Directorate General of Water Resources
Ministry of Public Works
The Republic of Indonesia

PREPARATORY SURVEY REPORT ON THE PROJECT FOR URGENT RECONSTRUCTION OF EAST PUMP STATION OF PLUIT IN JAKARTA, THE REPUBLIC OF INDONESIA

JUNE 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

YACHIYO ENGINEERING CO., LTD.

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PREFACE

Japan International Cooperation Agency (JICA) conducted the preparatory survey on the Project for Urgent Reconstruction of East Pump Station of Pluit in Jakarta in the Republic of Indonesia.

JICA sent to Indonesia a survey team from 21st October to 18th December, 2009.

The team held discussions with the officials concerned of the Government of Indonesia, and conducted a field survey at the survey area. After the team returned to Japan, further studies were made. Then, a mission was sent to Indonesia in order to discuss a draft outline design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Indonesia for their close cooperation extended to the teams.

June, 2010

Kikuo Nakagawa
Director General
Global Environment Department
Japan International Cooperation Agency

June, 2010

LETTER OF TRANSMITTAL

We are pleased to submit to you the preparatory survey study report on the Project for Urgent Reconstruction of East Pump Station of Pluit in Jakarta in the Republic of Indonesia.

This survey was conducted by Yachiyo Engineering Co., Ltd., under a contract to JICA, during the period from October, 2009 to June, 2010. In conducting the survey, we have examined the feasibility and rationale of the project with due consideration to the present situation of Indonesia and formulated the most appropriate outline design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Toshio Yano

Project Manager,
Preparatory Survey Team on
The Project for Urgent Reconstruction of East
Pump Station of Pluit in Jakarta in the Republic
of Indonesia.
Yachiyo Engineering Co., Ltd.

SUMMARY

SUMMARY

The Republic of Indonesia (hereinafter referred to as “Indonesia”) is the one of the largest island countries in Southeast Asia. Indonesia has a population of 228 million people and a land area of 1.89 million square kilometers with its GDP per capita of approximately 2,239 dollars in 2008.

Jakarta is located on the northwestern coast of the island of Java in Indonesia. Jakarta is the core city of Jakarta Metropolitan Area which has been developed and urbanized rapidly. However, Jakarta Metropolitan Area is quite prone to flooding because of its geographic formation on alluvial fan deposit. Moreover, the potential damage by flooding has been increased by high population density and properties in this flood hazard area. The Government of Indonesia (hereinafter referred to as “GOI”) developed the drainage and flood control basic plan in 1973 and has implemented the drainage works, however, huge scale floods occurred in 1976, 1996, 1998, 2002 and 2007. These floods had paralyzed the function of capital and as a result the areas of Jakarta had turned to chaos. On the other hand, land subsidence has occurred continuously in large area in the capital region of Jakarta. In addition, as a result of global warming, rainfall pattern in a year has been changed to precipitation decrease and increase in rainfall duration in the dry seasons and precipitation increase and decrease in rainfall duration in the rainy seasons. Thus, the frequency and magnitude of flood damage in Jakarta has been increasing year by year.

Under these circumstances, on February 17th, 2009, piping phenomenon underneath the bottom slab of East Pump House (hereinafter referred to as “EPH”) happened suddenly in the east part of Pluit Pump Station, which is one of the fundamental drainage stations in the capital region of Jakarta. A part of facilities sank and sea water flew into Pluit Pump Station and its control reservoir. At present, the Public Works Department, City of Jakarta (hereinafter referred to as “DINAS PU DKI Jakarta”), which is in charge of operation and maintenance of Pluit Pump Station, temporally implemented emergency measures, but all functions of the EPH are stopped.

Although DINAS PU DKI Jakarta intended to restart East Pump Station at first, it was too decrepit to start again because it was constructed more than 45 years ago. Then DINAS PU DKI Jakarta proposed the full reconstruction of East Pump Station. However, it was found that the reconstruction was difficult for DINAS PU DKI Jakarta financially and technically because the site is on the very soft foundation facing the sea, and land subsidence in large area due to dewatering have occurred constantly.

In June 2009, the GOI made a request for Grant Aid for the Project for Urgent Reconstruction of East Pump Station of Pluit in Jakarta in the Republic of Indonesia (hereinafter referred to as “the Project”) to the Government of Japan. The Government of Japan entrusted the survey to examine the viability of this request to the Japan International Cooperation Agency (hereinafter referred to as “JICA”), the official agency implementing Japanese Government’s technical assistance and expediting proper execution of the Japan’s grant aid. JICA examined to prioritize components of the Project and narrow these components down to the focal points. As a result, JICA decided to conduct a Preparatory Survey (hereinafter referred to as “the Survey”) and sent the survey team (hereinafter referred to as “the Team”) to Indonesia from 21st October until 18th December, 2009. The Team conducted the field survey, held a series of discussion with the officers concerned in Indonesia and confirmed the contents of the request made by Indonesia. On its return to Japan, the Team analyzed all of the relevant information. Following this analysis in Japan, JICA

sent a team to Indonesia from 25th May to 3rd June, 2010 to explain and discuss the contents of the outline design with the Indonesian side.

The outline design for the requested Grant Aid Project as finalized through these surveys is summarized below;

(1) Project Site

Pluit Pump Station in the North Jakarta of DKI Jakarta

(2) Main Component of the Project

1) Reconstruction of East Pump House (RC structure (steel pipe pile foundation), 3-story building, floor area: approximately 400m^2)

2) Installation of Pump Facility in East Pump Station (Discharge pump facility (Vertical mixed flow type, 5.0m^3/sec/unit): 3 units, Aboveground pipe line system (1500mm dia.): 3 sets, Emergency generator facility (1500kVA): 1 set, Screen and auxiliaries: 3units, Horizontal conveyer: 1 unit)

3) Reconstruction of Sea Tide Dike (in front of all pump houses) (Cantilever steel pipe sheet pile and Counterweight embankment type, Length: approximately 145m)

(3) Obligations of the Recipient Country

1) Access Road for Construction

2) Provision of Disposal Area of Demolished Construction Debris

3) Relocation of Power Receiving Facility

4) Alternate Drainage Facility during Reconstruction of East Pump Station

5) Relocation of Anchored Ships

6) Relocation of Marine Police Station and related facilities

7) Clearance of EIA Requirement

8) Other General Necessary Undertakings by the Recipient Country for Japanese Grant Aid

(4) Beneficiaries

1) Primary Direct Beneficiaries: Approximately 180 thousand people living in the direct affected area of the Pluit Pump Station

2) Secondary Direct Beneficiaries: Approximately 9.14 million people living in the urban center of Jakarta

3) Indirect Beneficiaries: Approximately 24 million people living in Jakarta Metropolitan Area

It is estimated that the Project implementation period will comprise approximately 5 months for the detail design, approximately 3.5 months for tendering work and selection of the Contractor, and approximately 24 months for construction of the facilities.

(5) Effects from the implementation of the Project

1) Direct Effect

- To recover the functions of East Pump Station to protect the inland drainage area from the intrusion of sea water, and to provide the appropriate drainage facility

- To recover the drainage function of Jakarta urban area, to reduce the damage due to flooding and to improve the sanitation for the primary direct beneficiaries (180 thousand people)
- To facilitate the adaptation to future land subsidence and to mitigate the risk of breakdown of water discharge system due to future land subsidence by adopting the aboveground pipe line system
- To mitigate the shortage of the required pumping head associated with land subsidence in a large area and sea level rise due to climate change
- To be able to cope with sea level rise due to climate change by reconstruction of Sea Tide Dike
- To reduce the risk of piping phenomenon and other damages in Central and West Pump Stations because the stop logs and the inspection can make it possible to find damage and protect.
- To minimize the damage of piping phenomenon by stop logs
- To make a future reconstruction easier and cheaper because of high water-tightness of sea tide dike

2) Indirect Effect

- To reduce the damage due to flooding for the important facilities, such as Jakarta Fishing Port, coastal industrial area, Jakarta Kota Station, thermal power plant, highway interchange, and related economic activities, etc.
- To reduce the indirect damages to the economic activities of 24 million indirect beneficiaries in the Jakarta Metropolitan area as a result of reduction in flood damage in Pluit Area by the Project

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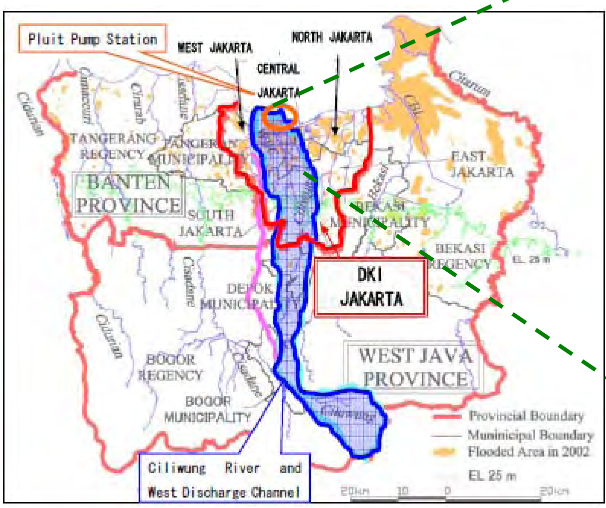
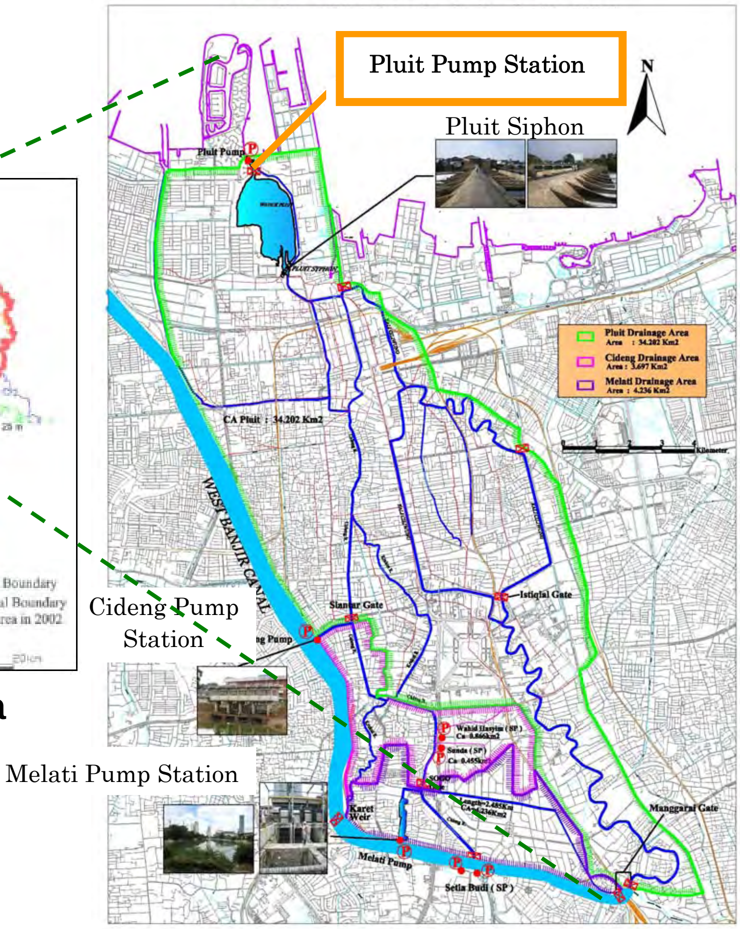
Map of the Republic of Indonesia



Jakarta Metropolitan Area



Lowland Area of Ciliwung River and Location of Pluit Pump Station

LOCATION MAP

The Perspective of the Pluit Pump Station

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Abbreviations

BBWSCC	Ciliwung-Cisadane River Basin Development Agency (one of local offices of Ministry of Public Works)
BPLHD	Jakarta Environmental Management Agency
dBA	Decibel A
DINAS PU DKI Jakarta	Jakarta Public Works, City of Jakarta
DGWR PU	Directorate General of Water Resources of Ministry of Public Works
EIA	Environmental Impact Assessment
EPH	East Pump House
E/N	Exchange of Notes
FL	Floor Level
GL	Ground level
GDP	Gross Domestic Product
GRDP	Gross Regional Domestic Product
HHWL (S)	Highest High Water Level at the sea
HWL (R)	High Water Level at the reservoir
HWL (S)	High Water Level at the sea
hr	Hour
JABODETABEK	The name of the metropolitan area surrounding Jakarta taken from **Ja**karta, **Bo**gor, **De**pok, **Ta**ngerang and **Bek**asi.
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
kVA	Kilo volt ampere
kW	Kilo watt
L	Liter
LWL (R)	Low Water Level at the reservoir
LWL (S)	Low Water Level at the sea
M/D	Minutes of Discussion
min	Minutes
mm	Millimeter
MSL	Mean Sea water Level
O & M	Operation and maintenance
pH	Hydrogen ion exponent
PLN	Indonesia Electricity Corporation
PP	“Priok Peil” which was established as the basis of LWL (S) at Tanjung Priok Port in 1925.
PU	Ministry of Public Works
RMU	Ring Main Unit
SDPU DKI Jakarta	Municipal Public Works of Water Resources of Public Works, City of Jakarta
sec	Second

CHAPTER 1

BACKGROUND OF THE PROJECT

Chapter 1 BACKGROUND OF THE PROJECT

1. BACKGROUND AND OUTLINE OF THE PROJECT

1-1 Background

Jakarta, the Capital City of Indonesia, is quite prone to flooding because of its geographic formation on alluvial fan deposit formed by 10 rivers. Moreover, the potential damage by flooding has been increased by high population density and properties. In addition, as a result of global warming, rainfall pattern in a year has been changed to precipitation decrease and increase in rainfall duration in the dry seasons and precipitation increase and decrease in rainfall duration in the rainy seasons. Thus, the frequency and magnitude of flood damage in Jakarta has been increasing year by year. Damage due to flooding is one of the risks of sustainable development in Indonesia because the damage makes not only the physical loss, but also stagnant economic activity, increase the poverty, etc. Under this circumstance, the Government of Indonesia (hereinafter referred to as "GOI") developed the drainage and flood control basic plan in 1973 and has implemented the drainage works, however, huge floods occurred in 1976, 1996, 1998, 2002 and 2007. Especially by the flood in 2002, about 13% of Jakarta (87.1km2) was submerged and 80 people were died. In recent years, the economic loss due to flood damage is estimated as about 10 trillion Rupia (10 billion yen).

JICA implemented Master Plan Study on "Comprehensive Water Management Plan in JABODETABEK" in 1997 and "Urgent Inventory Study on Damage of Flood" in 2002 to improve the related facilities and to suggest the countermeasures. And from March 2007, Technical Cooperation Study for "the Institutional Revitalization Project for Flood Management in JABODETABEK" (hereinafter referred to as "the JICA TCP") started for capacity development related to flood control and management. However, Jakarta has not yet realized the drainage plan fully according to the Master Plan under such situation mentioned above and with other obstruction factors, decaying drainage facility, random land development, increase of population and building area, land subsidence, climate change, etc.

Among three fundamental drainage stations for the drainage area of about $42.1km^2$ in Jakarta, Pluit Pump Station has the largest drainage area as $34.2km^2$. East Pump Station was constructed more than 45 years ago.

However, on February 17th, 2009, piping phenomenon underneath the bottom slab of East Pump House (hereinafter referred to as "EPH") happened suddenly in the East Pump Station of Pluit Pump Station. A part of facilities sank and sea water flew into Pluit Pump Station and its control reservoir. At present, the Public Works Department of City of Jakarta (hereinafter referred to as "DINAS PU DKI Jakarta"), which is in charge of operation and maintenance (hereinafter referred to as "O & M") of Pluit Pump Station, temporally implemented emergency measures, but all functions of East Pump Station are stopped. If a flood happens in this present situation, the flooding damage area would be more than $10km^2$ around the north Jakarta.

Although DKI intended to restart East Pump Station at first, it was too decrepit to start again because it was constructed more than 45 years ago. Then DKI proposed the full reconstruction of East Pump Station. However, it was found that the reconstruction was difficult for DKI financially and technically because the site is on the very soft foundation facing the sea, and land subsidence in a large area due to dewatering have occurred constantly. Therefore, GOI made a request for Grant Aid for the Project for Urgent Reconstruction of East Pump Station of Pluit in Jakarta (hereinafter referred to as "the Project") to the Government of Japan.

1-2 Outline of the Request for Grant Aid

The outline of the Request made by the recipient country on June 2009 is as follows:

(1) Project Site

Pluit Pump Station in the North Jakarta of DKI Jakarta

(2) Main Component of the Project

1) Installation of Pump Facility (4 sets)

2) Reconstruction of East Pump House (1-story building, floor area: approximately 400m^2)

3) Reconstruction of Sea Tide Dike in front of EPH (Length: approximately 40m)

(3) Estimation of Beneficiaries

1) Primary Direct Beneficiaries: Approximately 180 thousand people living in the direct affected area of the Pluit Pump Station

2) Secondary Direct Beneficiaries: Approximately 9.14 million people living in the urban center of Jakarta

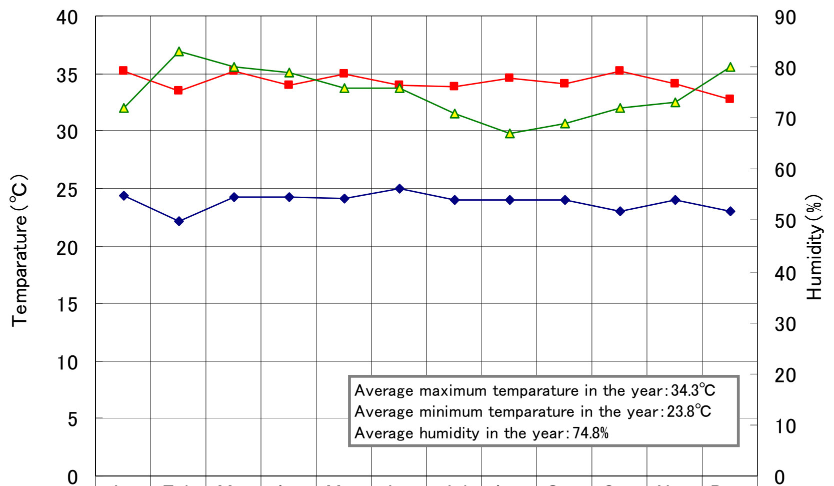
3) Indirect Beneficiaries: Approximately 24 million people living in Jakarta Metropolitan Area

2. NATURAL CONDITIONS

2-1 Climate Conditions

(1) Temperature and Precipitation

The climate in Jakarta is tropical and hot throughout the year. Maximum temperature is over 30℃ every month. Also the humidity is high all the year over. In particular in rainy season from December to March, humidity often crosses over 80%. Monthly temperature and humidity in Jakarta are shown in Figure 1-1.

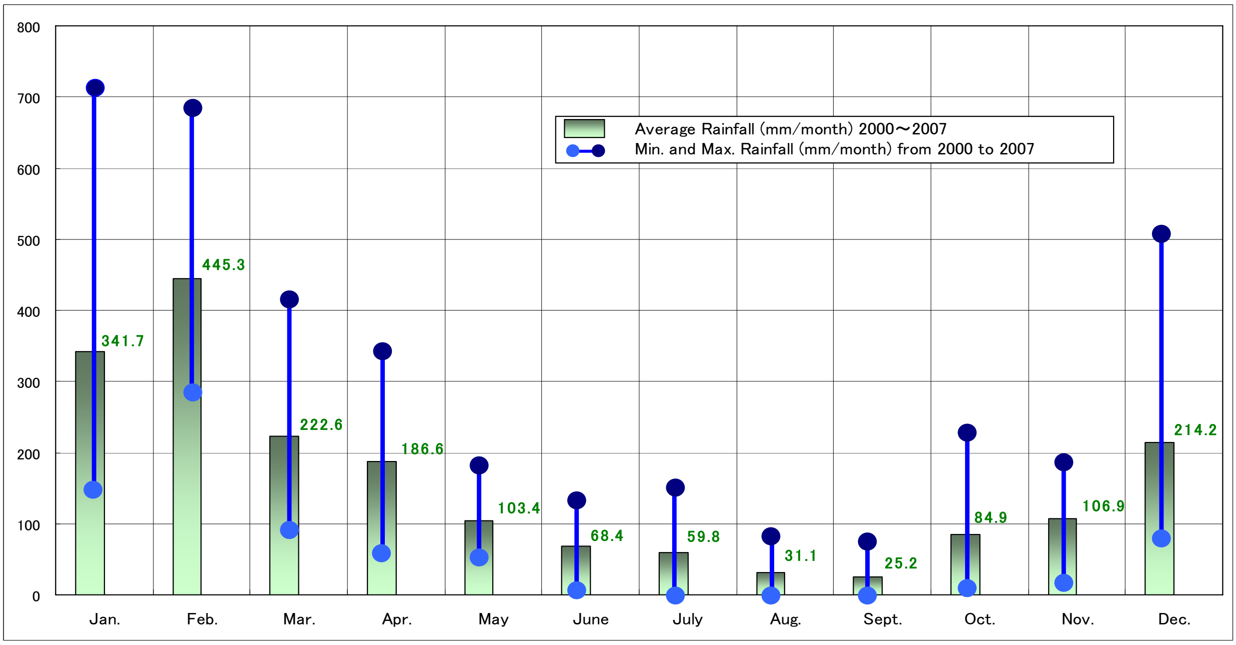


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum Daily Temparature (℃)	35.2	33.5	35.2	34	35	34	33.8	34.6	34.1	35.2	34.1	32.8
Minimum Daily Temparature (℃)	24.4	22.2	24.2	24.2	24.1	25	24	24	24	23	24	23
Humidity (%)	72	83	80	79	76	76	71	67	69	72	73	80

Source: Jakarta in Figures 2008

Figure 1-1 Monthly Temperature and Humidity in Jakarta in 2007

Rainfall in Jakarta is high in rainy season, and it is comparatively low in dry season from June to September. Monthly rainfall and its fluctuation in Jakarta is shown in Figure 1-2. This figure indicates the monthly precipitation is different year by year. Even in the dry season, the monthly precipitation is about 200mm/month. Therefore, Pump Station shall have the sufficient drainage capacity even in dry season to prevent from flooding.



Year	Monthly Rainfall (mm/month)											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
000	374.5	309.8	96.9	261.2	132.9	78.1	30.8	34.2	29.0	33.1	175.0	84.0
2001	292.3	294.3	182.7	102.3	66.2	142.2	30.4	88.7	10.8	147.9	139.3	116.0
2002	716.7	634.1	216.9	134.5	77.6	2.3	116.5	0.0	0.0	3.0	47.6	107.9
2003	142.8	562.5	112.3	67.7	63.9	3.4	0.0	2.6	23.6	231.1	195.2	434.6
2004	227.7	431.4	274.4	340.2	119.2	63.8	52.4	17.3	0.0	43.4	84.5	217.8
2005	393.0	353.8	417.6	105.5	93.3	134.1	160.6	39.1	78.5	135.7	101.8	132.6
2006	389.5	289.2	301.1	316.1	85.2	22.8	53.2	0.0	0.0	10.8	26.8	112.3
2007	196.9	687.2	179.0	165.5	188.5	100.5	34.5	66.6	59.8	74.0	85.1	508.6
Min.	142.8	289.2	96.9	67.7	63.9	2.3	0.0	0.0	0.0	3.0	26.8	84.0
Max.	716.7	687.2	417.6	340.2	188.5	134.1	160.6	66.6	78.5	231.1	195.2	508.6
Ave.	341.7	445.3	222.6	186.6	103.4	68.4	59.8	31.1	25.2	84.9	106.9	214.2

Source: Meteorological Observatory in Jakarta (from 2000 to 2007)

Figure 1-2 Monthly Rainfall in Jakarta from 2000 to 2007

(2) Effect of Climate Change in Indonesia

In Indonesia, ADB (2009)[1] cited that the mean temperature recorded in Jakarta increased about 1.04°C per century in the month of January (the wet season) and 1.40°C per century in July (the dry season). The disappearance of snow covering Mount Jayawijaya of Irian Jaya is seen as clear evidence that warming has occurred.

In addition, as a result of global warming, rainfall pattern in a year has been changed to precipitation decrease and increase in rainfall duration in the dry season and precipitation increase and decrease in rainfall duration in the rainy season. Thus, the frequency and magnitude of flood damage in Jakarta has been increasing year by year.

ADB (2009) also cited that mean sea level increased by 7 mm per year in Jakarta.

[1] ADB, April 2009. The Economics of Climate Change in Southeast Asia: A Regional Review.

3. ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

(1) Outline

This Project is rehabilitation of the damaged pump house and its facilities and not new provision of facilities, therefore, the impacts on the environment are not likely to be significant. However, it needs to be paid attention to several adverse impacts on the environment and society, which are mainly water quality, wastes, noise and vibration during the construction.

Table 1-1 shows the measures to avoid and minimize the adverse environmental and social impacts.

Table 1-1 Measures to Avoid and Minimize the Adverse Environmental and Social Impacts

Category	Concerned Adverse Impact	Estimated Measures in the Preparatory Survey	
		Planning Stage	Construction Stage
Air Pollution	Air pollution by the vehicles at the construction stage	To make appropriate construction and working plans in order to minimize the exhaust gas from the construction vehicles	To carry out a periodical maintenance of the equipment including the construction vehicles To give instructions for a contractor to follow appropriate construction and work plans
Water Pollution	Muddy water during construction of the sea tide dike and filling the discharge basin	To include the treatment facility for muddy water in the construction plan	To give instructions for a contractor to follow appropriate effluent treatment to avoid discharging the muddy water
Wastes	Wastes generated from demolition of the existing facilities		To transport and dispose wastes to the designated disposal site To give instructions for a contractor to prevent the scattering and falling of the waste during transportation
Noise and Vibration	Noise and Vibration by the vehicles at the construction stage	To use equipment and vehicles with low noise and vibration To install pumps on a rigid foundation in an enclosed room To make a construction plan with consideration of mitigating noise and vibration	To inform residents of a construction plan and schedule To make an appropriate construction plan and schedule To check and maintain construction equipment periodically To give instructions for a contractor to follow an appropriate construction procedure To carry out adequate traffic control
Traffic Accidents	Traffic accidents by the vehicles at the construction stage	To take an optimal route for construction vehicles to prevent the accidents by construction vehicles inside and outside the site To make an appropriate construction schedule to avoid peak traffic hours	To make an appropriate construction plan and schedule To check and maintain construction equipments periodically To give instructions for a contractor to follow an appropriate construction procedure To carry out traffic control

(2) Relocation of Unauthorized Anchored Ships

In front of the existing Sea Tide Dike of Pluit Pump Station, several ships are anchored without any authorization. This anchored area is under jurisdiction of DINAS PU DKI Jakarta. As a result of discussion with the Indonesian side, DINAS PU DKI Jakarta is responsible to relocate anchored ships in front of the Sea Tide Dike. They will announce and explain to residents and ship owners about relocation of the ships in cooperation with community leaders. They plan to start from September 2010 and to complete by January 2011 before tabling the implementation of the Project for approval of the Japanese Government in April 2011.

(3) Confirmation of IEE

The Team confirmed the procedure of Environmental and Social Consideration at IEE (Initial Environmental Examination: a report where potential impacts of a prescribed project are assessed with a view to determining whether the impacts are significant or not) level based on JICA Guidelines for Environmental and Social Considerations (April 2004).

Indonesian Government Regulation No. 27 of 1999 on Environmental Impact Assessment regulates the procedure of Environmental Impact Assessment (EIA) (hereinafter referred to as “AMDAL” which means EIA in Indonesian).

Jakarta Environmental Management Agency (hereinafter referred to as “BPLHD”) explained that the Project is not subject for AMDAL because it is reconstruction of the existing facility and its scale is small. However, UKL and UPL need to be prepared and implemented. The Project site is in a jurisdiction area of the north regional office of BPLHD. Therefore, DINAS PU DKI Jakarta has appointed the consultant for UKL and UPL in February 2010, and has submitted UKL and UPL to the north regional office of BPLHD in April 2010, and received an approval letter from the north regional office of BPLHD on April 16, 2010.

Related documents have been attached in APPENDIX-7.

CHAPTER 2

CONTENTS OF THE PROJECT

CHAPTER 2 CONTENTS OF THE PROJECT

2-1 BASIC CONCEPT OF THE PROJECT

2-1-1 Superior Goal and Project Goal

(1) Superior Goal

Jakarta Flood Control and Drainage Plan has been developed for the area between East and West Banjir Canals in 1993. This plan aims to upgrade the drainage capacity of existing rivers as the principal drainage canals for 1/25 return year floods and to construct discharge pump stations and discharge channels for 6 sub-areas in the above area. Upgrading of existing rivers and construction of pump houses had been realized.

At present, the capital region of Jakarta has a complex network for rainwater discharge with utilizing the existing rivers for protection of this area from flood damage. There are 18 pump stations and 23 gates along these rivers because of affected tidal change on these rivers. The main target facility of the Project, Pluit Pump Station, is one of the fundamental pump stations in the capital region of Jakarta.

Hence, the superior goal of the Project is to minimize the impact by the flood in Jakarta urban area.

(2) Project Goal

Three rivers (Ciliwung River, Cideng River and Duri River), which flow into a reservoir of Pluit Pump Station (Pluit Reservoir), are furnished with a gate at the mouth of each river (Marina Gate, Pasar Ikan Gate and Duri Gate). At present, these gates are not working because they are permanently closed or mostly closed. In case of a flood, almost all river water will directly flow into Pluit Reservoir and planned to be drained at Pluit Pump Station.

This Project is to reconstruct the East Pump Station in Pluit Pump Station to restore the original discharge capacity which has been lost by piping phenomenon and at the same time to reconstruct the Sea Tide Dike in front of all pump houses at Pluit Pump Station in order to cope with the future piping phenomenon for Central and West Pump Stations and sea level rise due to climate change in future.

Hence, the Project Goal is to recover the function of water discharge of Pluit Pump Station.

2-1-2 Outline of the Project

The outline of the Project is as follows:

(1) Project Site

Pluit Pump Station in the North Jakarta of DKI Jakarta

1) Reconstruction of EPH: RC structure (steel pipe pile foundation), 3-story building, floor area: approximately 400m^2
2) Installation of Pump Facility in East Pump Station: Discharge pump facility (Vertical mixed flow type, 5.0m^3/sec/unit): 3 units, Aboveground pipe line system (1500mm dia.): 3 sets, Emergency generator facility (1500kVA): 1 set, Screen and auxiliaries: 3units, Horizontal conveyer: 1 unit
3) Reconstruction of Sea Tide Dike in front of all pump houses: Cantilever steel pipe sheet pile and Counterweight embankment type, Length: approximately 145m

(2) Obligations of Recipient Country

1) Access Road for Construction

2) Provision of Disposal Area of Demolished Construction Debris

3) Relocation of Power Receiving Facility

4) Alternate Drainage Facility during Reconstruction of East Pump Station

5) Relocation of Anchored Ships

6) Relocation of Marine Police Station and related facilities

7) Clearance of EIA Requirement

Environmental Management Plan (Upaya Pengelolaan Lingkungan, hereinafter referred to as "UKL") and Environmental Monitoring Plan (Upaya Pemantauan Lingkungan, hereinafter referred to as "UPL")

8) Other General Necessary Undertakings by the Recipient Country for Japanese Grant Aid

(3) Estimation of Beneficiaries

1) Primary Direct Beneficiaries: Approximately 180 thousand people living in the direct affected area of the Pluit Pump Station

2) Secondary Direct Beneficiaries: Approximately 9.14 million people living in the urban center of Jakarta

3) Indirect Beneficiaries: Approximately 24 million people living in Jakarta Metropolitan Area

(4) Related Agencies

1) Executing Agency: Directorate General of Water Resources, Ministry of Public Works (DGWR PU)

2) Implementing Agency: DGWR PU and Public Works Department, City of Jakarta (DINAS PU DKI Jakarta) until completion of the Project and DINAS PU DKI Jakarta for O & M of the facilities after completion of the Project.

2-2 OUTLINE DESIGN OF THE JAPANESE ASSISTANCE

2-2-1 Design Policy

2-2-1-1 Basic Policies

Flood control policy in the coastal areas where the annual land subsidence is more than 10cm like Jakarta shall comply with the following three technical requirements:

- Primary Requirement: To protect the inland drainage area from the intrusion of sea water
- Secondary Requirement: To provide the appropriate drainage facility to drain water in the inland drainage areas
- Tertiary Requirement: To take appropriate countermeasures for land subsidence in the facility plan

The Team conducted the site investigation to verify the present conditions on the above three requirements, namely the present situation of the sea tide dike in front of Pluit Pump Station for Primary requirement, the discharge condition and capacity of Pluit Pump Station for Secondary requirement, and the present groundwater usage and the present situation of land subsidence from the geographical aspect for Tertiary requirement. Effect of Climate Change shall also be taken into account in Primary requirement.

As a result of the site investigations, the Team confirmed that the piping phenomenon under the East Pump Station caused by the differential settlement between EPH and discharge channel due to land subsidence, namely failure in Tertiary Requirement, and then the functions of East Pump Station were lost in terms of the Primary and Secondary requirements. Also the Team confirmed the serious situation of Pluit Pump Station where drainage of required volume of rain and sewage water cannot be done satisfactorily due to sea water intrusion through piping passage and the immense consequential damage to the public and economy in Jakarta. Therefore, the recovery of the three requirements mentioned above is requisite, very important and very urgent.

The basic concept of the Project is to make the outline design of facilities to meet the Primary, Secondary and Tertiary requirements mentioned above.

2-2-1-2 Policies regarding Natural Conditions

Policies regarding natural conditions on the outline design are set as follows:

(1) The influence by sea water should be considered because the Project site is facing with the Java Sea. Effect of Climate Change in sea water shall also be taken into account.

(2) The climate conditions, such as high temperature and rainy seasons, should be considered. Effect of Climate Change in precipitation shall also be taken into account.

(3) The geographical features, such as land subsidence and ground deformation, should be considered. The Project site is underlain by alluvium of Holocene age, and fan deposits with volcanic deposits of Pleistocene age. Alluvium at the site is proved to be about 11.5 to 18.5m thick. Diluvium and volcanic deposits underlies below alluvium up to 50 to 70m below ground surface.

(4) The design of pump facility should be based on the operation records of Pluit Pump Station and the observation results of water levels in Pluit Reservoir in order to reflect the actual flow capacity of upstream portion of rivers which flow into Pluit Reservoir.

2-2-1-3 Policies regarding Social and Economical Considerations

Pluit Pump Station is one of the fundamental drainage stations in the capital region of Jakarta to secure the drainage capacity of this area where the direct beneficiary is about 0.18 million people. Not only the population, but also the property of this area is accumulated as a result of urban development, such as Kota Jakarta Station, Jakarta fishing port, thermal power plant, industrial zone and large commercial complex, and so on. The loss of the function of these facilities by floods would lead to a huge impact on the economy of Indonesia. Ships and boats are anchored without authorization in front of the Sea Tide Dike of Pluit Pump Station and housing areas of both high income and low income are around the site. These social and economical conditions should be considered in the outline design of the Project.

2-2-1-4 Policies regarding Construction / Procurement and Local Contractor

Indonesia has already constructed a large number of numerous drainage facilities through its own efforts and with assistance from international donors. Many other buildings and public infrastructures have also been constructed, thus Indonesian contractors have sufficient technology and capability required to construct civil and building infrastructures and installations of mechanical and electrical equipment. Therefore, under the control provided by Japanese engineers and skilled operators, the local workers and contractors can construct and complete the Project within the schedule formulated under the Grant Aid scheme. For this reason, in the Project there is no need to employ engineers or workers from other third countries; so rather local workers and contractors may be as a rule utilized in this Project although a part of construction needs special and high level techniques.

In terms of the availability of construction equipment and materials, Indonesia has achieved sufficient progress in production volume and quality to be able to supply the major civil and building equipment and materials excluding some special items. Accordingly, major equipment and materials for the Project may basically be procured in the local market.

Since most of the mechanical and electrical facilities in the Project can be procured in Indonesia, spare parts for them can also be purchased in Indonesia. However, spare parts for main pumps shall be procured in Japan through local agent of pump manufacturer since main pumps will be procured in Japan in consideration of reliability and manufacturing period of the pumps and security of competitiveness in Tendering and transparency required for Japanese Grant Aid Project.

2-2-1-5 Policies regarding Operation and Maintenance

The O & M system of Pluit Pump Station is a 24-hr system with a two-shift system (7:00a.m. – 7:00p.m.). It has 12 staff in two teams in total. Each team operates whole facilities of the station and has basic skills for O & M. This system has not been changed for recent 5 years and DINAS PU DKI Jakarta plans to maintain it after the completion of the reconstruction of East Pump Station.

However, the new equipment shall be installed in the Project and systematic operation shall be necessary. Therefore, Japanese engineers shall implement the primary O & M guidance and training for the new facility, and prepare spare parts, maintenance tools and O & M manuals during the construction in order to operate the new and existing facilities effectively and efficiently.

2-2-1-6 Policies regarding Facilities Grades

When designing the facilities constructed in the Project, careful attention shall be paid to the grades of existing facilities and equipment and the technical level of DINAS PU DKI Jakarta in order to ensure that DINAS PU DKI Jakarta can easily operate and maintain the facilities after its commissioning. With the knowledge gained from the JICA TCP, the Project shall establish the appropriate grades of facilities and equipment.

2-2-1-7 Policies regarding Construction/Procurement Methods and Construction Period

The points requiring special attention in the outline design, and the measures required to deal with them, are as follows:

(1) Construction Method

Since the Project site is located adjacent to private houses and existing pump stations and the new facility shall be constructed on the soft ground, special care shall be required to ensure that the construction works do not have any adverse impact on the surrounding area.

The groundwater level is relatively high at GL-1.0m, therefore, water tight structure such as steel sheet piles shall be used for earth retaining. Moreover, concerning the method of driving steel sheet piles, it may be necessary to adopt pressure insertion method, because vibratory hammers and the like may be noisy and also may give a harmful vibration to adjacent structures.

Regarding the construction of Sea Tide Dike, the following points should be taken in account of: operation of Central and West Pump Stations, existing Sea Tide Dike, engagement of vehicles with low noise and vibration to minimize the influence to neighboring residents, marine construction including the material transportation, prevention of seawater pollution, obedience of maritime traffic laws, etc.

(2) Procurement Method

Since the Project is construction of drainage facilities and Sea Tide Dike, plant construction works in addition to the civil and building works will be required. This means that the special know-how for constructing and installing equipment /plant, etc., which equipment/ plant manufacturers own, is required. Accordingly, it will be necessary to construct the facilities based on a tie-up between a pump equipment manufacturer/plant company and a construction firm. For this reason, a procurement plan shall be drawn up after considering joint undertaking from a consortium between a construction firm and a pump equipment manufacturer/plant company.

(3) Construction Schedule

It is estimated that the construction for the Project will require approximately 24 months. Since the facilities constructed in the Project are drainage facility and Sea Tide Dike, the progressive operation can not be expected. Accordingly, since the phased construction may be hard to be planned, it is necessary to apply a Japanese government bond scheme.

2-2-2 Basic Plan

2-2-2-1 Design Conditions

(1) Soil Condition

The soil conditions based on the results of geotechnical survey conducted by the Team are as follows:

1) Soil Conditions

The Project site is underlain by alluvium of Holocene age, and fan deposits with volcanic deposits of Pleistocene age. Alluvium at the site is proved to be about 11.5 to 18.5m thick. Diluvium and volcanic deposits underlies below alluvium up to 50 to 70m below ground surface. Geological Profile is shown in Figure 2-13. Soil characteristics are shown in Table 2-1.

Table 2-1 Summary of Soil Properties

Geologic Age	Geological Formation	Symbol	Soil Type	Thickness	N-value	Compression Index	Note
Recent	Back Fill	D	Silty Clay Clayey Silt	1-2	5-6	0.4	Artificial soil
Holocene	Sand Layer	AS1	Clayey Sand	-	0-1	-	Soft ground, lenticular
	Clay Layer	AC1	Silty Clay/ Clay	13-15	0-1	1-1.5	Soft ground
		AC2	Silty Clay	2-3.5	2-5	0.6-0.9	
Pleistocene	Clay Layer	DC1	Silty Clay Clayey Silt	1.5-5	8-15	0.4	
		DC2	Silty Clay	7-12	12-22	0.4-0.5	
		DC3	Silty Clay	3-7	15-25		
		DC4	Silty Clay	>12	25-30		
	Sand Layer	DS1~3	Silty Sand	-	9-17	-	Lenticular distribution
Pleistocene	Volcanic Consolidated Clay Layer	VC1	Consolidated Clayey Silt Clayey Silt with Sand	2-15	35- >50	-	Tuff-like, Upper foundation bed
		VC2	Consolidated Silty Clay	1-15	35- >50	-	Tuff-like, Lower foundation bed
		VC3	Clayey Silt	2-6	35- >50	-	
	Volcanic Consolidated Sand Layer	VS1	Sand/ Silty Sand	1-8	35- >50	-	Upper foundation bed
		VS2	Silty Sand	8-13	>50	-	Lower foundation bed
		VS3	Sand	2-3	>50	-	Volcanic sand- like
	Volcanic Clay Layer	VC1-2a	Silty Clay	-	25-30	-	Lenticular distribution
	Volcanic Sand Layer	VS1-3a	Silty Sand/ Sand	-	20-30	-	Thin bed

2) Expected Foundation Layer

Two volcanic origin layers of Pleistocene age can be expected as the foundation layer. One is the upper foundation layer which consists of mainly consolidated silty sand and clayey silt of volcanic origin and the number of blows in Standard Penetration Test (hereinafter referred to as “SPT”), so called N-value, is over 50. The surface of the layer lies around EL-20.5 m up to EL-22.0 m. The thickness of this layer varies from about 2 meters to 6 meters. This upper layer cannot be expected as pile foundation because of existence of partial thin layer.

Another is the lower foundation layer which consists of mainly consolidated silty sand and clayey silt of volcanic origin with N-value of over 50. The surface of the layer lies around EL-38.5 m up to EL-39.5 m. The thickness of this layer varies from about 7 meters to 10 meters. This lower layer can be expected as sufficient pile foundation.

(2) Codes and Standards for Outline Design

For the outline design, Indonesian and Japanese codes and standards shall be applied.

(3) Elevation in Outline Design

1) Benchmark

The following benchmark was referred to in the topographical survey in the Preparatory Survey.

TTG-PDK Dayung: its elevation was MSL+0.826m (2007) and its site is in Tanjung Pondok Dayung under Indonesian Navy jurisdiction.

2) Adjustment of elevation

The topographic survey was conducted with the benchmark TTG-PDK Dayung as mentioned above. It is probable that this benchmark has been subsided for 2 years, however, the land subsidence is not announced to the public. Therefore, the elevation of the benchmark was adjusted with the result of the tidal observation survey for a month conducted by the Team in the Preparatory Survey. Although the period of observation is not so long, the results were acceptable since they had reflected the effect of land subsidence since 2007 to date and this shall not be significant at the outline design stage.

Table 2-2 shows the elevation comparisons with the benchmark of PL01 newly installed in the Project Site. For the outline design, the elevation of new benchmark PL01 is set as MSL-1.314m based on the reason mentioned above.

Table 2-2 Elevation Comparison with PL01

	Benchmark	Elevation (MSL)	Difference from TTG PDK Dayung	Note
1	Tidal observation result	-1.314m	-26mm	Observation period: 32 days
2	TTG PDK Dayung	-1.288m	0mm	Benchmark measured in 2007
3	TTG177 (T13)	-1.311m	-23mm	Benchmark measured in 2007

The topographical survey was conducted with reference to the benchmark of Tanjung PDK Dayung with its elevation established in 2007, namely item 2 in Table 2-2, therefore, all elevations in the topographical drawings are shown 26mm higher than the adjusted elevation based on Tidal Observation result. The elevations of the existing formations in the outline design have been corrected to reflect this difference.

In the Preparatory Survey, elevations are expressed in MSL basically excluding the level of Pluit Reservoir. At present, all pumps are operated with the PP standard, so the level of Pluit Reservoir is shown in both PP and MSL. However, PP in the Preparatory Survey remain unchanged from the original PP (PP±0.0=LWL (MSL-0.6m) and elevations is not reflected the land subsidence after the latest establishment of PP in the past.

The main elevations related to the Project components are shown as follows:

Crown elevation of existing Sea Tide Dike:	MSL+1.45m
Floor elevation of existing EPH:	MSL-0.70m
HWL of Pluit Reservoir:	MSL-2.65m（PP-0.5m）
LHL of Pluit Reservoir (water level when all pumps are stopped):	MSL-4.05m（PP-1.9m）

2-2-2-2 Overall Plan and Drainage Facility Plan

The outline design of Sea Tide Dike in front of Pluit Pump Station is to secure the water tightness of the dike during construction and the water tightness and safety of the sea tide dike after the reconstruction because the water tightness of the existing sea wall is not enough to prevent from piping phenomenon. Moreover, impact from sea level rise due to Climate Change as well as land subsidence in large area during service period of Sea Tide Dike shall be considered in the design of strength and water tightness of Sea Tide Dik,

However, it should be noted that the crown height of the reconstructed Sea Tide Dike is set based on the crown height of existing dike. This is because to cope with the progressive sea level rise due to Climate Change and wide area land subsidence anticipated in the coastal area of Jakarta, the raise of the crown height of the Sea Tide Dike just in front of Pluit Pump Station alone is not effective but that of the sea tide dike for whole coverage area in Pluit is indispensable and such work shall be done by Indonesian side separately in line with their routine upgrading work of the existing Sea Tide Dike.

Considering the urgency of the Project, the outline design for recuperation of drainage capacity of East Pump Station is to secure the existing drainage capacity of the station. The required drainage capacity will be verified in consideration of effective utilization of knowledge gained and information collected by the JICA TCP, the output from flow calculation, the capacity evaluation of Central and West Pump Stations and the future improvement plan of related water drainage facilities to be carried out by Indonesian side as self effort. Increase of required total pump head associated with sea level rise due to Climate Change and land subsidence in a large area in future, which is beyond the expected service period of new pumps, shall be solved separately at the time of replacement of pumps in future.

The type and number of the pumps for East Pump Station are examined in consideration of the necessary water discharge volume, operational correlation with Central and West Pump Stations, easiness of O&M, effective land use of the site, economical implication of overall costs for construction of pump house in addition to pump facilities and other factors.

The design of the water discharge pipe facility is to be realized considering the appropriate demolition procedure of the existing facilities, countermeasures against the land subsidence, security of water tightness of the sea tide dike and other factors.

The location and structural features of the reconstructed EPH are examined with the clearance of the demolition of existing facilities, minimization of impacts to surrounding facilities and environment, countermeasures for the subsurface soil conditions, large area land subsidence and other factors.

Regarding the Central and West Pump Stations, although the Team confirmed that each house and pump facility is workable at present, it is necessary to take countermeasures in order to prevent from the future potential piping phenomenon. However, in view of the easiness of preventive works against piping phenomenon, the works can be undertaken by Indonesian side as their self effort.

2-2-2-3 Drainage Plan

Three drainage stations including Pluit Pump Station in the capital region of Jakarta have shared in rainwater and sewage drainage. On the basis of the rainwater drainage records, the appropriate drainage plan of Pluit Pump Station shall be established in terms of the following features:

1) Pump operation in Pluit Pump Station at the flood in February 2008 was conducted by the different operation procedure from the normal operation rule. At that time, the maximum operation capacity was confirmed as 40.4m^3/sec.
2) DINAS PU DKI Jakarta has a plan to construct a pump station with the capacity of 6m^3/sec at Duri.
3) Pluit Pump Station should have a drainage capacity to manage the same magnitude of rainfall in February 2008 after the Project. The optimum operation rule before, during and after the reconstruction of East Pump Station should be examined. In the Preparatory Survey, the necessary pump capacity and operation rule were examined by the simulation of water levels of Pluit Reservoir not to be over the maximum water level (PP-0.36m) at the flood in February, 2008.
4) Adaptation to precipitation increase and decrease in rainfall duration in rainy season shall be studied in evaluation of overall drainage capacity of Pluit Pump Station and Duri Pump Station mentioned above, since such long term adaptation is out of the Project's scope.

2-2-2-4 Sea Tide Dike

(1) Type of the Dike

1) Technical Requirement

The following three requirements are technically requisite for the sea tide dike design in front of Pluit Pump Station:

Requirement 1: To protect from the intrusion of sea water

Requirement 2: To secure water tightness to protect from piping phenomenon

Requirement 3: To be easily adapted to future land subsidence and sea level rise due to climate change

2) Comparison

Based on the results of topological and geotechnical survey and site investigation, two alternative plans can be examined; i.e. "Plan 1: Embankment + Watertight sheet pile" and "Plan2: Cantilever steel pipe sheet pile + Counterweight embankment" as shown in Table 2-4.

3) Optimal Type

Considering the adaptability to land subsidence, sea level rise, efficiency of construction, construction cost and O&M efficiency, "Plan2: Cantilever steel pipe sheet pile + Counterweight embankment" will be the optimal type for the sea tide dike in front of Pluit Pump Station based on the following reasons:

Regarding a type of sheet pile structure, there are three types; i.e. steel pipe sheet pile, steel sheet pile and concrete sheet pile, available for the Project. The comparison of these types is shown in Table 2-3.

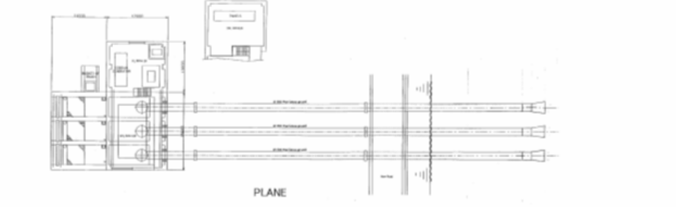
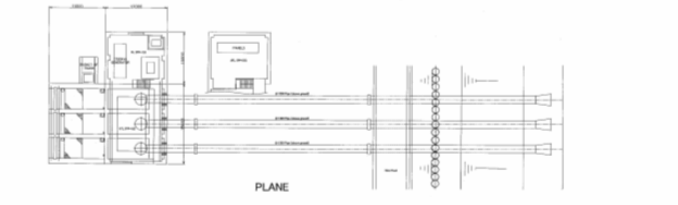
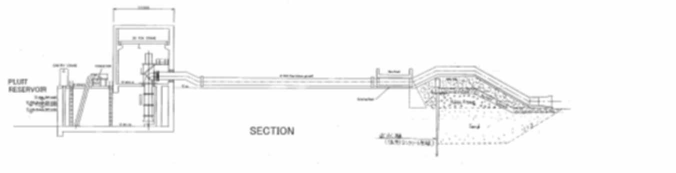
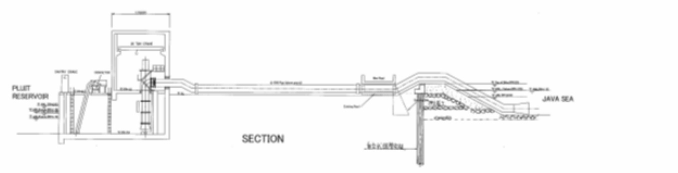
Economical efficiency is estimated based on cost of materials, labor and installation per unit width of sheet pile. Steel sheet pile is the most expensive because it is not produced in Indonesia. In terms of construction efficiency, concrete sheet pile has a disadvantage because it needs to be installed by large capacity vibrohammer and water tightness is unreliable. As a result of comparison, steel pipe sheet pile is the optimal.

Table 2-3 Comparison of Sheet Pile Structure

	Steel pipe sheet pile	Steel sheet pile	Concrete sheet pile
Water-tightness	◎	○	▲
Economical Efficiency	○	▲	○
Construction Efficiency	◎	◎	△
Evaluation	◎	▲	▲

Legend) ◎: Excellent, ○: Good, △: Fair, ▲: Not good

Table 2-4 Comparison of Alternative Plans of Sea Tide Dike

		Plan1 Embankment + Watertight Sheet Pile		Plan2 Cantilever Sheel Pipe Sheet Pile + Counterweight Embankment	
Schematic Drawing	Plan				
	Section				
General Description		Construct embankment with sand and stone in front of existing sea tide dike. Install concrete sheet pile for security of water tightness in the embankment. Secure cantilever hight of 2m equivalent to the strength of sheet pile.		Install Steel Pipe Sheet Pile in front of existing sea tide dike. To place rubble mound in front of the Steel Pipe Sheetpiling to prevent exessive displacement of sheet pile.	
Evaluation	Structure	Subsidence: Concrete sheet pile will be subsided as a result of subsidence of Embankment. In order to prevent such subsidence, total length of 22m of concrete sheet pile is required to place sheet pile toe on the supporting layer. Installation of such sheet pile is possible, however, installation precision is low in terms of water tightness. Water tightness: Inferior than Plan2. When installation precision is low, water tightness will not be secured.	△	Subsidence: Since sheet piles are driven to the depth of supporting layer, subsidence of sheet pile is small even if rubble mound subsides. Future raising work of crown of the new dike can be easily done by placing additional cocrete to cope with future land subsidence. Water tightness: High water tightness	◎
	Construction	･Construction work is easier than Plan2. ･Construction area is large and temporary sheetpiling in the sea is required. ･Construction period is longer than Plan2.	△	･High technology is required for installation of sheet piles with joints. ･Construction area is smaller than Plan1. ･Contruction work is relatively simple and construction period is shorter than Plan1.	○
	Economy	Higher than Plan2	△	Lower than Plan1	○
	O & M	Raising work of crown height of embankment is more frequent than Plan2 as a result of consolidation settlement and land subsidence.	△	Be able to cope with raising of sea tide dike by additional placement of concrete on top of the dike.	◎
Overall Evaluation		Inferior than Plan2 in all evaluation parameter, however, all material procurement can be done locally. △		Most advantageous system for taking measures against land subsidence. ◎	

Construction cost per 10m long

Plan1

Works	Quantity		Unit Price		Construction Cost
①Concrete Sheet Pile					
Material	150 m	×	21,000 yen	=	3,150,000
Installation	10 piles	×	150,000	=	1,500,000
②Embankment					
Backfilling with stone	240 m3	×	5,000	=	1,200,000
Material(Stone)	910 m3	×	5,000	=	4,550,000
Material(Sand)	1,680 m3	×	2,300	=	3,864,000
Dredging	1,680 m3	×	2,000	=	3,360,000
③Temporary sheetpiling					
Steel Sheet Pile (Type Ⅲ, 15m)	22.5 ton	×	200,000	=	4,500,000
Placement and removal	25 piles	×	15,000	=	375,000
				Total	22,499,000 per 10m
				ratio	1.52

Plan2

Works	Quantity		Unit Price		Construction Cost
①Steel Pipe Sheet Pile					
Material	77 ton	×	100,000 yen	=	7,700,000 yen
Installation	7 piles	×	200,000	=	1,400,000
②Rubble mound					
Backfilling (sand)	240 m3	×	2,300	=	552,000
Material (rubble)	225 m3	×	5,000	=	1,125,000
Material (sand)	310 m3	×	2,300	=	713,000
Dredging	1,680 m3	×	2,000	=	3,360,000
				Total	14,850,000 per 10m
				ratio	1.00

(2) Setting Up of Basic Configuration

1) Conditions for Configuration Set Up

The configuration of the sea tide dike will be studied in consideration of the following features:

a) Crown Height of Sea Tide Dike

The crown height of the Sea Tide Dike is set as MSL+1.90m in consideration of a layout plan of discharge pipes and wave height, while the crown height of the existing dike is MSL+1.45m by the information provided by DINAS PU DKI Jakarta. The design sea water levels are set as follows:

- HHWL (S): MSL+0.55m
- HWL (S) PP: MSL-0.6m

b) Normal Line of Sea Tide Dike

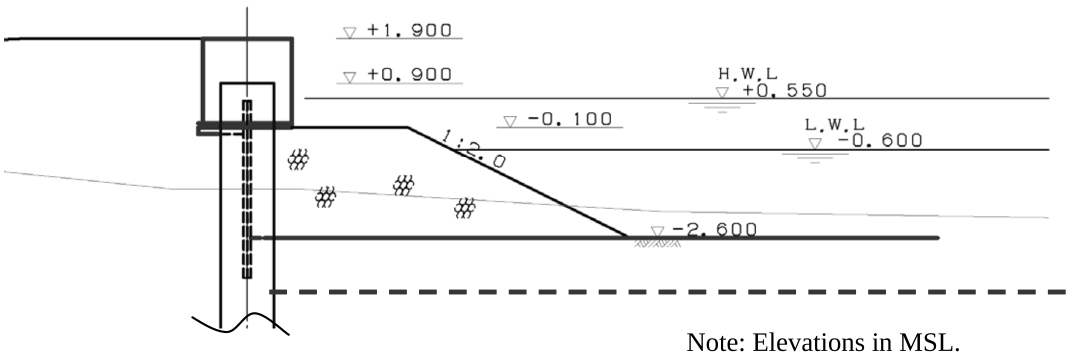
It is necessary to avoid the impact on the strength, stability and water tightness of the existing dike during construction of the new dike, to secure water tightness at the back of the dike, and to keep the elevation of existing road as low as possible. Therefore, the normal line of the sea tide dike is 12.50m offshore from the existing normal line.

c) Design Level of the Sea Bed

The design level of the sea bed is set as MSL-2.60m.

d) Sea Bed Protection Block

Rubble mound is necessary to prevent the front of the dike from scouring and to protect the foundation of discharge pipes. It also works for reduction of wave force to the dike.



Note: Elevations in MSL.

Figure 2-1 Configuration of Sea Tide Dike

2) Construction Range of Sea Tide Dike

The Project deals with the improvement of the dike in front of East, Central and West Pump Stations as shown in Figure 2-2. In consideration of the area to be protected from the intrusion of sea water as a cofferdam during the construction, and to be protected from the piping phenomenon in Pluit Pump Station after the completion, the stop logs shall be installed at the discharge outlet of the dike in front of Central and West Pump Stations to secure the present drainage functions.

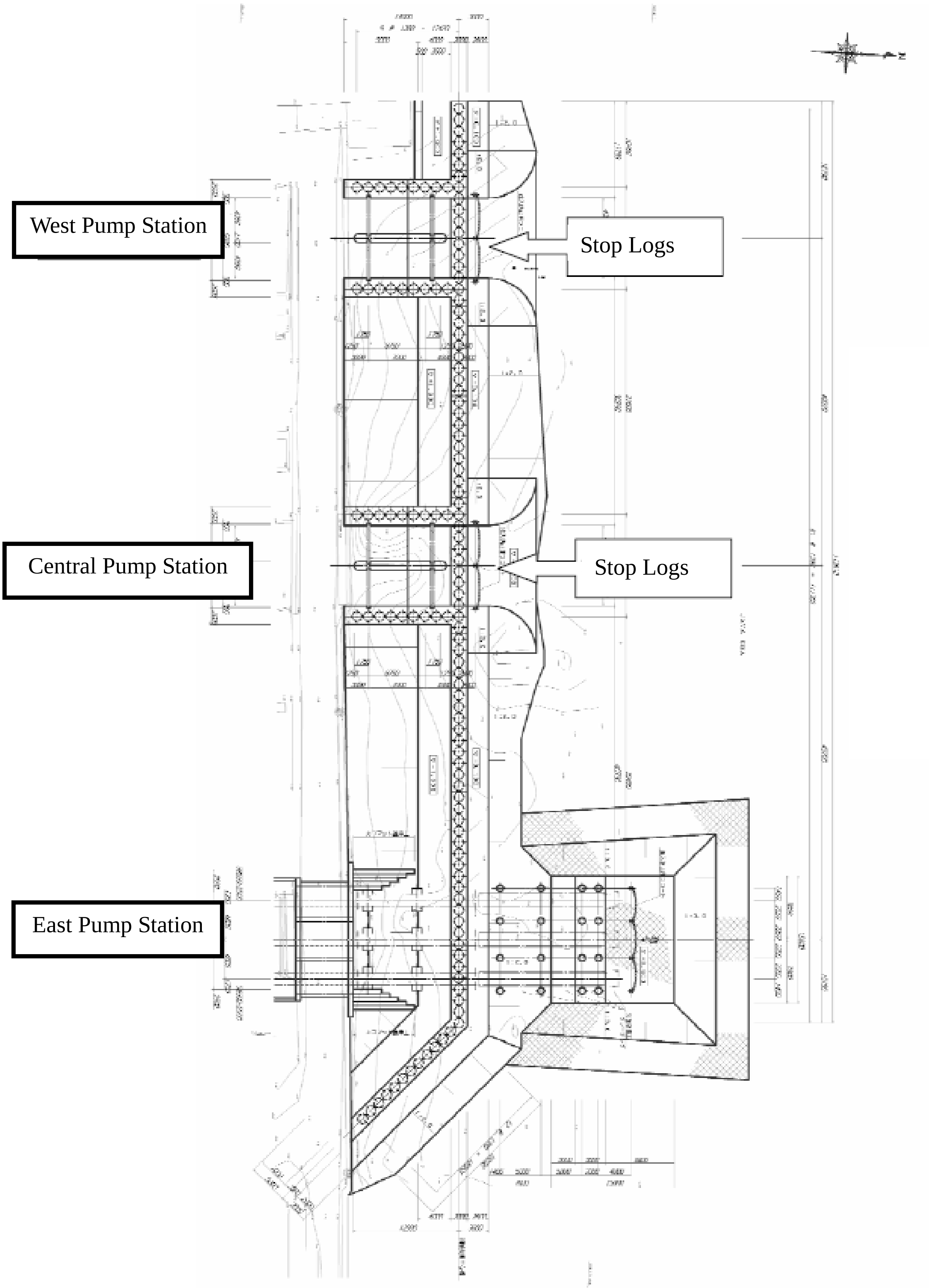


Figure2-2 Construction Range of Sea Tide Dike

(3) Design of Cantilever Sea Wall

1) Structure Model

Based on the design parameters of the cantilever steel pipe sheet pile and geotechnical conditions, the following structure model is established:

- Steel pipe: dia. = 1,200mm, t = 14mm, L = 22.5m
- Height of cantilever: 6.0m (1.90+3.90=5.80m)
- Design water level: water level (reservoir side) = GL−1.70m
  water level (sea side) = GL -2.50m
- Ground surface surcharge: permanent = 10kN/m^2
  seismic = 5kN/m^2
- Surcharge in front of the dike: Own weight of rubble mound with buoyancy = 10kN/m^2

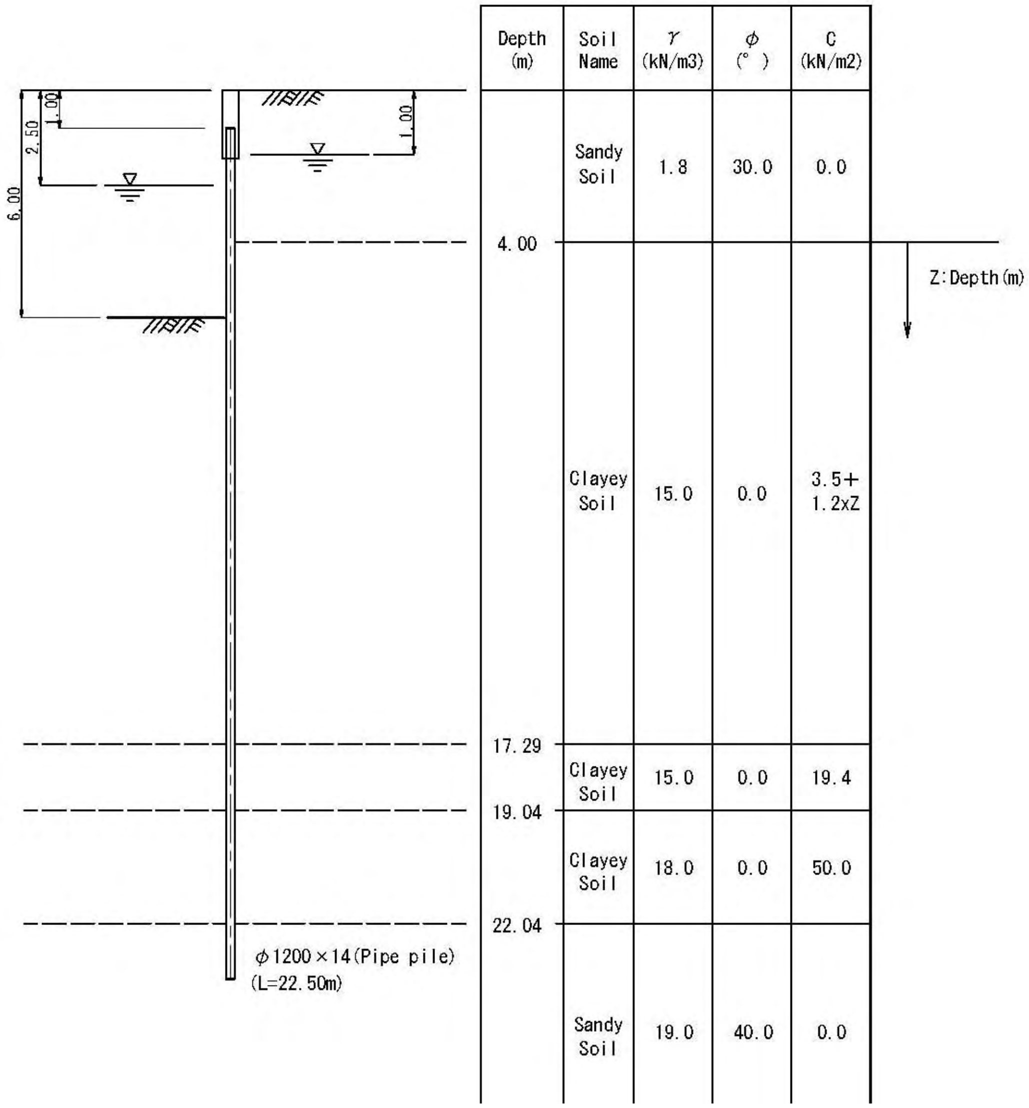


Figure 2-3 Structure Model of Sea Tide Dike

2) Design Equation

Chang's formula for multilayered ground is applied. With the design ground conditions, a required embedment length, Lo, is calculated by the following formula:

$$Lo = \frac{2.5}{\beta}$$

where β : refer to Table 2-25.

3) Design Parameters

The following parameters and the results of the geotechnical survey were applied for the outline design of Sea Tide Dike:

- Lateral pressure: Coulomb's earth pressure
- Design seismic coefficient: k = 0.12 (underwater: apparent seismic coefficient)
- Coefficient of subgrade reaction (lateral): $K_h = 0.691 \times N^{0.406}$ (Fukuoka-Utsu equation)
- Soil properties: refer to the structure model
- Material: Steel sheet pile (SKY490) Allowable stress σ

  σ_a = 185N/mm^2 → 180N/mm^2 (permanent)

  σ_{ae} = 277N/mm^2 → 270N/mm^2 (seismic)
- Allowable displacement δ

  δ_a = 50mm (permanent)

  δ_{ae} = 75mm (seismic)

4) Design Horizontal Seismic Coefficient

To obtain the horizontal seismic coefficient, the following parameters were calculated:

Procedure 1) Seismic hazard zoning coefficient C was given by the seismic hazard map in which Indonesia was divided into 6 zones as shown in Figure 2-4.

Procedure 2) Significance coefficient I was given according to the significance of each building as shown in Table 2-5.

Procedure 3) Structure type coefficient K was given as shown in Table 2-6.

With the above parameters, the horizontal seismic coefficient was calculated as follows:

a) Design seismic coefficient

$K_h = C \times I \times K$

K_h: Design seismic coefficient

C: Seismic hazard zoning coefficient

I: Significance coefficient

K: Structure type coefficient

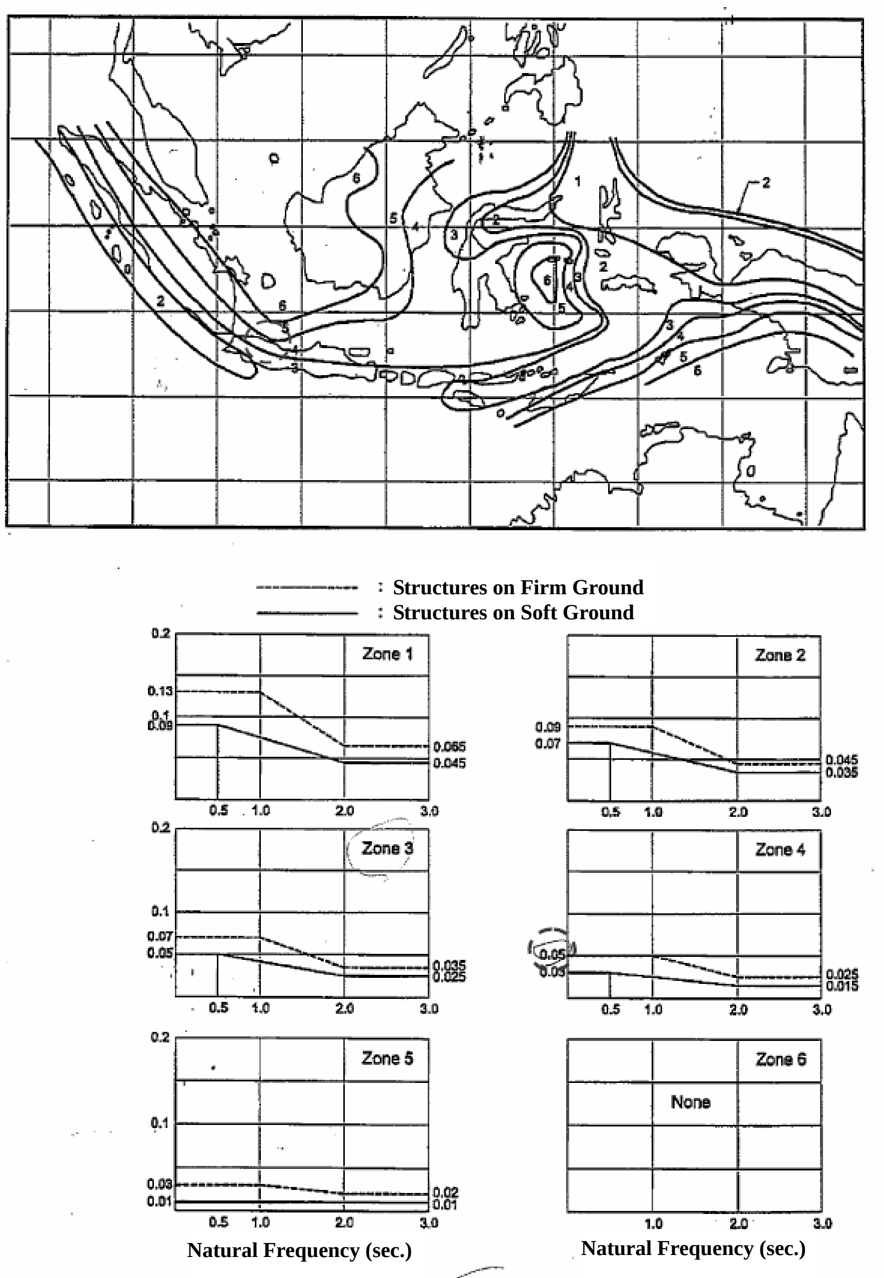
The following coefficient values are applied for the outline design:

C: 0.05 (maximum value in Zone 4)

I: 1.5

K: 1.5 (cantilever structure with earthquake-proof wall)

K_h : 0.05 x 1.5 x 1.5 = 0.113 → 0.12



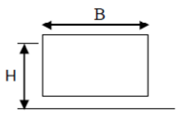
Source : Standard Design Criteria for Ports in Indonesia, January, 1994

Figure 2-4 Seismic Hazard Zoning Coefficient

Table 2-5 Significance Coefficient

Category	Building	Significance Coefficient (I)
(a)	Historical buildings	1.5
(b)	Buildings to keep the function after the earthquake (Hospitals, Schools, Food storehouses, Emergency medical centers, Power plants, Water storage facilities, Broadcasting stations, Amusement parks)	1.5
(c)	Gas and oil transportation facilities for the city center	2.0
(d)	Hazardous materials storage facilities	2.0
(e)	Others	1.0

Table 2-6 Structure Type Coefficient

Structure Type	Matrials	Structure Type Coefficient (K)
Structures on the ground to become weak during earthquake	Reinforced concrete Prestressed concrete Steel Wood	1.0 1.4 1.0 1.7
Structures without earthquake-proof wall	Reinforced concrete	1.0
Structures with earthquake-proof wall under the limitation as B/H >2.0 and B min > 1.5m  B: Width of structure H: Height to bedrock	Reinforced concrete Hollow reinforced concrete wall Wood	1.2 2.5 2.0
Structures with earthquake-proof wall beyond the above limitation and other structures	Reinforced concrete Hollow reinforced concrete wall Wood	1.5 3.0 2.5
Structures with diaphragm	Reinforced concrete Steel Wood	2.5 2.5 3.0
Cantilever structure of one-story house	Reinforced concrete Steel Wood	2.5 2.5 3.0
Cantilever structure of one-story house	Reinforced concrete Steel	2.5 2.5
Stacks and small tanks	Reinforced concrete Steel	3.0 3.0

5) Calculation Results

Calculation results are as follows:

Sheet pile: dia. 1200x14 (pipe type)

			Permanent	Seismic
Moment of inertia	I (cm^4)	634000		
Modulus of Section	Z (cm^3)	10600		
Maximum bending moment	Mmax (kNm/m)		215.39	556.79
Stress intensity	σ (N/mm^2)		24 (180)	62 (270)
Horizontal displacement	δ (mm)		19.24 (50.0)	68.70 (75.0)
Embedment length	D (m)		17.50	17.50
Whole length of sheet pile	L (m)	22.5		

Note: Figures in ( ) are allowable limits.

(4) Design of Stop Logs

1) Discharge Outlet Channel

In order to secure the function at each discharge outlet for Central and West Pump Stations, two openings shall be constructed at the steel pipe sheetpiling. The stop logs shall be installed at these openings, which shall be opened during permanent operation and be closed in case of emergency. This enables the openings to be easily blocked when Central and West Pump Stations will be re-constructed to change into the proposed aboveground pipe line system in future. The stop logs shall also be used for periodical visual inspection of existing Central and West discharge channels whether or not any cracks are developed due to future land subsidence. Vertical grooves shall be provided in walls in two locations, one beside the existing road and another close to the normal line of sheetpiling. The former shall be used for routine maintenance and visual inspection as well as in case of emergency and the latter shall be used for future reconstruction.

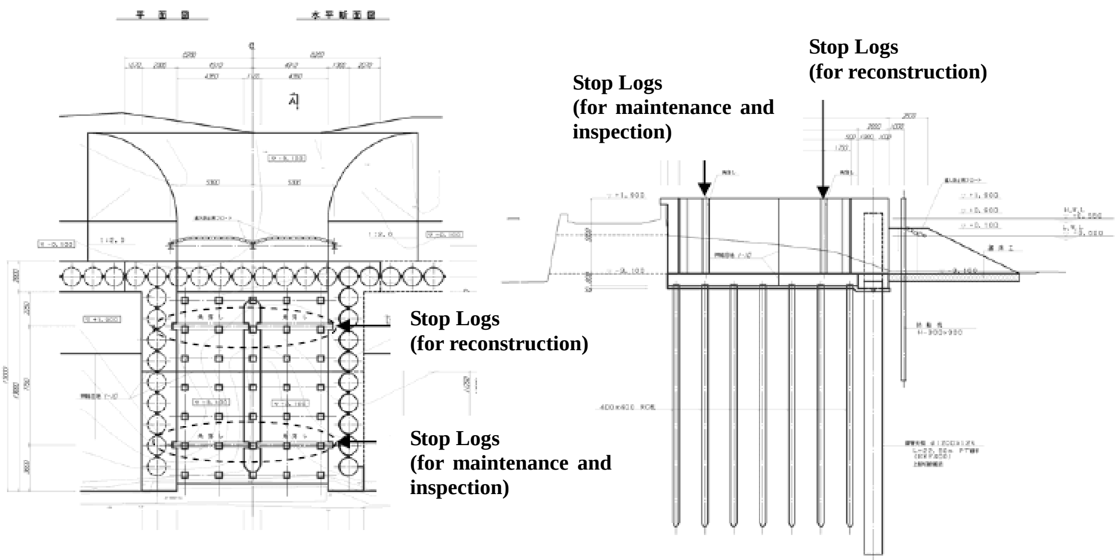


Figure 2-5 Design of Stop Logs

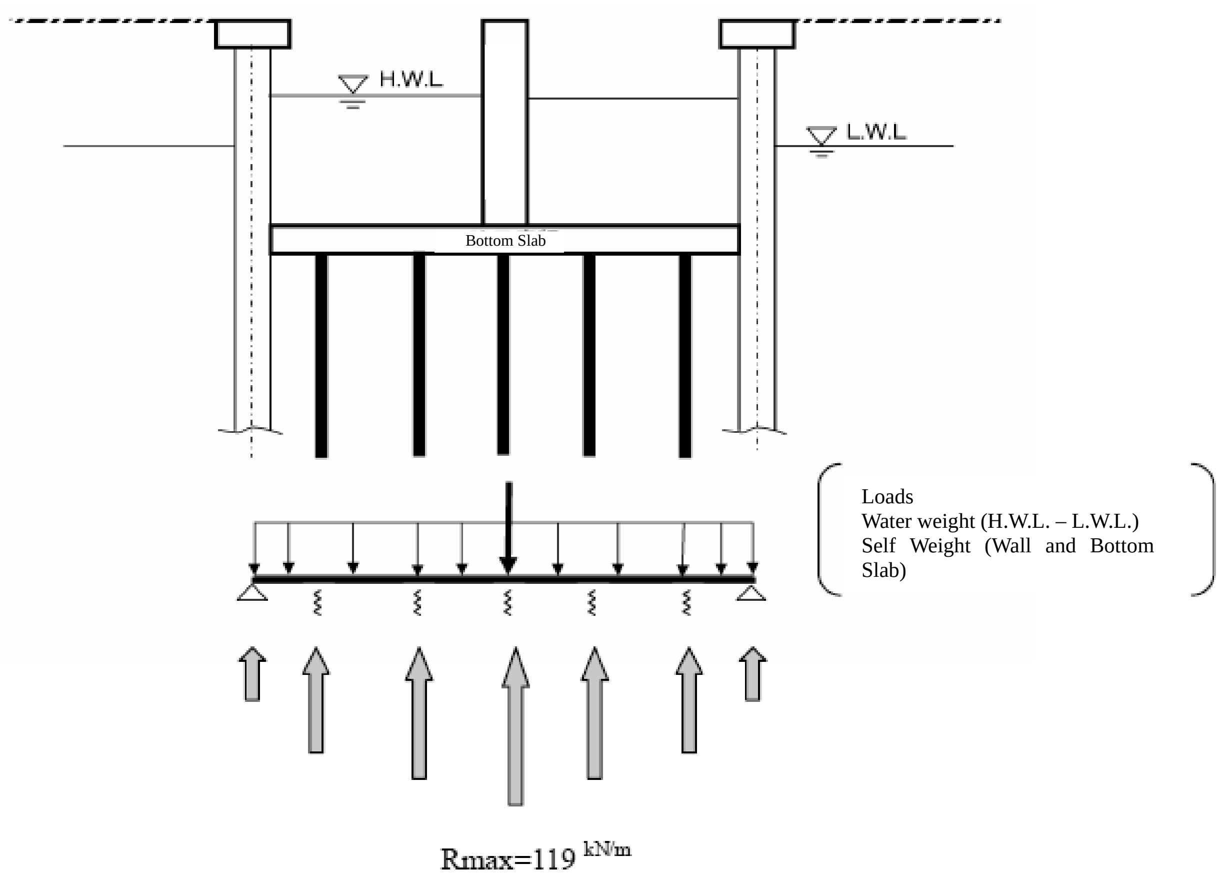
Steel pipe sheet pile and bottom slab for discharge outlet shall be in one structure to secure water tightness at openings.

2) Bottom Slab of Foundation of Discharge Outlet

It is highly possible that the discharge outlet and steel pipe sheet pile will be affected by the land subsidence because the discharge outlet shall be constructed on the soft ground.

Therefore, the discharge outlet shall be supported by pile foundation. The pile supporting layer is the upper layer described in 2-2-2-1 (1) and the prestressed concrete piles shall be used.

Under the conditions of the width of discharge outlet, middle wall, and fixing condition of bottom slab, reaction force of the pile is calculated with the structure model with the spring bearing point of piles.



When 5 piles in a row shall be installed in 2.0m spacing, pile reaction can be obtained as follows:

R_0 = 119 kN/m x 2.0 m/pile =238 kN/pile $\leqq$ R_a = 240 kN/pile

(5) Protection of Discharge Pipe

1) Protection of Discharge Pipe

The outlet end of the discharge pipe is submerged into sea water. Therefore, the pipe shall be protected with lining concrete for 360° to prevent from the damage by sea water, wave, ships, etc. The bottom of this pipe is supported by concrete beam supported by steel pipe pile.

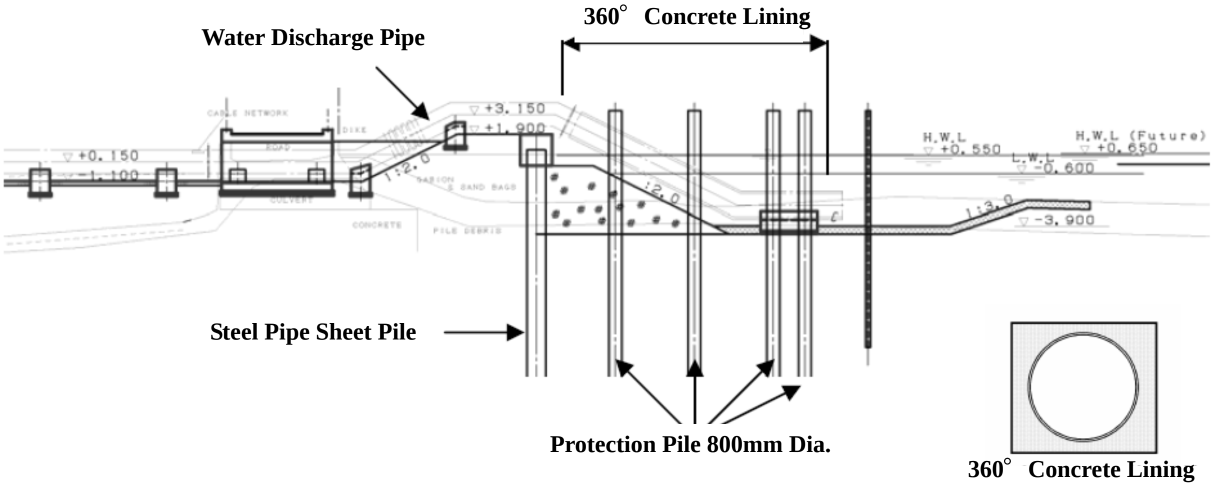


Figure 2-6 Protection of Discharge Steel Pipe

2) Sea Bed Protection at Pipe Discharge Outlet

As a sea bed protection, rubble mound shall be constructed to prevent the front of the dike from scouring.

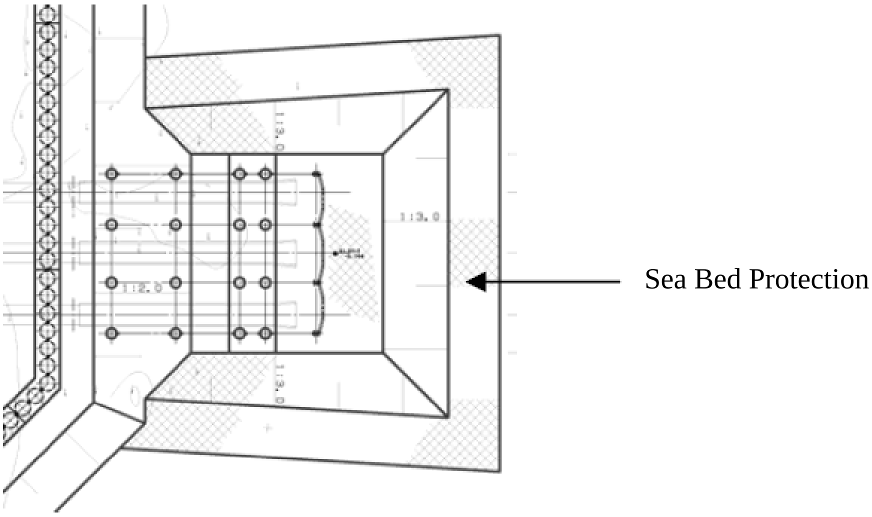


Figure 2-7 Sea Bed Protection at Pipe Discharge Outlet

(6) Intersection Structure between Discharge Pipe and Road

Intersection structure between the discharge pipe and existing road shall be box culvert structure to secure the function of the road. The foundation of this culvert is a spread foundation to minimize the difference of the relative subsidence with the discharge pipe foundation.

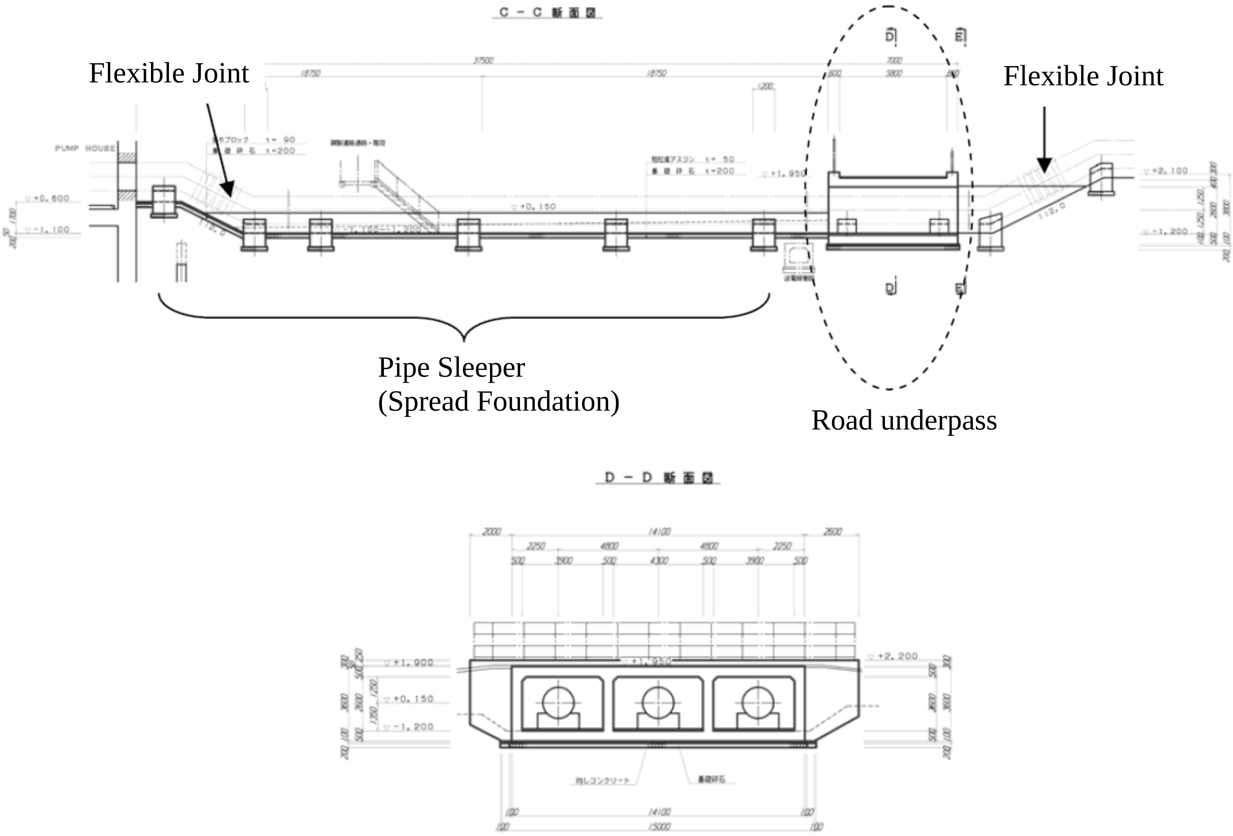


Figure 2-8 Intersection Structure between Discharge Pipe and Road

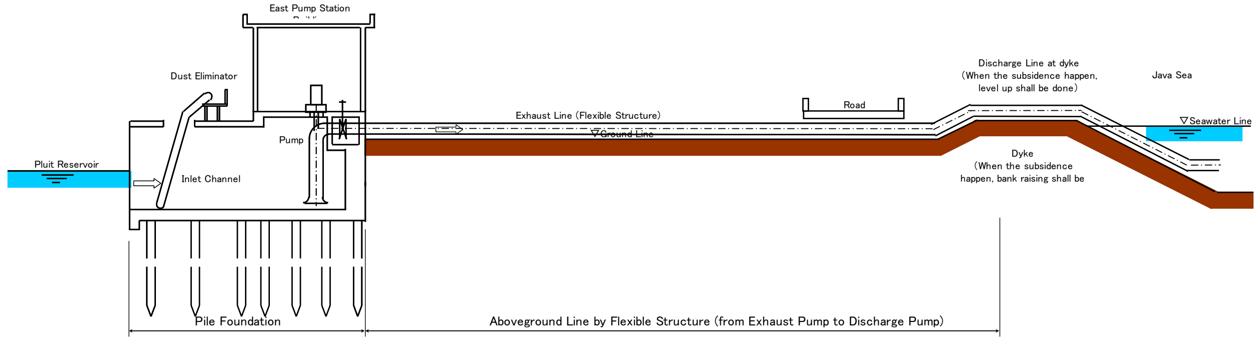
2-2-2-5 Pump House Plan

(1) Pump House Civil Facilities

1) Reconstruction Method

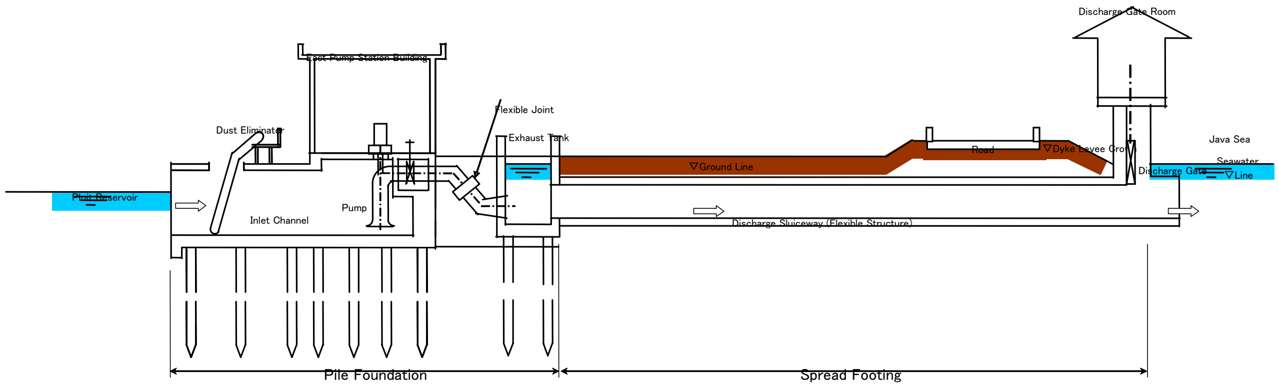
The Team compared two options for water discharge system from new pump facility in East Pump Station; i.e. "Aboveground Pipe Line System" and "Discharge Sluiceway System" (Figure 2-9). Based on the site and document investigations, "Aboveground Pipe Line System" is selected because it is superior in terms of the construction and economical efficiency, and high adaptability to the ground subsidence.

1.Aboveground Pipe Line System



East Pump Station: Aboveground Line System(Cross-section drawing) : Recommended Practice

2. Discharge Sluiceway System



East Pump Station: Discharge Sluiceway System(Cross-section drawing)

Figure 2-9 Options for Reconstruction of Water Discharge System

2) Facility Layout

As a result of the comparison among three layout plans for the position of reconstructed EPH, namely PLAN-1: new pump house constructed upstream of the existing EPH, PLAN-2: new one constructed at the same place as the existing one and PLAN-3: new one constructed down steam of the existing one. PLAN-2 is selected based on the water tightness, construction and economical efficiency as shown in Table 2-7.

There are hollow spaces created by the piping phenomenon underneath the bottom slab of the existing EPH. It is necessary to demolish the existing EPH, and also to take effective measures to fill this space, otherwise it could be left as water path after the completion of the works.

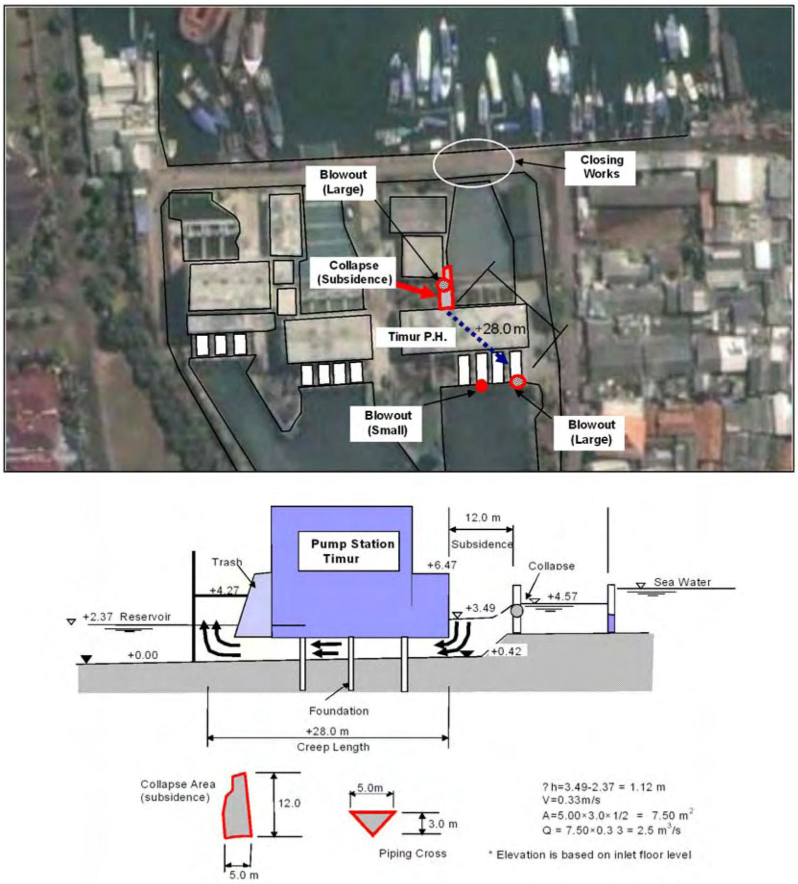


Figure 2-10 Situation of Piping Phenomenon

Because of the space created by piping phenomenon, it is necessary to expand the temporary earth retaining work to include the existing EPH in case of PLAN-1 and PLAN-3. Therefore, the costs of PLAN-1 and PLAN-3 will be higher than that of PLAN-2.

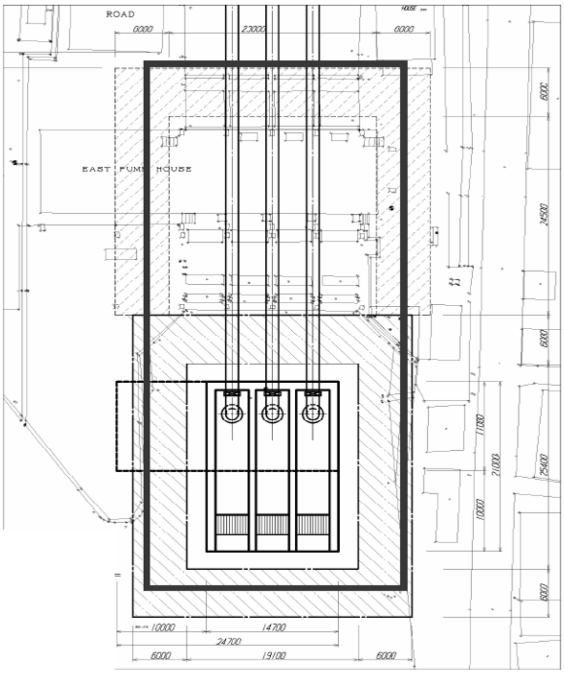


Figure 2-11 Range of Earth Retaining Work of PLAN-1

In case of PLAN-3, the electrical room for West and Central Pump Stations should also be relocated. Therefore, PLAN-3 needs a longer construction period and higher construction cost compared to PLAN-1 and PLAN-2.

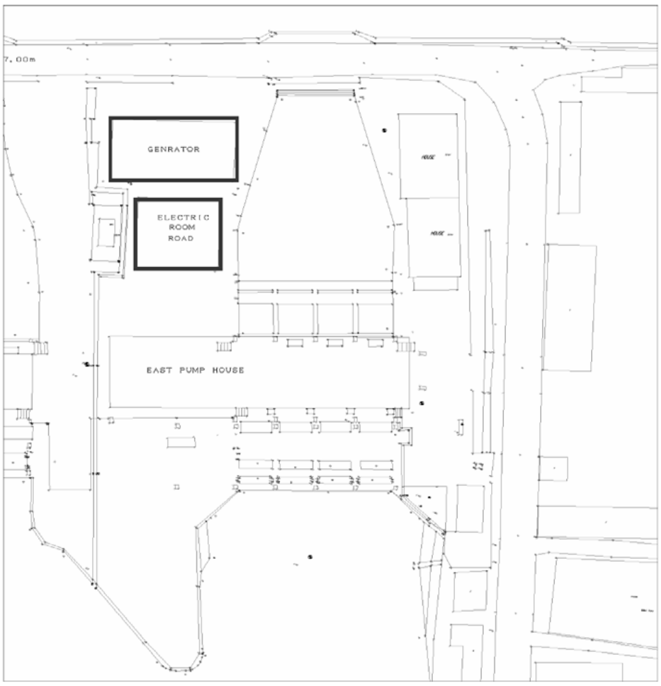


Figure 2-12 Position of Electrical Room

Regarding the foundation pile construction, economical efficiency of all plans is considered equivalent because there is no difference in the depth of supporting layer for each plan. Refer to Figure 2-13.

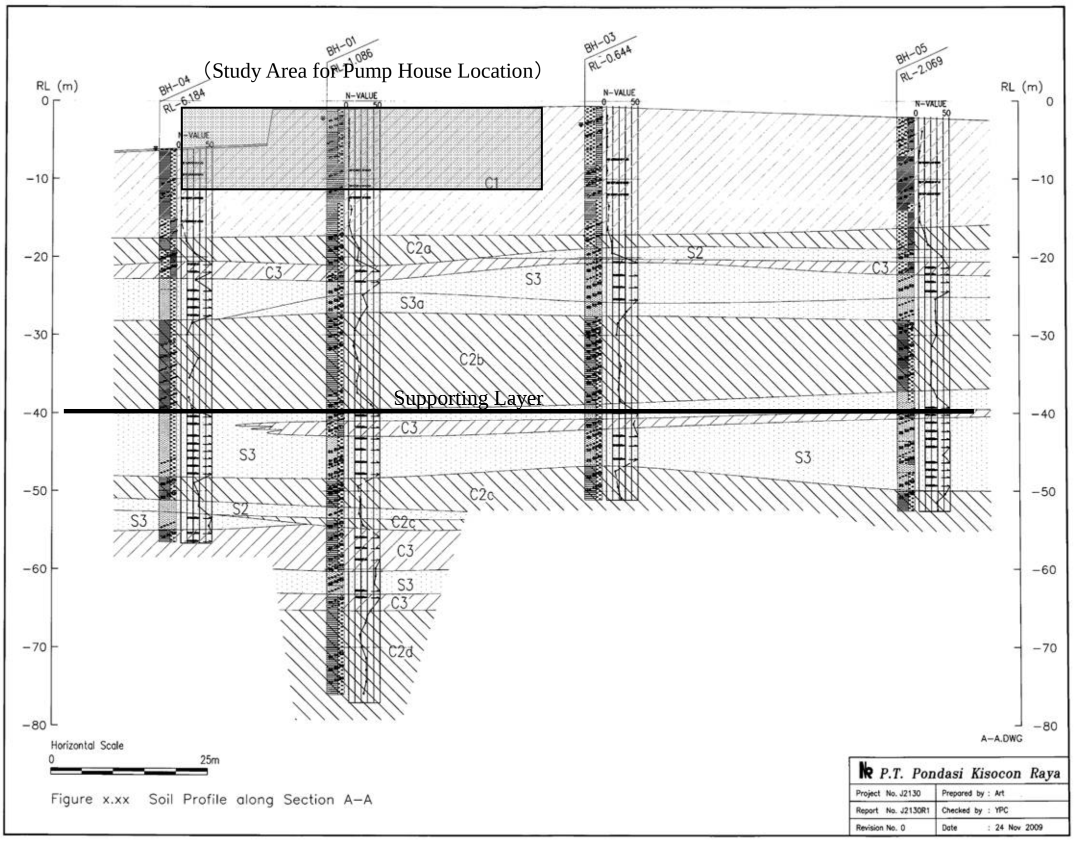
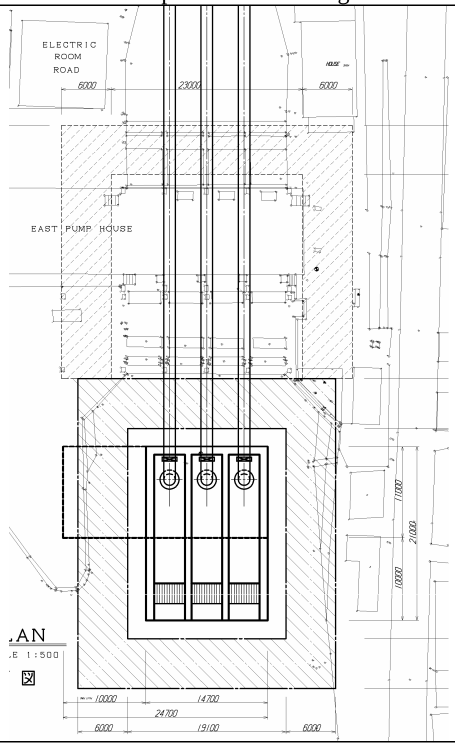
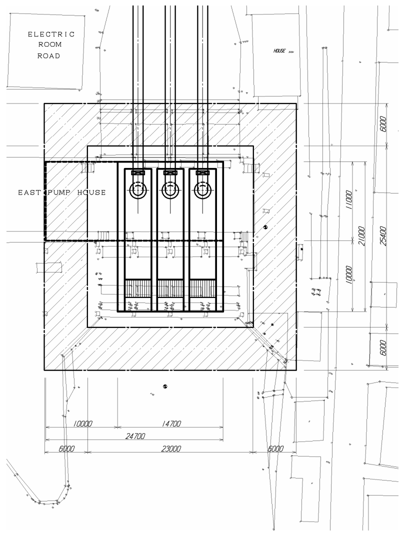
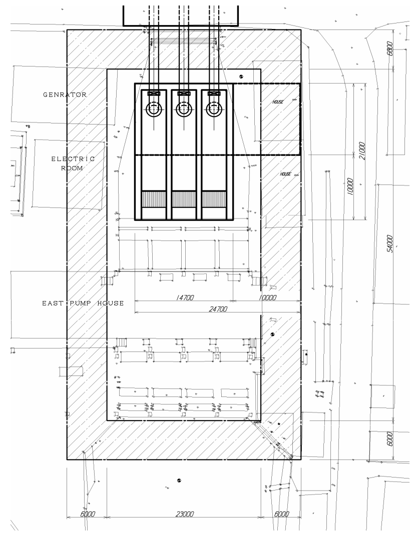


Figure2-13 Soil Profile (Longitude Cross Section)

Table 2-7 shows the summary of Comparison Evaluation of Facility Plan.

Table 2-7 Comparison Evaluation of Facility Plan

Plan	Plan-1 Upstream of Existing EPH	Plan-2 Same Location as Existing EPH	Plan-3 Downstream of Existing EPH
General Outline			
Description of Plan	• New pump house will be constructed upstream of the existing EPH. Discharge pipe will be installed on the place where the existing EPH and existing discharge channel are located after demolition of the above ground portion of existing EPH and backfilling at EPH and discharge channel. Length of pipe is 95m.	• New EPH will be constructed in the same place as the existing EPH. • New discharge pipe will be installed on the backfill of existing discharge channel. Length of pipe is 65m.	• New EPH will be constructed at the downstream of existing EPH in the same place as existing discharge channel after demolition of it. • New discharge pipe will be installed on the backfill of existing discharge channel and the length of pipe is 35m.
Flood Control	• Existing EPH will be demolished and all existing pumps will be out of function, therefore, alternate discharge facility is necessary in replacement of discharge capacity of existing EPH during construction work.	• Since the demolition of existing suction pit shall be completed in the first place, operation of pumps in the existing EPH can not be made during reconstruction works. (Alternate temporary discharge facility will be required.)	• Operation of the existing East pump facility can not be done since demolition of existing discharge channel shall be done first. (Alternate temporary discharge facility will be required.)
	• Temporary pump units with the same capacity as existing 2 units of pumps (3.2m^3/sec x 2 units) will be installed in the vicinity of Central or West Pump Station.	• Same as left.	• Same as left.
	• Since the existing suction pit will be left undemolished, space or water path created by piping phenomenon will also be left underneath the bottom slab of existing suction pit, thus future risk of expansion of such space or path and consequential subsidence or collapse of surrounding ground will be expected. (Reliability in safety of the facility is low due to existence of collapsing structure in the ground)	• Existing suction pit can be completely removed. Visual confirmation of hollow space or water path and appropriate treatment for space fill can be done, thus, security and reliability in safety is high.	• For construction of new inflow channel, the existing EPH shall be demolished, therefore, as same as Plan 2, the space underneath the existing suction pit created by piping can be completely removed. Security and reliability in safety is high.
	• Although countermeasures for piping, watertight steel sheetpiling can be provided at new suction pit, such installation will induce the expansion of the existing water path in the east and west direction.	• Future pipe phenomenon as a result of expansion of existing water path can be prevented completely since complete treatment of existing water path can be made.	• Same as left.
	• New EPH will be constructed further upstream of the existing EPH as compared with the existing Central and West Pump Houses. This will cause irregular flow in the inlet channel which may lead to impact on the operational water level of other 2 pump stations.	• Inflow condition is unchanged from the present, thus no hydraulic impact on other pump stations expected.	• New EPH will be constructed further downstream form Plan 2. There is no hydraulic impact on other pump houses.
	△	◎	○
Construction	• Construction period is shorter than other plans because demolition work of existing aboveground structures of the existing EPH and construction work of new EPH can be done in parallel. • Demolition of underground portion of existing EPH will not be the determining factor on the construction period, thus the construction period is shorter than other plans. (When the underground portion of EPH will also be demolished, the construction period is almost the same as Plan 2.) • Construction work of new EPH is easier than other plans since no underground obstruction such as existing piles in the construction place of new EPH.	• Construction period is longer than Plan 1 since demolition of existing EPH firstly and parallel work can not be done. (But still within 24 months of construction period.) • Demolition of existing EPH including underground portion is requisite. • Use of steel pipe pile with 1000 mm dia. can avoid the overlapping of new piles with the existing ones.	• Since both existing EPH and discharge channel shall be demolished, the required construction period for civil facility is as same as in Plan 2. • Prior relocation of existing electrical room, generator room and storage rooms in addition to removal of EPH and discharge channel is requisite. (Overall construction cost including the above replacement is longer than Plan 2.) • No concern is required for installation of new piles for EPH since there is no existing piles at the construction place of new EPH.
	◎	○	△

Plan	Plan-1 Upstream of Existing EPH	Plan-2 Same Location as Existing EPH	Plan-3 Downstream of Existing EPH
Temporary Works	• Construction work volume is smaller than those of other plans when the existing underground portion of EPH will not be demolished. (Construction work volume is more than those of Plan 2 when the above demolition will be carried out.)	• When underground portion will be demolished, construction work volume is smaller than other plans since the temporary earth retaining works can be used for both of demolition and reconstruction works of EPH.	• Scale of temporary earth retaining works is larger than other plans.
	○	○	△
Approx. Construction Period	21 months	24 months	27 months
	○	△	×
Impact to Mechanical and Electrical facilities	• The discharge pipe length is longer by 30m than Plan 2, thus, friction loss in pipe is larger than Plan 2. (Motor output of pump will be increased as a result of pump head increase.) Pipe length:95m	• Friction loss in pipe is smaller than Plan-1. Pipe length 65m.	• Pipe friction loss is smaller than other plans. Pipe length 35m.
	• Since new discharge pipe will be installed on the backfill of existing suction pit of EPH, the long-term safety will be reduced. (Cost to prevent above concern so as not to cause any damage after construction will be very high and even if such prevention work is implemented, reliability still can not be secured.)	• There is no problem on the stability of pipe sleeper foundations since the foundation will be constructed on the backfill on the discharge channel which had not suffered piping phenomenon.	• No problem anticipated since all existing facilities will be removed and reconstructed.
	×	◎	◎
Economy	• Construction cost is higher than other plans because of longer length of pipe. Running cost of pumps will be higher than other plans due to increase of friction loss in pipe. • Countermeasures against space or water path underneath the bottom slab of existing suction pit, cost for temporary earth retaining work (sheetpiling) is higher than Plan 2.	• Construction cost is lower than other plans since the demolition and reconstruction of pump house can be done within the same temporary earth retaining structures.	• As same as Plan-2, the temporary earth retaining structure for demolition of existing EPH is large and construction cost is high. • Length of discharge pipe is shorter than other plans and running cost is low. • Relocation of the existing electrical room which is commonly used by Central and West pump stations is required and construction cost is high. • Additional cost for demolition and reconstruction of existing warehouses is required. Such works is not necessary in other plans.
	△	○	△
Overall Evaluation	△ • Inferior in terms of effectiveness of flood control, long-term safety and reliability.	○ • Overlapping of new piles with existing ones under the existing EPH can be avoided by using 1000mm dia. Steel pipe pile. Security of construction is high and water discharge capacity is also high.	× • Large impact on the surrounding facilities during construction. Impractical plan.

Note: A; advantages are shown in blue characters, and disadvantages are shown in red characters.

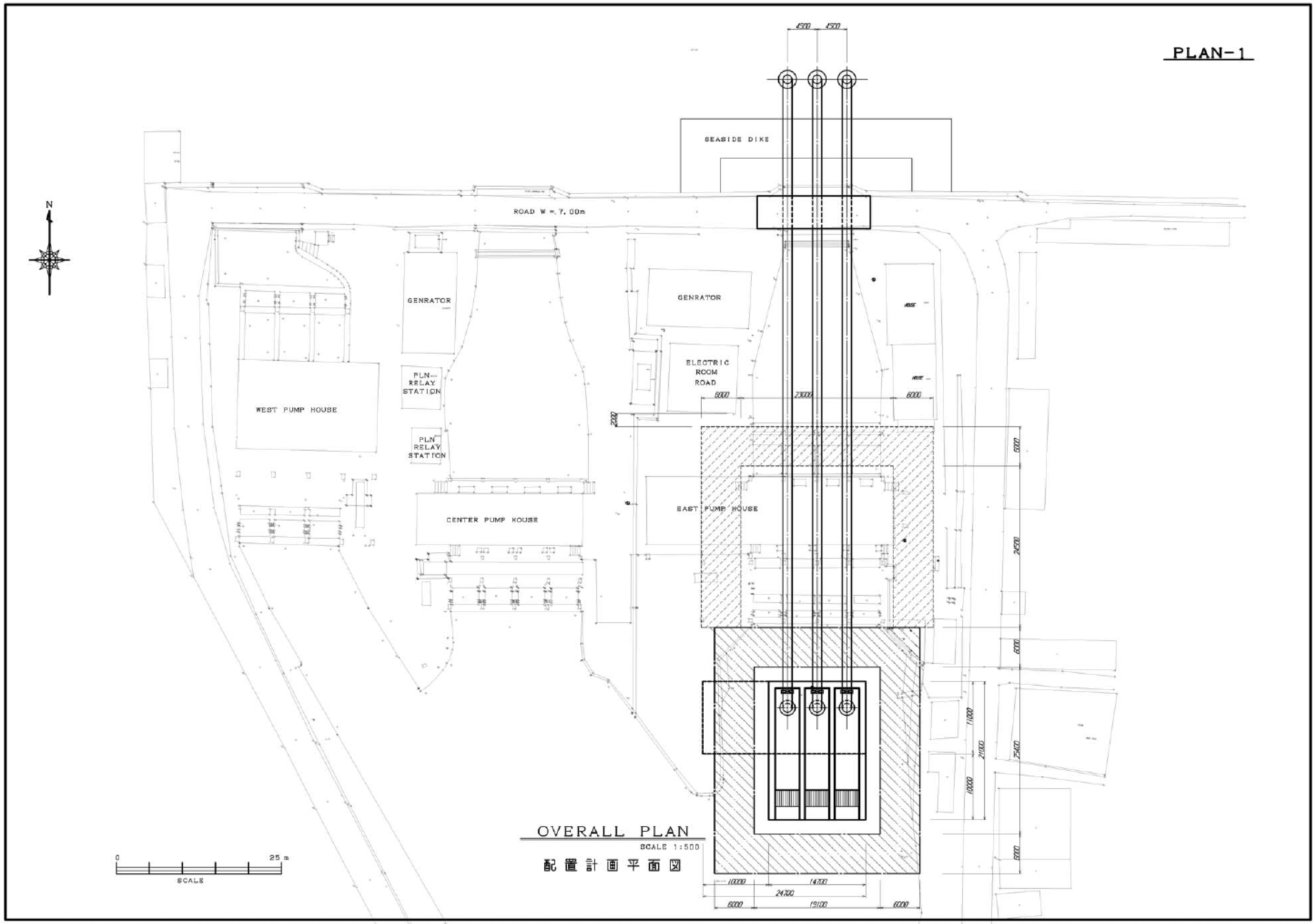


Figure 2-14 Facility Plan of PLAN-1 Upstream of Existing EPH

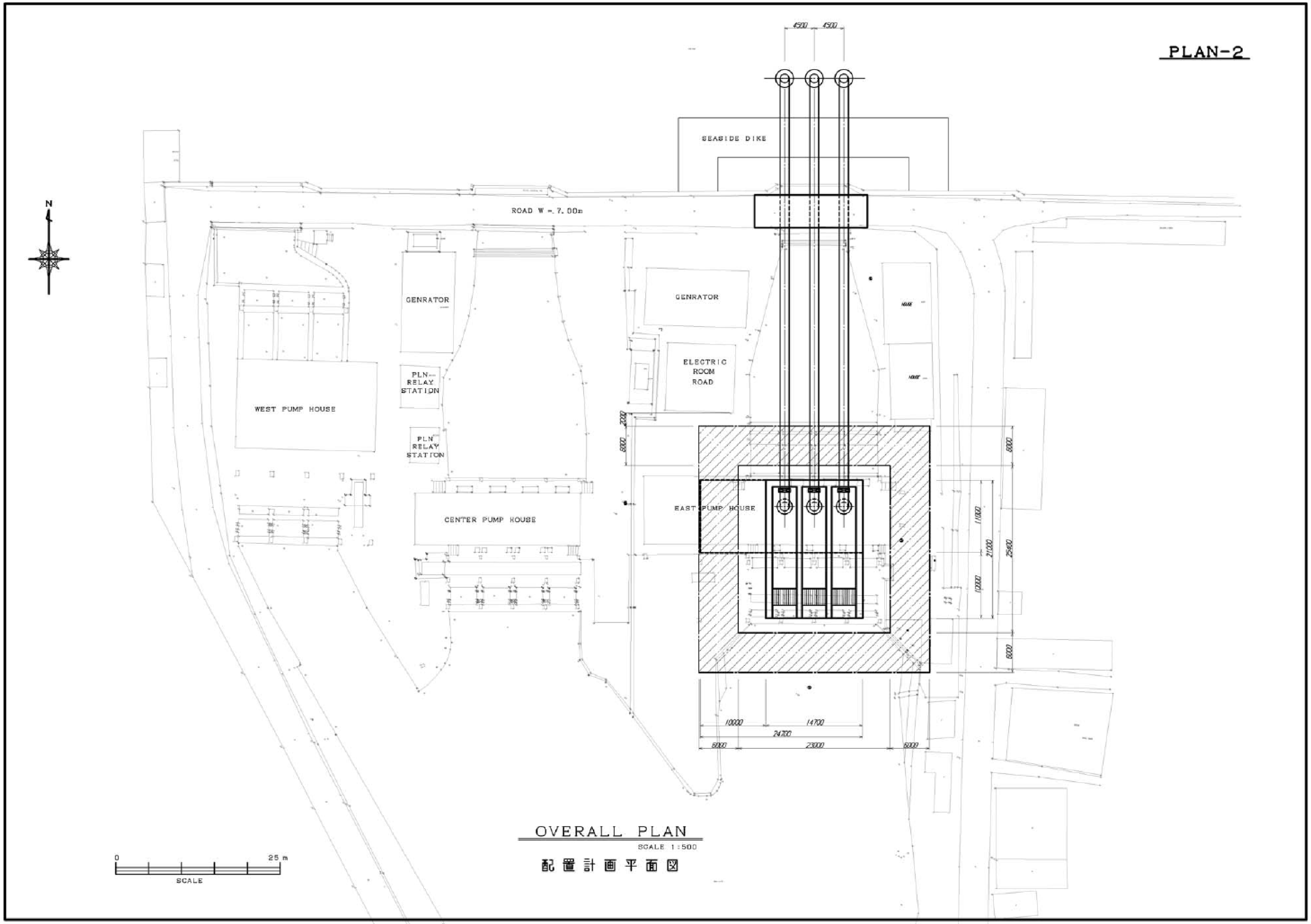


Figure 2-15 Facility Plan of PLAN-2 Same Position as Existing EPH

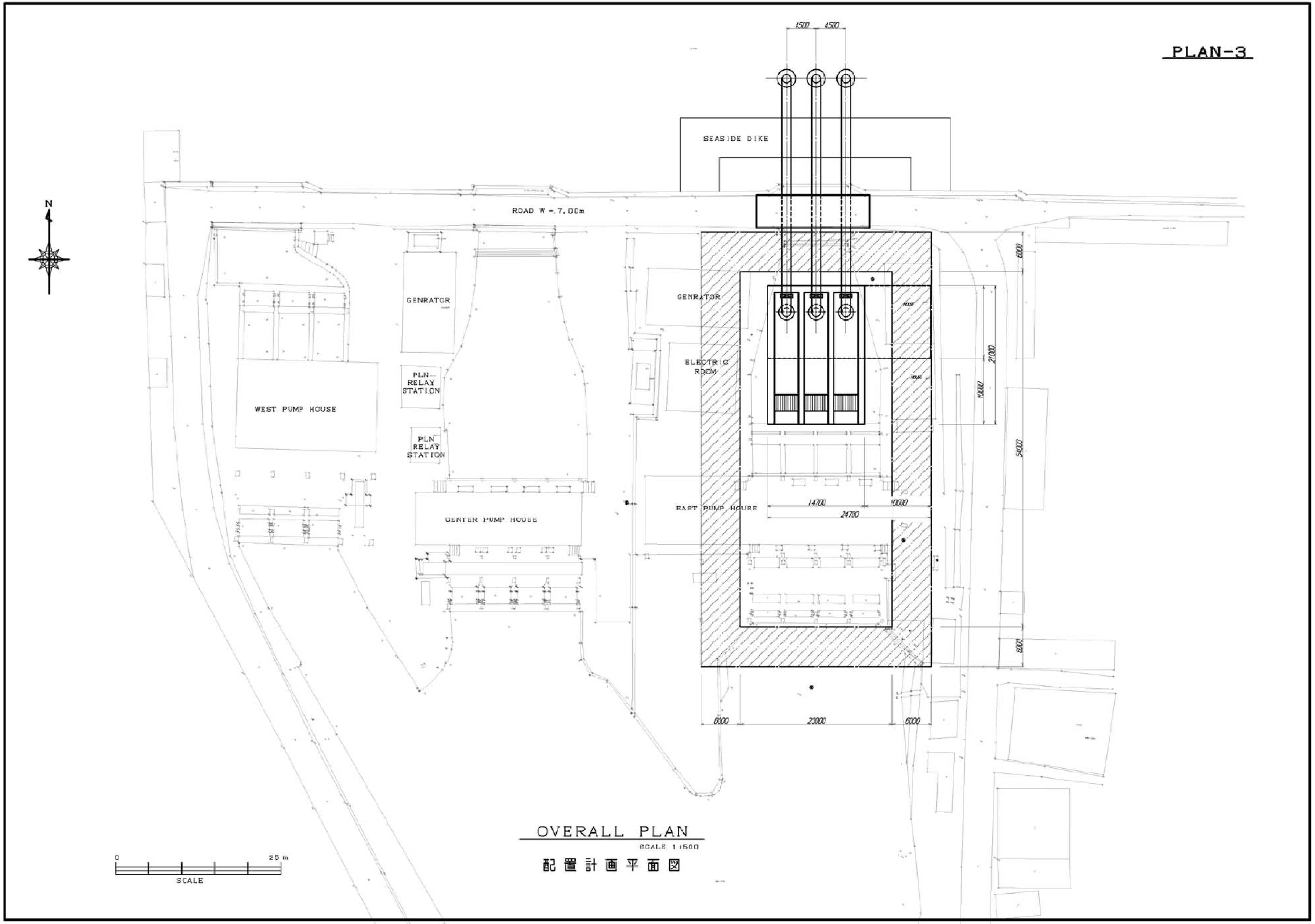


Figure 2-16 Facility Plan of PLAN-3 Downstream of Existing EPH