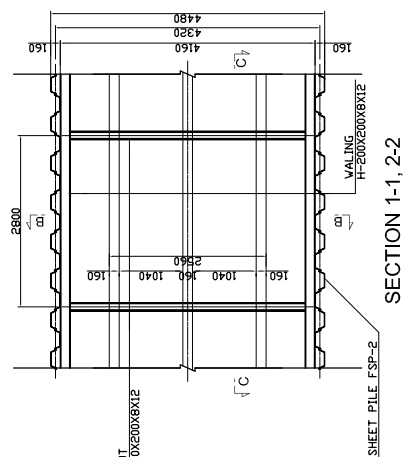
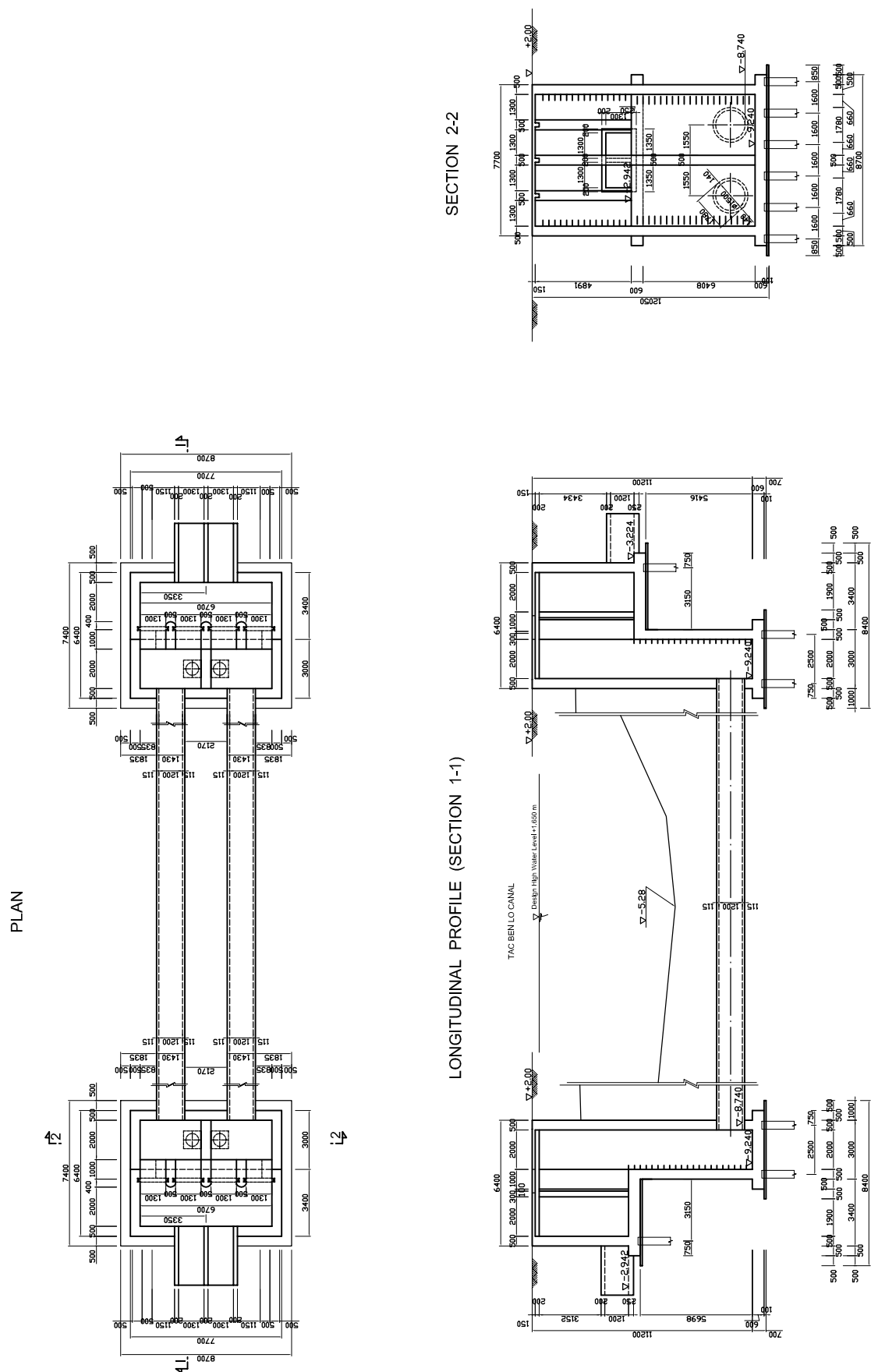
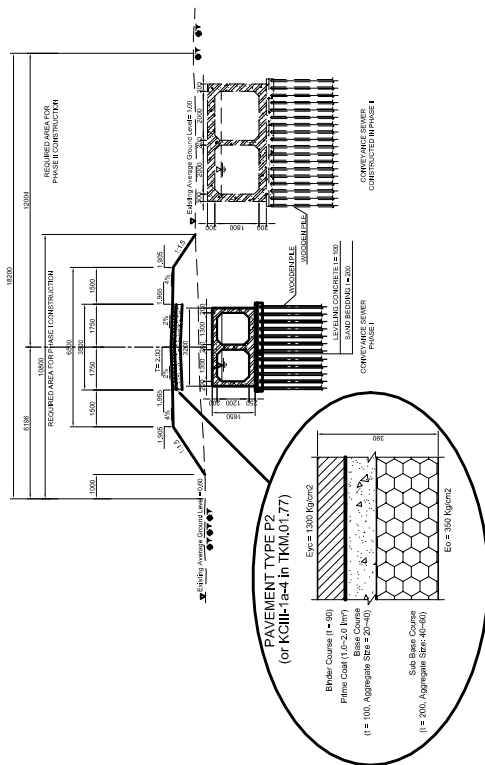


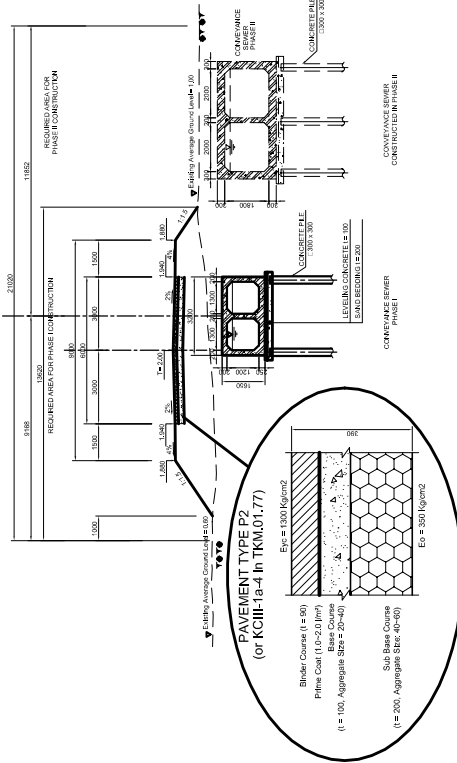
FIG 6.5 TYPICAL PLAN AND SECTION OF TIMBER WALL AND BRACED SHEETING



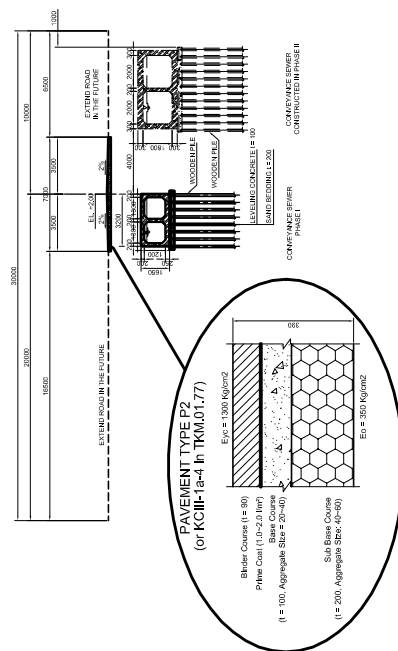
TYPE A
(BETWEEN IWPS AND DONG DIEU ROAD)
Scale: 1/100



TYPE B
(CM5 - CM13 - BETWEEN THE SOUTH END OF DONG DIEU ROAD AND THE JUNCTION OF PLANNED CHANH HUNG ROAD)
Scale: 1/100



EXISTING DONG DIEU ROAD
(CM13 - CM31)
Scale: 1/150



TYPE C
(CM31 - CM36 - BETWEEN THE JUNCTION OF THE PLANNED CHANH HUNG ROAD AND PLANNED BRIDGE)
Scale: 1/100

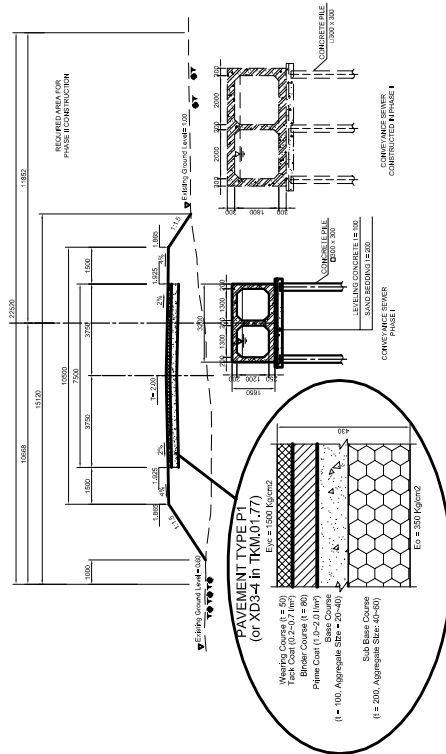


FIG 6.8 TYPICAL CROSS SECTION OF INSPECTION/MAINTENANCE ROAD

Chapter 7

***EXISTING COMBINED
SEWER IMPROVEMENT
(PACKAGE D)***

CHAPTER 7 EXISTING COMBINED SEWER IMPROVEMENT (PACKAGE D)

7.1 General

The combined sewer improvement was proposed to mitigate flood damage in the 2 catchments of C and D defined in the Definitive Plan. The areas of C and D catchments are 440.6 ha and 447.0 ha, respectively.

At present, inundation occurs along main streets. The duration varies from 30 minutes to 3 hours and inundation depth is estimated at from 0.3 m to 0.5 m.

7.2 Scope of Project

This project consists of additional sewer construction and replacement of the existing sewers for six (6) lines in the C and D catchment as shown in Fig. 7.1. The total length of the proposed sewer 9,523 m, that is, additional sewer of 7,127 m long and replaced sewer of 2,396 m long. Four (4) outlets of Line 2, Line 3 that Line 1 and 4 are connected to, Line 5 and Line 6 are reinstalled.

7.3 Applicable Code and Criteria

There has been no change in applying the following codes and standards since Basic Design.

- 1) Vietnamese Standard (TCVN)
- 2) Vietnamese Standard on Outside Sewer Network No. 20 TCN-51-84, Ministry of Construction
- 3) Proceedings of Vietnam Construction Standards, Volume III, Ministry of Construction, 1997
- 4) Sewerage Facilities Planning and Design Manual, Japan Sewerage Works Agency Standards (JSWAS), 1994
- 5) Japanese Industrial Standard (JIS)
- 6) Reinforced Concrete Sewer Pipe, Japan Sewerage Works Agency Standards (JSWAS), 1987
- 7) Reinforced Concrete Pipe Jacking Sewer Pipe, Japan Sewerage Works Agency Standards (JSWAS), 1999
- 8) Standard Specification for Design and Construction of Concrete Structure, The Japan Society of Civil Engineers, 1996
- 9) American Society for Testing and Materials (ASTM)
- 10) American Association of State Highway and Transportation Officials (AASHTO)
- 11) Typical Sewer Design from HCMC Urban Drainage Company for reference

7.4 Design Condition and Criteria

Design rainfall frequency : 3 - year return period.

Design rainfall intensity	: $I = 4.610 (t + 23) \quad t < 3 \text{ hours,}$ where, I: point rainfall intensity (mm/hr) t : duration						
Design flood water level	: 2- year return period						
Design high water level	: +1.500 m						
Design mean water level	: +0.270 m						
Design low water level	: -2.120 m						
Pipe and box culvert material	: Reinforced concrete pipe						
Flow system	: Gravitation						
Flow equation	: Manning equation $n=0.013$ for concrete pipe						
Minimum velocity	: 0.7 m/s						
Standard slope velocity of 0.7 m/s	: The slope was determined to maintained a minimum velocity of 0.7 m/s						
Minimum earth covering	: 1.2 m						
Manhole interval	: The interval of manhole is designed as follows;						
<table border="1"> <thead> <tr> <th>Diameter (mm)</th><th>Manhole Interval (m)</th></tr> </thead> <tbody> <tr> <td>$< \varnothing 1500$</td><td>30</td></tr> <tr> <td>$\varnothing 1500 \leq$</td><td>50</td></tr> </tbody> </table>		Diameter (mm)	Manhole Interval (m)	$< \varnothing 1500$	30	$\varnothing 1500 \leq$	50
Diameter (mm)	Manhole Interval (m)						
$< \varnothing 1500$	30						
$\varnothing 1500 \leq$	50						
Pipe	: Precast centrifugal reinforced concrete structure made of concrete Type D-250 kg/cm ²						
Box culvert	: Precast reinforced concrete made of concrete Type D-250 kg/cm ²						
Manholes material	: Cast-in-situ reinforced concrete structure made of concrete D-250 kg/cm ²						
Inlets materials	: Cast-in-situ reinforced concrete structure made of concrete D-250 kg/cm ²						
Manhole cover	: Circler shape cover (Type E) made of cast iron covers with a load of 30 tones						
Inlet cover	: Square shape cover (Type E) made of cast iron with a load of 6 tones						

7.5 Design of Manholes

There are four (4) general types of manholes for circular pipes and four (4) general types of manholes for box culvert depending on the size of sewers. Besides, based on the size and number of lateral/connection pipe and the connected direction. The structure design of manholes are presented in Figs. 7.2(1)-(4) and 7.3(1)-(6). Consequently, total number of the proposed manhole amount to 296. The breakdown of the number of manhole by line is listed below.

Line Name	Sewer Type	New Manhole	Improved Manhole	Total
1	Pipe	24	4	28
	Box Culvert	-	-	-
2	Pipe	19	4	23
	Box Culvert	-	-	-
3	Pipe	-	3	3
	Box Culvert	44	-	44
4	Pipe	10	19	29
	Box Culvert	28	-	28
5	Pipe	38	21	59
	Box Culvert	21	-	21
6	Pipe	14	-	14
	Box Culvert	46	-	46
Total	Pipe	105	51	156
	Box Culvert	139	-	139
	Total	244	51	296

7.6 Design of Sewer Bedding

According to the installation depth, three (3) types of sewer bedding are designed as shown in Fig. 7.4. Length by the sewer bedding is summarized below.

Bedding Type	Length (m)
Sand 360	6,152
Concrete 120	674
Concrete 360	301
Total	7,127

7.7 Design of Inlets and Connection Pipes

Principally connection pipes from households are connected to inlets nearby and thus the inlets collect the stormwater and the wastewater from households. Inlets along the sewers are spaced at about 30 m – 40 m. Based on the location and structure of the existing inlets the inlets are classified into three (3) types:

- (i) Type 1.a : These inlets are connected with the existing trunk sewer installed under the sidewalk by the connection pipe Ø400 mm or Ø600 mm.
- (ii) Type 1.b : These inlets are connected with the existing trunk sewer installed under the roadway by the existing connection pipe of Ø400 mm and Ø600 mm and conduits of brick arch (400 mm x 600 mm), (600 mm x 800 mm), (600 mm x 1200 mm).
- (iii) Type 2 : Inlets are combined into manholes installed for the existing trunk sewer under the roadway.

From the existing condition mentioned-above, design of inlets and new connection pipes are considered as follow:

- (i) Type 1.a : Some of inlets, which are connected with the proposed manholes, will be improved because the large diameter of new connection pipes are used. The remains of them are reused.
- (ii) Type 1.b : All of inlets are reused without improved. Only a part of the existing connection pipes broken by the trench excavation will be restored with the same size and material.
- (iii) Type 2 : Some of inlets will be improved because of the larger connection pipes between the existing trunk sewer and new ones. The remains of them are reused without improvement.

The layout design of the inlets and connection pipes is shown in Fig. 7.5. The total number of the inlets improved is 53 for six (6) lines and the breakdown is listed below.

Line Name	Improved Inlet
1	9
2	7
3	13
4	3
5	7
6	14
Total	53

The size of the proposed connection pipes, which are replaced for the existing ones, will be equal or larger than the existing trunk sewer in order to increase the capacity of intake. The others are only restored for their broken section in the trench.

7.8 Design of Sewer

The structure design of a sewer pipe is based on the following conditions;

(1) Line 1

The center line of the proposed Ø1000 mm diameter sewer is designed under the Dien Bien Phu road and is spaced at about 5.0 m from the right edge of the road. The inlet of Type 1.a is proposed for this line.

(2) Line 2

The center line of the proposed Ø1500 mm sewer is designed under the Nguyen Bieu road and is spaced at;

- 3.5 m from the left edge of the road for the section from Phan Van Tri street to Tran Hung Dao street,
- 4.0 m from the left edge of the road for the section from Tran Hung Dao street to Cao Dat street, and
- 3.0 m from the left edge of existing road for the section from the start point of

Y-Bridge to the Tau Hu Canal.

The proposed inlets for this line are;

- Type 1.a for the section from Phan Van Tri street to Tran Hung Dao street, and
- Type 2 for the section from Tran Hung Dao street to Tau Hu canal.

One (1) outlet of Ø1500 will be constructed.

(3) Line 3

Box culverts (2000 mm x 2000 mm) and (2500 mm x 2000 mm) are designed under the Tran Binh Trong road. The center line of the proposed sewer is the same as that of the existing sewer, which is arch shape and is made of brick sewer, and it is spaced at approximately 2.5 m from the left edge of the road. Therefore, the existing sewer will be replaced to the proposed one. Inlet of Type 1.b is proposed for this line.

One (1) outlet of box culvert (2500 mm x 2000 mm) will be constructed at the same position of the existing outlet.

(4) Line 4

Section 4.1 :

The center line of the proposed Ø1500 mm sewer and the proposed box culvert (2000 mm x 2000 mm) is designed under the roadway and is spaced at;

- 6.0 m – 7.2 m from the left edge of the road for the section from 3 Thang 2 road to Nga 7 rotary,
- 11.0 m – 12.0 m from the left edge of the road for the section from Nga 7 rotary to Hung Vuong road,
- 19.0 m – 21.0 m from the left edge of the road for the section from Hung Vuong road to Tran Phu road, and
- 12.0 m – 13.0 m from the left edge of the road for the section from Tran Phu road to An Duong Vuong road.

The inlets of Type 1.a and Type 2 are proposed.

Section 4.2 :

The center line of the proposed box culvert (2000 mm x 2000 mm) is designed under the roadway and is spaced at 11.0 m – 12.4 m from the left edge of the road. The inlet of Type 2 inlet is proposed for this line.

(5) Line 5

Section 5.1 :

The center line of the proposed Ø1000, Ø1500, Ø1800 and Ø2000 mm sewers is designed under the road and is spaced at:

- 5.0 m – 5.8 m from the right edge of the road for the section from 3 Thang 2 road to Ly Thai To rotary,
- 3.5 m – 4.0 m from the right edge of the road for the section from Ly Thai To road to Ngo Gia Tu street, and
- 4.0 m – 6.0 m from the right edge of the road for the section from Ngo Gia Tu road to An Duong Vuong road.

The inlets of Type 1.a and Type 2 are proposed for this line.

Section 5.2 :

The center line of the proposed box culvert (2000 mm x 2000 mm) is designed under the roadway and 4.0 m from the left edge of the road. The inlet of Type 1.a is proposed for this line.

Section 5.3 :

The center line of the proposed box culvert (2000 mm x 2000 mm) is designed under the roadway and is spaced at;

- 4.0 m from the right edge of the road for the section from An Duong Vuong road to Nguyen Trai road,
- 2.5 m from the right edge of the road for the section from Nguyen Trai road to Tran Hung Dao road, and
- 3.0 m – 4.0 m from the right edge of the road for the section from Tran Hung Dao road to the Tau Hu Canal.

The inlet of Type 1.a and Type 2 are proposed for this line.

One (1) outlet of box culvert (2000 mm x 2000 mm) will be constructed.

(6) Line 6

Section 6.1 :

The center line of the proposed Ø2000 mm sewer is designed under the roadway and is spaced at 4.0 m – 5.0 m from the right edge of the road. The inlet of Type 1.a is proposed for this line.

Section 6.2 :

The center line of the proposed box culvert (2500 mm x 2000 mm) is designed under the roadway and is spaced at about 5.0 m from the right edge of the road . The inlet of Type 1.a is proposed for this line.

Section 6.3 :

The center line of the proposed box culvert (2500 mm x 2000 mm) is designed under the roadway and is spaced at 4.0 m – 5.0 m from the left edge of the road. Type 1.b inlet is proposed for this line.

Section 6.4 :

The center line of the proposed box culvert (2500 mm x 2000 mm) is designed under the roadway and is spaced at 1.5 m – 3.5 m from the right edge of the road. Type 2 inlet is proposed for this line.

Section 6.5 & 6.6:

Box culvert (2500 mm x 2000 mm) is designed under the roadway. The center line of the proposed sewer is the same as that of the existing sewer, which is arch shape and is made of brick sewer. The inlet of Type 1.b is proposed for this line.

One (1) outlet of box culvert (2500 mm x 2000 mm) will be constructed at the same position of the existing outlet.

Line Name	Sub-line ID	Type of installation	Sewer Dimension			Sewer Invert Elevation (IE)	
			Length (m)	Dimensions (mm)	Slope (‰)	Upstream (m)	Downstream (m)
Line 1	-	Additional	722.0	1000	1.0	+1.75	+1.03
Line 2	-	Additional	677.2	1500	0.6	-1.30	-2.56
Line 3	-	Replace	452.5	2000x2000	0.8	-0.26	-0.62
			908.7	2500x2000	1.5	-0.64	-2.37
			Sub Total of Line 3	1,361.2	-	-	-
Line 4	Line 4.1	Additional	359.3	1500	0.8	+0.81	+0.53
			678.1	2000x2000	0.6	+0.53	-0.12
			388.8	2000x2000	1.0	+0.12	-0.27
	Line 4.2	Additional	296.6	2000x2000	1.2	-0.27	-0.64
	Sub Total of Line 4		1,722.8				
Line 5	Line 5.1	Additional	193.7	1000	1.2	+2.00	+1.77
		Additional	365.9	1500	1.2	+1.27	+0.83
		Additional	529.0	1800	1.0	+0.53	+0.01
		Additional	299.2	2000	0.8	-0.19	-0.43
	Line 5.2	Additional	216.5	2000x2000	0.6	-0.43	-0.56
	Line 5.3	Additional	723.8	2000x2000	0.8	-0.56	-2.41
	Sub Total of Line 5		2,328.1				

Line 6	Line 6.1	Additional	743.0	2000	1.2	+1.10	+0.26
	Line 6.2	Additional	339.5	2500x2000	0.8	-0.72	-1.03
	Line 6.3	Replace	358.1	2500x2000	0.8	-1.03	-1.31
	Line 6.4	Additional	594.8	2500x2000	0.8	-1.31	-1.91
	Line 6.5	Replace	471.4	2500x2000	0.8	-1.91	-2.32
	Line 6.6	Replace	204.9	2500x2000	0.8	-2.32	-2.52
Sub Total of Line 6			2,711.7				
Total	Additional		7,127.4				
	Replace		2,395.6				
			9,523.0				

7.9 Design of Outlets

There are four (4) outlets of every dimension from designed lines. The positions of outlets are located at the left bank of improved Tau Hu canal.

Line No.	Dimension (mm)	Invert Elevation of Outlet (m)
LINE 2	1500	-2.56
LINE 3	2500 x 2000	-2.37
LINE 5	2000 x 2000	-2.41
LINE 6	2500 x 2000	-2.52

7.10 Design of Trench

Cutting the road first, then excavate the soil by using backhoe because the depth < 6m. Install the pipes and box culvert by the suitable crane.

Support the trench by using timber with the timber board 30 mm x 300 mm as piles, timber beam 60 mm x 120 mm (double) as strut and bracing if the excavation depth is smaller than 4.0 m and using steel sheet piles if the excavation depth is deeper than 4.0m.

In case that the excavation depth is smaller than 4 m from the existing ground level, timber wall is proposed to maintain the stability of the trench wall. Conversely, if the excavation depth is greater than 4 m, braced sheeting is proposed as retaining wall.

The detailed design of retaining wall is described as below:

(1) Timber Wall

Timber wall of 300 mm wide and 30 mm thick, timber wailing of 120 mm wide and 60 mm thick and timber brace of 120 mm wide and 60 mm thick are used. The timber wailing is designed to be driven into 0.5 m below the bottom of trench and the timber struts are designed to be longitudinally spaced at 3 m center-to-center. The typical plan and section of timber wall are shown in Fig. 7.6.

(2) Braced Sheeting

Sheet pile of FSP-2 type with a total length of 9 m is used. The driven length of the sheet pile below the bottom level of the trench is computed based on the conditions that the wall yields laterally, by (i) sliding sideways or (ii) rotating about the bottom of the wall.

Two (2) stages of struts with H-shape are longitudinally spaced in at 5 m center-to-center and two (2) stages of wale with H-shape are horizontally spaced at 2.5 m center-to-center. The typical plan and section of braced sheeting are shown in Fig. 7.7(1)-(2).

The excavation width (m) is proposed as follow :

Diameter (mm)	Ø300	Ø400	Ø500	Ø600	Ø800	Ø900
H < 4.0 m	1.4	1.4	1.4	1.4	1.4	1.5
4.0 m < h < 5.0 m	2.0	2.0	2.0	2.0	2.0	2.0
5.0 m < h < 6.0 m	2.0	2.0	2.0	2.0	2.0	2.15

Diameter (mm)	Ø1000	Ø1200	Ø1500	Ø1800	Ø2000
H < 4.0 m	1.6	2.0	2.3	2.6	2.9
4.0 m < h < 5.0 m	2.0	2.2	2.6	2.95	3.5
5.0 m < h < 6.0 m	2.3	2.7	3.1	3.6	3.9

7.11 Design of Road Restoration

Pavement structure of the road in the project area is classified into five (5) types according to the Vietnamese standard of “ 20 TCN 104-83, Urban Highway Design, MOC ”. The pavement structure of road by each type is listed below.

Type	P1	P2	P3	P4	P5
Material					
Wearing Course	5 cm	-	5 cm	5 cm	5 cm
Tack Coat	0.2 – 0.7 l/m ²	-	0.2 – 0.7 l/m ²	0.2 – 0.7 l/m ²	0.2 – 0.7 l/m ²
Binder Course	8 cm	9 cm	5 cm	7 cm	9 cm
Prime Coat	1.0 – 2.0 l/m ²	1.0 – 2.0 l/m ²	1.0 – 2.0 l/m ²	1.0 – 2.0 l/m ²	1.0 – 2.0 l/m ²
Base Course	10 cm	10 cm	19 cm	26 cm	29 cm
Sub Base Course	20 cm	20 cm	20 cm	15 cm	20 cm
Total Thickness	43 cm	39 cm	49cm	53 cm	63 cm

The road where the existing combined sewers are installed are identified as Type 4 and Type 5 (refer to Fig. 7.8).

7.12 Construction Plan

This section deals with construction plan and schedule of the existing combined sewer improvement construction.

7.12.1 Basic Condition

For preparation of construction plan and schedule, the following consideration has been taken as a basic concept of construction works.

(1) Scope of Work

The construction work consists of the following main construction component:

- (a) Construction of main sewer (Total length = 9.519m)

- Excavation of trench : $V = 153,134 \text{ m}^3$
- Backfilling : $V = 134,558 \text{ m}^3$
- Reinforced Concrete : $V = 1,322 \text{ m}^3$
- (b) Construction of Manhole (250 places)
 - Reinforced Concrete : $V = 2,519 \text{ m}^3$
- (c) Reconstruction of Existing manholes and inlets (104 places)
 - Reinforced Concrete : $V = 507 \text{ m}^3$
- (d) Construction of Outlets (4 places)
 - Reinforced Concrete : $V = 45.3 \text{ m}^3$
- (e) Construction of Revetments (2 places)
 - Wet Stone Masonry : $V = 21.24 \text{ m}^3$
- (2) Other Conditions
 - (a) Model of Construction

The construction shall be carried out by sufficient contractor(s) selected through the international bidding (ICB).
 - (b) Availability of Construction Plant and Equipment

The major construction works shall be conducted by applying heavy equipment, which are mostly supplied locally, due to limited construction period and keeping good quality of construction.
 - (c) Construction Materials

Most of basic construction materials could be considered available in this country. Some particular processed materials (steel sheet pile, H-type steel beam, mechanical and electrical equipment and etc.) are to be procured from outside.
 - (d) Pattern of Construction Method

Main work comprises of trench excavation and backfilling, concrete work and pipe installation work.

7.12.2 Major Works of the Construction

Major works of existing combined sewer construction consists of the followings:

- (1) Construction of Sewer Pipes and Box Culverts
 - (a) Excavation and shoring works for trench

Excavation shall be conducted by back hoe for excavation depth smaller than 6.0 m and shall be conducted by clamshell for excavation depth greater than 6.0 m.

Timber sheeting has been considered as a shoring for a trench with a depth less than 4.5 m. While, continuous sheet piling with H-type steel bracing have been designed as shoring for a depth greater than 4.5 m. Sheet piles shall be driven into the required depth by vibro hammer. Excavation shall be limited to 0.5 m below at each strut level. Length of trench section has been considered 30 m. Recycling time of sheet pile and H-shape have been estimated at between 30 and 50 times depending on the length of trench section along which the same length of sheet pile is used.

The excavated soil is directly loaded to dump truck by excavators and is transported to the proposed dumping site.

The trenches should be dewatered for concrete placement and pipe laying, and they should be kept continuously dewatered for as long as necessary. Dewatering shall be executed by sump drainage method.

(b) Installation of pipe and box culvert by Open Cut Method

Pipe and box culvert installation work consists of the following works:

- Sand backfilling
Sand backfill of 200 mm thick is designed at the bottom of any trench. Sand backfilling shall be carried out with the yellow sand and by tamper.
Sand backfill for sand bedding shall be carried out up to 200 mm above the pipe crown with the same material and manner.
- Concrete work for concrete cradle and encasement is required, if necessary.
- Pipe and box culvert placement
Pipe and box culvert should be handled in a manner that eliminate any possibility of high impact or point loading due to dropping or impacting, with care taken always to protect the joints.

Sewer pipe and box culvert should be laid on a firm, true to line and grade, with uniform bearing under the full length of its barrel.

(c) Backfill work

Backfilling should proceed immediately on curing of trench-made joints and after the concrete cradle, or other structures gain sufficient strength to withstand loads without damage. Backfilling shall be executed with the black sand up to the road sub-grade level. The pipe (or box culvert) zone extends from the foundation material to 200 mm above of the sewer pipe or box culvert or structure and consists of the specified material according to the bedding type. This zone should be compacted by rammer in such a manner as not to disturb the sewer pipe (or box culvert) and structure

- (d) Removal of struts and sheet pile for shoring

Struts shall be removed when backfilling reaches the strut levels. After backfilling complete to road sub-grade, sheet piles shall be carefully drawn without loosening the surrounding ground.
- (2) Construction of New Manholes
 - (a) Excavation works shall be conducted in the same manner as trench described in (1) for the remaining depth from the trench bottom of pipe (or box culvert).
 - (b) Concrete work comprises (i) reinforced concrete of manhole bottom, wall, and slab, (ii) invert concrete Class F.
 - (c) Backfill work and removal of strut and sheet pile for shoring is included in pipe (or box culvert) installation work.
- (3) Reconstruction of Existing Manholes and Inlets
 - (a) Excavation works shall be conducted in the same manner as trench described in (1) for the remaining depth and width from the existing dimensions of existing manholes and inlets that will be improved.
 - (b) Concrete work of the existing manholes reconstruction is the same ones of the new manholes construction as described in (2) (b).
 - (c) Concrete work of the existing inlets reconstruction is the same ones of the existing manholes reconstruction without invert concrete.
- (4) Construction of Outlets and Revetments
 - (a) Excavation work shall be conducted after driving steel sheet piles with steel beam shoring as a fence preventing high tide water level for the trench.
 - (b) Wooden piles shall be driven under the bottom of the foundation of outlets in order to improve soil bearing capacity. The head of piling is covered by black sand for outlets and gravel for revetments.
 - (c) Concrete work : using leveling concrete for smoothly foundation and after that, with :
 - Outlets : using reinforced concrete in-situ for slab, head and wing walls.
 - Revetments : using precast concrete block as their foot.
 - (d) Revetment work will be conducted by laying and arrange the materials as following order : geotextile sheets, gravel and cobble stone.
 - (e) Backfilling by sandy soil after the concrete structures has enough strength to stand loads without damage.
 - (f) Removal struts and sheet piles after finishing all above works.

(5) Road Restoration Work

After backfilling the trench with completely compacted by tamper, road restoration can be started with these layers from the bottom :

- Sub Base Course
- Base Course
- Prime Coat
- Binder Course
- Tack Coat
- Wearing Course

7.12.3 Construction Schedule

To consider the construction conditions, such as possible working area, working items, applicable construction machines and numbers, construction period for each works are expected as following:

(1) Preparatory Work	2 Months
(2) Major Work	26 Months
(3) Cleaning and Handing Over	1 Month

Construction schedule is shown in Table 6.1 in “Chapter 6 Conveyance Sewer Construction”.

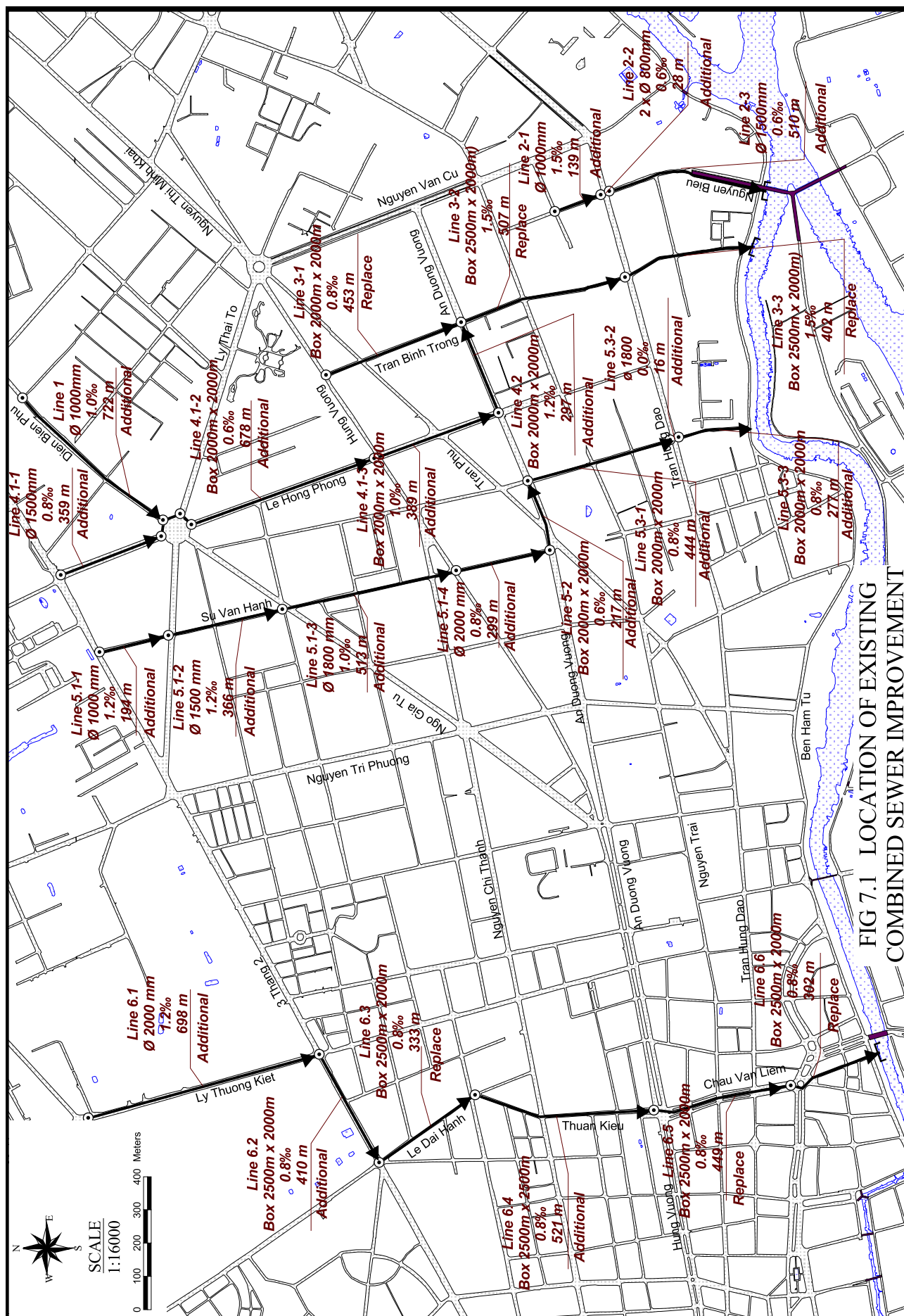
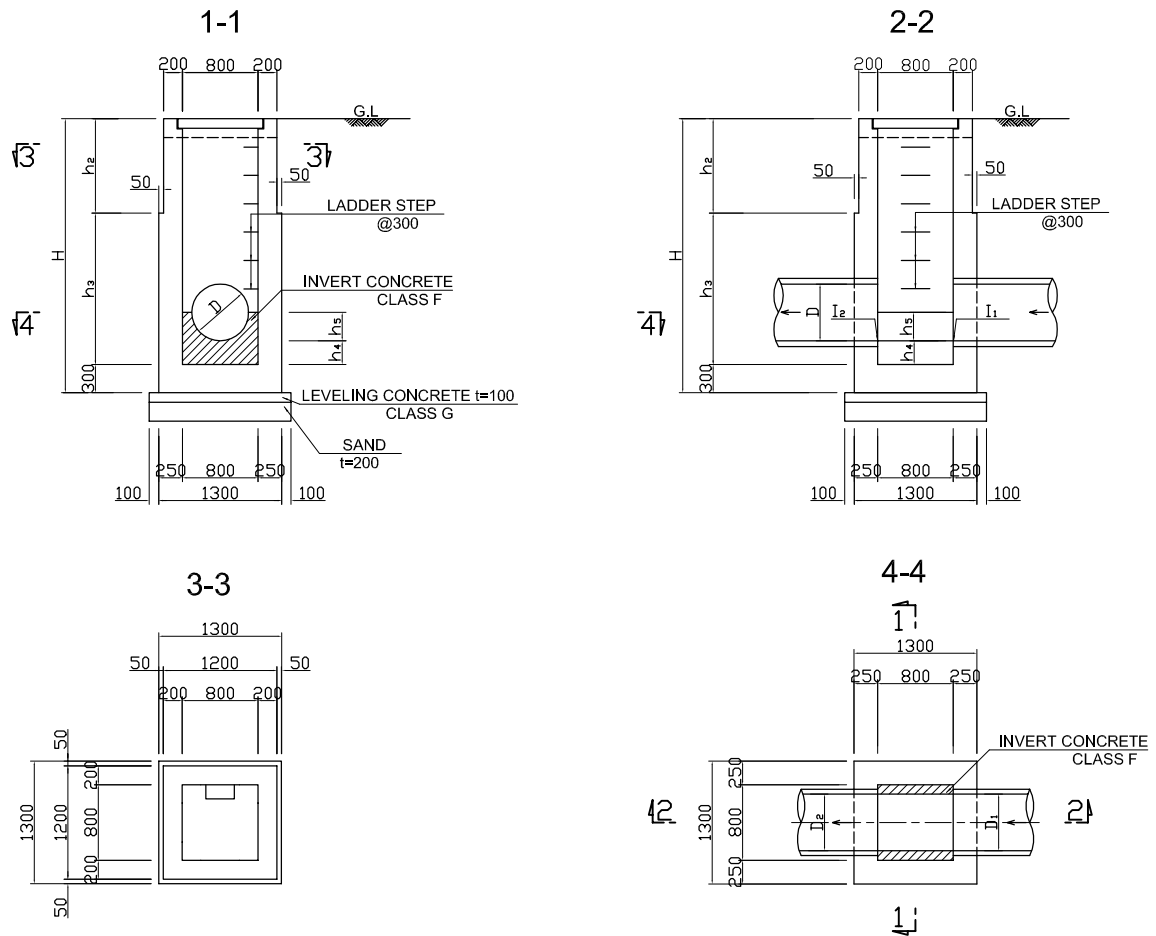
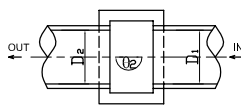


FIG 7.1 LOCATION OF EXISTING
COMBINED SEWER IMPROVEMENT

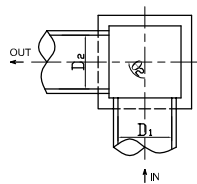
TYPE 1 Ø300 - Ø600



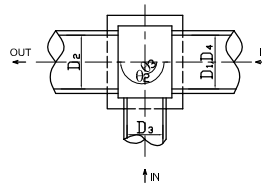
CONNECTION TYPE



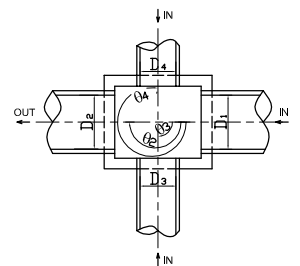
TYPE A



TYPE B



TYPE C



TYPE D

TYPE OF MANHOLE

Type of Manhole			Diameter (mm)		Dimension (m)		
General type ^{*)}	Connection type	Connection pipe ^{*)}	Main pipe (D ₁ , D ₂)	Connecting pipe (D ₃ , D ₄)	L	L ₁	L ₂
1	A, B, C	-	Ø300-Ø600	Ø300-Ø600	-	-	-

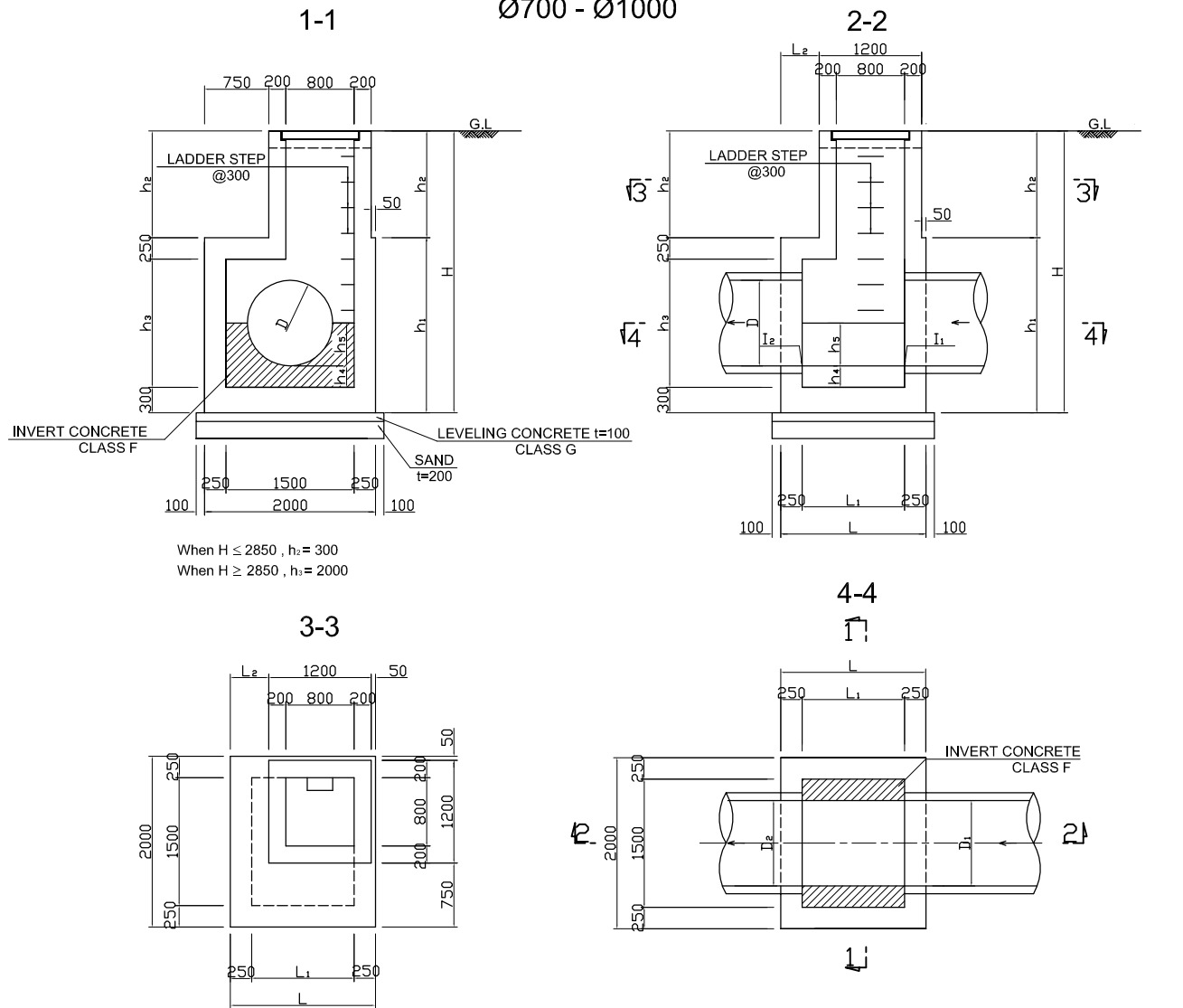
This table is applied at a depth of up to 2.5m
Note:

*1) General type of Manhole type is categorized in diameter of Main pipe, D₁ and D₂.

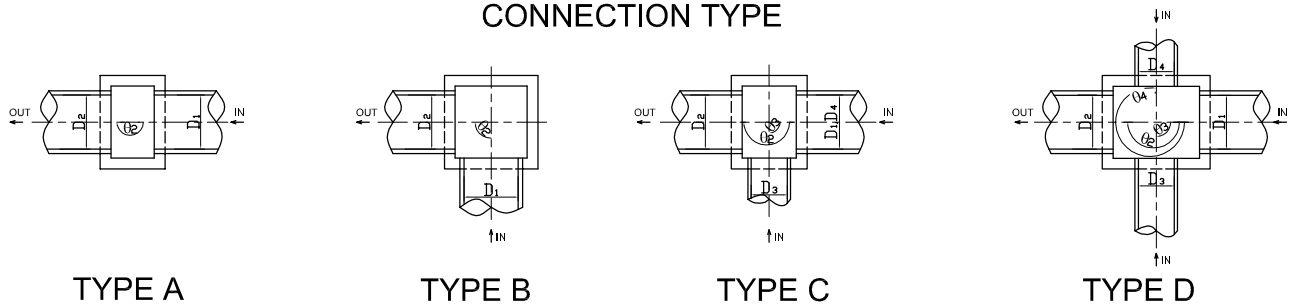
*2) Connection pipe of Manhole type is categorized in a diameter of connection pipe.

FIG. 7.2(1) TYPICAL MANHOLE FOR CIRCULAR PIPES

TYPE 2 Ø700 - Ø1000



CONNECTION TYPE



TYPE OF MANHOLE

Type of Manhole			Diameter (mm)		Dimension (m)		
General type ^{*)}	Connection type	Connection pipe ^{*)}	Main pipe (D ₁ , D ₂)	Connecting pipe (D ₁ , D ₂)	L	L ₁	L ₂
2	A	—	Ø700-Ø1000	—	1,700	1,200	450
	B	—		—	2,000	1,500	750
	C	1		Ø300-Ø600	1,700	1,200	450
		2		Ø700-Ø1000	2,000	1,500	750
	D	1		Ø300-Ø600	2,500	2,000	1,250
		2		Ø700-Ø1000	2,900	2,400	1,650

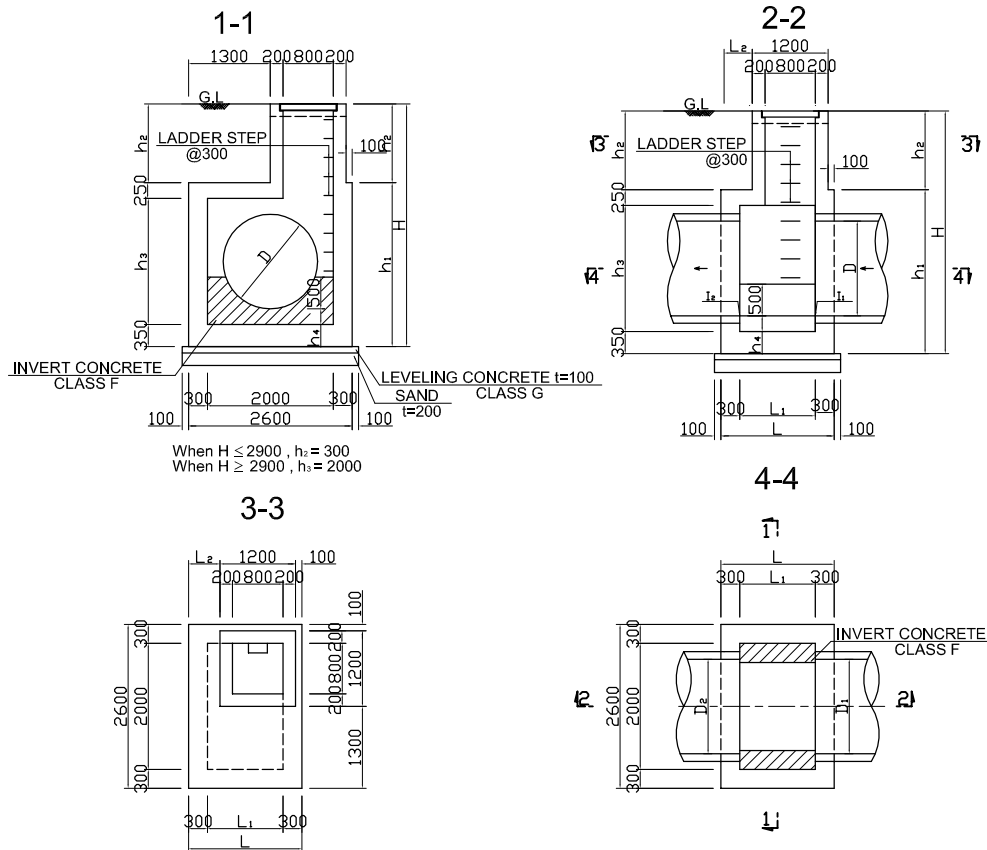
This table is applied at a depth of up to 7.0m
Note:

*1) General type of Manhole type is categorized in diameter of Main pipe, D₁ and D₂.

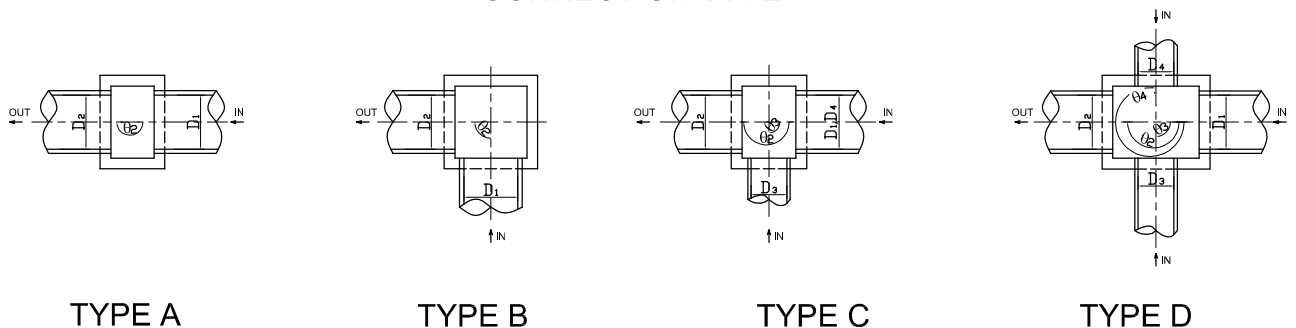
*2) Connection pipe of Manhole type is categorized in a diameter of connection pipe.

FIG. 7.2(2) TYPICAL MANHOLE FOR CIRCULAR PIPES

TYPE 3 Ø1200 - Ø1500



CONNECTION TYPE



TYPE OF MANHOLE

General type ⁽¹⁾	Type of Manhole		Diameter (mm)		Dimension (m)		
	Connection type	Connection pipe ⁽²⁾	Main pipe (D ₁ , D ₂)	Connecting pipe (D ₃ , D ₄)	L	L ₁	L ₂
3	A	—	Ø1200-Ø1500	—	1,800	1,200	500
	B	—		—	2,600	2,000	1,300
	C	1		Ø300-Ø600	1,800	1,200	500
		2		Ø700-Ø1000	2,100	1,500	800
		3		Ø1200-Ø1500	2,600	2,000	1,300
	D	1		Ø300-Ø600	2,600	2,000	1,300
		2		Ø700-Ø1000	3,000	2,400	1,700
		3		Ø1200-Ø1500	3,600	3,000	2,300

This table is applied at a depth of up to 5.0m

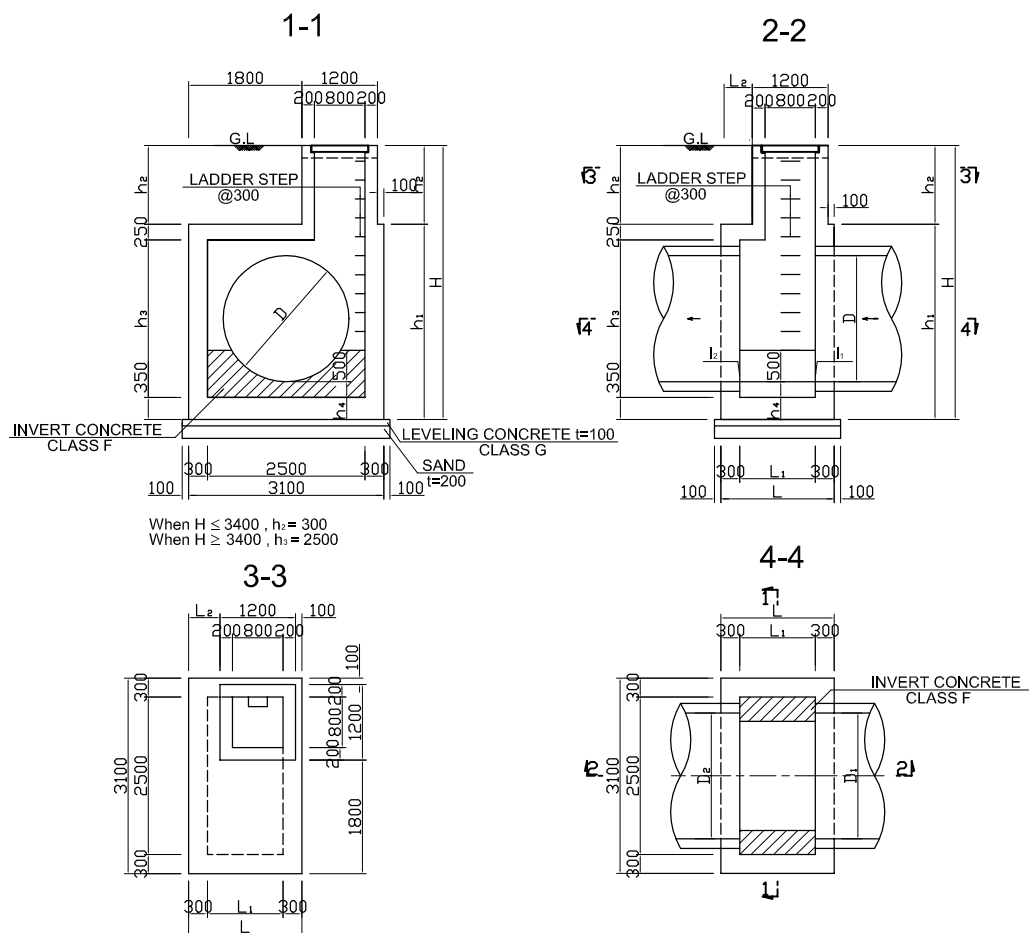
Note:

*1) General type of Manhole type is categorized in diameter of Main pipe, D₁ and D₂.

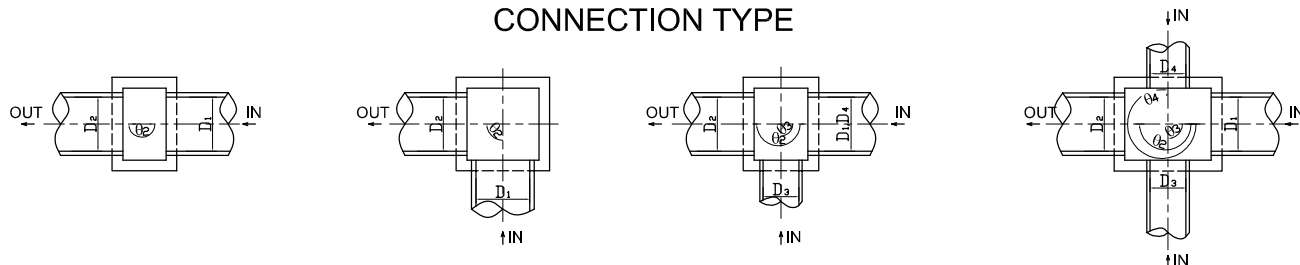
*2) Connection pipe of Manhole type is categorized in a diameter of connection pipe.

FIG. 7.2(3) TYPICAL MANHOLE FOR CIRCULAR PIPES

TYPE 4 Ø1600 - Ø2000



CONNECTION TYPE



TYPE A

TYPE B

TYPE C

TYPE D

TYPE OF MANHOLE

General type	Type of Manhole		Diameter (mm)		Dimension (m)		
	Connection type	Connection pipe	Main pipe (D ₁ , D ₂)	Connecting pipe (D ₃ , D ₄)	L	L ₁	L ₂
4	A	—	Ø1600-Ø2000	—	1,800	1,200	500
	B	—		—	3,100	2,500	1,800
	C	1		Ø300-Ø600	1,800	1,200	500
		2		Ø700-Ø1000	2,100	1,500	800
		3		Ø1200-Ø1500	2,600	2,000	1,300
		4		Ø1600-Ø2000	3,100	2,500	1,800
	D	1		Ø300-Ø600	2,600	2,000	1,300
		2		Ø700-Ø1000	3,000	2,400	1,700
		3		Ø1200-Ø1500	3,600	3,000	2,300
		4		Ø1600-Ø2000	4,100	3,500	2,800

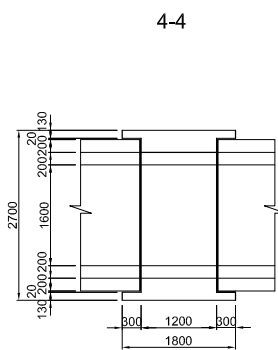
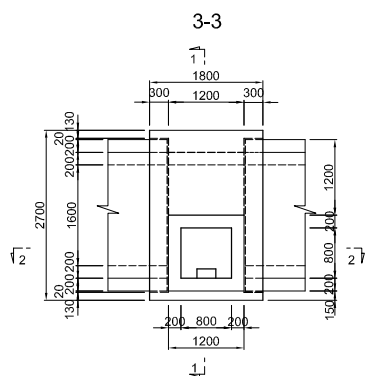
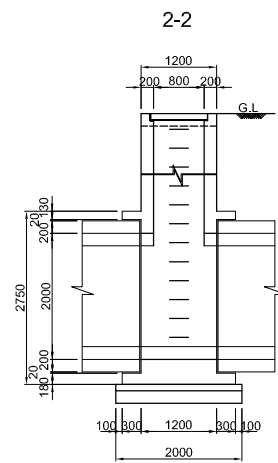
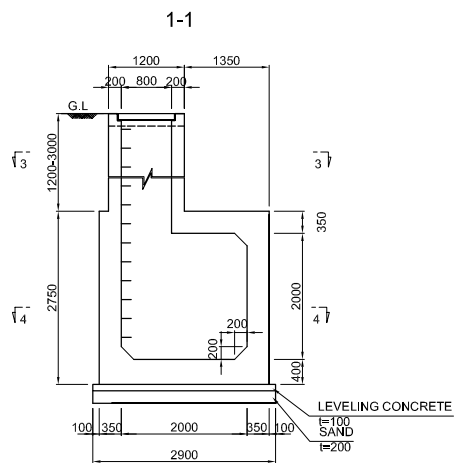
This table is applied at a depth of up to 5.0m
Note:

*1) General type of Manhole type is categorized in diameter of Main pipe, D₁ and D₂.

*2) Connection pipe of Manhole type is categorized in a diameter of connection pipe.

FIG. 7.2(4) TYPICAL MANHOLE FOR CIRCULAR PIPES

TYPE 1A-0



TYPE 1A-1

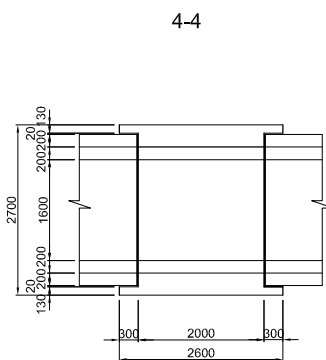
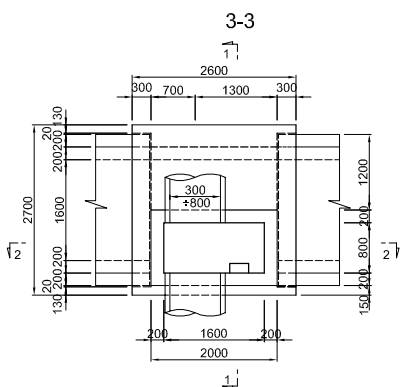
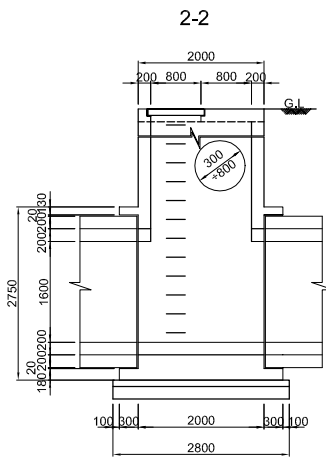
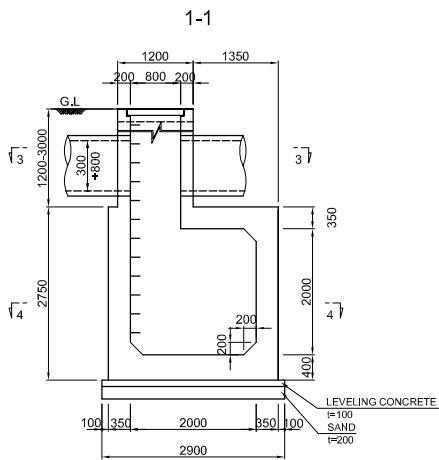
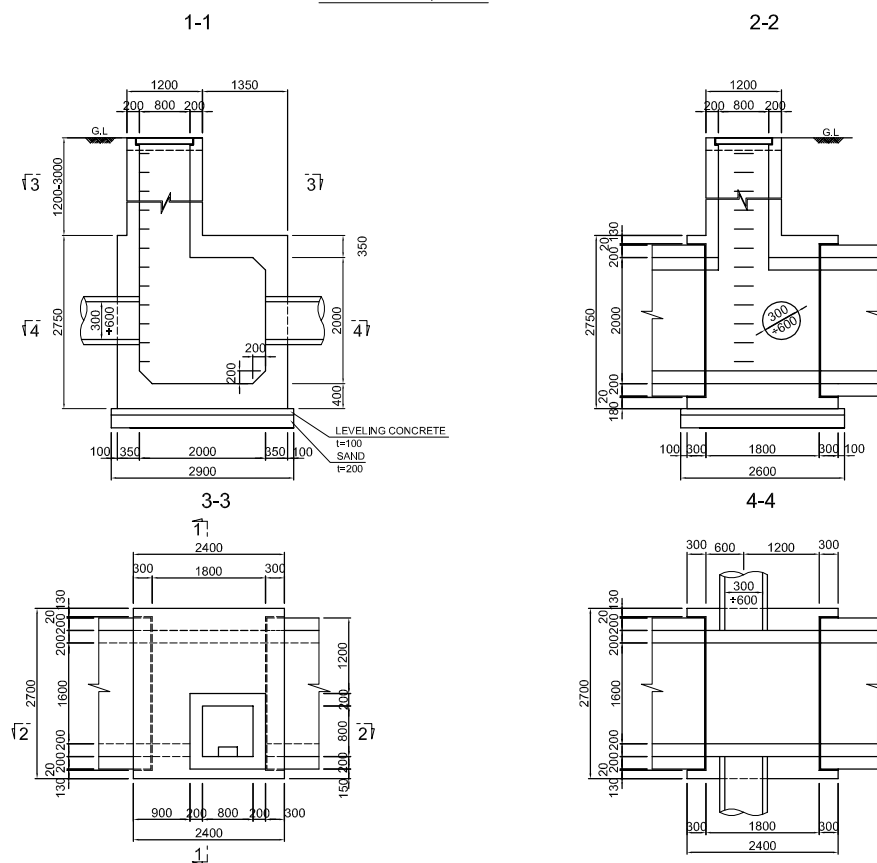


FIG. 7.3 (1) TYPICAL MANHOLE FOR BOX CULVERTS

TYPE 1B-1 ; 1C-1



TYPE 1B-2 ; 1C-2

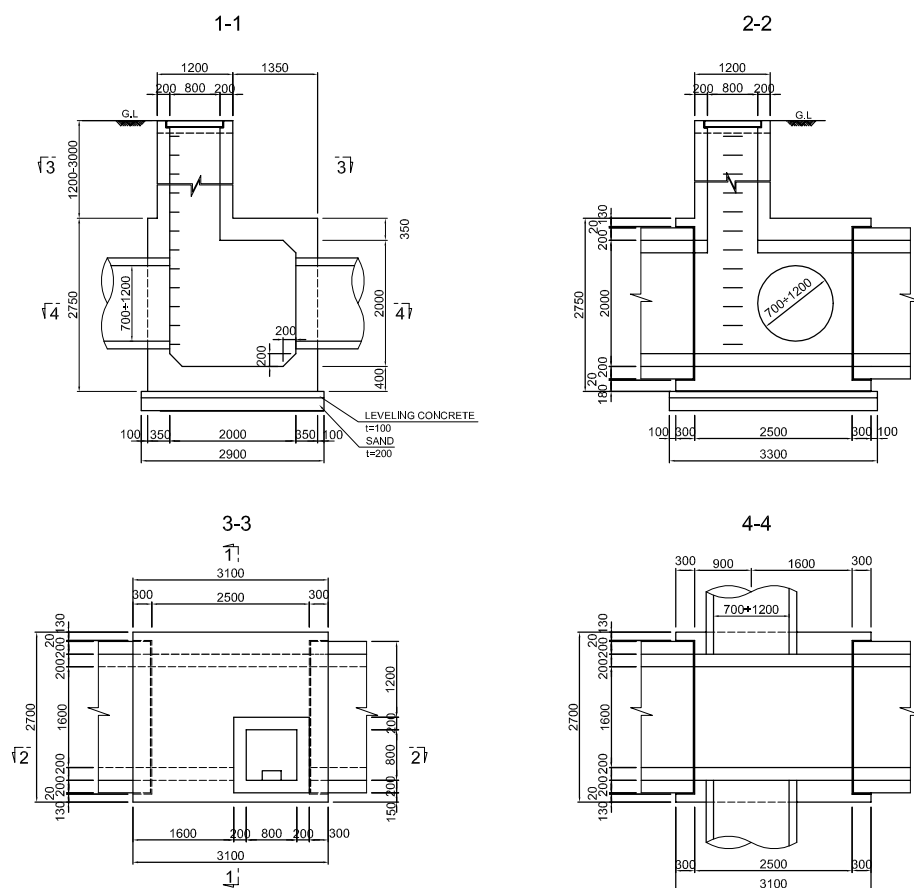


FIG. 7.3 (2) TYPICAL MANHOLE FOR BOX CULVERT

TYPE 2A-0

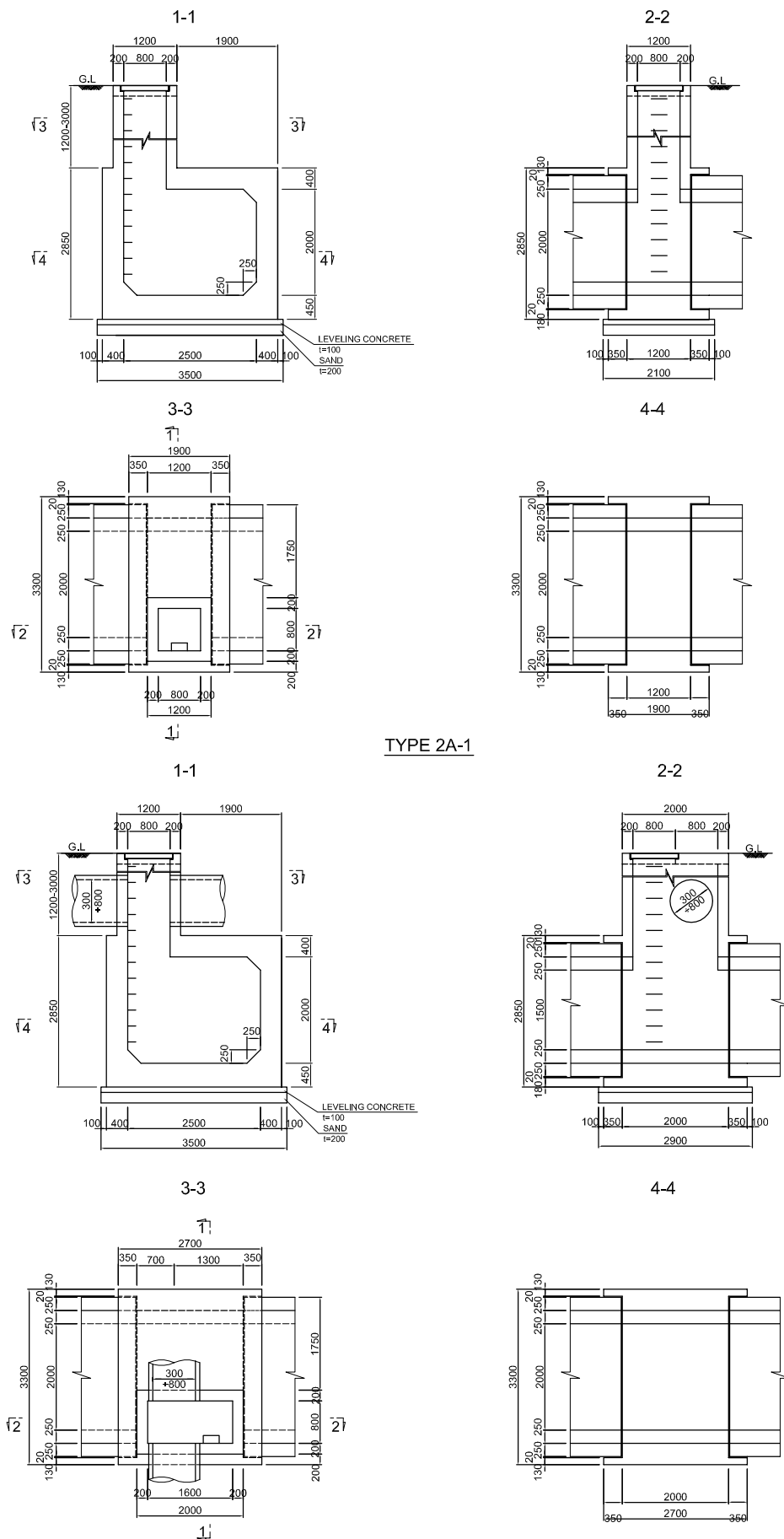
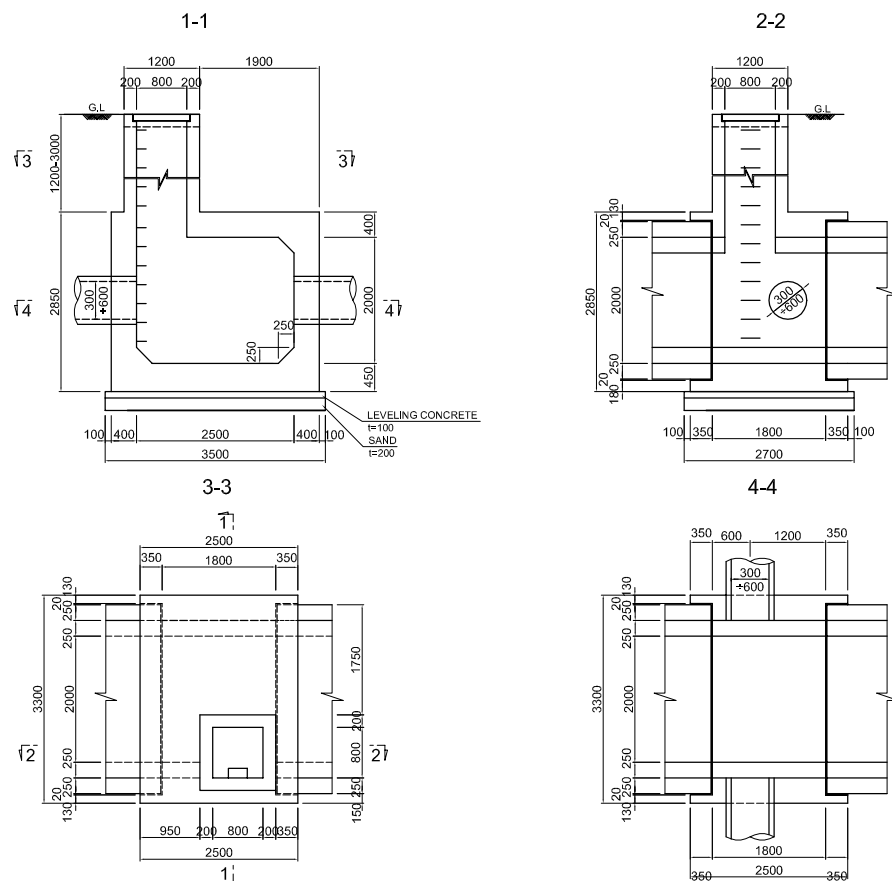


FIG. 7.3 (3) TYPICAL MANHOLE FOR BOX CULVERT

TYPE 2B-1 ; 2C-1



TYPE 2B-2 ; 2C-2

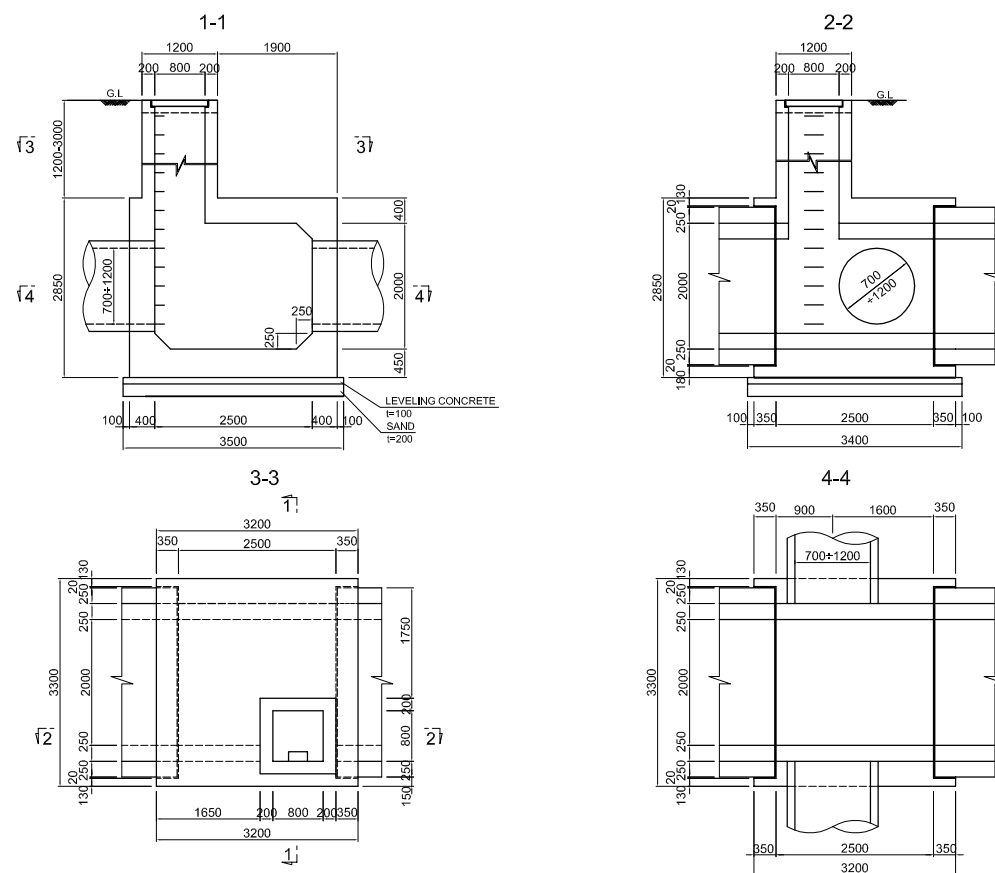
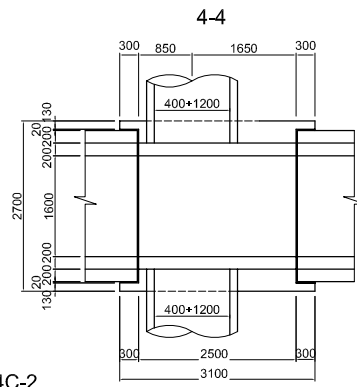
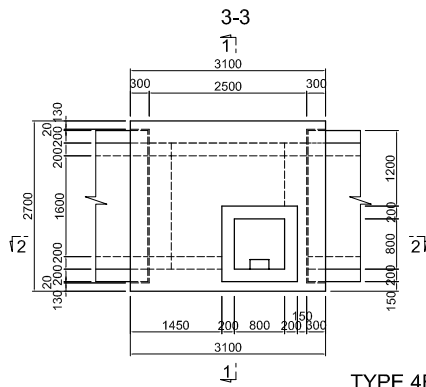
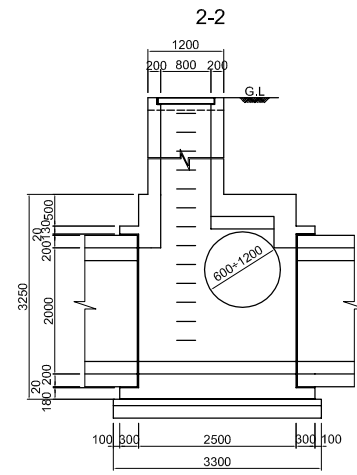
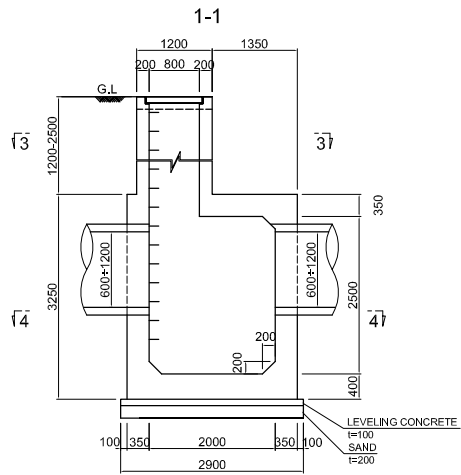


FIG. 7.3 (4) TYPICAL MANHOLE FOR BOX CULVERT

TYPE 3B-1 ; 3B-2 ; 3C1 ; 3C-2



TYPE 4B-1 ; 4B-2 ; 4C1 ; 4C-2

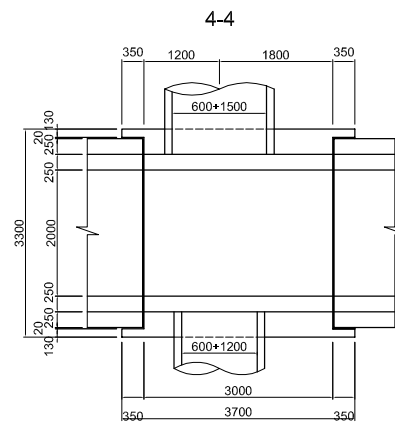
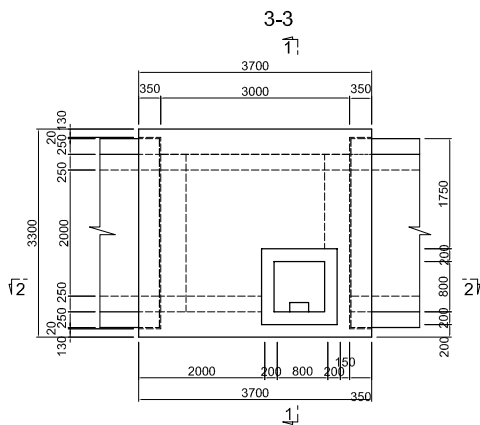
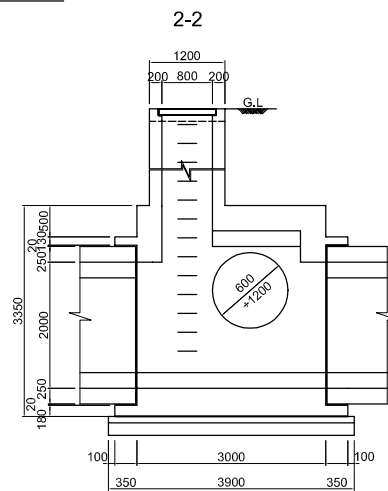
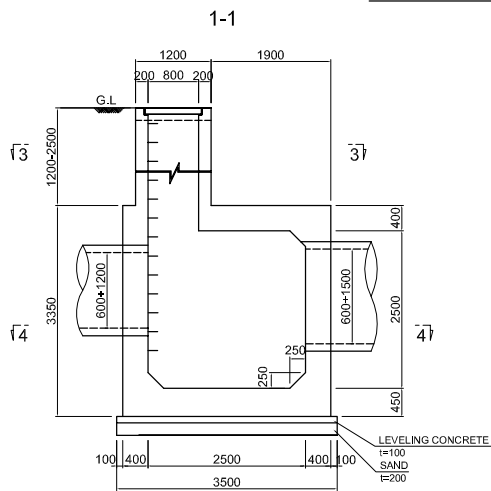
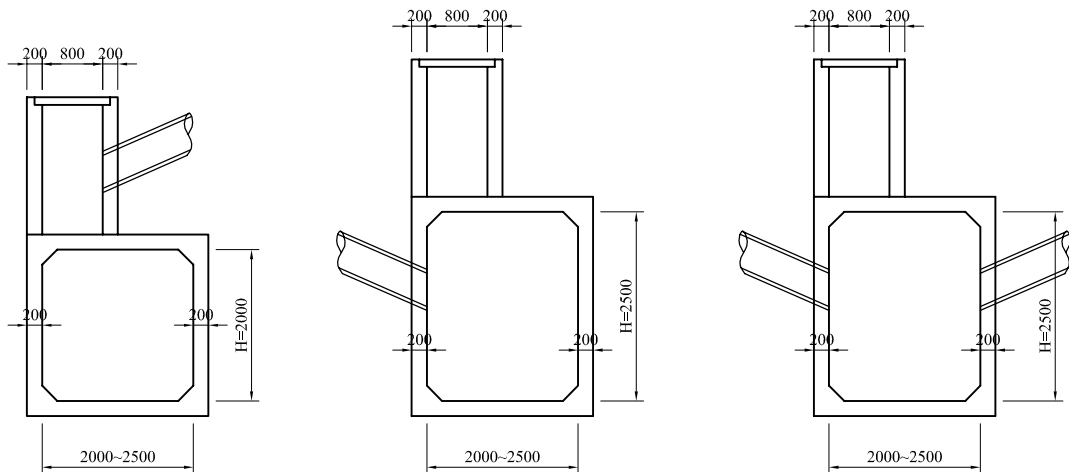


FIG. 7.3 (5) TYPICAL MANHOLE FOR BOX CULVERT

TYPE OF MANHOLE

Type of Manhole			Dimensions (mm)		
General Type	Connection Type	Connection Pipe	Box Culvert		Connection Pipe
			B	H	
1 H = 2.0m	A	0	2000	2000	No Connection
		1			D300-D800
	B	1	2000	2000	D300-D600
		2			D700-D1200
	C	1	2000	2000	D300-D600
		2			D700-D1200
2 H = 2.0m	A	0	2500	2000	No Connection
		1			D300-D800
	B	1	2500	2000	D300-D600
		2			D700-D1200
	C	1	2500	2000	D300-D600
		2			D700-D1200
3 H = 2.5m	A	1	2000	2000	D300-D600
		2			D700-D1500
	B	1	2000	2000	D300-D600
		2			D700-D1500
4 H = 2.5m	A	1	2500	2000	D300-D600
		2			D700-D1500
	B	1	2500	2000	D300-D600
		2			D700-D1500

CONNECTION TYPE



TYPE A

TYPE B

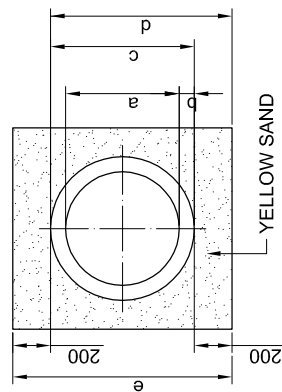
TYPE C

FIG 7.3 (6) TYPICAL MANHOLE FOR BOX CULVERT

Type S 360

Excavation Depth Under 6.0m

Pipe; Class-2

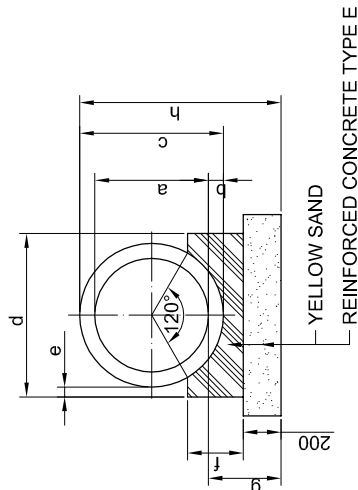


	a	b	c	d	e
φ300	300	50	400	600	800
φ400	400	50	500	700	900
φ500	500	60	620	820	1020
φ600	600	80	760	960	1160
φ800	800	80	960	1160	1360
φ1000	1000	90	1180	1380	1580
φ1200	1200	120	1440	1640	1840
φ1500	1500	120	1740	1940	2140
φ1800	1800	150	2100	2300	2500
φ2000	2000	150	2300	2500	2700

Type C 120

Excavation Depth ≈4.0m~5.0m

Pipe; Class-2

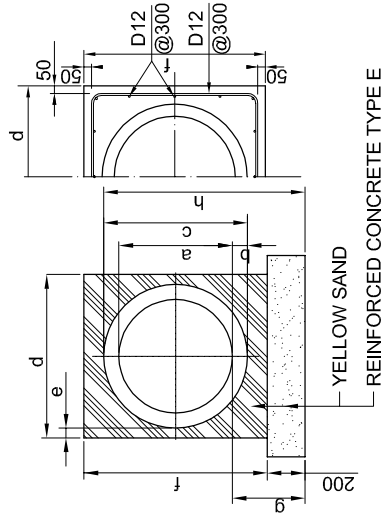


	a	b	c	d	e	f	g	h
φ2000	2000	150	2300	2600	150	860	635	2785

Type C 360

Excavation Depth ≈5.0m~7.5m

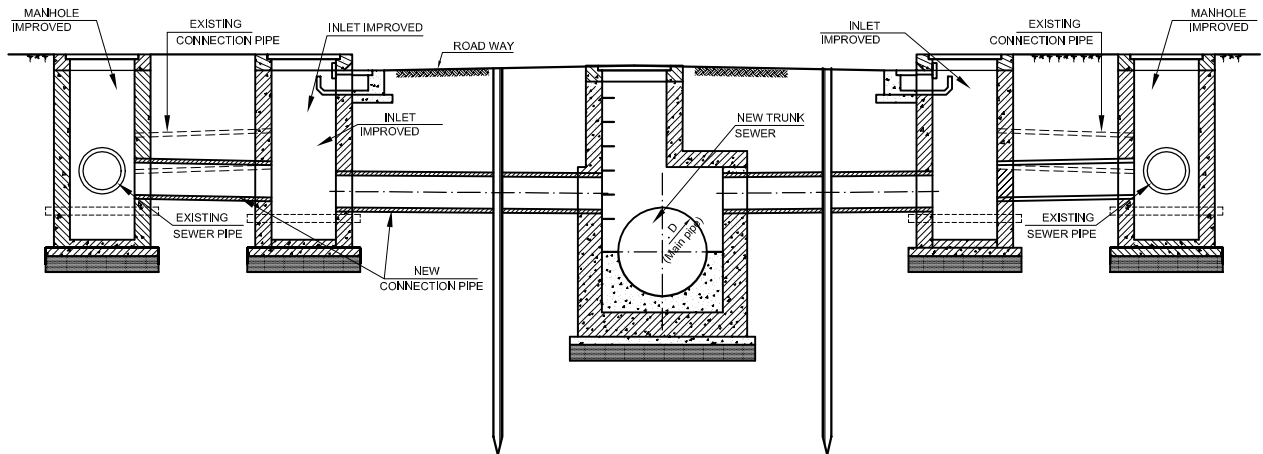
Pipe; Class-1



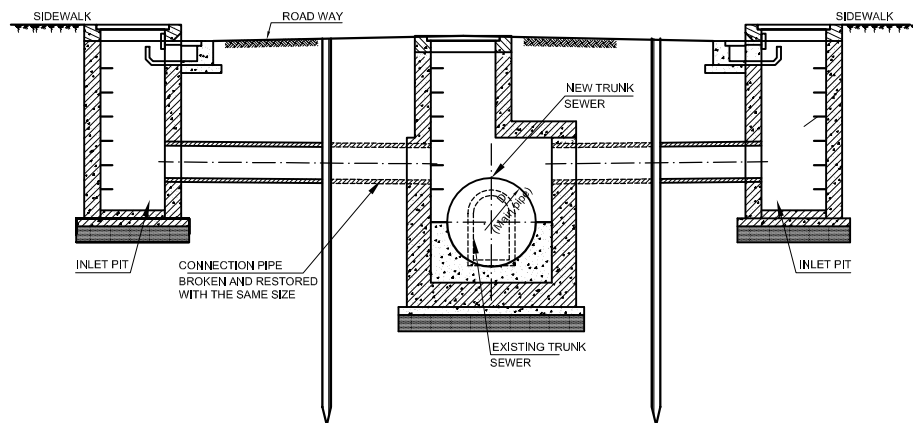
	a	b	c	d	e	f	g	h
φ1800	1800	150	2100	2600	250	2600	600	2550
φ2000	2000	150	2300	2880	290	2880	640	2790

FIG. 7.4 TYPICAL SEWER PIPE BEDDING

TYPE 1A:



TYPE 1B:



TYPE 2:

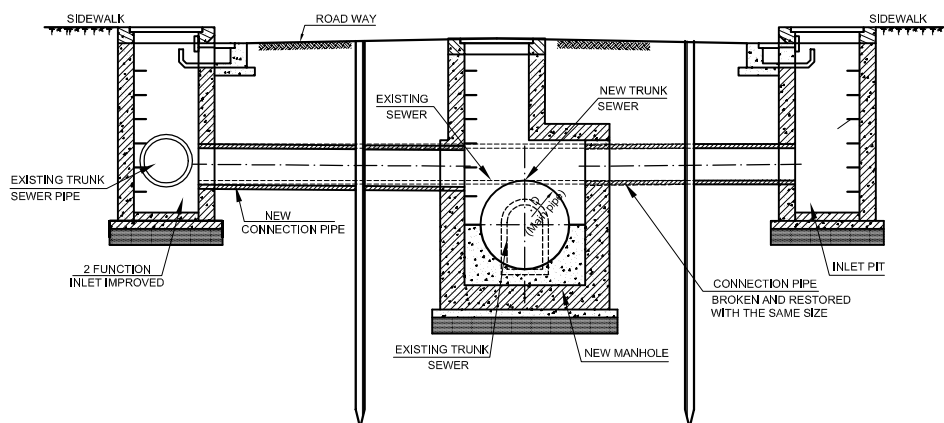
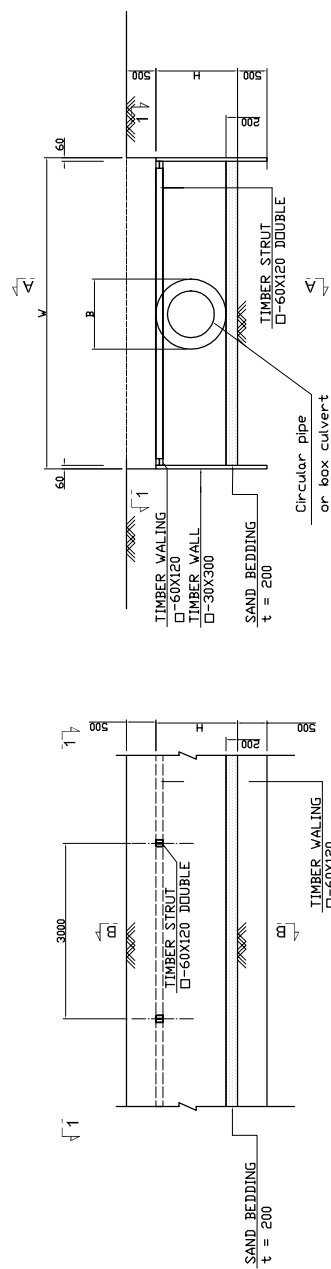


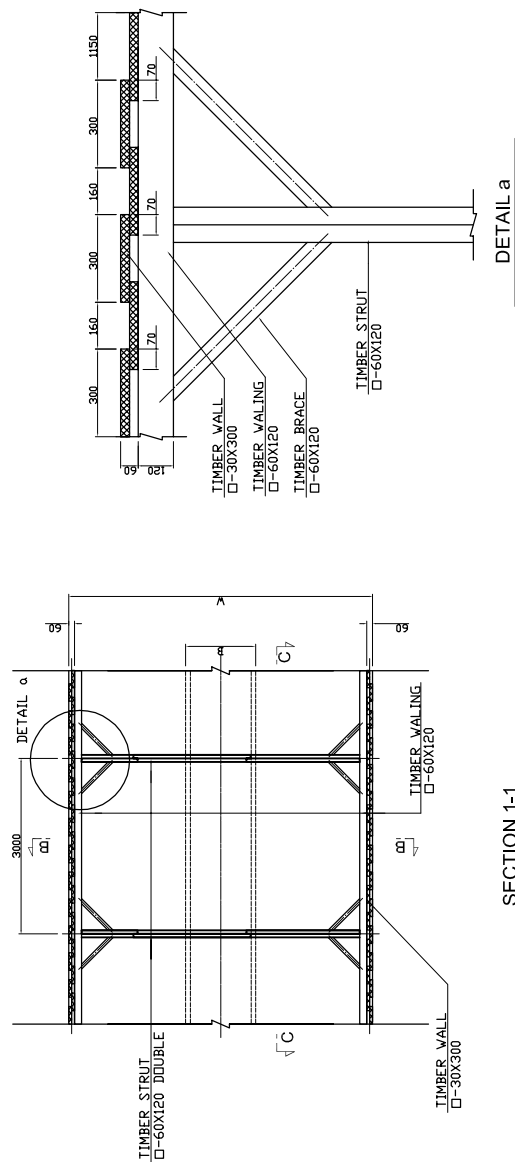
FIG. 7.5 TYPICAL LAYOUT OF TRUNK SEWER AND COLLECTION SYSTEM



SECTION A-A

SECTION B-B

Size of sewer (mm)	B (mm)	W (mm)
ø400	500	1400
ø500	620	1400
ø600	760	1400
ø800	960	1400
ø1000	1180	1600
ø1200	1440	2000
ø1500	1740	2300
ø1800	2100	2600
ø2000	2300	2900
2000x2000	2400	3200
2500x2000	3000	3800



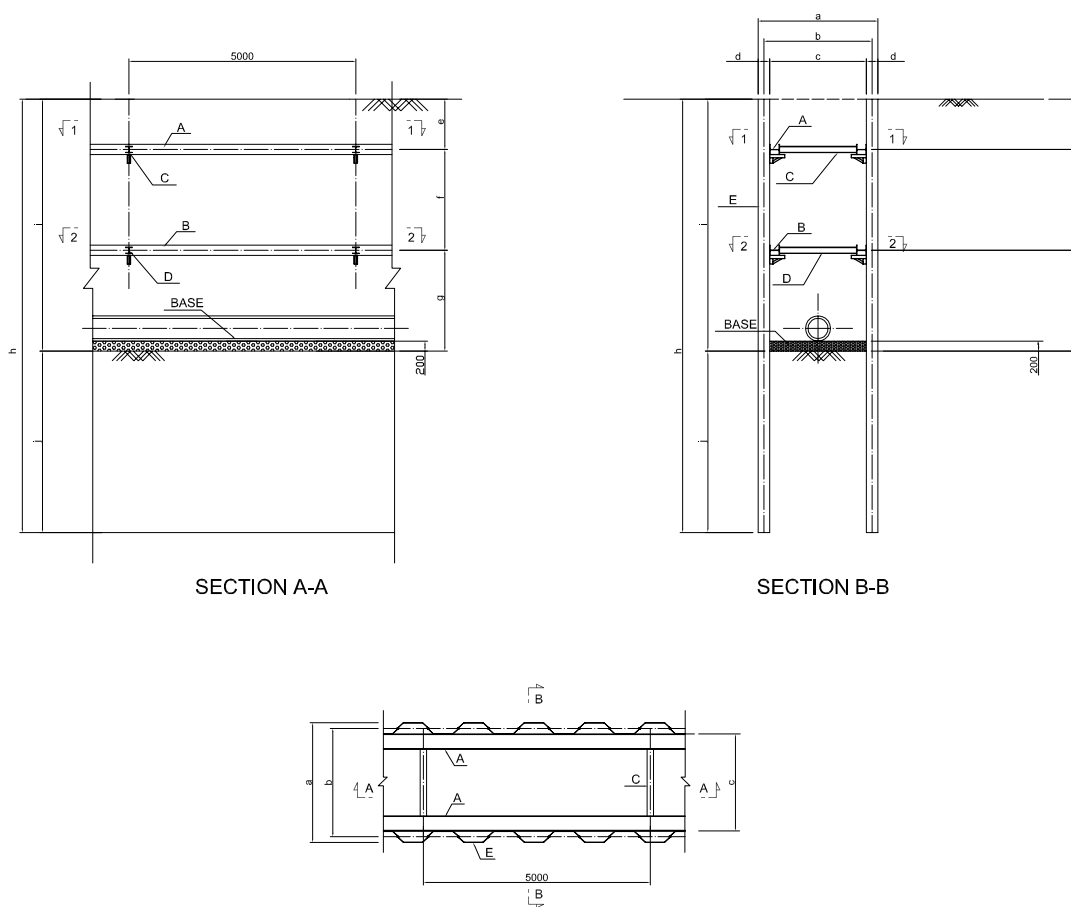
SECTION 1-1

DETAIL a

FIG. 7.6 TYPICAL TIMBER WALL STRUCTURE

TYPE 1

Excavation Depth = 4,000~5,000



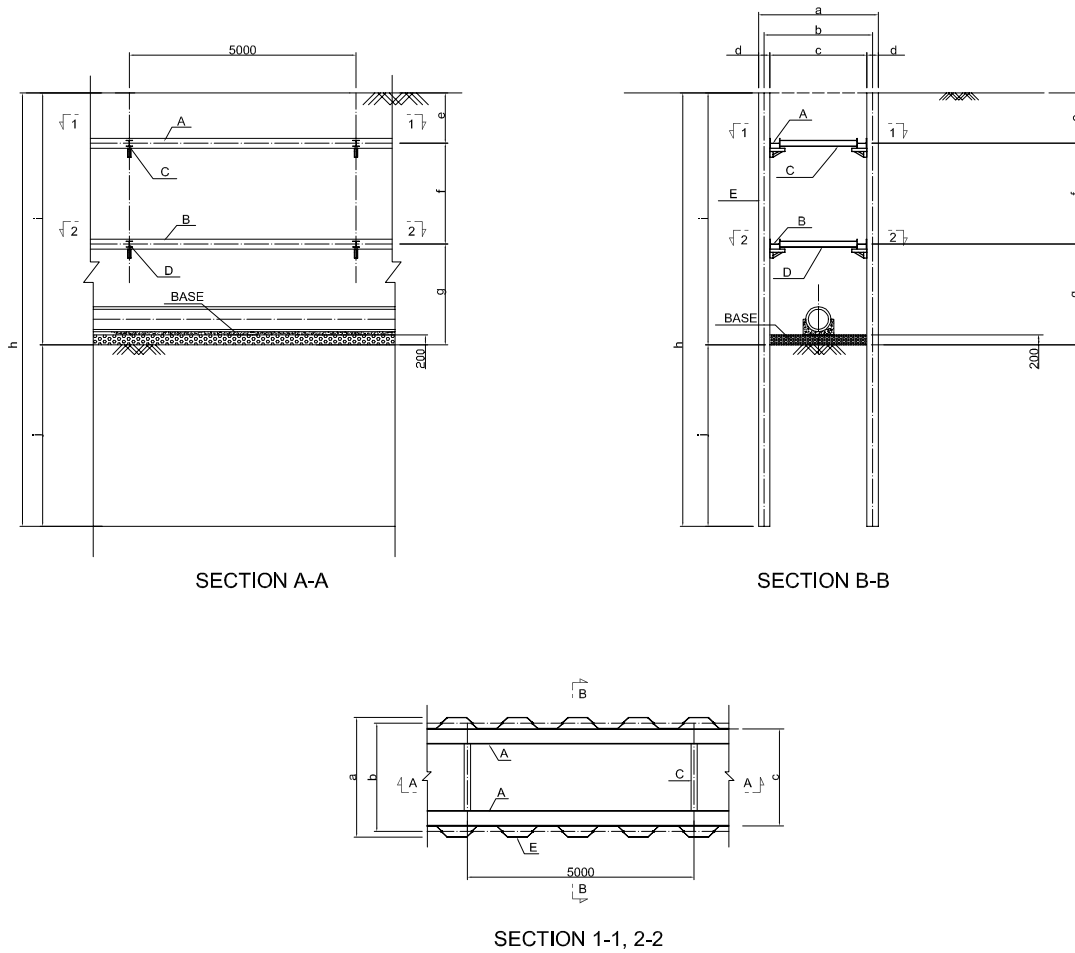
SECTION 1-1, 2-2

		W=2,000	W=2,200	W=2,600	W=2,950	W=3,500
Width	a	2,200	2,400	2,800	3,150	3,700
	b	2,000	2,200	2,600	2,950	3,500
	c	1,800	2,000	2,400	2,750	3,300
	d	200				
Depth	e	1,000				
	f	2,000				
	g	1,000 ~ 2,000				
	h	8,600				
	i	4,000 ~ 5,000				
	j	4,600 ~ 3,600				
Walling	A	H-300x300x10x15				
	B	H-300x300x10x15				
Strut	C	H-125x125x6.5x9	H-125x125x6.5x9	H-150x150x7x10		H-150x150x7x10
	D	H-125x125x6.5x9	H-150x150x7x10	H-150x150x7x10		H-175x175x7.5x11
Sheet pile	E	FSP - 2				

FIG.7.7 (1) TYPICAL BRACED SHEETING STRUCTURE

TYPE 2

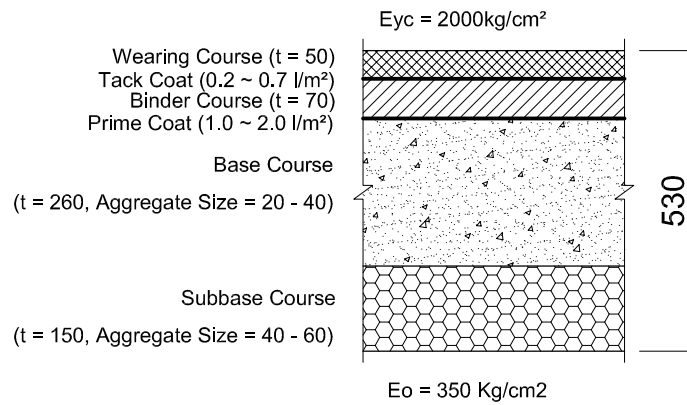
Excavation Depth = 5,000~6,000



		W=2,000	W=2,300	W=2,700	W=3,100	W=3,600	W=3,900
Width	a	2,200	2,500	2,900	3,300	3,800	4,100
	b	2,000	2,300	2,700	3,100	3,600	3,900
	c	1,800	2,100	2,500	2,900	3,400	3,700
	d	200					
Depth	e	1,000					
	f	2,500					
	g	1,500 ~ 2,500					
	h	10,100					
	i	5,000 ~ 6,000					
	j	5,100 ~ 4,100					
Walling	A	H-300x300x10x15					
	B	H-350x350x12x19					
Strut	C	H-125x125x6.5x9	H-150x150x7x10			H-175x175x7.5x11	H-175x175x7.5x11
	D	H-150x150x7x10	H-175x175x7.5x11			H-175x175x7.5x11	H-200x200x8x12
Sheet pile	E	FSP - 2					

FIG.7.7 (2) TYPICAL BRACED SHEETING STRUCTURE

TYPE P4



TYPE P5

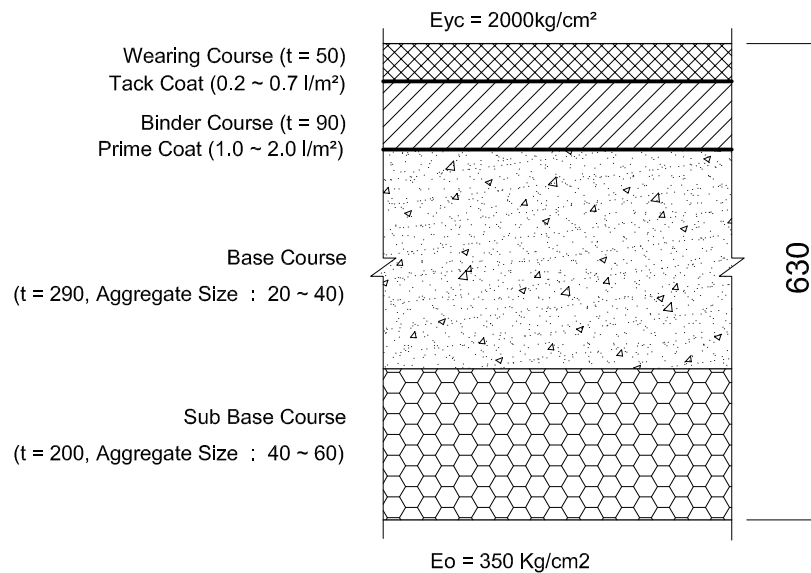


FIG. 7.8 TYPICAL ROAD RESTORATION