3) Structural Design

a) Suction Pit

The dimension of the suction pit will be set as in the Figure 2-17. The shape of the suction pit will be determined by the dimensions of machinery, such as diameter of pump, trash screens, generator set and so on. The suction pit itself is constructed underground, and the generator room is built as on-ground structure, therefore, the load of the on-ground facilities needs to be taken into account for the design of the suction pit.

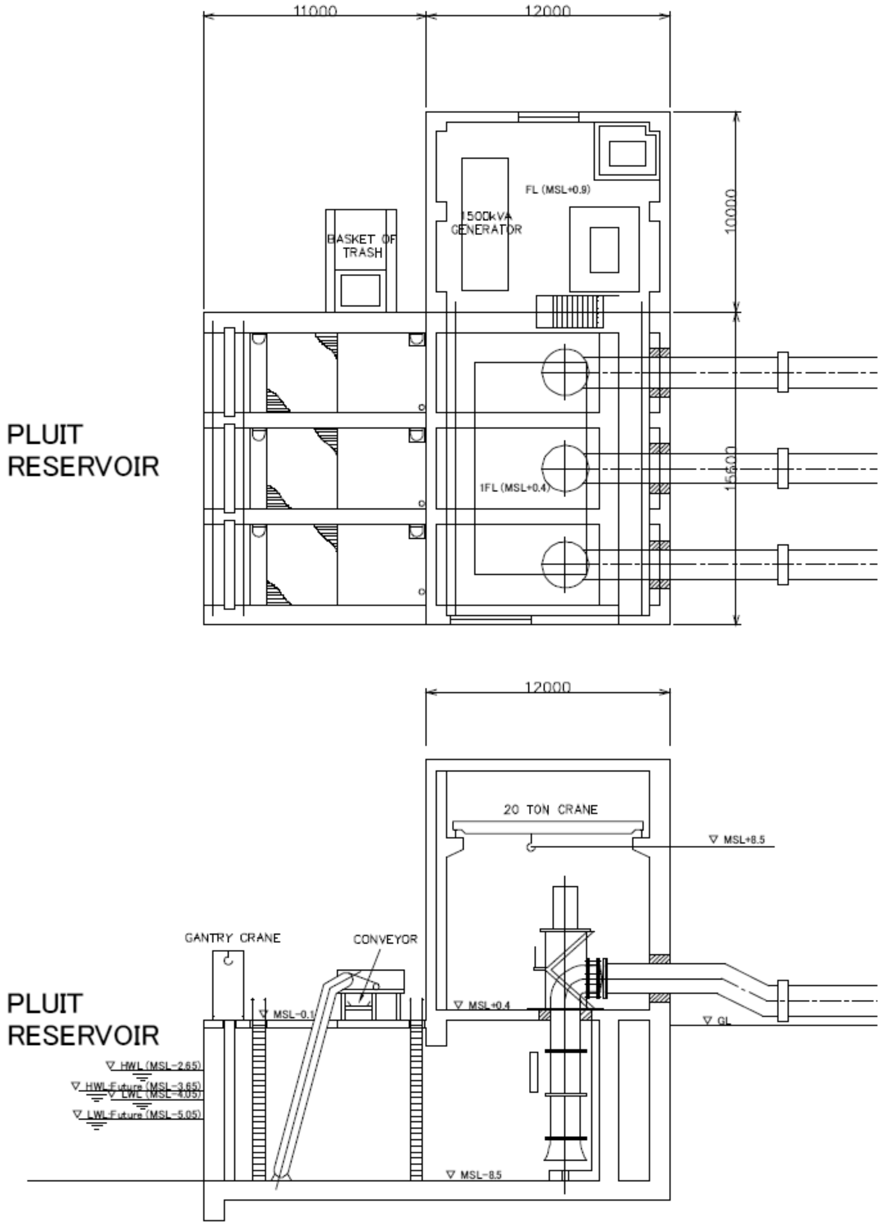


Figure2-17 Dimensions of Suction Pit

b) Design Procedure

The foundation of EPH is the pile foundation type determined by the very soft soil condition. The outline design procedure is as shown in Figure 2-18.

(Load calculation)

- To calculate loads for the foundation design

↓

(Foundation Design)

- To design the pile foundation

↓

(Structure Design)

- To design the suction pit

Figure 2-18 Design Procedure for Suction Pit

c) Design Loads

There are 4 cases of the load combinations for design as shown in Table 2-8.

Table 2-8 Cases of Load Combinations for Suction Pit Design

		Case 1 (permanent)	Case 2 (permanent)	Case 3 (seismic)	Case 4 (seismic)
1)	Self weight	o	o	o	o
2)	Earth pressure at rest, Hydrostatic pressure (permanent)	o	o		
3)	Dynamic load of facilities	o	o	o	o
4)	Load of building	o	o	o	o
5)	Uplift by underground water	o	o	o	o
6)	Inner water load	o		o	
7)	Active earth pressure, Hydrostatic pressure (seismic: temporary)			o	o
8)	Seismic force of building			o	o
9)	Seismic force of dead weight of facilities			o	o
10)	Dynamic water pressure			o	o

Note: Groundwater level is set as GL-1.0m based on the geographical survey result.
Uplift is calculated inion with the consideration of the difference in water pressure between LWL (R) and HWL (S).

Loading model is shown in Figure 2-19.

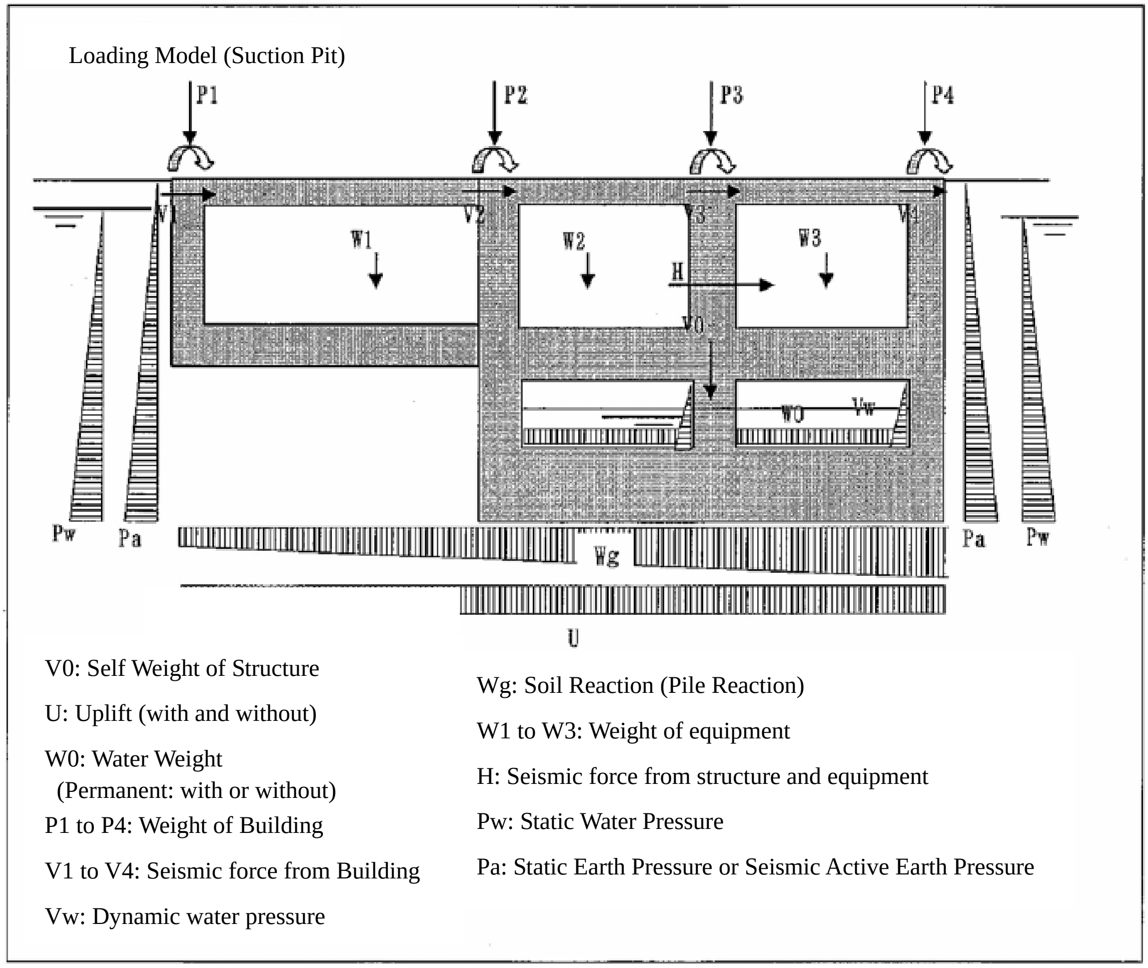


Figure 2-19 Loading Model of Suction Pit

d) Selection of Foundation Type

d-1) Type of Foundation

The foundation for EPH is the pile foundation because the soft clayey soil (N-value = 0) is found at 20m below ground surface and a differential subsidence should be minimized. Considering the dimensions of the building, PC pile (concrete pile) and steel pipe pile can be applied, however, steel pipe pile is selected for EPH. The reasons of selection are as follows:

It is necessary to install new piles onto the existing 40cm square piles because it is impossible to grasp the precise positions of existing piles. Steel pipe piles can be applied for this construction, and its thickness should be rather thin and its diameter should be more than 1,000mm. PC pile with a large diameter is not produced in Indonesia, but steel pipe pile is produced and available in Indonesia.

Table 2-9 shows the Foundation Type Selection.

Table 2-9 Foundation Type Selection

Selection Criteria		Foundation Type	Spread Foundation	Driven Piled Foundation: RC Pile	Driven Piled Foundation: PHC / SC Pile	Driven Piled Foundation: Steel Pile: Driving Method	Driven Piled Foundation: Steel Pile: Vibrohammer	Bored Pile Foundation: PHC・SC Pile: Final Driving Method	Bored Pile Foundation: PHC・SC Pile: Cement Milk Jetting & Mixing Method	Bored Pile Foundation: PHC・SC Pile: Concrete Placing Method	Bored Pile Foundation: Steel Pipe: Driving Method	Bored Pile Foundation: Steel Pipe: Cement Milk Jetting & Mixing Method	Bored Pile Foundation: Steel Pipe: Concrete Placing Method	Steel Pipe Soil Cement Pile Foundation	Pre-bored Pile Foundation	Cast-in-Place Pile Foundation: All Casing	Cast-in-Place Pile Foundation: Reverse-rotary Drilling	Cast-in-Place Pile Foundation: Earth Drill	Deep Foundation	Caisson Foundation: Pneumatic	Caisson Foundation: Open	Steel Pipe Sheet Pile Foundation	Cast-in-situ Diaphragm Wall Foundation
Ground Condition	From surface to Supporting Layer	Intermediate Very Soft Layer	△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	×	○	○	○	○
Ground Condition	From surface to Supporting Layer	Intermediate Very Hard Layer	○	×	△	△	△	○	○	○	○	○	○	○	○	△	○	△	○	○	△	△	○
Ground Condition	From surface to Supporting Layer	Intermediate Gravel Layer: Gravel Size ≦ 5cm	○	△	△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Ground Condition	From surface to Supporting Layer	Intermediate Gravel Layer: Gravel Size 5cm to 10cm	○	×	△	△	○	△	△	△	△	△	△	○	○	○	○	△	○	○	○	△	○
Ground Condition	From surface to Supporting Layer	Intermediate Gravel Layer: Gravel Size 10cm to 50cm	○	×	×	×	×	×	×	×	×	×	×	×	×	△	×	×	○	○	△	×	△
Ground Condition	From surface to Supporting Layer	Liquifiable ground	△	△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Ground Condition	Supporting Layer	Depth of Bearing Layer: < 5m	○	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	○	×	×	×	×
Ground Condition	Supporting Layer	Depth of Bearing Layer: 5 to 15 m	△	○	○	○	○	○	○	○	○	○	○	○	○	○	△	○	○	○	○	△	△
Ground Condition	Supporting Layer	Depth of Bearing Layer: 15 to 25 m	×	△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Ground Condition	Supporting Layer	Depth of Bearing Layer: 25 to 40 m	×	×	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	○	○	○	○
Ground Condition	Supporting Layer	Depth of Bearing Layer: 40 to 60 m	×	×	△	○	○	△	△	△	○	○	○	○	○	△	○	×	×	△	○	○	○
Ground Condition	Supporting Layer	Depth of Bearing Layer: 60m<	×	×	×	△	△	×	×	×	×	×	×	△	△	×	△	×	×	×	△	△	△
Ground Condition	Supporting Layer	Supporting Layer: Clayey Soil (20 ≦ N)	○	○	○	○	○	○	×	△	○	×	△	△	×	○	○	○	○	○	○	○	○
Ground Condition	Supporting Layer	Supporting Layer: Sand・Gravel(30 ≦ N)	○	○	○	○	○	○	○	×	○	○	×	○	○	○	○	○	○	○	○	○	○
Ground Condition	Supporting Layer	Large Inclination (approx. 30° ≦)	○	×	△	○	○	△	△	△	○	○	○	△	△	○	△	△	○	○	△	△	△
Ground Condition	Supporting Layer	Heavily Uneven	○	△	△	○	○	△	△	△	○	△	△	△	△	○	○	○	○	○	△	△	○
Ground Condition	Groundwater Condition	Groundwater table close to ground surface	△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	○	○	○	○
Ground Condition	Groundwater Condition	High Flow Volume	△	○	○	○	○	○	○	○	○	○	○	○	△	○	○	△	×	○	○	○	△
Ground Condition	Groundwater Condition	Pressured Groundwater Table within 2m from ground surface	×	○	○	○	○	×	×	×	×	×	×	○	×	×	×	×	×	△	△	○	×
Ground Condition	Groundwater Condition	Flow velocity more than 3m/min	×	○	○	○	○	○	×	×	○	×	×	×	×	×	×	×	×	○	△	○	×
Characteristics of Structure	Magnitude of Loads	Small Veritical Load(Span<=20m)	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	×	△	×	×
Characteristics of Structure	Magnitude of Loads	Medium Vertical Load(20m<Span<50m)	○	△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Characteristics of Structure	Magnitude of Loads	Large Vertical Load(Span>50m)	○	×	△	○	○	△	△	△	○	○	○	○	△	○	○	△	○	○	○	○	○
Characteristics of Structure	Magnitude of Loads	Vertical Load > Horizonal Load	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△
Characteristics of Structure	Magnitude of Loads	Vertical Load < Horizonal Load	○	×	△	○	○	△	△	△	○	○	○	○	○	○	○	○	○	○	○	○	○
Characteristics of Structure	Load Support System	End Bearing Pile	/	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	/	/	/	/
Characteristics of Structure	Load Support System	Friction Pile	/	○	○	○	○	/	/	/	/	/	/	○	○	○	○	○	/	/	/	/	/
Construction Conditions	Water Surface	Water depth less than or equal to 5m	○	○	○	○	○	△	△	△	△	△	△	△	×	×	○	△	×	△	△	○	×
Construction Conditions	Water Surface	Water depth more than 5m	×	△	△	○	○	△	△	△	△	△	△	△	×	×	△	×	×	△	△	○	×
Construction Conditions		Small Work Space	○	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	○	△	△	×	△
Construction Conditions		Batter Pile	/	△	○	○	○	×	×	×	△	△	△	△	×	△	×	×	×	/	/	/	/
Construction Conditions		Influence of Poisonous Gas	△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	×	×	○	○	○
Construction Conditions	Surrounding Environment	Countermeasures against noise and vibration	○	×	×	×	△	△	○	○	△	○	○	○	○	△	○	○	○	○	○	×	○
Construction Conditions	Surrounding Environment	Influence to Adjoining Structures	○	×	×	△	△	△	○	○	△	○	○	○	○	○	○	○	△	△	△	△	○

Compatibility ○: High △:Intermediate ×:Low

Source: Pile Foundation Design Manual, Japan Road Association

d-2) Supporting Layer

In order to prevent the differential settlement, the pile foundation system is required for the pump facility installed in the Project because the pump facility needs a high horizontal precision.

Although the supporting layer for existing piles is the upper foundation layer at about 20m below the ground surface, the supporting layer for new piles is the lower layer at about 40m below the ground surface due to thin thickness of the layer and in order to secure stable bearing capacity, to minimize the subsidence and to secure the function of EPH. Since the pile diameter is 1000mm in this Project, the thickness of supporting layer needs more than 5m. Therefore, the supporting layer shall be VS2 Layer around MSL-40m as shown in Figure 2-20.

It is estimated that the ground subsidence in the past is about 1.5m for 45 years at East Pump Station.

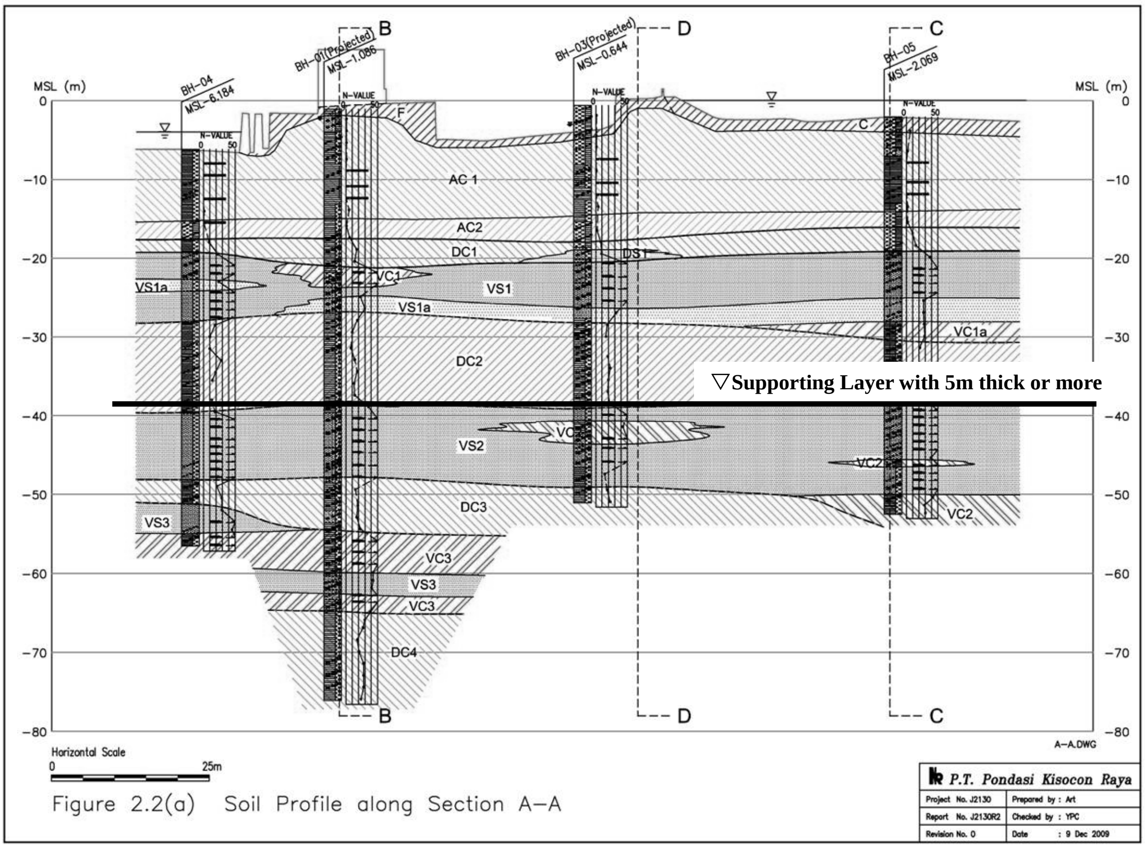
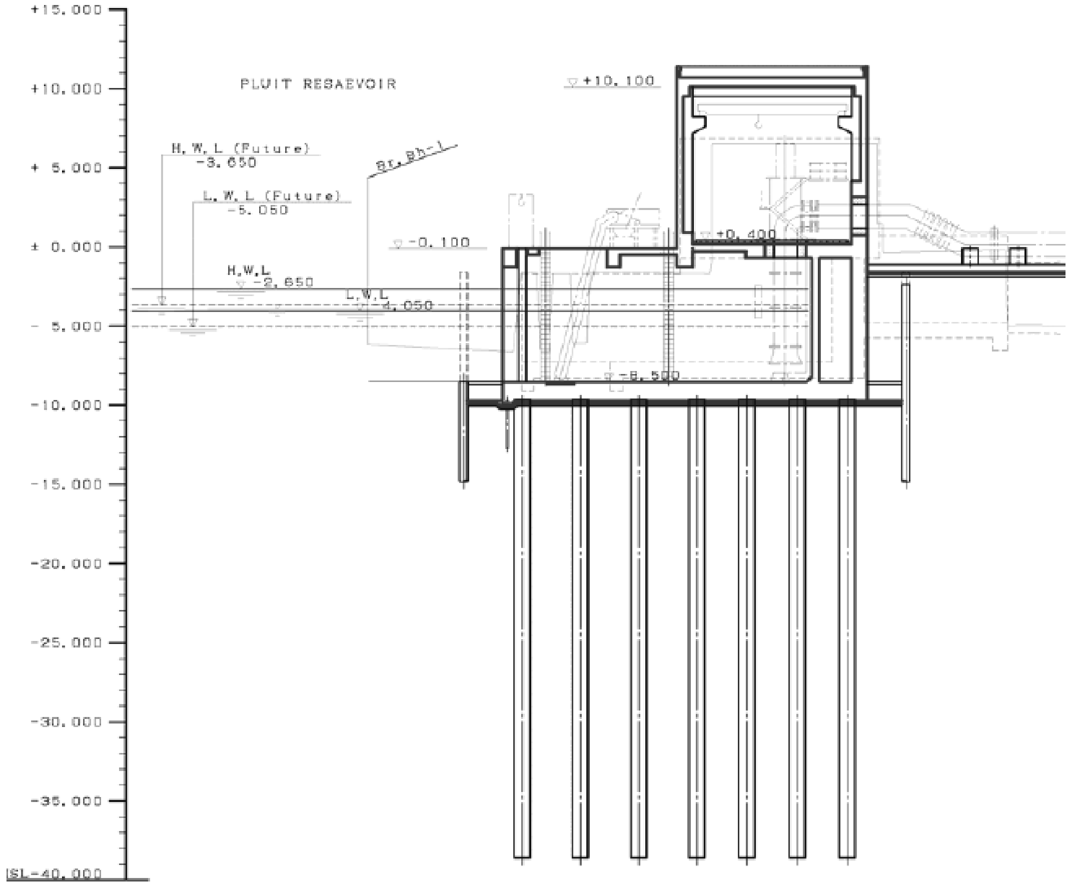
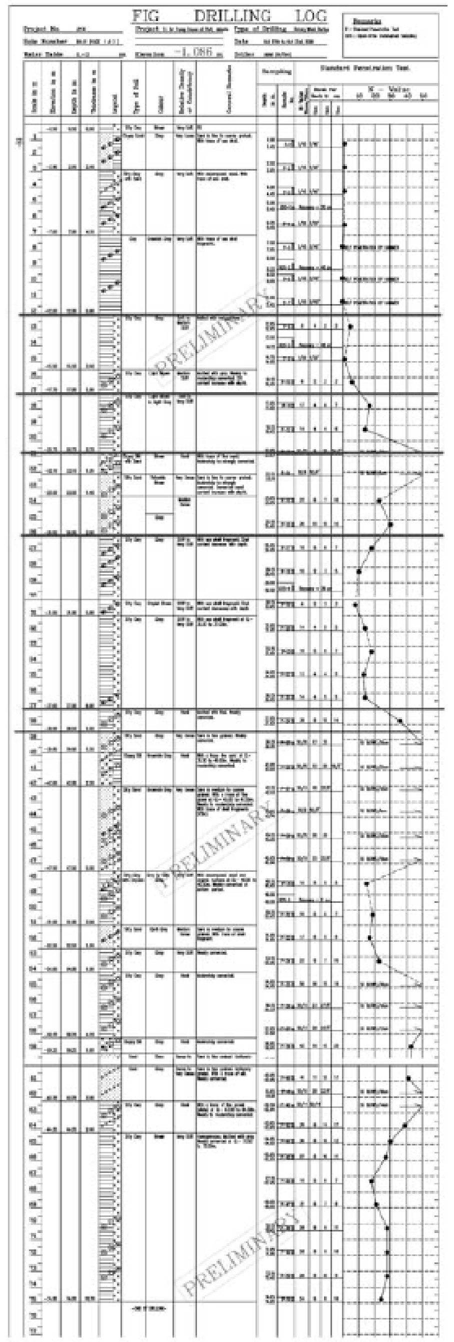


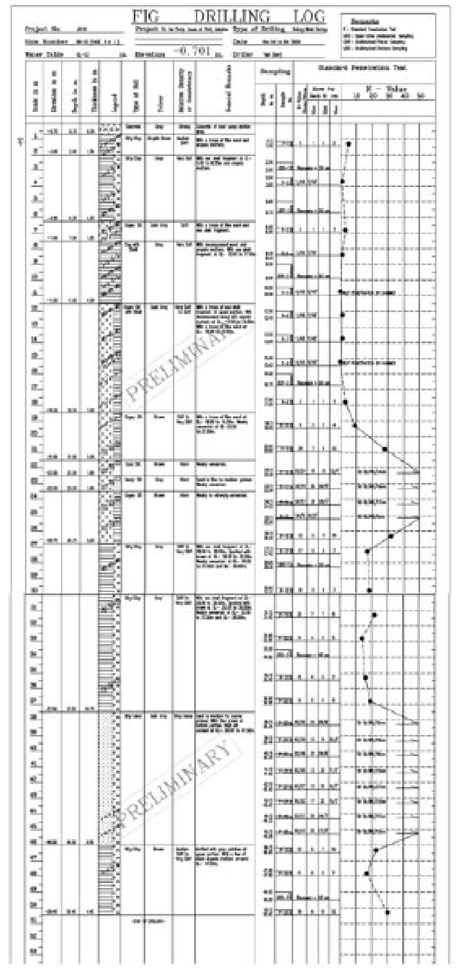
Figure 2-20 Soil Profile along the Section of East Pump Station



(BH－01)



(BH－02)



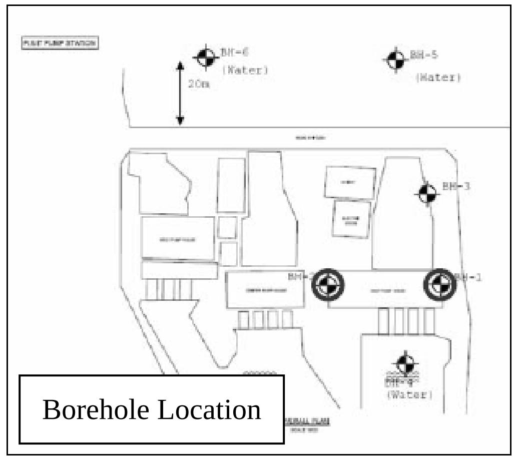


Figure 2-21 Layout of Pile Foundation

d-3) Existing Piles and Arrangement

Pile arrangement of the existing EPH could not be provided by related agencies. However, according to the design drawings, shown in Figure 2-22, for construction of Central and West Pump Stations and extension of automatic trash screen for East Pump Station, the existing piles and their arrangement can be estimated as follows:

Size: square pile (400mm)

Type: PC pile manufactured in Indonesia (observed from the piping hole)

Arrangement: center of side wall, inner wall and each inflow course

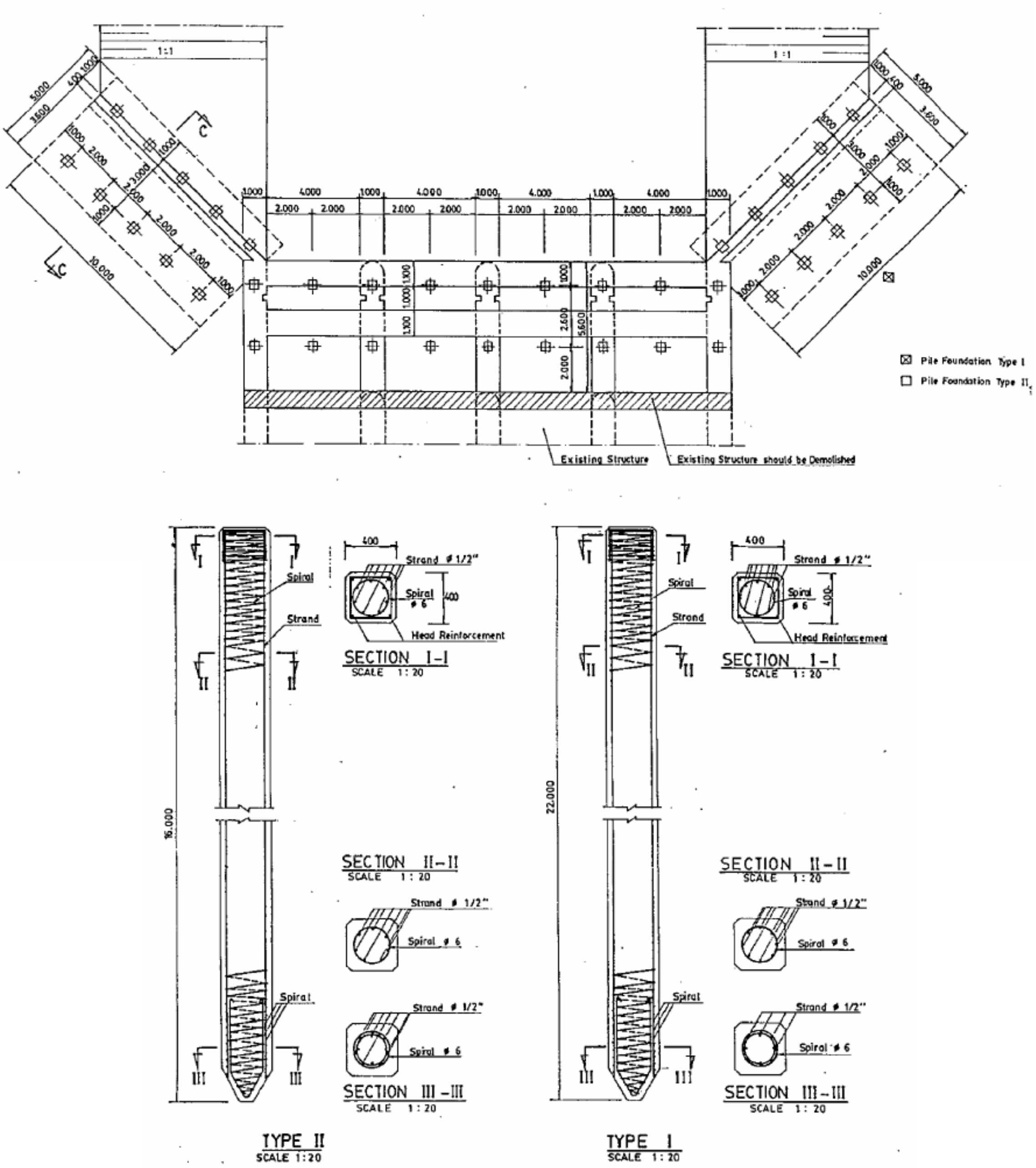


Figure 2-22 Design Drawing for Extension of Automatic Trash Screen

d-4) New Piles and Arrangement

It is preferable not to overlap the existing piles and new piles, however, the precise positions of existing piles are unknown. Therefore, it is necessary to confirm the pile position after the demolition of existing bottom slab of suction pit, to make a minor adjustment of pile position if required, but not to change the number of piles. And steel piles with more than dia. 1,000mm should be selected for the case of overlap.

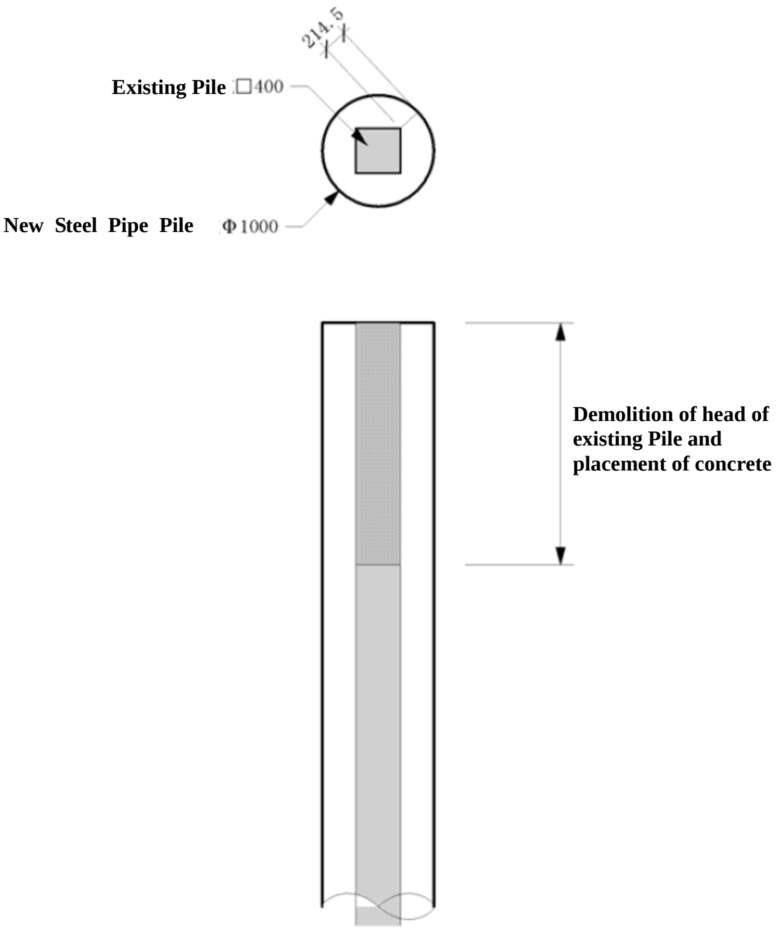
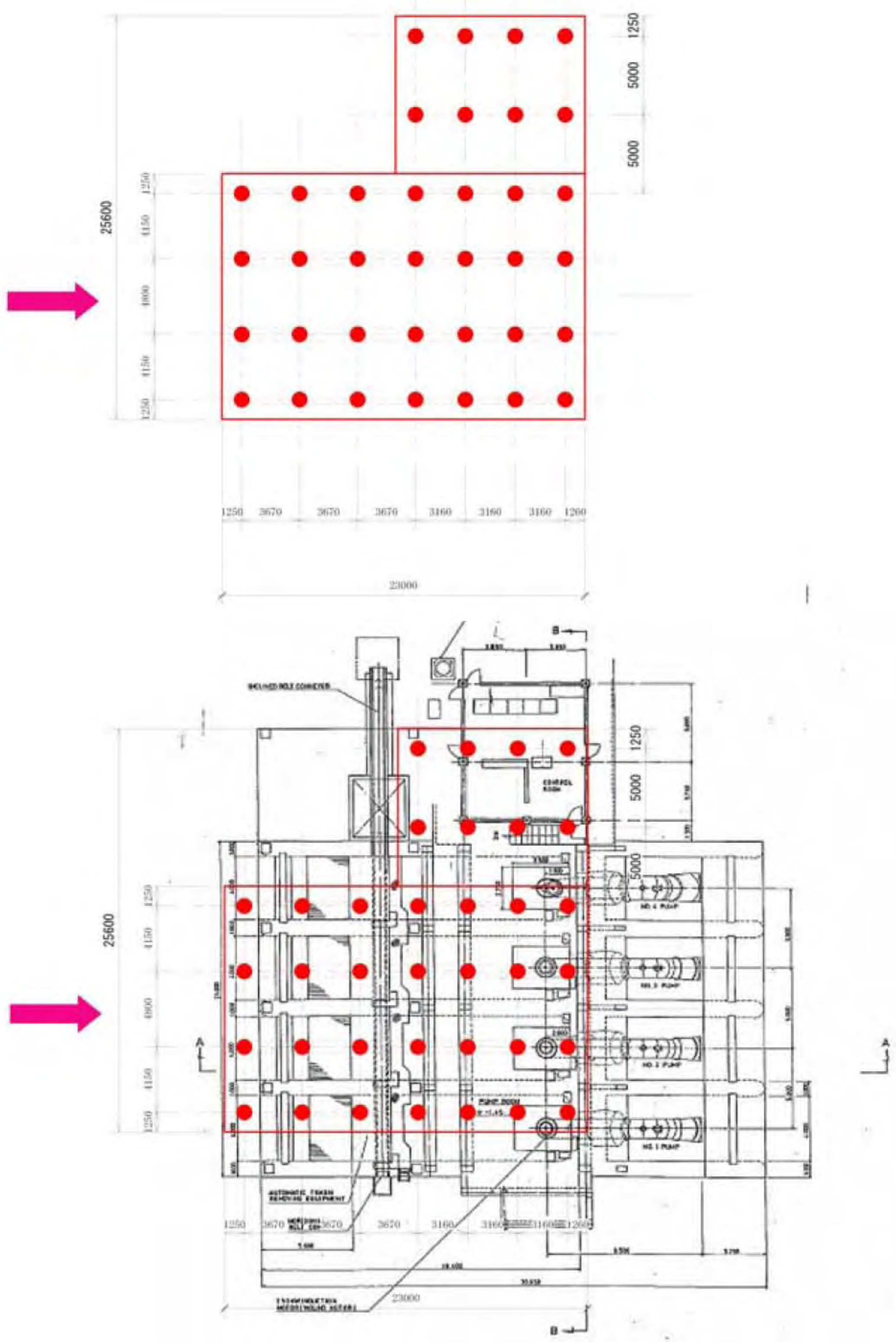


Figure 2-23 Pile Placement for Overlap

The following figure shows the overlap of new piles on the existing EPH. A possibility of overlapping of piles is not so high because the inflow course is different between the existing 4 courses, and reconstructed 3 courses; however, the piles in the center of channel have a high possibility to be overlapped or close. These piles should be planned to be placed at the positions with a low possibility of overlap as less as possible.



Note: Red line show the bottom of new suction pit.

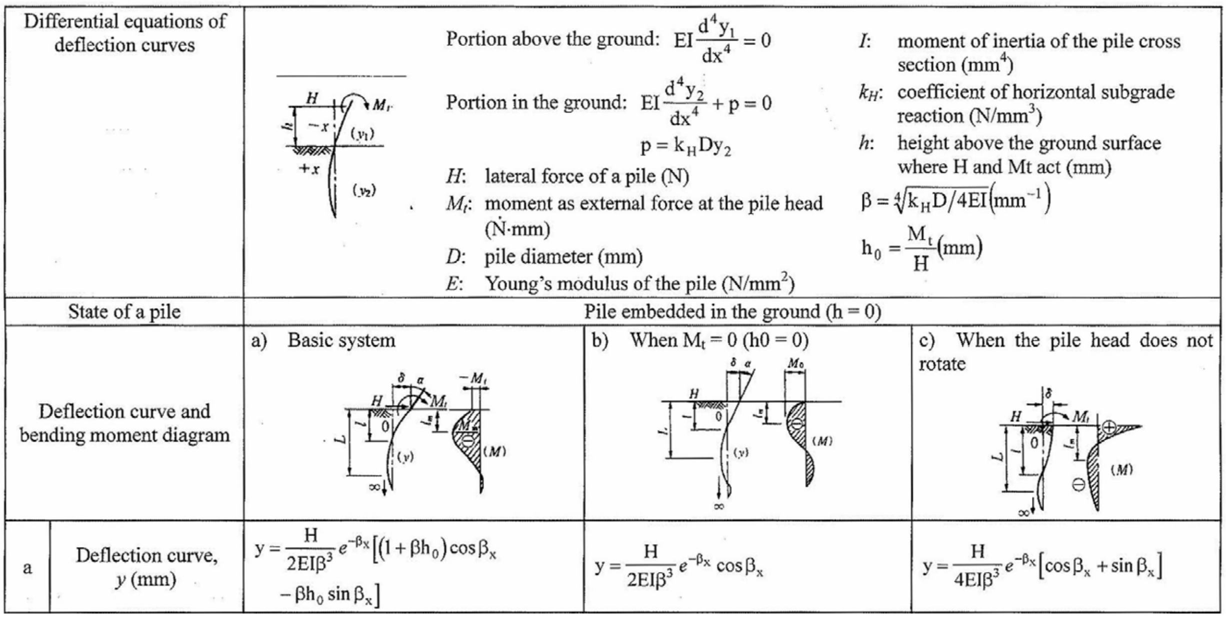
Figure 2-24 Arrangement Plan of New Piles

d-5) Effect by the Position Change of Piles

Generally piles are designed with examination of vertical and horizontal bearing capacity. The horizontal force will be supported evenly by the piles. In the Pump Station, the horizontal bearing capacity is the main factor to determine the necessary number of pile because the unsymmetrical earth pressure from the side of discharge channels is permanently acting.

Pile design for horizontal force is done by verifying the displacement and bending stress at pile head using Chang’s formula shown in Figure 2-25. Since the modulus of Elasticity of soft clay in the vicinity of pile head is very small, it is apparent that the pile specification and number will be determined by horizontal force.

In case of the position change of piles at the time of construction, the safety for the horizontal bearing capacity shall be secured with placing the same number of piles setting at the design stage. Regarding the vertical bearing capacity, the change in the pile reaction shall be small and be still within the allowable limit.



Differential equations of deflection curves		Portion above the ground: $EI\frac{d^4y_1}{dx^4}=0$ Portion in the ground: $EI\frac{d^4y_2}{dx^4}+p=0$ $p=k_H D y_2$ *H*: lateral force of a pile (N) *Mt*: moment as external force at the pile head (N·mm) *D*: pile diameter (mm) *E*: Young’s modulus of the pile (N/mm^2)	*I*: moment of inertia of the pile cross section (mm^4) k_H: coefficient of horizontal subgrade reaction (N/mm^3) *h*: height above the ground surface where H and Mt act (mm) $\beta=\sqrt[4]{k_H D/4EI}\,(mm^{-1})$ $h_0=\frac{M_t}{H}(mm)$	
State of a pile		Pile embedded in the ground (h = 0)		
Deflection curve and bending moment diagram		a) Basic system	b) When M_t = 0 (h0 = 0)	c) When the pile head does not rotate
a	Deflection curve, *y* (mm)	$y=\frac{H}{2EI\beta^3}e^{-\beta_x}\left[(1+\beta h_0)\cos\beta_x-\beta h_0\sin\beta_x\right]$	$y=\frac{H}{2EI\beta^3}e^{-\beta_x}\cos\beta_x$	$y=\frac{H}{4EI\beta^3}e^{-\beta_x}\left[\cos\beta_x+\sin\beta_x\right]$

Figure 2-25 General Formulas for Lateral Forces and Moments as External Forces

(Source: Specification for Highway Bridges Part IV Substructures, Japan Road Association, March 2002, P.339.)

e) Auxiliary structures

e-1) Grouting Hole

As same as the present situation, space can be created between the bottom slab of suction pit of new EPH and the ground surface as a result of the future land subsidence. As a countermeasure for this situation, grouting hole is provided at the bottom slab of partition space behind the Suction Pit of EPH.

e-2) Discharge Pipe Pit

Since discharge pipe pit will be installed above ground over the existing discharge channel, the channel shall be backfilled with soil and the upper portion of wall coming out from the designed ground surface shall be demolished in order to avoid any adverse effect to the surrounding facilities. Designed ground elevation, where discharge pipes are installed, shall be lower than the existing ground surface to minimize the additional overburden pressure to the existing channel structure, however, not to affect the formation of siphon effect in the discharge pipes and be low enough to secure passage of the pipes under road along side of the Sea Tide Dike.

The inner surface of this pit shall be covered by gravel and gravity drainage for surface water shall be constructed. Also openings in the bottom slab of the existing discharge channel shall be provided prior to backfilling to avoid accumulation of rainwater in the backfilled portion of the channel.

Around the pit, the fence for safety, and steel walkway and stairway for inspection and maintenance shall be furnished.

The existing 20kV power cables presently over crossing the discharge channel shall be reinstalled directly in the ground under the discharge pipes.

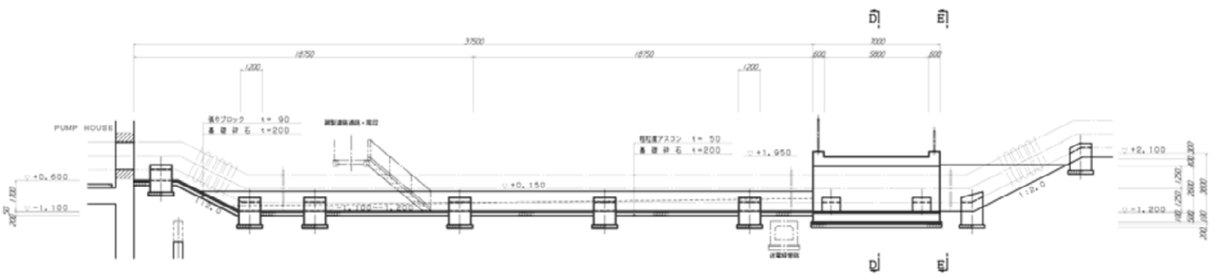


Figure 2-26 Longitudinal Section of Discharge Pipe Pit

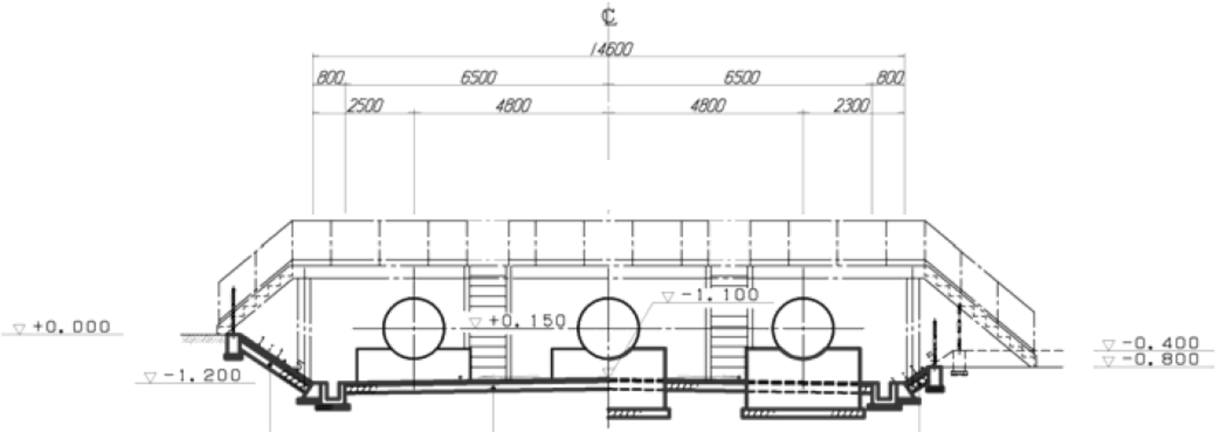


Figure 2-27 Section of Discharge Pipe Pit

(2) Pump House Building Facilities

1) Floor Layout Planning

- Pump room: The space will be enough for installing 3 pump units (5m^3/sec each) and auxiliary machines, and for O & M
- Generator room: The space will be enough for installing 1 generator set (1500kVA) and 1 transformer unit (2000kVA), and for O & M
- Control room: The space will be enough for installing the control panels (width: 800mm) and other panels for O & M
- Standby room: The space will be enough for taking rest for 6 staff (necessary persons for 1 shift) and various types of meetings required for O & M
- Storage: The space will be enough for storing tools and documents (manuals, design documents, daily records, maintenance records, etc.)
- Multipurpose room: The space will be enough for meetings and for panel exhibition, visitors, etc.

2) Height Planning

- Pump room: The minimum height will be determined by construction gage of 20tons overhead traveling crane with consideration of the lifting height (FL+8.1m) of overhead traveling crane for pump installation and maintenance.
- Generator room: The height will be enough to installation and operation of the generator set, exhaust duct and the space for O & M.
- Control room: The height will be enough for the height of panels and for O & M.
- Standby room, storage and multipurpose room: The clearance under beams will be designed as 2.55m in consideration of height of pump room, generator room and control room.

3) Main Structure Planning

- Main structure will be rigid framed structure of reinforced concrete.

4) Finish Planning

- Exterior finish: The roof and balcony will be waterproof, and the wall will be fair finish brick masonry.
- Interior finish: The floor of pump room and control room will be 300mm square tile finish on the cinder concrete.
- Generator room: The floor will be oil proof paint over steel troweled cinder concrete.
- Control room and multipurpose room: Floor will be 300mm square tile finish on the mortared foundation.
- Storage: The floor will be steel toweled concrete.
- The wall will be paint finish over steel troweled mortar and the ceiling will be exposed concrete finish.

5) Planning of Building Facility

- Lighting fixtures, power points, and air supply and exhaust facility will be installed in the each room.
- Lightning rod facility will be installed.

2-2-2-6 Pump Facilities Plan

(1) Design Plan for Pump Facilities

The existing pump facilities have been deteriorated through long time operation, and breakdowns occur frequently. It is necessary to install new high efficient pump facilities because the existing pump facilities cannot adapt to the aboveground discharge pipe line system in the Project. Consequently, all facilities shall be renewed in the Project.

1) Water Discharge System

The water discharge by pump itself is as same as existing one, but water discharge system is aboveground piping from pump outlet to the Java Sea by over-passing the sea tide dike. By making flexible structure for aboveground pipe line, it is possible to secure the easy adjustment of pipe line level for future land subsidence. Over-passing of the reconstructed dike will be more advantageous than existing dike with open mouth for water discharge, which will cause piping phenomenon.

And a siphon breaker will be provided at the highest level of the discharge pipe in order to prevent a backflow of seawater when the pump stops.

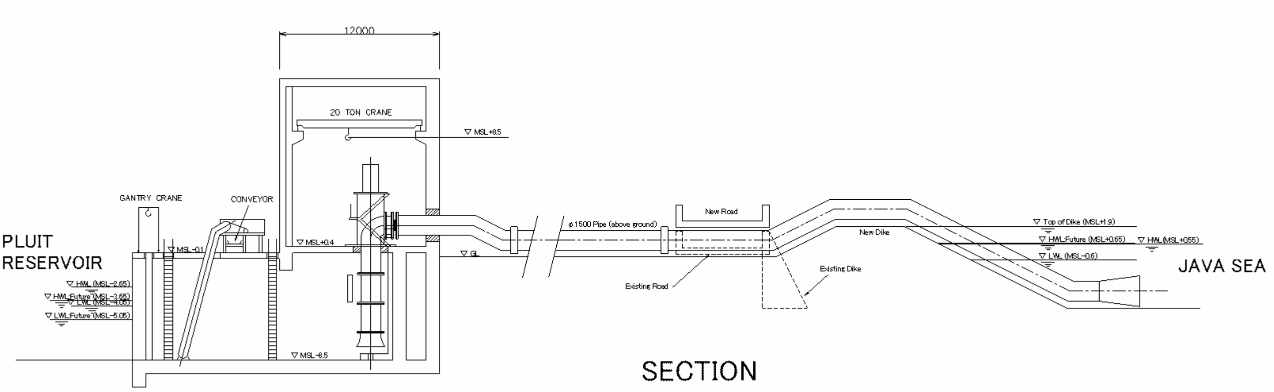


Figure 2-28 Water Discharge System

2) Pump Capacity

As shown in Table 2-10, maximum operating capacity of new pump will be as same as the existing one and will be $10.0m^3$/sec in total. The number of pump units will be three in consideration of the easiness of O&M and construction cost.

Table 2-10 Comparison for Pump Capacity Setup

Item	Unit	Existing	Case 1 (4 Pumps)	Case 2 (3 Pumps)
Nos. of Pumps Installed	Nos.	4	4	3
(Nos. of Pumps in Normal Operatio	Nos.	3	3	2
(Nos. of Pumps in Stand-by)	Nos.	1	1	1
Unit Discharge Capacity		No.1 / No.2 / No.3 / No.4	No.1 / No.2 / No.3 / No.4	No1 / No.2 / No.3
	m^3/s	3.2 / 3.2 / 3.2 / 3.7	3.333 / 3.333 / 3.333 / 3.333	5.0 / 5.0 / 5.0
Total Discharge Volume (All pumps in operation)	m^3/s	13.3	13.3 ○	15.0 ○
Maximum Total Discharge Volume in Normal Operation (Except Stand-by pump)	m^3/s	9.6～10.1	10.0 ○	10.0 ○
Continuous Operation Hours per pump (Always 8 hours in Stand-by			18 hr/day △ Operation hours of each pump is longer and life time of pump is shorter than Case 2.	16 hr/day ○ Operation hours of each pump is shorter and life time of pumps is longer than Case 1.
Floor area required for Pump facility (Pump room and Inflow channel)	m		18.8m wide × 23m long △	15.6m wide × 23m long ○
(Overall Layout)				Pump Layout is more compact than that of Case 1. Overall layout of Pump House is more spacious than Case 1.
Security of Discharge Volume of $10m^3/s$			Same as Case 2 (Even when one pump is out of function, remaining 3 pumps can discharge $10m^3/s$.) ○	Same as Case 1 (Even when one pump is out of function, remaining 2 pumps can discharge 10m3/s.) ○
Easiness of Daily Inspection and O & M			Take longer time than Case 2 because nos. of pumps is more than Case 2. △	Easier than Case 1 because nos. of pumps is less than Case 1. ○
Cost required for Periodical Inspection and Overhaul			Higher. △	Lower. ○
Cost of Electrical Power			Same as Case 2 (Total discharge volume in Normal operation and total head are the same as Case 2.) ○	Same as Case 1 (Total discharge volume in Normal operation and total head are the same as Case 1.) ○
Construction Cost (ratio)			1.00 △	0.98 ○
Overall Evaluation			△	○

3) Design Pump Head

The new pumps will be designed for pump head satisfying with the future ground settlement of 1.0m, and also raising up of sea water level by 14cm in 20 years due to climate change.

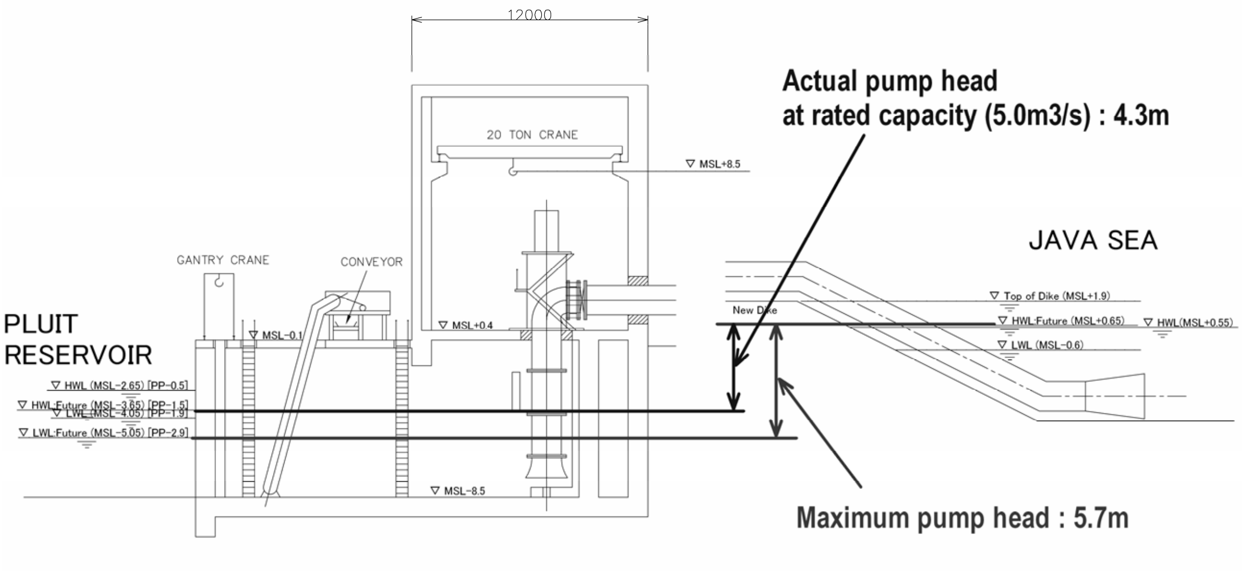


Figure 2-29 Pump Head

4) Main components of New Pump Facilities

The main specifications for the new pump facilities are shown as below.

(Pump facility)

Pump	Type: vertical, mixed flow
	Capacity: 5.0m^3/sec/unit
	Total pump head: 5.8m
	Quantity: 3 units
Generator set	Type: vertical, three-phase induction motor, direct connection with pumps
	Motor Power: 375kW
	Quantity: 3 units
Discarge valve	Type: motor driven butterfly valve
	Diameter: 1500mm dia.
	Quantity: 3 units
Siphon breaker	Purpose: to prevent a backflow of seawater when the pump stops
	Place: the highest point of the discharge pipe
	Type: automatic air driven valve, vertical, axial flow
	Diameter: 200mm dia.
	Quantity: 3 units

(Emergency generator facility)

Emergency generator	Type: package form, silencer type (75dBA 1m from generator side) Capacity: 1250kVA, 1500 kVA for 2 pump units operation Quantity: 1 unit
Fuel tank	Type: box form installed in a generator room Capacity: 750 L Quantity: 1 unit Material: steel
Fuel Transfer Pump	Purpose: to transfer fuel from the existing fuel tank to the new fuel tank Type: gear pump installed in a generator room Capacity: 20 L/min/unit Quantity: 2 units for 2 pump units operation

(Screen and auxiliaries)

Screen	Type: rotary type Quantity: 3 units Mesh spacing: 75mm Material: steel Motor output: 3.7kW
Stop log	Purpose: to maintain screen and auxiliaries Quantity: 3 sets for 3 units of pump facilities Material: steel Installation: to set and remove by chain blocks
Horizontal belt conveyer	Type: trough conveyor Quantity: 1 unit Motor output: 2.2kW
Trash storage container	Type: box form Capacity: $1.0m^3$ Material: stainless steel. Quantity: 2 units

(Power receiving equipment)

1 set

(Electrical control equipment)

1 set

(Discharge pipe)

Diameter: 1500mm dia.

Quantity: 3 sets

Material: steel (on the ground), stainless steel with concrete protection (in the sea)

(2) General Layout of Reconstructed East Pump Station

General layout of the reconstructed East Pump Station is shown in Figure 2-30, and drawing No.1 and No.2 in Section 2-2-3. The new pump house will be constructed in the same place as existing pump house, and aboveground discharge pipe line will be installed from discharge outlet of pump up to discharge outlet of pipes in the sea. The main equipment for water discharge are shown below.

1) Screen (3 units)
2) Stop logs (3 sets) and hoist for installation and removal of stop logs(1 set)
3) Horizontal belt conveyor (1 set)
4) Trash storage container (2 units)
5) Discharge pump ($5.0m^3$/sec×3 units): to be installed in the pump house
6) Motor (3 units) : to be installed in the pump house
7) Discharge valve (1500mm dia.×3 units): to be installed in the pump house
8) Overhead traveling crane (20ton×1 unit): required for installation and maintenance of pump facility
9) Discharge pipe (1500mm dia×3 lines)
10) Emergency Generator Set (1250kVA×1 set): to be installed in the generator room (1st floor)
11) Transformer (2000kVA×1 unit): to be installed in the generator room (1st floor)
12) Control panel (1 set): to be installed in the control room (2nd floor)

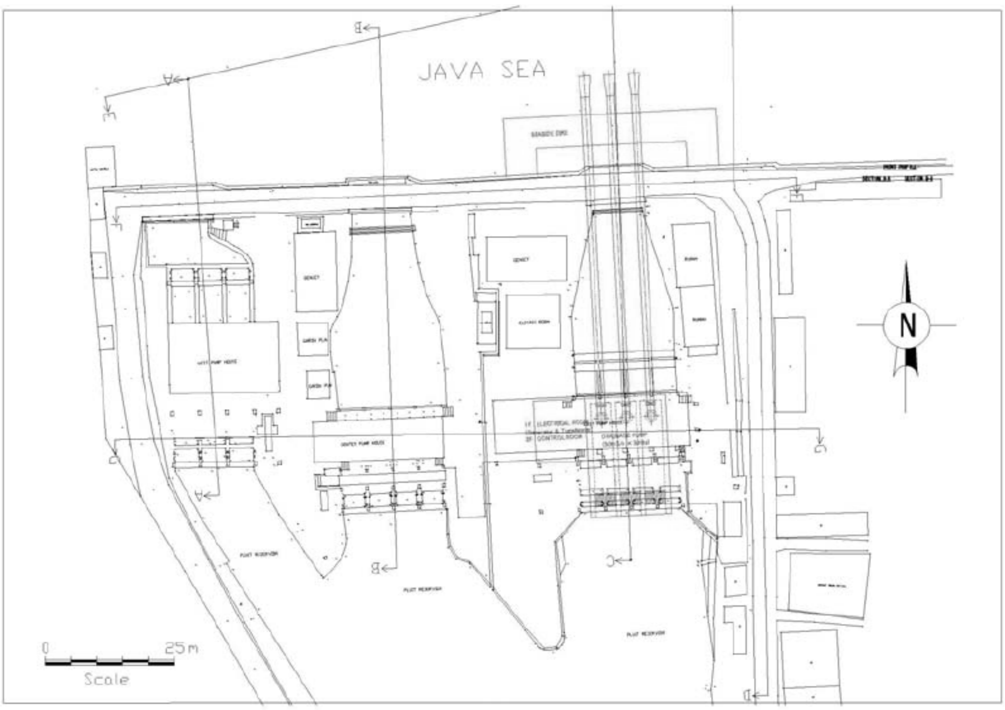


Figure 2-30 General Layout of Reconstructed East Pump Station

(3) Electrical Power Supply System

It will be necessary to relocate existing PLN panel presently installed in EPH and build new PLN power receiving panel in the different place. The power cables in the existing panel are shown in the following figure:

The electrical power system is shown in the drawing No.20 Single Line Diagram in Section 2-2-3. The electrical power to existing East and Central Pump Stations is supplied by common electrical facility (transformer: 1250kVA×3 units, and Generator sets: 530kVA×3 units), but capacity of these facilities is not enough as explained in the next section. Therefore the new power supply facility will be constructed in this Project. Existing and new power supply system to pump is shown in Figure 2-31.

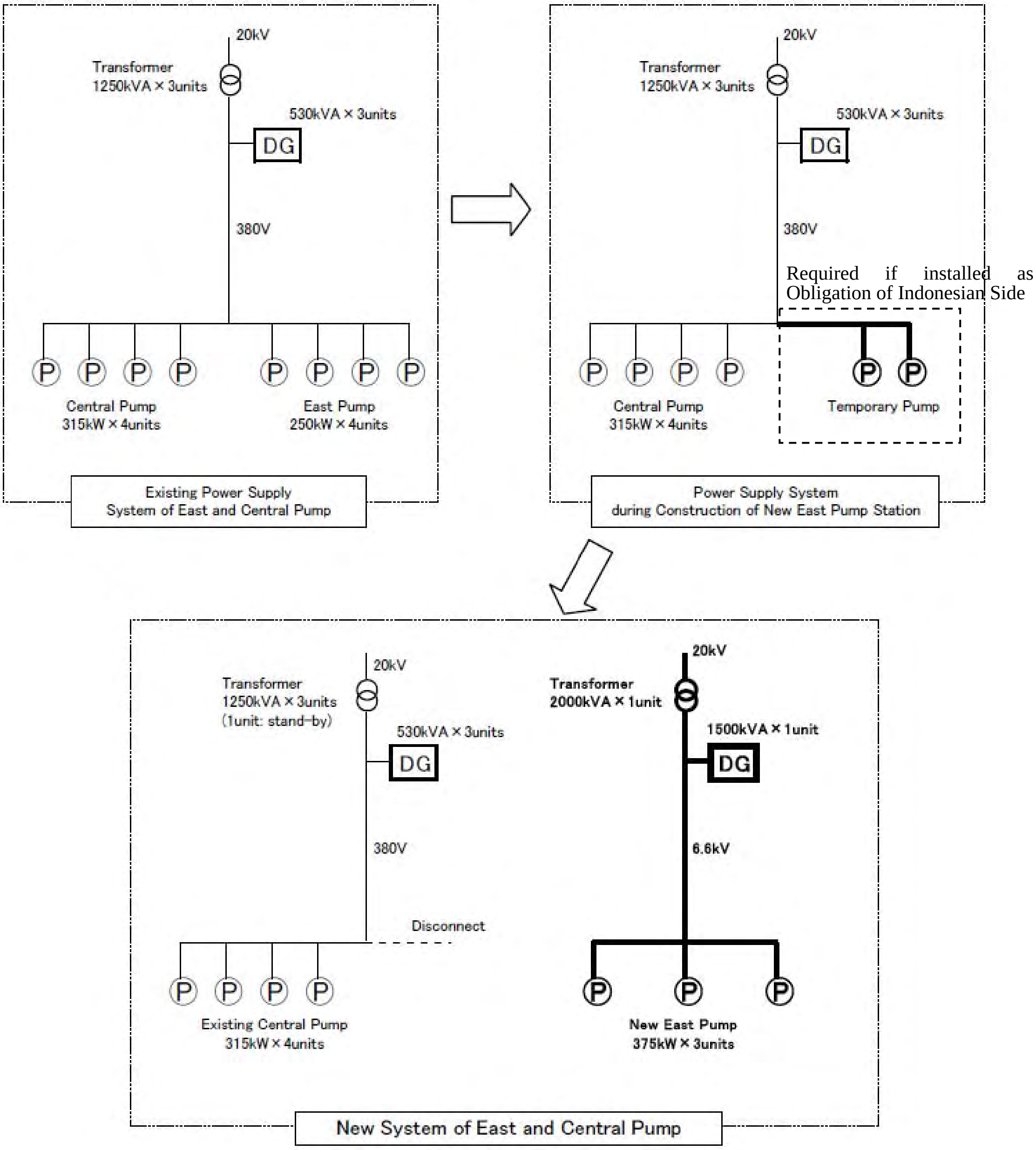


Figure 2-31 Power Supply System

(4) Emergency Diesel Engine Generator Set

Outline of existing emergency generator sets in Pluit Pump Station is shown in Table 2-11. The emergency generator set in West Pump Station has the capacity to operate 2 daily use pumps, but the capacity of the generator sets in East and Central Pump Stations is only for 3 pumps out of 6 daily use pumps.

Table 2-11 Outline of Existing Emergency Generator

	Emergency Generator for East and Central Pump Stations	Emergency Generator for West Pump Station
Number of generators	3 units	1 unit
Capacity	530kVA each (Total: 1590kVA)	1500kVA
Number of pumps with power supplied by the generator sets	East and Central Pump Stations: 3 units (the number of daily use pump: 6 units)	West Pump Station: 2 units (the number of daily use pump: 2 units)

Therefore, the capacity of emergency generator set for reconstructed East Pump Station will be for operating 2 daily pumps, as same as for West Pump Station. Also the existing emergency generator sets for East and Central Pump Stations will be used only for Central Pump Station after completion of the Project.

2-2-2-7 Construction Method

(1) East Pump Station

Existing East Pump Station is facing with the road and the Java Sea in the north side, road and private housing in the east side, existing Central Pump Station in the west side and Pluit Reservoir in the south side. Although the road in the east side of the Pump Station will be used as the access road for construction work, the road is narrow, and it is also used as the residential road at the moment. Therefore, width and length of construction materials and equipment will be restricted. Also special attention will have to be paid to the safety of the residents. As the subsurface soil in the Project site is thick in soft clay deposit, it is necessary to consider the influence of ground deformation in neighboring buildings due to temporary closure and earth retaining works.

Also the site area of Pluit Pump Station is so small that it is difficult to procure the additional area to store equipment and materials, therefore it is necessary to consider using the space over Pluit Reservoir as temporary storage area with use of temporary platform.

In this connection, low vibration and low noise construction method, countermeasures against soft ground, efficient use of the space in the reservoir will be considered during construction.

Reconstruction work of East Pump Station will be carried out in the following sequence of construction works:

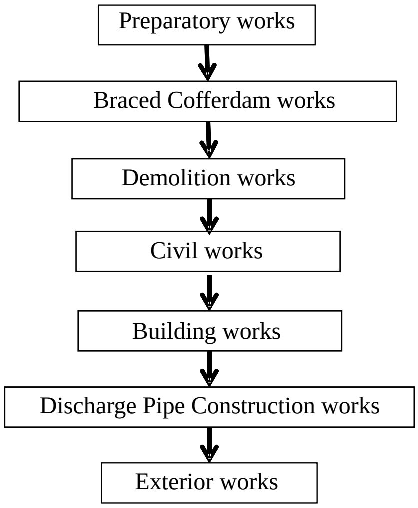


Figure 2-32 Construction Process of East Pump Station

1) Preparatory Works

(i) Topographic survey to confirm the existing condition and to install benchmarks

(ii) Site reconnaissance survey

(iii) Installation of hoarding for safety protection of surrounding residents

(iv) Site leveling

(v) Installation of material storage area and provision of construction roads

(vi) Demolition of existing pump house (aboveground only)

2) Braced Cofferdam Works and Demolition Works

(i) Installation of tied bulkhead with steel pipe sheet piles at the south of existing pump house and sheetpiling with steel pipe sheet piles for other three sides

(ii) Excavation together with demolition of existing concrete structures and installation of struts and wales where necessary

(iii) Demolition of top portion of existing concrete piles while remaining portion of piles left undemolished

3) Civil Construction Works

(i) Installation of Temporary Platform for pile driving

(ii) Pile driving

(iii) Pile head treatment and assembling of reinforcing bars, installation of forms and concrete casting

(iv) Removal of temporary installation except steel pipe sheet pile around the pump house concrete structure

(v) Backfilling

4) Building Construction Works, Pump Facility and Discharge Pipe Installation, and Exterior Works

(i) Construction of Building

(ii) Installation of Pump facilities and discharge pipes

(iii) Exterior works and site cleaning

(2) Sea Tide Dike

Basically sea tide dike construction will be executed on the sea, and construction equipment and materials will be transported from nearest quay by salvage barge. Low vibration and low noise construction method is adapted for pile-driving works, and it is necessary to take preventive measures against sea water pollution during construction work such as dredging and installation of rubble-mound. Also it is necessary to follow the maritime regulation to secure safety of ships near the construction site during construction.

In consideration of the climate condition and minimum operation of Central and West Pump Stations, construction work of Sea Tide Dike will be carried out in the following 3 construction stages:

- 1st stage: construction of Sea Tide Dike in front of East Pump Station in parallel with the civil work of East Pump Station
- 2nd stage: construction of Sea Tide Dike in front of Central Pump Station in the dry season in 2012
- 3rd stage: construction of Sea Tide Dike in front of West Pump Station in the dry season in 2013

Construction process of Sea Tide Dike is shown in Figure 2-33.

1st stage:

Construction of Sea Tide Dike in front of East Pump Station in parallel with the civil work of East Pump Station

Step1

① Preparatory Works
- Bathymetric Survey
- Detailed Investigation of Existing Sea Tide Dike

② Dredging of sea bed at the front of Existing Sea Tide Dike to secure required draft of Pile Installation Berge

Step2

① Steel Pipe Sheet Pile installation by Pile Installation Berge

② Pre-treatment (washing and mortar filling) for pile cut

Step3

① Placement of Filling Material from land at the back of Steel Pipe Sheet Piles

② Placement of Rubble Mound from land at the front of Steel Pipe Sheet Piles

Step4

① Construction of Sea Tide Wall on top of Steel Pipe Sheet Piles

↓

2nd stage:

Construction of Sea Tide Dike in front of Central Pump Station in the dry season in 2012

Step5

① Steel Pipe Sheet Pile installation by Pile Installation Berge

② Pre-treatment (washing and mortar filling) for pile cut

③ Pile Installation for Discharge Outlet Channel

Step6

① Excavation inside of Steel Pipe Sheetpiling

② Connection of reinforcing bars for bottom slab and Steel Pipe Sheet Piles, Arrangement of reinforcement and Placement of concrete for bottom slab

③ Arrangement of reinforcement and Placement of concrete for Side Walls and Middle Wall

Step7

① Cutting of Steel Pipe Sheet Pile

② Placement of Filling Material from land at the back of Steel Pipe Sheet Piles

③ Placement of Rubble Mound from land at the front of Steel Pipe Sheet Piles

Step8

① Construction of Sea Tide Wall on top of Steel Pipe Sheet Piles

↓

3rd stage:

Construction of Sea Tide Dike in front of West Pump Station in the dry season in 2013

Step9

① Steel Pipe Sheet Pile installation by Pile Installation Berge

② Pre-treatment (washing and mortar filling) for pile cut

③ Pile Installation for Discharge Outlet Channel

Step10

① Excavation inside of Steel Pipe Sheetpiling

② Connection of reinforcing bars for bottom slab and Steel Pipe Sheet Piles, Arrangement of reinforcement and Placement of concrete for bottom slab

③ Arrangement of reinforcement and Placement of concrete for Side Walls and Middle Wall

Step11

① Cutting of Steel Pipe Sheet Pile

② Placement of Filling Material from land at the back of Steel Pipe Sheet Piles

③ Placement of Rubble Mound from land at the front of Steel Pipe Sheet Piles

Step12

① Construction of Sea Tide Wall on top of Steel Pipe Sheet Piles

Figure 2-33 Construction Process of Sea Tide Dike

2-2-2-8 Confirmation of Pump Operation of Pluit Pump Station

(1) Inflow into Pluit Pump Station

At present, three rivers (Ciliwung River, Cideng River and Duri River) flow into Pluit Reservoir and overflow occurs in several portions of these rivers because the flow capacity of each river is not enough. Therefore, the inflow volume into Pluit Reservoir shall be at large 130m^3/sec as shown in the following figure:

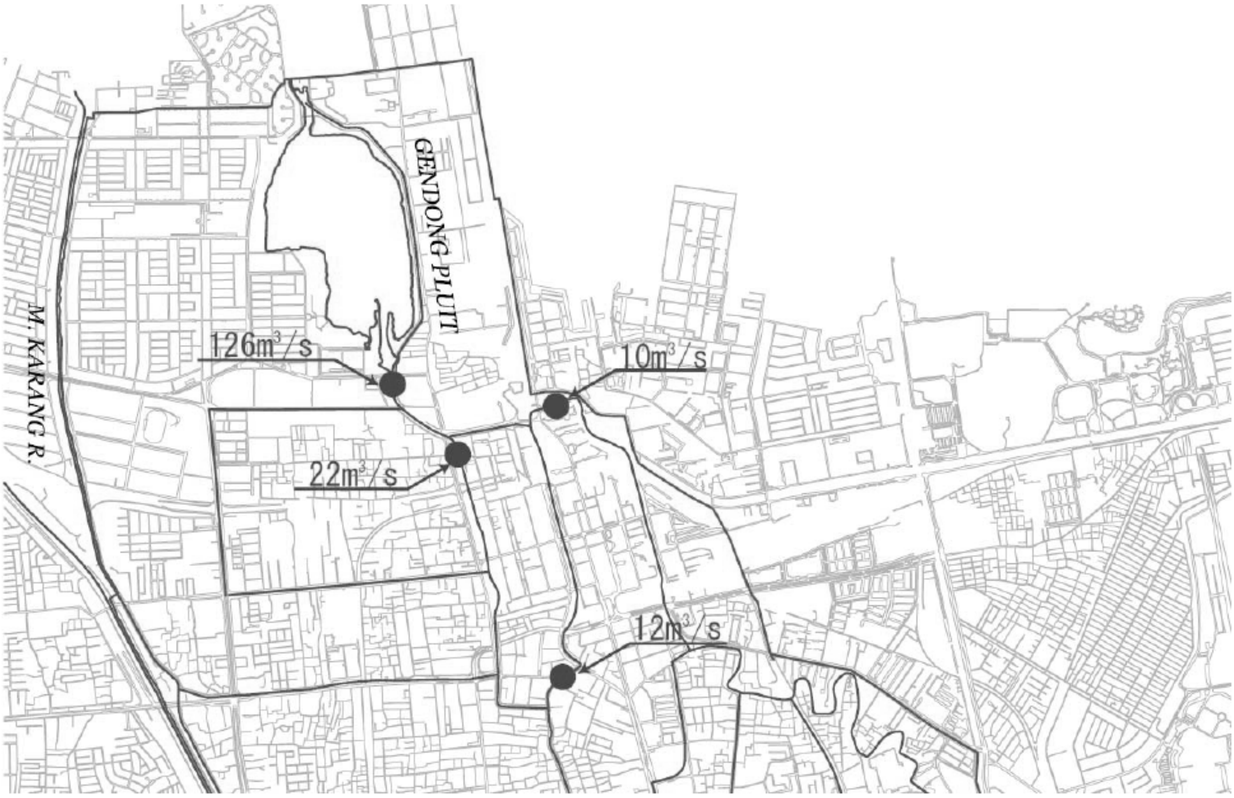


Figure 2-34 Minimum Flow Capacity Point Close to Pluit Pump Station

(2) Present Drainage Capacity of Pluit Pump Station

1) Estimation of Target Hydrograph

H-V curve of Pluit Reservoir, which obtained from the survey conducted in November, 2008 by the JICA TCP, is adopted to estimate the Inflow hyetograph.

Table 2-12 Storage Volume of Pluit Reservoir

Reservoir Water Level (m PP)	Area (m²)	Section Volume (1,000m³)	Total Volume (1,000m³)
0.000	799,633	395	3,290
-0.500	780,749	385	2,895
-1.000	760,127	376	2,510
-1.500	742,430	365	2,134
-2.000	717,860	352	1,769
-2.500	689,129	326	1,417
-3.000	616,010	285	1,091
-3.500	525,232	247	806
-4.000	463,610	215	559
-4.500	398,271	175	233
-5.000	299,734	119	169
-5.500	175,572	47	50
-6.000	13,058	3	3
-6.500	422	0	0

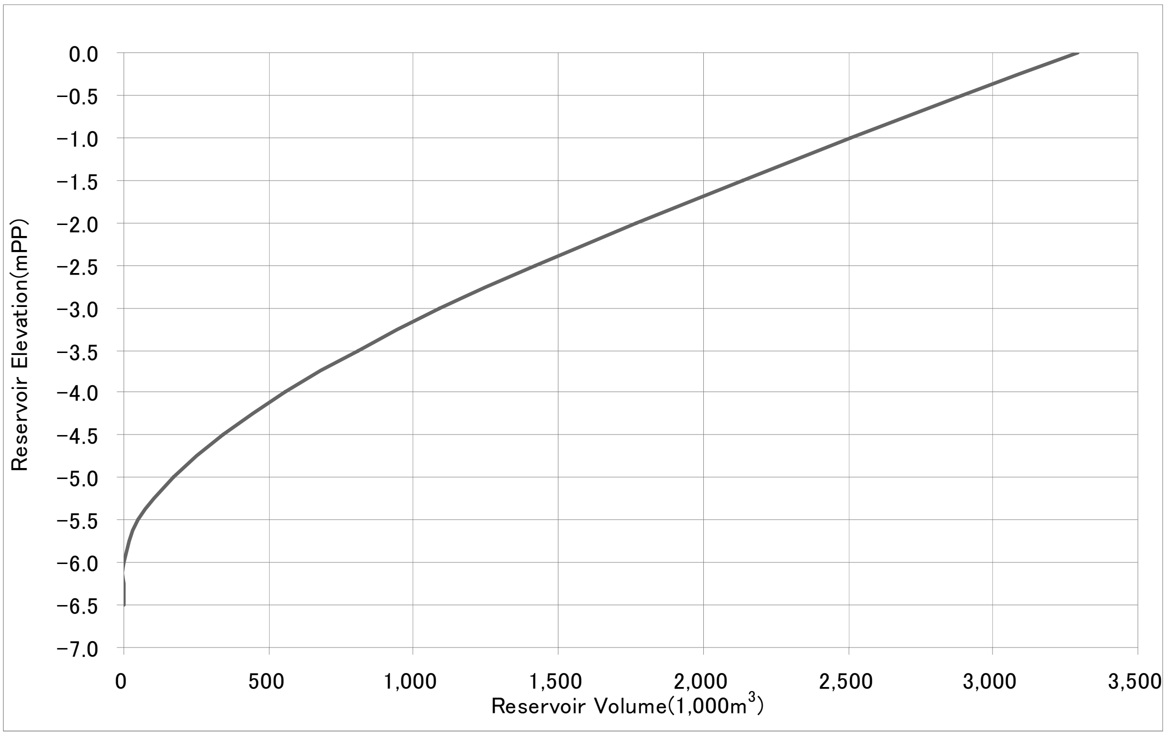


Figure 2-35 H-V Curve of Pluit Reservoir

Figure 2-37 shows the results of simulation of water level at flood in February, 2008 by means of the actual rainfall, observed reservoir water level, pump operation and estimated hydrograph. Water level simulated is in very good coincidence with actual reservoir water level, so hydrograph estimated is judged to be highly adaptable. Therefore, evaluation of pump capacity of Pluit and operation of pumps are studied by applying this Inflow hydrograph.

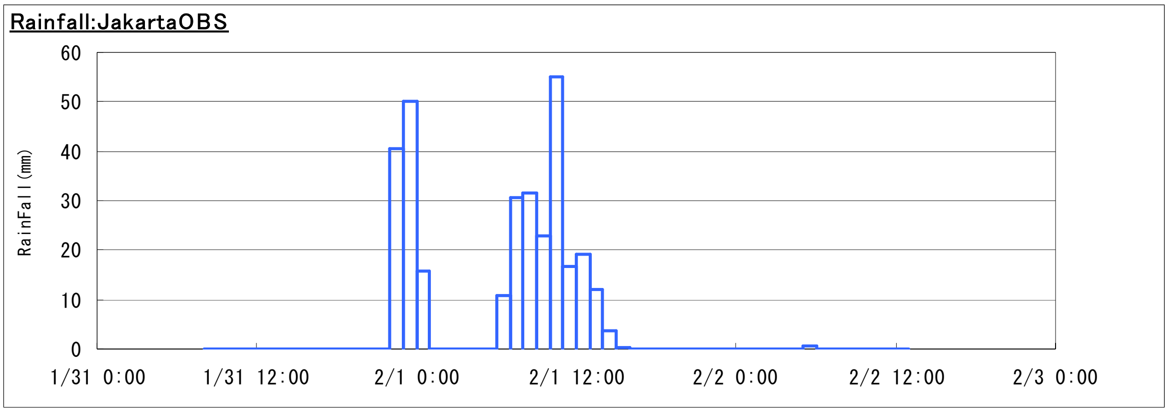


Figure 2-36 Jakarta OBS Hyetograph

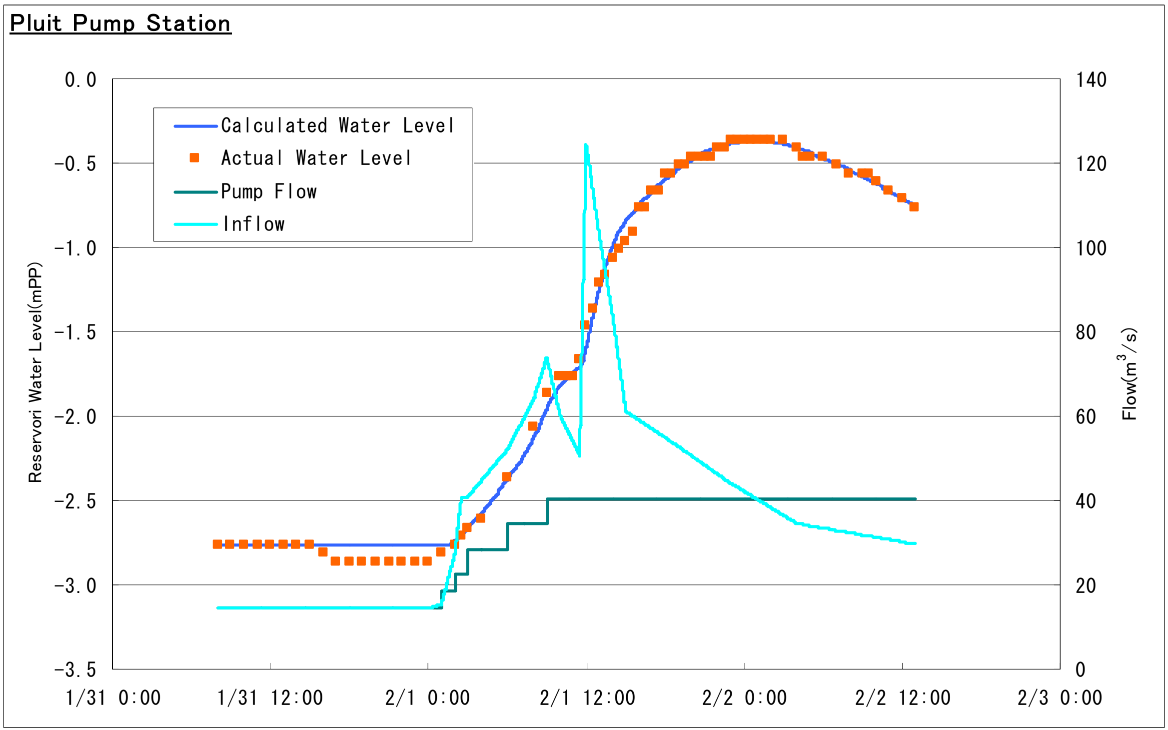


Figure 2-37 Volume and Inflow of Pluit Reservoir

2) Drainage Capacity of Pluit Pump Station and Operation Rules

Drainage capacity of original furnished pump units in Pluit Pump Station and operation rule are shown in Table 2-13 and Table 2-14. At the flood in February 2008, the maximum discharge volume was 40.4m3/sec at maximum and the operation rule was not the same as the permanent one.

Table 2-13 Original Pump Capacity

Pump House	No. of Pumps	Capacity (m^3/s)	Maximum pump suction (m PP)
East	Pump1	3.2	-1.90
	Pump2	3.2	-1.90
	Pump3	3.2	-1.90
	Pump4	3.7	-1.90
	total	13.3	
Middle	Pump1	4.0	-1.90
	Pump2	4.0	-1.90
	Pump3	4.0	-1.90
	Pump4	4.0	-1.90
	total	16.0	
West	Pump1	6.0	-1.40
	Pump2	6.0	-1.40
	Pump3	6.0	-1.40
	total	18.0	
Grand total	11	47.3	

Table 2-14 Present Operation Permanent Rule

Reservoir Water Level	Pumps Operated				Pumps Stop			
	West	Middle	East	Pumping Capacity (m^3/s)	West	Middle	East	
-1.90				0.0	1,2,3	1,2,3,4	1,2,3,4	Maintained on -1.90m
-1.80				0.0	1,2,3	1,2,3,4	1,2,3,4	
-1.70		1,2		8.0	1,2,3	3,4	1,2,3,4	
-1.60		1	1,2	10.4	1,2,3	2,3,4	3,4	
-1.50		3,4	3,4	14.9	1,2,3	1,2	1,2	
-1.40		1,2,3	1,2	18.4	1,2,3	4	3,4	
-1.30		1,2,3,4	3,4	18.4	1,2,3		1,2	Middle pumps fully operated, reserve 1 unit every 8 hours
-1.20		1,2,3,4	3,4	18.4	1,2,3		1,2	
-1.10		1,2,3,4	1,2,3,4	21.6	1,2,3			East pumps fully operated, reserve 1 unit every 8 hours
-1.00	1	1,2,3,4	1,2,3,4	27.6	2,3			West pumps fully operated, reserve 1 unit every 8 hours
-0.90	1,2,3	1,2,3,4	1,2,3,4	33.6				
-0.80	1,2,3	1,2,3,4	1,2,3,4	33.6				
-0.70	1,2,3	1,2,3,4	1,2,3,4	33.6				
-0.60	1,2,3	1,2,3,4	1,2,3,4	33.6				
-0.50	1,2,3	1,2,3,4	1,2,3,4	33.6				

3) Evaluation of Present Drainage Capacity

Present drainage capacity of Pluit Pump Station was evaluated by the unsteady flow analysis under the above mentioned conditions with HEC-RAS. On the evaluating drainage capacity of Pluit Pump Station, water levels of Pluit Reservoir were simulated on each probable rainfall and verified water level of Pluit Reservoir not to be over the maximum water level at the flood in February, 2008.

Hydrograph corresponding to probable rainfall is acquired by multiplying the magnified rate to actual 24 hr rainfall (309.1mm/24hr) of Jakarta OBS in February, 2008. Return period of rainfall in February, 2008 is estimated to be about 1/19 return year. Table 2-15 shows the probable rainfall and magnified rate against rainfall in February, 2008.

Table 2-15 Probable Rainfall

Return period	Probable Rainfall (mm/24hr)	Multiplier
2	150.8	0.488
3	183.9	0.595
4	205.0	0.663
5	220.7	0.714
6	233.2	0.754
7	243.6	0.788
8	252.4	0.817
9	260.2	0.842
10	267.0	0.864
20	311.5	1.008
25	325.6	1.053
30	337.0	1.090
40	355.1	1.149
50	369.0	1.194
60	380.3	1.230
70	389.9	1.262
80	398.2	1.288
90	405.5	1.312
100	412.1	1.333
200	455.0	1.472

Table 2-16 Result of Unsteady Flow Calculation

Return Period (year)	Resevoir H.W.L (mPP)	Water Level by Calculation (mPP)
5	-0.36	-1.18
10		-0.36
15		0.19
Actual		0.59

Results of unsteady flow analysis are shown in Figure 2-38. Present drainage capability of Pluit Pump Station is estimated to be 1/10 return year. With this estimation, the water level and pump discharge volume are calculated as shown in Figure 2-38.

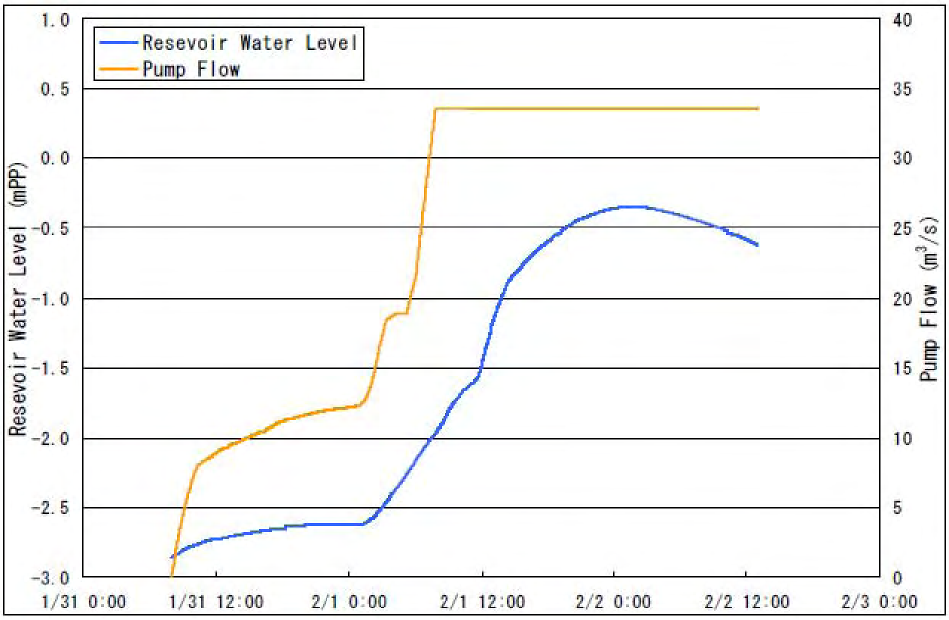


Figure 2-38 Calculation of Water Level and Pump Flow

(3) Effect of Shutdown of East Pump Station

Effect of shutdown of East Pump Station is evaluated by comparing water level of Pluit Reservoir at operation in case of normal condition (present operation rule) with that in case of shutdown of East Pump Station.

1) Condition

At present, pump operation of East Pump Station is stopped.

1/10 Hydrograph given by above mentioned method is applied.

Operation of West Pump Station is started from PP-1.4m.

1 unit of Central and West Pump Stations is reserved from operation respectively.

2) Simulation result

As shown in Figure 2-39, reservoir water level rises by 105cm at shutdown of East Pump Station comparing with operation of flood in February, 2008 due to maximum drainage capacity being decreased from 33.6m^3/sec to 24.0m^3/sec. And evaluation of capacity at shutdown of East Pump Station is estimated to be 1/5 return year.

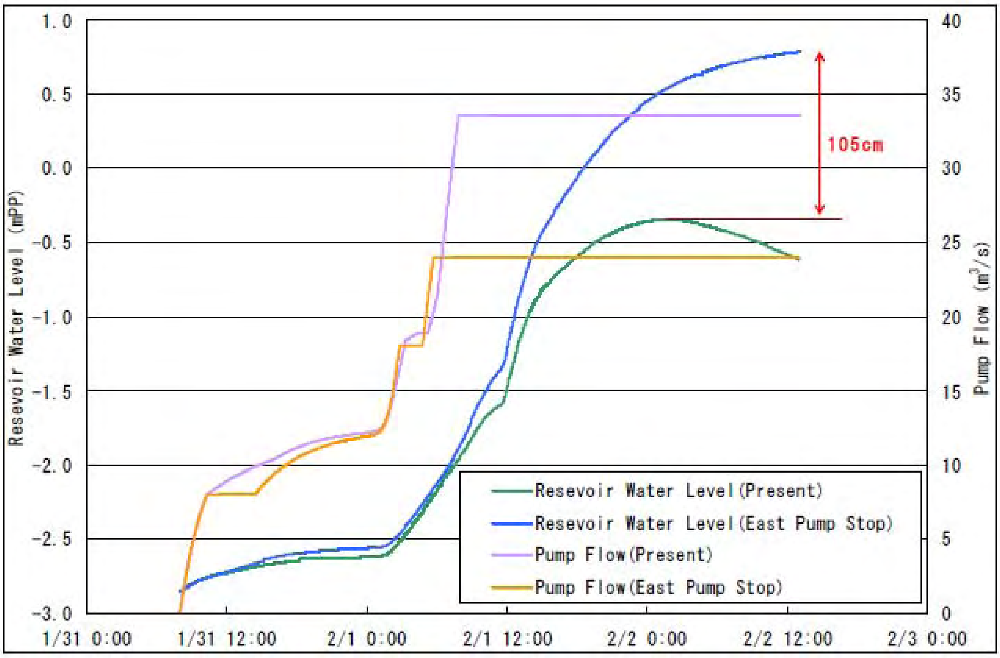


Figure 2-39 Simulation Result of Effect by Shutdown of East Pump Station

(4) Operation Rule during Shutdown of East Pump Station Reconstruction

From above mentioned results, the safety level would become low if the present pump operation rule is continued during shutdown of East Pump Station. To revise the operation rule, the simulation is examined under the following conditions:

- All pump units of West and Central Pump Stations including reserve pumps are to be operated in order to secure the safety
- 2 pump units in East Pump Station are not to be operated as much as possible for a possibility of piping phenomenon
- Temporary pump units shall be installed during the reconstruction for management against the same scale flood as in February 2008. For this flood, the total drainage capacity of 40.4m^3/sec can be secured if all pump units in Central and West Pump Station and 2 pump units in East Pump Station are in operation. Therefore, temporary pump units of equivalent capacity as 2 pumps in East Pump Station shall be installed for an emergency case under responsibility of Indonesian side.

As shown in the following simulation result, the safety level, as same as the present, shall be secured with operation of all pump units in Central and West Pump Stations.

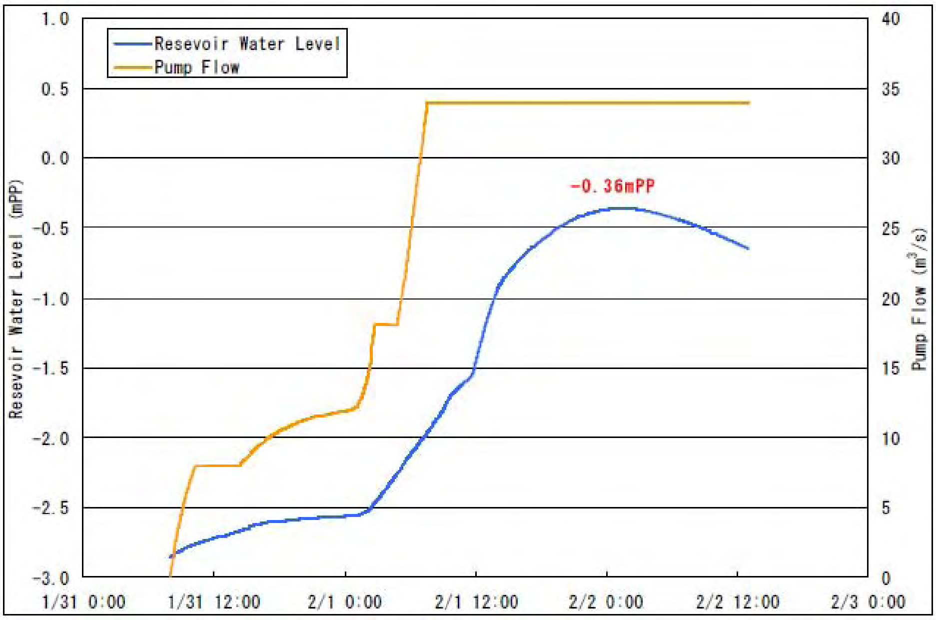


Figure 2-40 Simulation Result during Shutdown of East Pump Station Reconstruction

Table 2-17 Present Operation

Reservoir Water Level	Flow	West			Central				East			
		1	2	3	1	2	3	4	1	2	3	4
0.0	33.6	↑ Reserve 1 unit every 8 hours ↓	6.0	6.0	↑ Reserve 1 unit every 8 hours ↓	4.0	4.0	4.0	3.2	3.2	3.2	↑ Reserve 1 unit every 8 hours ↓
−0.1	33.6		6.0	6.0		4.0	4.0	4.0	3.2	3.2	3.2	
−0.2	33.6		6.0	6.0		4.0	4.0	4.0	3.2	3.2	3.2	
−0.3	33.6		6.0	6.0		4.0	4.0	4.0	3.2	3.2	3.2	
−0.4	33.6		6.0	6.0		4.0	4.0	4.0	3.2	3.2	3.2	
−0.5	33.6		6.0	6.0		4.0	4.0	4.0	3.2	3.2	3.2	
−0.6	33.6		6.0	6.0		4.0	4.0	4.0	3.2	3.2	3.2	
−0.7	33.6		6.0	6.0		4.0	4.0	4.0	3.2	3.2	3.2	
−0.8	33.6		6.0	6.0		4.0	4.0	4.0	3.2	3.2	3.2	
−0.9	33.6		6.0	6.0		4.0	4.0	4.0	3.2	3.2	3.2	
−1.0	27.6			6.0		4.0	4.0	4.0	3.2	3.2	3.2	
−1.1	21.6					4.0	4.0	4.0	3.2	3.2	3.2	
−1.2	18.9					4.0	4.0	4.0			3.2	3.7
−1.3	18.9					4.0	4.0	4.0			3.2	3.7
−1.4	18.4					4.0	4.0	4.0	3.2	3.2		
−1.5	14.9						4.0	4.0			3.2	3.7
−1.6	10.4							4.0	3.2	3.2		
−1.7	8.0						4.0	4.0				
−1.8	0.0											
−1.9	0.0											

Table 2-18 Pump Operation during Shutdown of East Pump Station

Reservoir Water Level	Flow	West			Central				East			
		1	2	3	1	2	3	4	1	2	3	4
0.0	34.0	6.0	6.0	6.0	4.0	4.0	4.0	4.0				
−0.1	34.0	6.0	6.0	6.0	4.0	4.0	4.0	4.0				
−0.2	34.0	6.0	6.0	6.0	4.0	4.0	4.0	4.0				
−0.3	34.0	6.0	6.0	6.0	4.0	4.0	4.0	4.0				
−0.4	34.0	6.0	6.0	6.0	4.0	4.0	4.0	4.0				
−0.5	34.0	6.0	6.0	6.0	4.0	4.0	4.0	4.0				
−0.6	34.0	6.0	6.0	6.0	4.0	4.0	4.0	4.0				
−0.7	34.0	6.0	6.0	6.0	4.0	4.0	4.0	4.0				
−0.8	34.0	6.0	6.0	6.0	4.0	4.0	4.0	4.0				
−0.9	34.0	6.0	6.0	6.0	4.0	4.0	4.0	4.0				
−1.0	28.0		6.0	6.0	4.0	4.0	4.0	4.0				
−1.1	22.0			6.0	4.0	4.0	4.0	4.0				
−1.2	18.0			6.0		4.0	4.0	4.0				
−1.3	18.0			6.0		4.0	4.0	4.0				
−1.4	18.0			6.0		4.0	4.0	4.0				
−1.5	12.0					4.0	4.0	4.0				
−1.6	8.0						4.0	4.0				
−1.7	8.0						4.0	4.0				
−1.8	0.0											
−1.9	0.0											

(5) Operation Rule after Completion of East Pump Station Reconstruction

Furnished pump capacity of East Pump Station is determined to be the same capacity with original ones. For the reconstructed East Pump Station, 15.0m^3/sec (5.0m^3/sec×3 units) capacity is recommended to be installed instead of original capacity 13.3m^3/sec (3.2m^3/sec×3 units+ 3.7m^3/sec×1 unit) of pump units. Total pump capacity after renovation will be 49.0m^3/sec, which is exceed 1.7m^3/sec from original total capacity of 47.3m^3/sec. Therefore, reconstructed East Pump Station can manage the flood in February, 2008 with more safety.

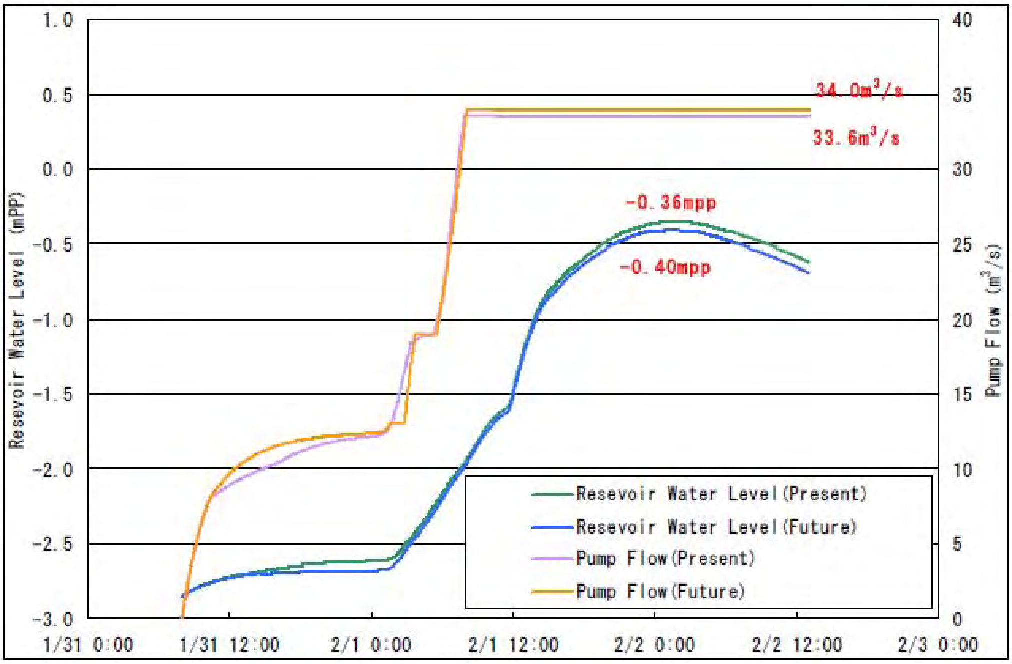


Figure 2-41 Simulation Result of Reservoir Water Level for Present and Future

Table 2-19 Present Pump Operation

Reservoir Water Level	Flow	West			Central				East			
		1	2	3	1	2	3	4	1	2	3	4
0.0	33.6	↑ Reserve 1 unit every 8 hours ↓	6.0	6.0	↑ Reserve 1 unit every 8 hours ↓	4.0	4.0	4.0	3.2	3.2	3.2	↑ Reserve 1 unit every 8 hours ↓
−0.1	33.6		6.0	6.0		4.0	4.0	4.0	3.2	3.2	3.2	
−0.2	33.6		6.0	6.0		4.0	4.0	4.0	3.2	3.2	3.2	
−0.3	33.6		6.0	6.0		4.0	4.0	4.0	3.2	3.2	3.2	
−0.4	33.6		6.0	6.0		4.0	4.0	4.0	3.2	3.2	3.2	
−0.5	33.6		6.0	6.0		4.0	4.0	4.0	3.2	3.2	3.2	
−0.6	33.6		6.0	6.0		4.0	4.0	4.0	3.2	3.2	3.2	
−0.7	33.6		6.0	6.0		4.0	4.0	4.0	3.2	3.2	3.2	
−0.8	33.6		6.0	6.0		4.0	4.0	4.0	3.2	3.2	3.2	
−0.9	33.6		6.0	6.0		4.0	4.0	4.0	3.2	3.2	3.2	
−1.0	27.6			6.0		4.0	4.0	4.0	3.2	3.2	3.2	
−1.1	21.6					4.0	4.0	4.0	3.2	3.2	3.2	
−1.2	18.9					4.0	4.0	4.0			3.2	3.7
−1.3	18.9					4.0	4.0	4.0			3.2	3.7
−1.4	18.4					4.0	4.0	4.0	3.2	3.2		
−1.5	14.9						4.0	4.0			3.2	3.7
−1.6	10.4							4.0	3.2	3.2		
−1.7	8.0						4.0	4.0				
−1.8	0.0											
−1.9	0.0											

Table 2-20 Future Pump Operation

Reservoir Water Level	Flow	West			Central				East			
		1	2	3	1	2	3	4	1	2	3	4
0.0	34.0	↑ Reserve 1 unit every 8 hours ↓	6.0	6.0	↑ Reserve 1 unit every 8 hours ↓	4.0	4.0	4.0	5.0	5.0	↑ Reserve 1 unit every 8 hours ↓	
−0.1	34.0		6.0	6.0		4.0	4.0	4.0	5.0	5.0		
−0.2	34.0		6.0	6.0		4.0	4.0	4.0	5.0	5.0		
−0.3	34.0		6.0	6.0		4.0	4.0	4.0	5.0	5.0		
−0.4	34.0		6.0	6.0		4.0	4.0	4.0	5.0	5.0		
−0.5	34.0		6.0	6.0		4.0	4.0	4.0	5.0	5.0		
−0.6	34.0		6.0	6.0		4.0	4.0	4.0	5.0	5.0		
−0.7	34.0		6.0	6.0		4.0	4.0	4.0	5.0	5.0		
−0.8	34.0		6.0	6.0		4.0	4.0	4.0	5.0	5.0		
−0.9	34.0		6.0	6.0		4.0	4.0	4.0	5.0	5.0		
−1.0	28.0			6.0		4.0	4.0	4.0	5.0	5.0		
−1.1	23.0			6.0		4.0	4.0	4.0	5.0			
−1.2	19.0			6.0			4.0	4.0	5.0			
−1.3	19.0			6.0			4.0	4.0	5.0			
−1.4	19.0			6.0			4.0	4.0	5.0			
−1.5	13.0						4.0	4.0	5.0			
−1.6	13.0						4.0	4.0	5.0			
−1.7	8.0						4.0	4.0				
−1.8	0.0											
−1.9	0.0											

(6) Effect of Duri Pumps

DINAS PU DKI Jakarta have a plan to furnish pumps with its capacity of 6m^3/sec at Duri. Therefore simulation of Pluit Pump Station after completion of Duri Pumps is carried out to examine whether temporary pump units proposed in 2-2-2-8(4) are necessary or not.

1) Simulation Condition

Conditions are as follows:

1. Simulation is carried out for the flood in February, 2008
2. Pluit Drainage Area is 34.2km^2 include Duri Drainage Area
3. Duri Drainage Areas is 4.4km^2.
4. Discharge from Duri Drainage Area is given by the portion of Duri drainage area and Pluit drainage area from inflow of Pluit Reservoir.
5. In case that discharge from Duri drainage area is exceeds 6.0m^3/sec, exceeded discharge is to flow into Pluit Reservoir.

2) Simulation Result

As shown in the following figure, water level of Pluit Reservoir is over about only 10 cm compared with actual operation in February, 2008. Therefore, after completion of Duri Pumps, it can be said that flood in February, 2008 can be managed by the Central and West Pump Stations of Pluit and Duri Pump Station.

This means that Duri Pumps can be considered as alternate temporary pump units during reconstruction of East Pump Station.

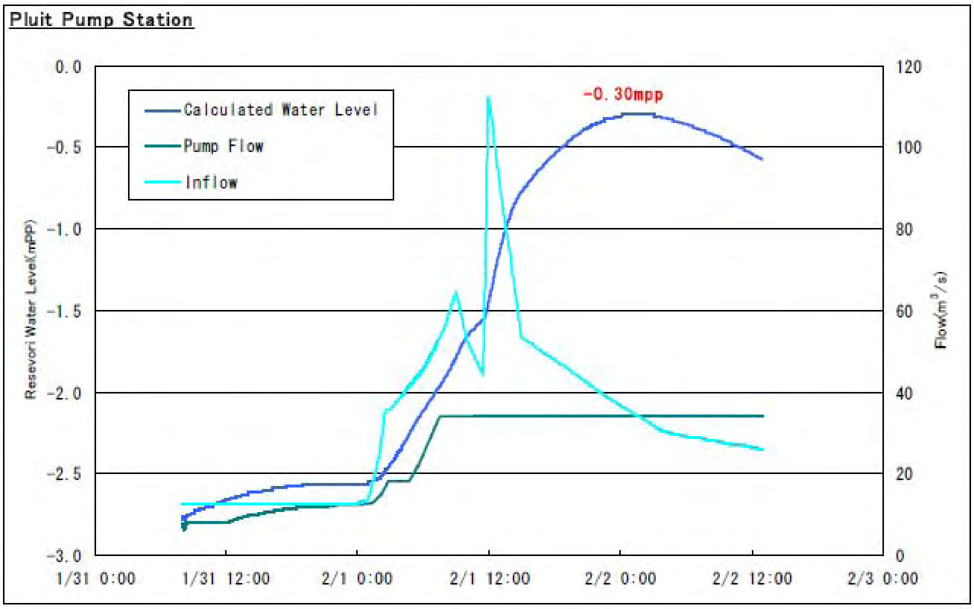


Figure 2-42 Simulation Result of Pluit Reservoir (After Completion of Duri Pumps without Temporary Pump Units)

(7) Adaptation to Climate Change

1) Effect of Climate Change

(i) Occurrence of Climate-Related Floods

Figure 2-42 shows the number of floods occurred in decades between 1960 and 2008 in Indonesia. Number of floods in 9 years after the year 2000 is almost double of floods in the previous decade.

Figure 2-43 shows the frequencies of intervals of occurrence of large scale floods in Indonesia between 1621 and 2007. The figure indicates that the frequencies of occurrence of floods in recent years are very high.

Concentration of population and social stock in Indonesia is accelerating year by year, thus the risk of flood damage in Jakarta is also increasing.

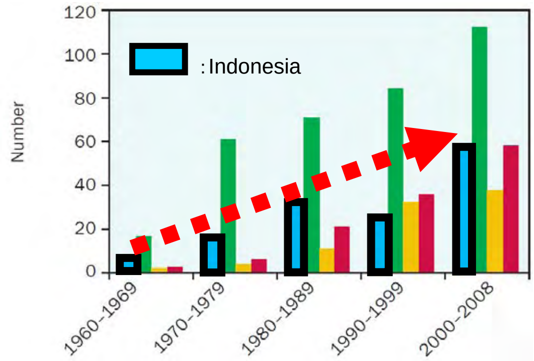


Figure 2-43 Occurrence of Floods

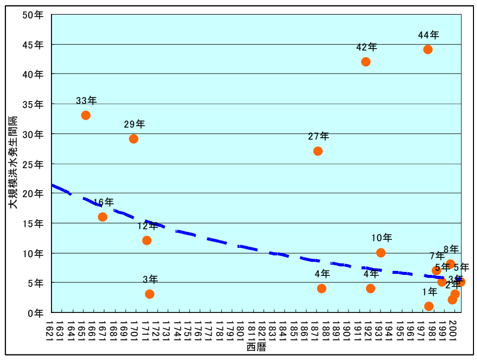


Figure 2-44 Intervals of Large Scale Floods

2) Increase of Precipitation due to Climate Change and Adaptation

(i) Increase of Precipitation due to Climate Change

Increase of precipitation due to Climate Change was estimated based on the rainfall data during more than 20 years observed at the Pondok betung Observatory, which is located in the vicinity of Pluit Pump Station.

Table 2-21 shows the maximum precipitation observed for 1 hour, 6 hours, 12 hours and 24 hours in a year and the average annual rainfall from 1989 to 1998and from 1999 to 2008. Increase rate of precipitation in decade is ranging from 1% to 9 %.

Table 2-21 Rainfall Date at Pondok betung Observatory

Unit：mm

year	1 hour		6 hours		12 hours		24 hours	
	Rain	Date	Rain	Date	Rain	Date	Rain	Date
1982	53.1	1982/7/21	69.4	1982/3/28	69.4	1982/3/28	69.4	1982/3/27
1983	59.3	1983/10/27	74.6	1983/10/27	74.6	1983/10/27	74.7	1983/10/26
1984	55.6	1984/3/17	101.2	1984/5/16	114.4	1984/5/16	114.6	1984/5/16
1985	54.0	1985/4/1	105.4	1985/5/20	105.5	1985/5/20	105.5	1985/5/20
1986	58.8	1986/11/20	153.1	1986/12/14	162.6	1986/12/14	173.9	1986/12/14
1987	68.0	1987/11/9	76.9	1987/12/7	80.5	1987/11/9	81.8	1987/6/5
1988	38.3	1988/10/29	64.7	1988/10/23	105.4	1988/12/19	106.2	1988/12/19
1989	74.1	1989/5/8	81.8	1989/5/8	86.6	1989/2/7	129.2	1989/2/6
1990	83.8	1990/5/31	124.5	1990/5/13	130.7	1990/5/13	130.7	1990/5/13
1991	75.9	1991/5/1	116.6	1991/3/24	118.3	1991/3/24	125.2	1991/3/16
1992	63.5	1992/12/30	116.2	1992/4/24	128.9	1992/4/24	128.9	1992/4/23
1993	81.9	1993/4/22	102.5	1993/4/22	102.7	1993/4/22	130.2	1993/2/8
1994	55.6	1994/4/23	88.9	1994/4/23	89.2	1994/4/23	89.5	1994/1/21
1995	70.0	1995/9/25	104.2	1995/9/25	125.3	1995/6/18	125.3	1995/6/18
1996	70.0	1996/2/11	164.8	1996/2/11	196.1	1996/2/11	213.3	1996/2/11
1997	46.8	1997/3/23	79.5	1997/4/10	83.4	1997/1/14	110.9	1997/1/14
1998	60.0	1998/3/28	76.3	1998/4/16	122.8	1998/3/28	123.8	1998/3/28
1999	54.0	1999/1/14	110.0	1999/1/14	110.3	1999/1/14	113.2	1999/1/14
2000	68.0	2000/2/20	103.4	2000/11/17	103.4	2000/11/17	107.3	2000/11/16
2001	68.5	2001/10/2	103.8	2001/10/2	104.0	2001/10/2	112.9	2001/10/2
2002	109.0	2002/1/23	109.2	2002/1/23	109.9	2002/1/29	128.7	2002/1/22
2003	50.0	2003/5/13	107.4	2003/2/14	130.4	2003/2/14	130.4	2003/2/13
2004	61.7	2004/3/14	93.6	2004/1/31	94.0	2004/1/31	95.9	2004/3/13
2005	63.5	2005/8/3	99.0	2005/3/25	99.0	2005/3/25	109.6	2005/3/24
2006	61.3	2006/4/21	69.4	2006/4/21	69.4	2006/4/21	70.3	2006/1/17
2007	80.0	2006/12/7	187.1	2006/2/2	246.4	2006/2/2	346.3	2006/2/2
2008	70.0	2008/1/29	157.0	2008/2/2	179.6	2008/2/2	209.4	2008/2/2
Ave. 1989～1998	68.16		105.53		118.40		130.70	
Ave. 1999～2008	681.6		113.99		124.64		142.40	
Increase Ratio	1%		8%		5%		9%	

(ii) Adaptation to climate change at Pluit Pump Station

i) Drainage Capacity of Pluit Pump Station

Drainage capacity of Pluit Pump Station under normal operation is equivalent to 1/10 return year and 1/5 return year respectively before and after piping phenomenon of East Pump Station with precipitation without effect of climate change.

ii) Drainage Capacity of Duri Pump Station

DINAS PU DKI Jakarta is planning to construct Duri Pump Station (submerged pump) as temporary pump units during reconstruction of East Pump Station.

Drainage simulation was conducted for the same precipitation as above in consideration of completion of Duri Pump Station with its capacity of 6.0m^3/sec together with Pluit Central and West Pump Stations, namely 6.0m^3/sec at Duri, 16.0m^3/sec with all 4 pumps in operation at Pluit Central Pump Station and 18.0m^3/sec with all three pumps in operation at Pluit West Pump Station. As a result, the water level in Pluit Reservoir is estimated as -0.28m in 1/10 return year, which is equivalent to the return period of the drainage capacity of Pluit Pump Station before piping phenomenon.

iii) Evaluation of Drainage Capacity with precipitation increase due to climate change

Precipitation increase due to climate change after 20 years is estimated considering the service period of new pumps. Increase rate of precipitation per decade is 9% as shown in Table 2-21, therefore, increase rate in 20years will be estimated as 18%.

Drainage simulation is conducted for flow volume with 18% more than that in 1/10 return year as precipitation affected by climate change based on full operational drainage capacity of Duri Pump Station (6.0m^3/sec) in addition to Pluit Central and West Pump Stations (34.0 m^3/sec:16.0 m^3/sec +18.0 m^3/sec). As a result, the maximum water level of Pluit Reservoir is estimated as 0.30m, which is more than 1.0m higher than that of precipitation in 1/10 return year. This shows that total full operational drainage capacity of Duri Pump Station together with Pluit Central and West Pump Stations is not enough to manage precipitation affected by climate change after 20 years.

iv) Adaptation to Climate Change

Drainage simulation is carried out for the same flow volume as above iii) with full operational drainage capacity of Duri Pump Station (6.0m^3/sec), Pluit Central Pump Station (16.8m^3/sec), West Pump Station (18.0m^3/sec) and East Pump Station (15.0m^3/sec) as emergency situation.

As a result, the maximum water level in Pluit reservoir will be -0.34m, which is approximately as same as HWL of the reservoir. If all pumps in Duri Pump Station and Pluit Pump Station will be in operation as emergency situation, it will be manageable to drain rainwater affected by climate change even after 20 years.

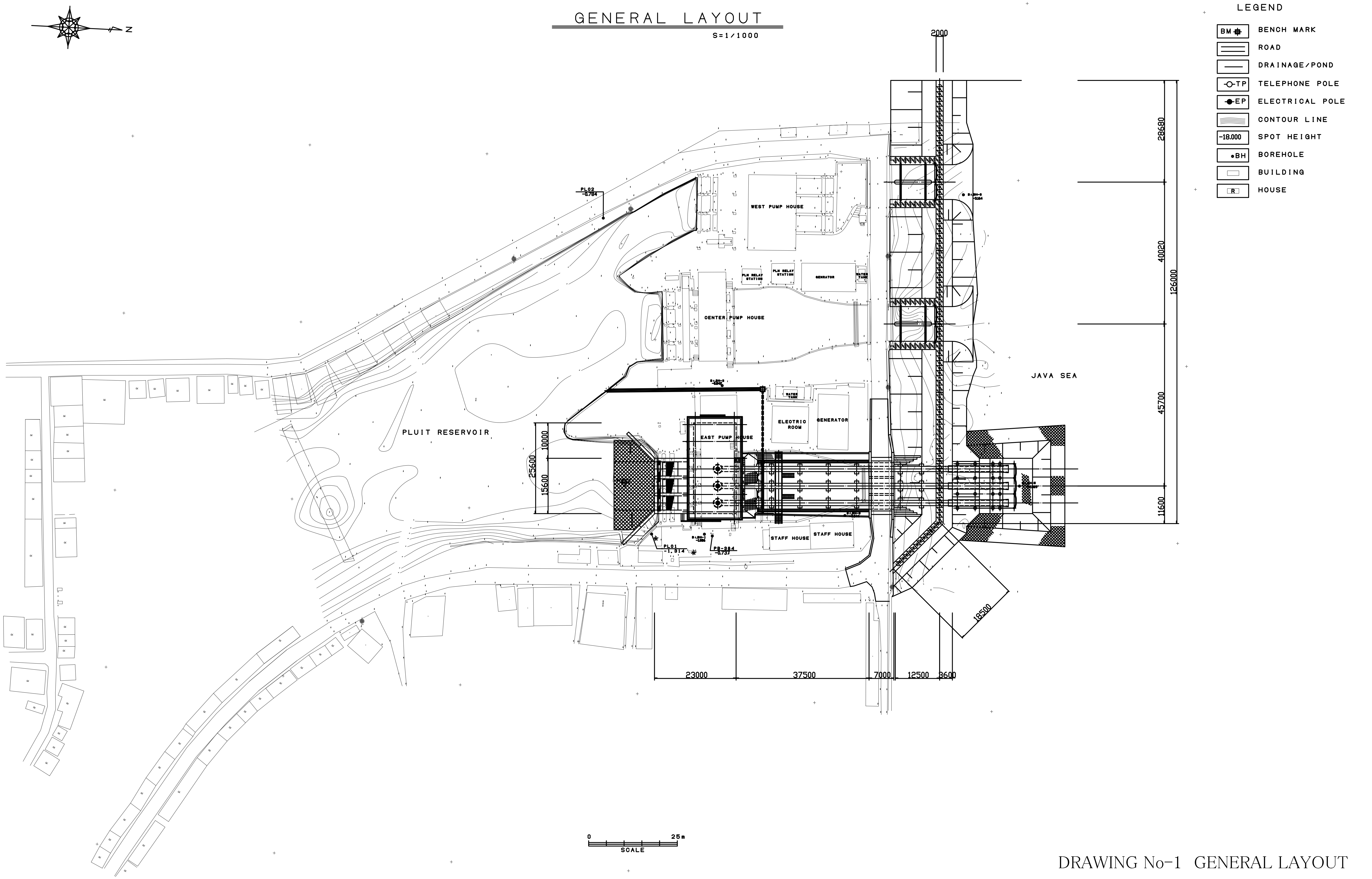
2-2-3 Outline design drawings

The outline design drawings are as follows:

No.	Title
1	GENERAL LAYOUT
2	GENERAL OUTLINE (1/3)
3	GENERAL OUTLINE (2/3)
4	GENERAL OUTLINE (3/3)
5	PUMP STATION STRUCTURAL DRAWING (1/4)
6	PUMP STATION STRUCTURAL DRAWING (2/4)
7	PUMP STATION STRUCTURAL DRAWING (3/4)
8	PUMP STATION STRUCTURAL DRAWING (4/4)
9	WING WALL STRUCTURAL DRAWING
10	PILING ARRANGEMENT
11	DISCHARGE PIPE PIT STRUCTURAL DRAWING (1/2)
12	DISCHARGE PIPE SYSTEM STRUCTURAL DRAWING (2/2)
13	SEA TIDE WALL (1/2)
14	SEA TIDE WALL (2/2)
15	CENTRAL AND WEST DISCHARGE OUTLET
16	BUIDLING WORK OF EAST PUMP HOUSE (SECTION AND ELEVATION)
17	BUIDLING WORK OF EAST PUMP HOUSE (PLAN)
18	MECHANICALACHINARY AND ELECTORICAL FACILITY LAYOUT (ELEVATION)
19	MECHANICALACHINARY AND ELECTORICAL FACILITY LAYOUT (PLAN)
20	SINGLE LINE DIAGRAM

GENERAL LAYOUT

S=1/1000

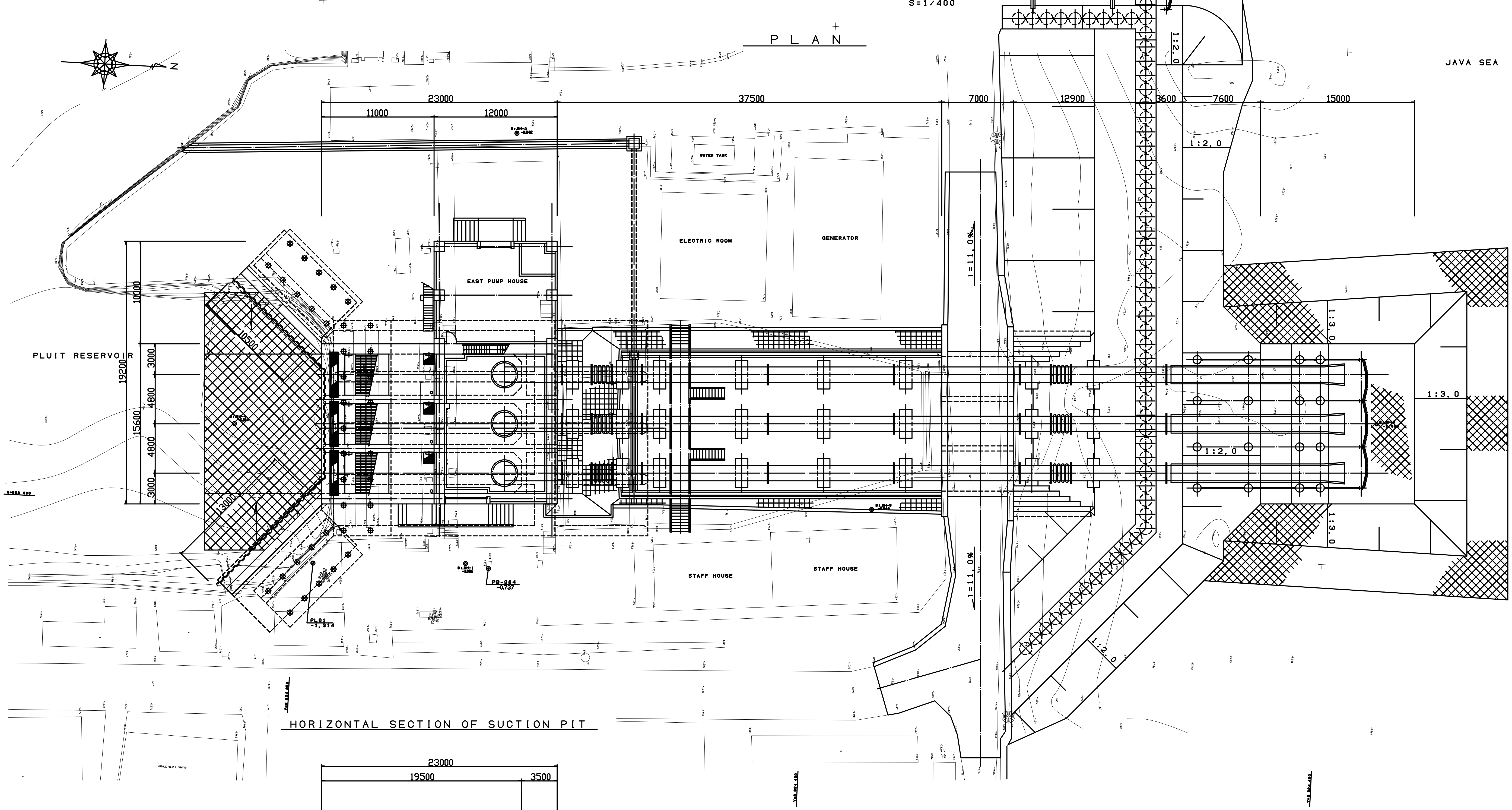


DRAWING No-1 GENERAL LAYOUT

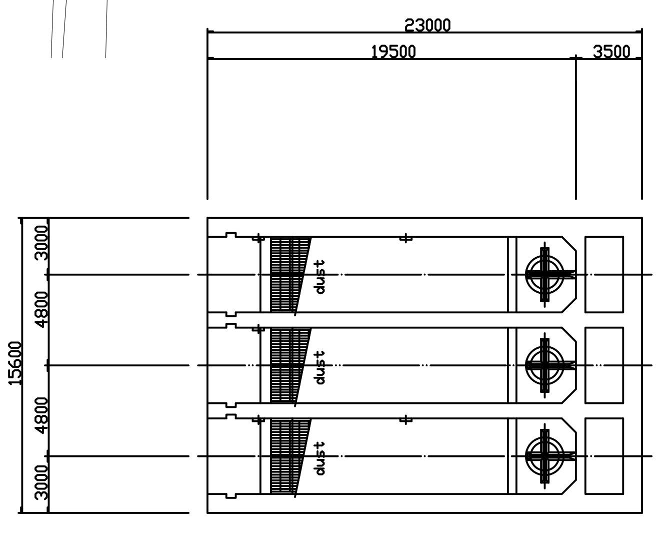
GENERAL OUTLINE (1/3)

S=1/400

PLAN



HORIZONTAL SECTION OF SUCTION PIT



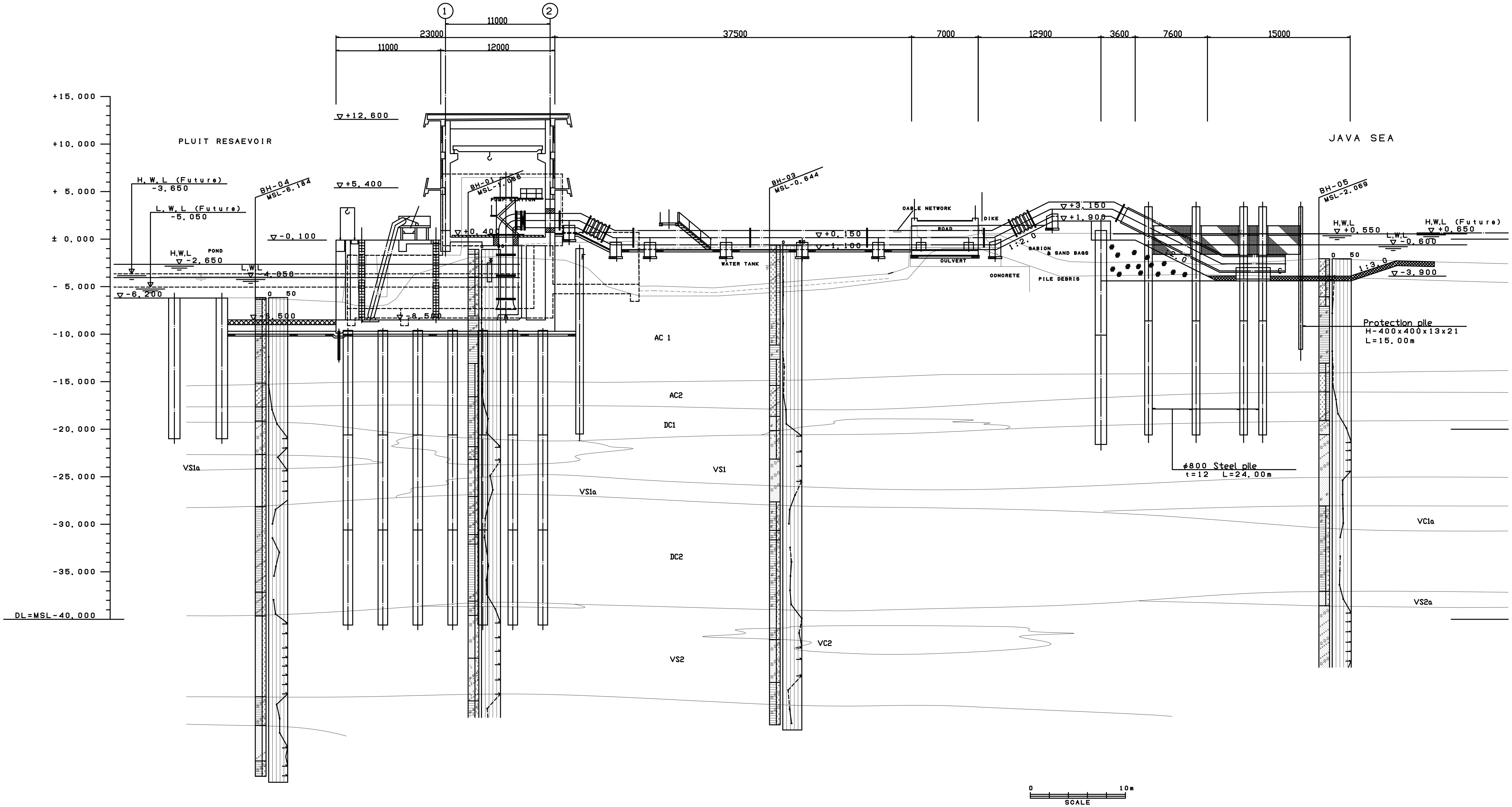
0 10m
SCALE

DRAWING No-2 GENERAL OUTLINE(1/3)

GENERAL OUTLINE (2/3)

S=1/400

LONGITUDINAL SECTION

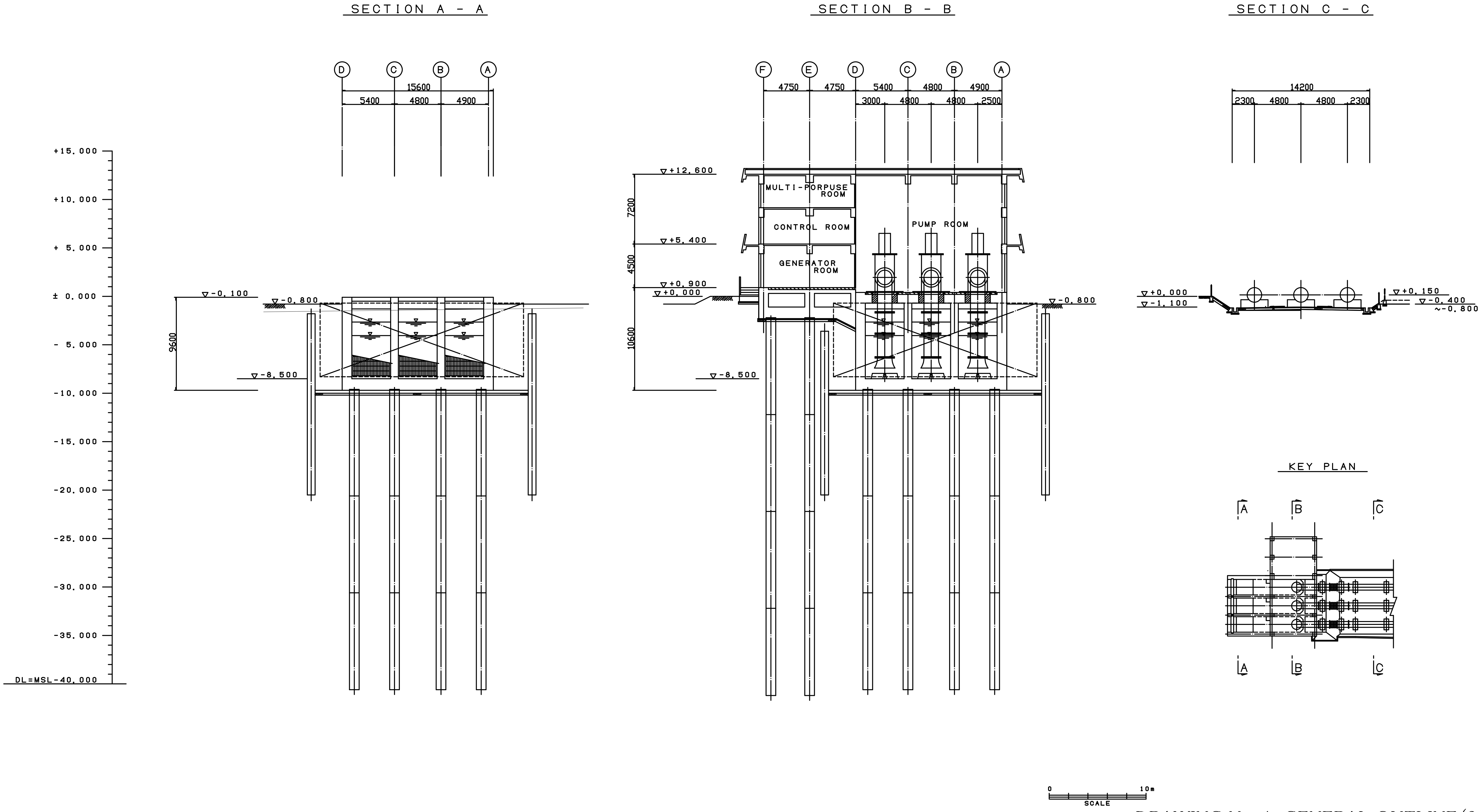


DRAWING No-3 GENERAL OUTLINE(2/3)

GENERAL OUTLINE (3/3)

S=1/400

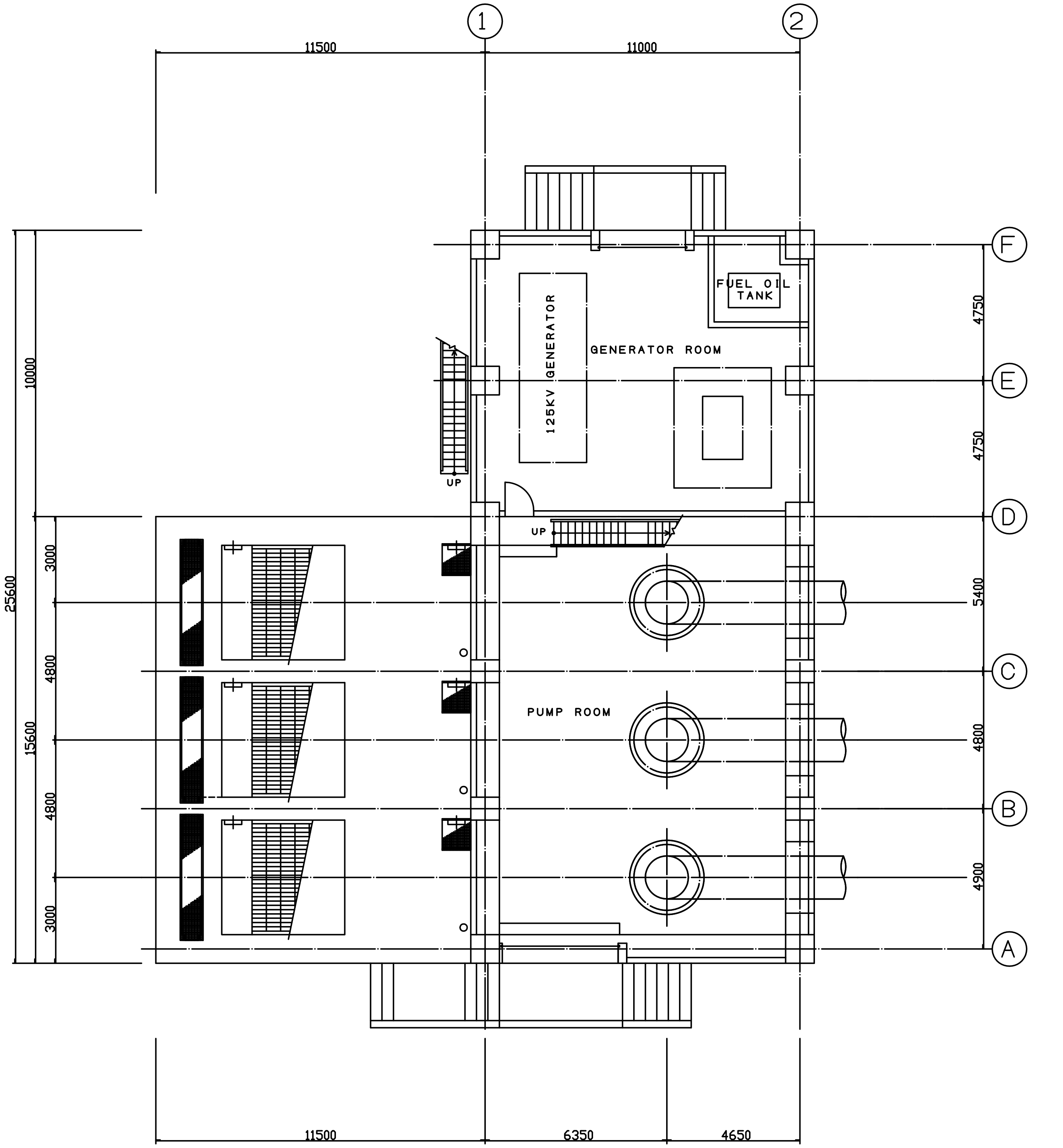
TRANSVERSAL CROSS SECTION

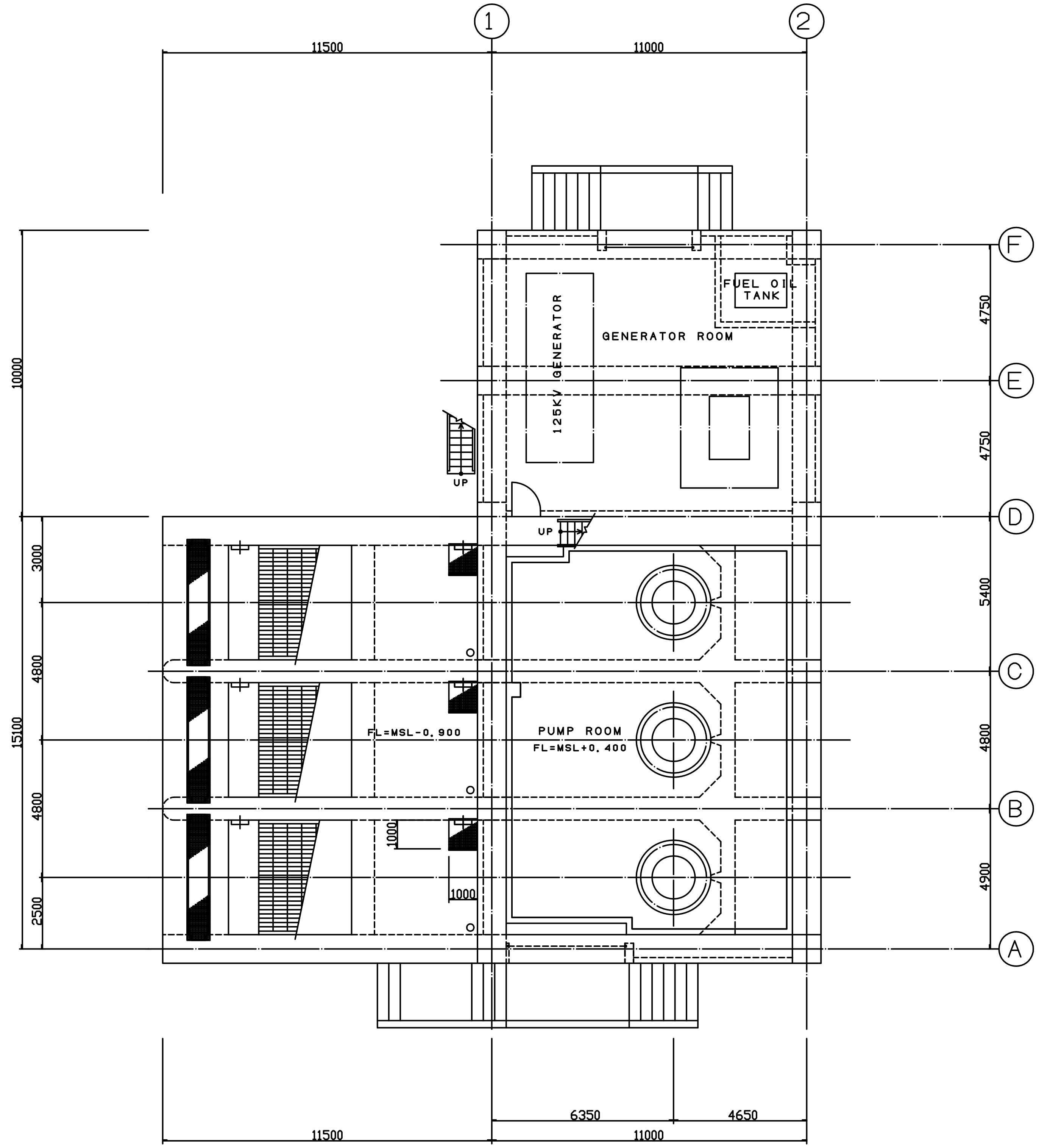


DRAWING No-4 GENERAL OUTLINE(3/3)

PUMP STATION STRUCTURAL DRAWING (1/4)

S=1/200





0 5m SCALE

PUMP STATION STRUCTURAL DRAWING (2/4)

S=1/200