Japan International Cooperation Agency

The Supplemental Study
for
Metropolitan Sanitation Management Investment Program: Sewerage System Development in DKI Jakarta (E/S)
in
Republic of Indonesia

FINAL REPORT
VOLUME 1 : Main Report

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ABBREVIATION LIST

AMDAL	Environmental Impact Assessment (Indonesian)
ANDAL	Environmental Impact Statement (Indonesian)
ARP	Abbreviated Resettlement Plan
ASP	Activated Sludge Process
BOD	Biochemical Oxigen Demand
BPLHD	Regional Environmental Agency (Indonesian)
C/P	Counterpart
CAS	Conventional Activated Sludge Process
CSO	Combined Sewer Overflow
DGHS	Directorate General of Human Settlements
DKI	Special Capital City District (Indonesian)
EIA	Environmental Impacts Assessment
ES	Engineering Service
FIDIC	International Federation of Consulting Engineers (French)
FS	Feasibility Study
GC	Condition of Contract for Construction
GIS	Geographic Information System
GOI	Government of the Republic of Indonesia
GOJ	Government of Japan
IEE	Initial Environmental Evaluation
ITR	Interim Report
JEDI	Jakarta Emergency Dredging Initiative
JICA	Japan International Cooperation Agency
JO	Joint Operation
JST	JICA Study Team
LARAP	Land Acquisition & Resettlement Action Plan
MBBR	Moving Bed Bio-Reactor
MBR	Membrane Bio-Reactor
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MP	Master Plan
MPA	Metropolitan Priority Area
MST	Modified Septic Tank
NCICD	National Capital Integrated Coastal Development
O&M	Operation and Maintenance
ODA	Official Development Assistance
P/Q	Pre-Qualification
PMU	Project Management Unit
PP	Pilot Project
PPP	Public–Private Partnership
PU	Ministry of Public Works and People's Housing
RAP	Resettlement Action Plan
UKL-UPL	Environmental Management and Monitoring (Indonesian)
WWTP	Wastewater Treatment Plant

CHAPTER 1 INTRODUCTION

1.1 Backgrounds and Objectives of the Study

1.1.1 Background

The sewerage coverage ratio in the Republic of Indonesia (Indonesia) is only approximately 2%[1], which is significantly lower than that of the neighboring countries (Philippines: 7%, Vietnam: 14%, Thailand: 34% and Malaysia: 38%). In particular, the capital and largest city in Indonesia, DKI Jakarta, (population 9.6 million) and the entire metropolitan area Jabodetabek (population 26.64 million) are suffering from serious deterioration in water environment because of the rapid population growth and urbanization associated with recent economic developments. Therefore, drastic improvement of sewerage service is urgently required.

Figure 1.1 shows the history of the previous master plans and studies for Jakarta sewerage and the relation of them. The Pilot Project will be conducted before the Jakarta Sewerage Zone 1 Projects using ODA loan.

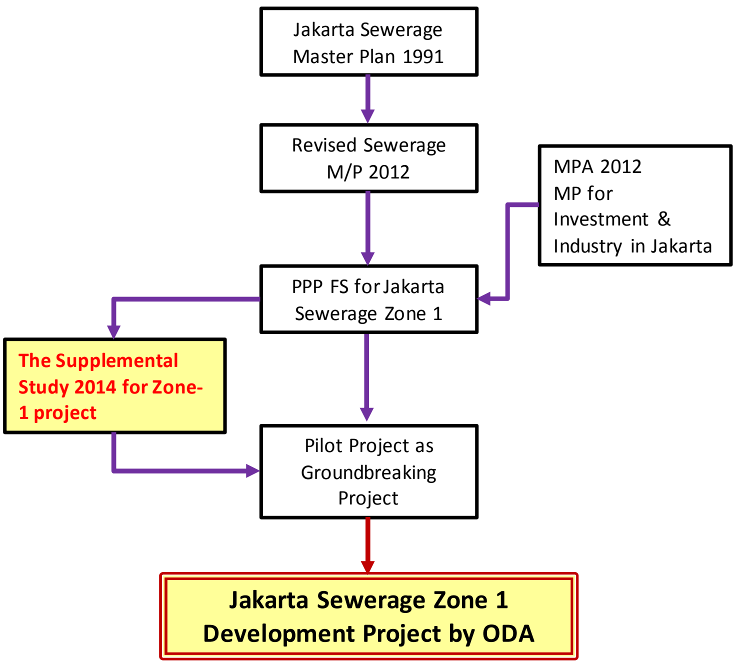


Figure 1.1 The history and the relation of the previous master plans and studies for Jakarta sewerage

[1] PD PAL Jaya Concept and Strategy for Wastewater Management of Jakarta City, 2014
Global Water Intelligence, 2014

Although the Jakarta Sewerage Master Plan was formulated in 1991, the proposed sewerage development did not happen because of political changes and economic crises. The "New Master Plan for Improvement of Wastewater Management in DKI Jakarta" (New M/P) was subsequently prepared with a planning horizon of 2050. The New M/P designates 15 sewerage zones and proposes two priority projects, one in Zone-1 and the other in Zone-6 for completion by 2020. The development of sewerage systems in Zone-1 and Zone-6 was approved in October, 2012, as flagship projects in the Metropolitan Priority Area (MPA).

In March 2013 on completion of the "Preparatory Survey on the Central Sewerage Treatment System in Jakarta" (PPP F/S) for the Zone-1 sewerage project, the Government of Japan (GOJ) pledged to the Government of Indonesia (GOI), support for the engineering services, including tender assistance and detailed design of the sewer network.

The Ministry of Public Works and People's Housing (PU) and the Governor of DKI Jakarta agreed that they would use GOI funding to construct some sewers in Zone-1. An alternative site different from that proposed in the PPP F/S and the New M/P was put forward for the wastewater treatment plant (WWTP). The GOI requested the Japan International Corporation Agency (JICA) to conduct a Supplemental Study to provide technical assistance in the preparation for the Pilot Project and to confirm the validity of the alternate site proposed for the WWTP.

The scope of work for the Supplemental Study for the Metropolitan Sanitation Management Investment Program: Sewerage System Development in DKI Jakarta (E-S), was confirmed between the Directorate General of Human Settlements (DGHS), PU, DKI Jakarta, and JICA on September 13, 2013.

1.1.2 Objectives of the Study

The objectives of the Study are:

1) to provide support for the Pilot Project from detailed design to tender evaluation; and
2) to examine the suitability of the alternative site for the construction of the WWTP.

1.2 Main Tasks of the Study

The main tasks of the Study are:

1) to assist in the preparation for the Pilot Project,
2) to examine the new site for the WWTP,
3) to study the effective development of wastewater collection system using existing drainage, and
4) to review the environmental and social considerations.

1.3 Contents of Final Report

Chapter 1 introduces the objectives, the scope work and outline of the Study.

Chapter 2 explains the outline of the detailed design works of a part of trunk sewer to be implemented as the Pilot Project and the prequalification (P/Q) and tender documents prepared for the Pilot Project.

Chapter 3 presents the conditions of the existing drainage system based on the findings from the field survey; as well as the suggestions and recommendations on the introduction of an interceptor sewer system which would provide more immediate improvements on the water environment.

Chapter 4 presents the preliminary design of the treatment facilities and the cost estimation.

Chapter 5 explains the status of the assistance provided on EIA and land acquisition related to the Pluit site.

Chapter 6 reports on the first and the second seminar in Jakarta held in June and November 2014 and the first workshop in Japan held in August 2014.

Chapter 7 presents the conclusion and recommendations throughout conducting the Study.

CHAPTER 2 ASSISTANCE WITH THE IMPLEMENTATION OF THE PILOT PROJECT FOR SEWERAGE SYSTEM DEVELOPMENT IN DKI JAKARTA

2.1 Progress with the Preparation for the Pilot Project

Table 2.1 shows the status of preparations for the Pilot Project.

Table 2.1 Status of Preparations for the Pilot Project

Task	Action	Status
1) Confirmation of Trunk Sewer Route	・Study the road conditions, trunk sewer plan, road plan and subway plan. ・Confirm crossings with existing rivers, storm-water drainage channels, and planned subway lines.	・Field surveys were conducted in Feb. and Mar. 2014. ・Specifications for levelling surveys along the trunk sewer route were prepared.
2) Confirmation of Trunk Sewer Profile	・Review the PPP F/S trunk sewer plan. ・Prepare a preliminary design and profiles of the trunk sewers, based on the results of the levelling survey.	・The preliminary design of trunk sewers in Zone-1 was updated in April and May 2014. ・The results of the levelling survey along the revised trunk sewer route were used to prepare the profiles.
3) Site Selection for the Pilot Project	・Survey the proposed site. ・Confirm the site selection is appropriate, taking into consideration the use of the latest pipe jacking technology.	・Field surveys and discussions on Pilot Project site were conducted in Feb. and Mar. 2014.
4) Preparation of Pre-Qualification (P/Q) Documents	・Prepare the P/Q documents, ensuring that the actual performance of sewer pipe laying using pipe jacking and experience with deep vertical shaft construction can be verified.	・Simplified P/Q process would be used at the initial stage of the Study. The full scale P/Q document preparation would be required for the construction of deep vertical shafts and application of the latest installation technology. ・Full scale P/Q documents were submitted in July 2014 and were modified through discussions with PU.
5) Preparation of Tender Documents	・Based on the results of topographic and soil surveys, prepare detailed design, drawings, bill of quantities, technical specifications, and cost estimation.	・Detailed design of the Pilot Project was completed. ・Tender Documents were prepared and submitted in July 2014, and modified in response to the comments from PU.

Source: JICA Study Team

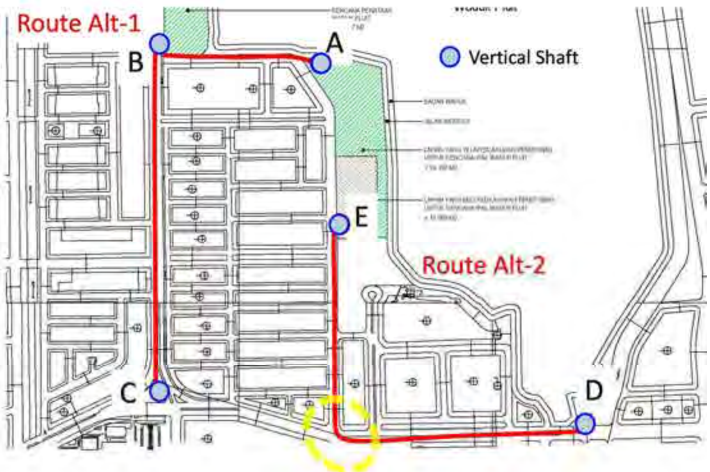
2.2 Selection of the Pilot Project Site and Data Collection

2.2.1 Selection of Trunk Sewer Route

Table 2.2 compares the two alternative trunk sewer routes, proposed in February 2014. It should be noted that the diameter and length of trunk sewers, construction period, and cost estimates in Table 2.2 were revised at a later stage of the Study.

Ministry of Public Works and People's Housing (PU) and DKI Jakarta selected Alternative 1 for the trunk sewers. PU's official letter on the selection was issued on 17th of March 2014.

Table 2.2 Comparison of Two Alternative Trunk Sewer Routes for the Pilot Project (As of February 2014)

Item	Alternative 1	Alternative 2
1) Plan		
2) Main Feature	2,200 mm dia and 870 m. There is enough space at all locations from A to C for the construction of vertical shafts.	2,000 mm dia and 900 m. There is enough space at locations D and E but no space available between D and E. The construction of vertical shafts is very difficult on the road (total 4 lanes, 14 m wide) at Pluit Selatan Ray which is the main road for truck trailers and has heavy traffic all day.
3) Const. Method	Pipe jacking (micro-tunneling) method can be used for trunk sewer construction. The line would only have to navigate a moderate curve. Using this method, the work can be carried out 2 times faster than shield tunneling due the use of pre-fabricated pipes.	The shield tunneling method should be used for the sharp curve (R=10 m) at the location circled in yellow in the above figure. It is more expensive and takes longer to build due to segmented assembly.
4) Const. Period	15 months in total	21 months in total
5) Cost	USD 9.3 Million (Pipe jacking: USD 6.8 Million) (Vertical shaft A, B, and C: USD 2.5 Million)	USD 16.5 Million (Shield tunneling: USD 15.0 Million) (Vertical shaft D and E: USD 1.5 Million)
6) Evaluation	Shorter construction period and less expensive.	Longer construction period and more expensive
7) Conclusion	Recommended	Not Recommended

Note; USD 1.0 = Yen 102.00 as of February, 2014
Source: JICA Study Team

2.3 Assistance with the Preparation of the Detailed Design of the Pilot Project

2.3.1 Preliminary Design of Trunk Sewer for Zone-1

PPP F/S proposes that the trunk sewer would run through the central area, including the Jl Thamrin and Jl. Gaya Mada districts, taking into account some major underground infrastructure projects.

All trunk sewer designs proposed in the PPP F/S were reviewed, confirmed and modified as required, based on the site conditions and sewer construction methods such as pipe jacking. The trunk sewer route to the WWTP was revised when the site was switched from Pejagalan to Pluit.

Figure 2.1 shows the revised trunk sewer route in Zone-1.

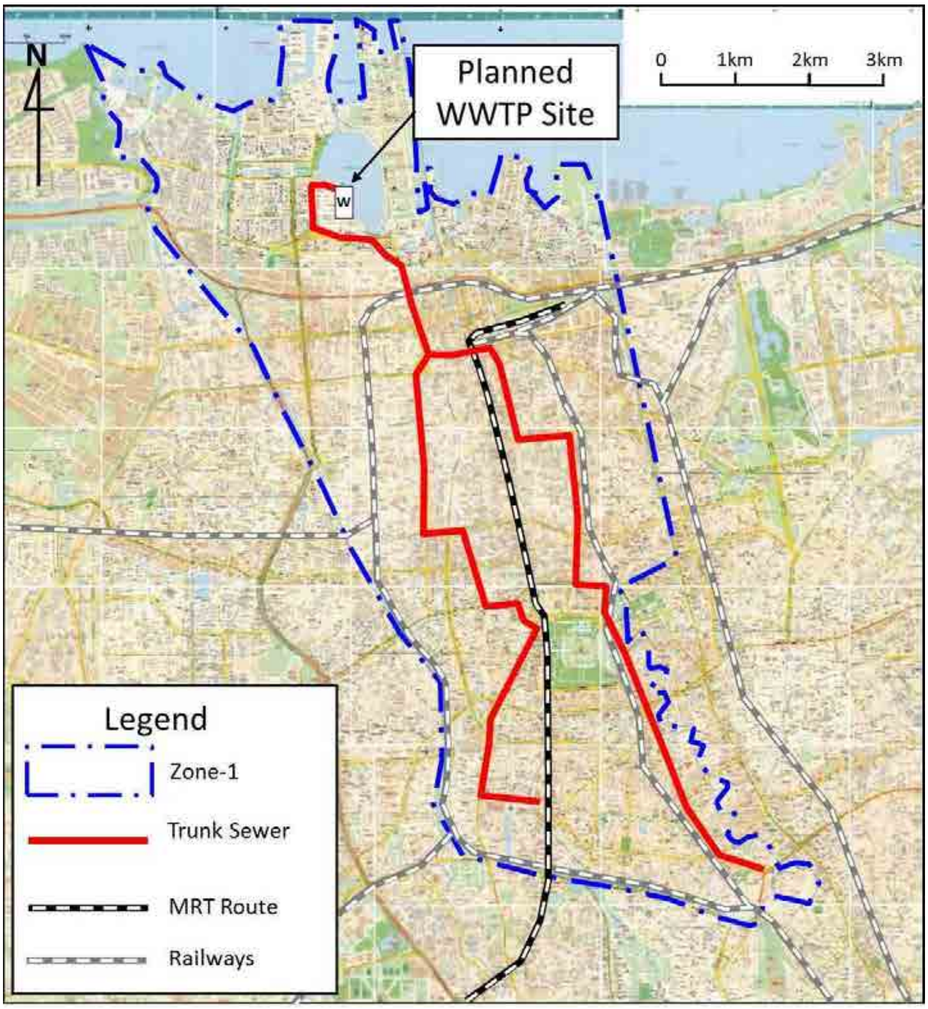


Figure 2.1 Revised Trunk Sewer Route in Zone-1

The design average flow for the sewerage system in Zone-1 was decided in the PPP FS as follows:

Table 2.3 Design Average Daily Flow for the Sewerage System in Zone-1

Administration Population in 2030 (cap.)	Sewerage coverage ratio (%)	Service Population in 2030 (cap.)	Unit Wastewater Generation (lpcd)	Design Average Flows (m^3/d)
1,236,736	80	989,389	200	**198,000** (197,878)

Source: PPP F/S

Table 2.4 shows the part of the trunk sewer design that was used for the determination of pipe diameter. The final trunk sewer connecting to the WWTP, Pipe "AT-6", is designed for the maximum hourly flow of 4.079 m^3/s, the average daily flow of 197,877 m^3/day (2.290 m^3/s), multiplied by the peaking factor of 1.781. Considering the required allowance of 30%, the trunk sewer sections "AT-5" and "AT-6" (to be constructed under the Pilot Project) would have a diameter of 2000 mm.

The profile drawings for trunk sewers are prepared using the results of the levelling surveys along the revised trunk sewer route shown in Figure 2.1. The profiles drawings for trunk sewers are presented in the Appendix 5. .

Table 2.4 Partial Results of the Review of Trunk Sewer Design Calculations for Zone-1

Line No. of Upper Sewer	Line No. of Lower Sewer	Population		Average Flow (m3/d)	Peak Factor	Max. Flow (m^3/s)	Sewer Line			
		Increment	Total				Dia. (mm)	Slope (o/oo)	V (ms/)	Cap. (m^3/s)
	to trunk sewers to WWTP									
AT-1	AT-2	0	647,329	129,466	1.901	2.849	1,800	1.2	1.565	3.982
AT-2	AT-3	0	647,329	129,466	1.901	2.849	1,800	1.2	1.565	3.982
ST-69	ST-70	7,658	7,658	1,532	3.764	0.067	400	3.0	0.908	0.114
ST-71	ST-70	1,551	1,551	310	4.815	0.018	250	2.8	0.833	0.041
ST-70	AT-3	2,371	11,580	2,316	3.532	0.095	450	2.8	0.949	0.151
ST-67	ST-68	20,674	20,674	4,135	3.231	0.155	600	2.6	1.107	0.313
ST-68	AT-3	16,566	37,240	7,448	2.951	0.255	700	2.2	1.129	0.434
AT-3	AT-4	12,334	708,483	141,697	1.875	3.076	2,000	1.2	1.679	5.274
AT-4	AT-5	0	950,905	190,181	1.792	3.945	2,000	1.2	1.679	5.274
AT-5	AT-6	14,204	965,109	193,022	1.787	3.993	2,000	1.2	1.679	5.274
AT-6	WWTP	0	989,386	197,877	1.781	4.079	2,000	1.2	1.679	5.274

Note: Pipe AT-5 and AT-6 are the pipes for the Pilot Project
Source: JICA Study Team

2.3.2 Detailed Design of Trunk Sewers of the Pilot Project

The detailed design work of trunk sewers had been finished and the detailed design documents were submitted to PU. The design documents were modified to reflect the comments of PU and relevant Indonesia organizations. The modified design documents were finally submitted to PU. The design report is presented in the Appendix 6. Table 2.5 and Figure 2.2 show the outline of the designed trunk sewers and the plan of trunk sewers of the Pilot Project, respectively. The detailed design documents would be finalized by the Indonesian Tendering Committee.

Table 2.5 Outline of Detailed Design of Trunk Sewers to be constructed under the Pilot Project

Detailed Design Outline	
1.	Sewer Diameter: 2000 mm
2.	Sewer Length: Total 962.91 m Shaft A to Shaft B (L1): 286.63 m, Shaft B to Shaft C (L2): 676.80 m
3.	Invert Level: GL -26.5m to –GL -27.7m
4.	Ground Level (GL): +0.05 m to +0.76 m
5.	Vertical Shaft 1) Shape: Circular Type 2) Departure Shaft A: Dia. 8,400mm, Wall Thickness 1,100mm, Depth 28.5m 3) Departure Shaft C: Dia. 8,400mm, Wall Thickness 1,100mm, Depth 27.3m 4) Arrival Shaft B: Dia. 5,000mm, Wall Thickness 700mm, Depth 28.8m
6.	Micro-tunneling (Pipe Jacking) 1) Pushing Length: Total 949.51 m Shaft A to Shaft B: 279.93 m, Shaft C to Shaft B:669.58 m 2) Maximum earth cover: 27.4 m 3) Groundwater level: GL-2.43 m to GL -2.83 m 4) Groundwater pressure: 27 m (0.3 MPa) 5) Micro-tunneling method: proposed appropriate method by Contractor 6) Minimum curvature radius: R= 240 m (1 location) 7) Maximum curvature radius: R=270 m (1 location)

Source: JICA Study Team

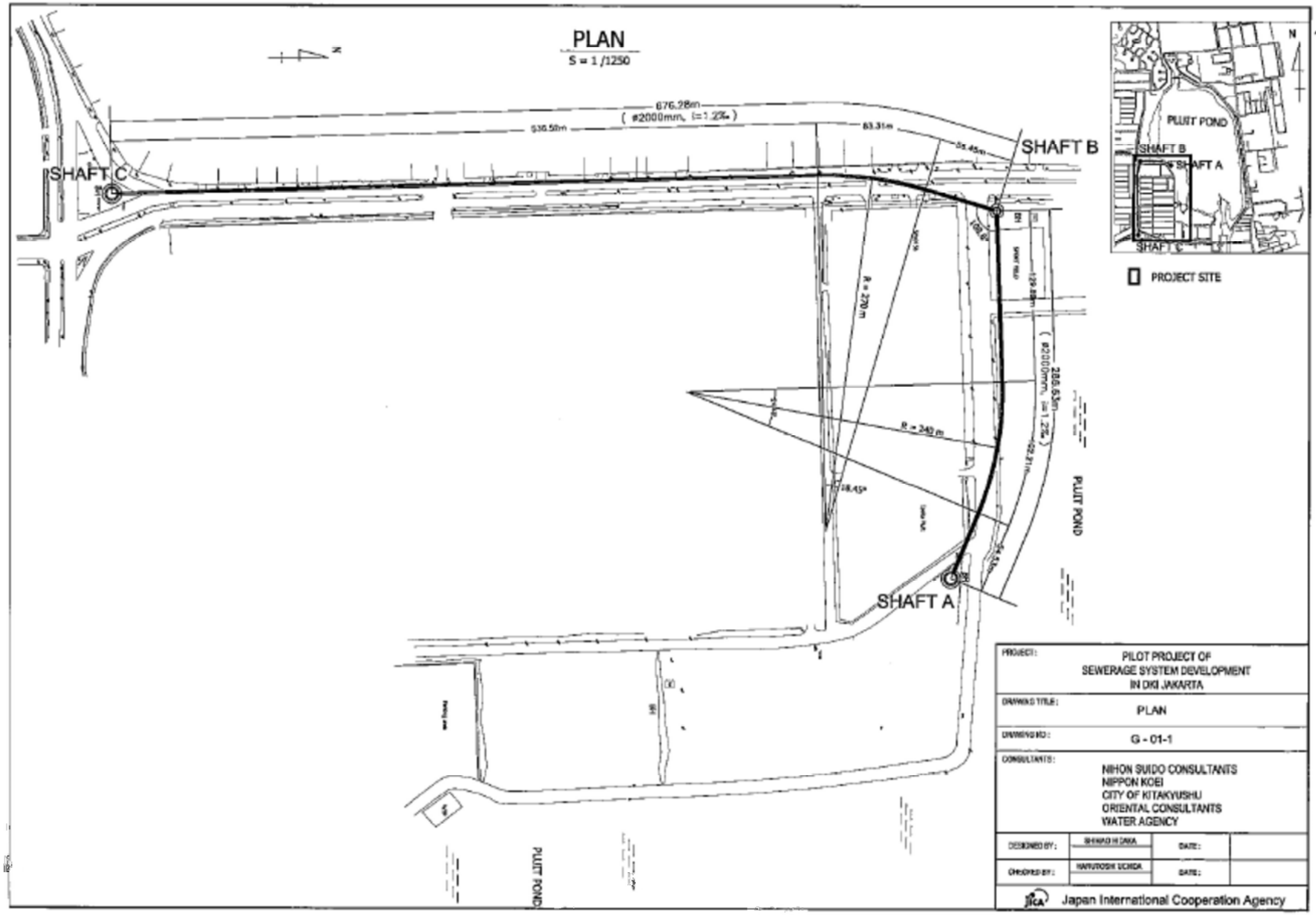


Figure 2.2 Plan of Trunk Sewers of Pilot Project

2.4 Assistance for the Preparation of Pre-qualification and Tender Documents

The Pilot Project will be carried out utilizing the Indonesian local finance and the contractor shall be procured following the Indonesian Procurement Law and local bidding procedure and condition. Therefore, the pre-qualification and tender documents shall be prepared utilizing the PU's standard pre-qualification and tender documents. The JICA Study Team assisted in the preparation of the following documents necessary in this JICA Study:

1) Pre-qualification Document;
2) Tender Document;
3) Technical Specifications- General Requirements; and
4) Technical Specifications- Civil Works.

The main conditions proposed in the above documents are described below.

2.4.1 Pre-qualification Document

a. The foreign contractor can participate in the Pilot Project as a joint operation (JO) company with the Indonesian prime contractor or a subcontractor of it. According to the Indonesian Procurement Law, the main work, which is the microtunneling and shafting works in this Pilot Project, cannot be subcontracted. In the case of Ciliwung River Project, in which the procurement of the contractor was carried out by the Water Resource Directorate General of PU, the Japanese contractors of microtunneling works participated in the project as the supporting company of prime Indonesian contractor (P.T. Wijaya Karya (WIKA)). They provided the technical assistance and microtunneling shield machine for the Indonesian prime contractor in the project. In terms of tendering of the Pilot Project, the JICA Study Team confirmed that the company who provides the supporting letter to the prime Indonesian contractors can participate in this Pilot Project and their experience will be evaluated appropriately in the bidding.

b. The required project experiences of the companies who would want to participate in the Pilot Project were proposed as follows:
   (i) Experience in long distance microtunneling works
   The contractors must have the experience in microtunneling works which satisfy the following conditions:
   - Diameter of jacking pipe is more than and equal to 1,800 mm for sewer pipe; and
   - Span between shafts is more than 500 m.

   (ii) Experience in curved microtunneling works
   The contractors must have the experience in curved microtunneling works under the curvature radius being not more than 250 m

   (iii) Experience in microtunneling works under the high groundwater pressure
   The contractors must have the experience in microtunneling works under the

groundwater pressure being more than 0.2 MPa (20 m).

(iv) Experience in deep shafting work
The contractor must have the experience in shafting works for which excavation depth is more than 30 m.

c. Proposed below are the required equipment for the participants of the Pilot Project to comply with:

No.	Type	Capacity	Number
1	Machines for long distance and curved microtunneling works	φ2000 mm	1 unit
2	Slurry separation facilities		1 unit
3	Machines for press-in caisson method		3 unit
4	Clamshell		3 unit

Note: The participants can nominate the equipment of related foreign companies with the letter of agreement for the cooperation to the project.

d. The required materials to be procured by the participants of the Pilot Project are proposed as follows:

Item	Requirement
Type	Precast Reinforced Jacking Concrete Pipe with Collar
External Strength	Class II
Concrete Compressive Strength	50 N/mm^2
Dimension	2000 mm
Joint Specification	JC-0.3 MPa
Water Resistance	0.3 MPa (Water resistant under 0.4 MPa shall be tested in the factory)
Hydrogen Sulfide (H_2S) Resistance	Resistance under 10 ppm of H_2S: The reinforced concrete jacking pipe which is made with an additive for H_2S resistance or equivalent H_2S resistant jacking pipe shall be used. The inner lining pipe is not applicable considering the difficulty of quality control.

e. The participants of the Pilot Project must meet the proposed personnel requirements as follows:

No	Level of Education	Positions in the Proposed Work	Work Experience (years)	Profession/Expertise
1	2	3	4	5
1	Civil/Bachelor	Project Manager (Team Leader)	More than 15 years of microtunneling works. More than 5 years as a team leader of the project.	Civil/ Field supervision
2	Civil/Bachelor	Site Manager	More than 10 years of construction works	Civil/ Field supervision

3	Civil/Bachelor	Site Engineer Manager	More than 10 years of construction works	Civil/ Field supervision
4	Civil or Mechanical/ Bachelor	Jacking Operator	More than 10 years as an operator of jacking pipe.	Operator of microtunneling jacking machine
5	Civil/Bachelor	Geotechnical Engineer	More than 10 years of civil work including shaft work.	Civil/ Construction of deep shaft
6	Civil/Bachelor	Quantity Surveyor Manager	More than 5 years of construction works	Civil/ Field supervision
7	Civil/Bachelor	Quantity Engineer	More than 5 years of construction works	Civil/ Field supervision
8	Civil/Bachelor	Quality Engineer	More than 5 years of construction works	Civil/ Field supervision
9	Civil/ Bachelor	Supervisor	More than 5 years of construction works	Civil/ Field supervision
10	Environment/ Bachelor	Environmental Specialist	More than 5 years of construction works	Environment/ Field supervision
11	Civil or Social/ Bachelor	Social Expert	More than 5 years of construction works	Social/ Field supervision

Note: The participants can nominate the staff of related foreign companies with the letter of agreement for the cooperation to the project.

f. All project experiences of the company which satisfy the conditions indicated in Clause b will be submitted for evaluation as part of the pre-qualification procedure. The JICA Study Team prepared the additional submission form.

g. The pre-qualification documents prepared by the applicants are written in Bahasa Indonesia; however, the technical proposal for the Pilot Project is requested to be prepared in English so that the JICA Study Team can support the evaluation.

h. According to the Indonesian Procurement Law, a minimum of three candidates should pass the pre-qualification stage; however, the JICA Study Team requested to change the said condition, but Indonesia did not agree to change it because the procurement procedure will be monitored and appraised by a related organization which is in charge of the Indonesian procurement.

2.4.2 Tender Document

a. The Indonesian Condition of Contract for Construction (GC) is applied in the contract condition of the Pilot Project. The Indonesian GC is different from the International Federation of Consulting Engineers' (*Fédération Internationale Des Ingénieurs-Conseils:* FIDIC) GC because it does not assign "the Engineer", which is stipulated in FIDIC's GC.
b. The proposed main works in the Pilot Project are as follows: i) microtunneling work, ii) shafting work, and iii) procurement of jacking pipe.
c. The proposed main supporting works in the Pilot Project are as follows: i) site preparation, ii)

soil investigation, and iii) contractor's temporary facilities.

d. Defect notification period is tentatively proposed for 1-2 years and the final decision will be made by the procurement committee.

e. The proposed evaluation criteria include the following:

Items to be Evaluated	Evaluation Weight	Threshold
Construction method	30%	70%
Construction time schedule (should not exceed the time limit stipulated in the bidding document)	10%	70%
Contractor's equipment and major materials	20%	70%
Key personnel and staffing schedule	30%	70%
Safety Management Plan (Pre RK3K)	10%	70%

Note: The threshold of total evaluated score is proposed at 80%.

f. The technical and cost ratios are proposed as: technical 80%: cost 20%.

g. An interview is proposed in the technical evaluation in addition to the written technical proposal so that the contractor's technical ability and the authenticity of the applicants' experiences could be confirmed and further explanation of the technical proposal can be made.

2.4.3 Technical Specification

The technical specification was prepared and divided into two materials: General Requirements and Civil Works. The contents of each document are as follows:

1) General Requirements

Section 1 - General Requirements
Section 2 - Work Constraints
Section 3 - The Site
Section 4 - Documents to be Provided/Approved by the Engineer
Section 5 - Contractor's Temporary Facilities
Section 6 - Mobilization and Demobilization
Section 7 - Contractor's Design
Section 8 - Contractor's Management of the Works
Section 9 - Contractor's Drawings
Section 10 - Method Statements of Works
Section 11 - Workmanship, Plant, and Materials
Section 12 - Tests and Inspections
Appendix A: Soil Investigation Report
Appendix B: Topographic Survey Report

2) Civil Works

Section 1 - Topographic Survey of Site

Section 2 - Soil Investigation
Section 3 - Earth-retaining Wall for Prevention of Collapse
Section 4 - Excavation
Section 5 - Backfilling
Section 6 - Shaft Works (Press-in Caisson Method)
Section 7 - Microtunneling Works (Pipe Jacking Method)
Section 8 - Manhole Works
Section 9 - Concrete
Section 10 - Reinforcing Steel Bar
Section 11 - Formwork/Finishing
Section 12 - Fencing
Section 13 - Demolition
Section 14 - Clearing and Grubbing
Section 15 - Metal Works
Section 16 - Welding

2.5 Potential Risks and Measures to Avoid Their Adverse Impacts on the Pilot Project

Risk management involves identifying what could go wrong at each stage of project development and what steps can be taken to mitigate or manage these risks. Once the risks have been identified, they must be continuously monitored until the end of the project. Careful risk assessment usually leads to a reduction in contingency. The potential risks that can be identified for detailed design, construction and operation of the PP and the necessary measures to avoid their adverse impacts are summarized in Table 2.6.

Table 2.6 Potential Risks and Measures to Avoid Their Adverse Impacts at the Stages of Detailed Design, Construction and Operation for the Pilot Project

Stage	Potential Risks	Measures to Avoid the Adverse Impacts
1. Detailed Design Stage		
The adverse impacts of potential risks at the DD stage can be avoid or eliminated generally by conducting a comprehensive verification of each design component, based on a verification list prepared for the planning and design of the PP. Mitigation measures against risks 1) to 4) listed below were implemented prior to the actual detailed design of the PP.		
1)	Change required in pipe diameter, slope etc, due to inaccurate information on planning bases such as wastewater generation rates.	The design flows in PPP F/S Study Report were revised based on the findings in the Supplementary Study.
2)	Change required in the construction plan (e.g. the planned location of a manhole needs	During the Supplementary Study, information and data were collected from relevant government

Stage	Potential Risks	Measures to Avoid the Adverse Impacts
	to be revised requiring changes to the invert level of the pipelines), due to lack of information and data on private/public properties and underground utilities.	agencies, verified by reconnaissance surveys and ultimately confirmed at a meeting organized by the DKI Jakarta. It is confirmed that the three locations for vertical shaft construction are on public properties such as parks and buffer zones of intersections, and that there is enough space at each site for the construction of the vertical shafts. DKI Jakarta bylaws were also reviewed to determine whether occupancy right would be needed if micro-tunneling at 30 m depth for pipe installation were to be conducted on private property.
3)	Increase in construction cost when construction activities are regulated during heavy traffic period or day-time, due to lack of information on traffic conditions in the construction area.	Large vehicles such as dump trucks are allowed to use the roads adjacent to the vertical shaft construction locations from 22:00 at night to 5:00 in the morning. The construction plan and cost estimate was prepared according to this condition.
4)	Incorrect sewer profiles, requiring costly modification before the wastewater can be conveyed properly by the trunk sewer, due to wrong levelling data for the roads.	A series of topographic survey were conducted using the control point located near the Pilot Project site. This control point was also used for the sea port projects. The profiles of all trunk sewers in Zone-1 have been updated using the findings from the levelling survey for all trunk sewer routes.
5)	Low safety or possibility of collapse of the structure requiring re-calculation of structural analysis, due to inadequate geotechnical analysis.	Based on the results of the soil laboratory test, safer values of soil properties were selected after comparing the results of original values and the converted values by use of N-value. A safer value of water table was also determined. Structure analysis was carried out using these values.
6)	Low safety, possibility of collapse of the structure, or unstable construction, due to lack of knowledge of applicable standards or norm for structural analysis and/or supplemental construction method.	Commonly used structural standards and norms in Japan, as well as safety designs used in similar projects were adopted.
7)	Unexpected increase in construction cost due to errors in quantity estimation and	Reinforcing steel quantity estimates would be compared to the re-bar density commonly used.

Stage	Potential Risks	Measures to Avoid the Adverse Impacts
	scheduling, resulting in project abandonment because of budget shortage.	The quantities would be confirmed by a second independent quantity survey. The adequacy of the construction schedule would be verified for micro tunneling, taking into consideration local weather conditions and also by referring to construction schedules of similar projects.
2. Construction Stage		
The adverse impacts of potential risks in the construction stage could be avoided or eliminated by the preparation of an operation manual (checklist) containing all the mitigation measures. These measures would be continuously reviewed and updated. Careful selection and assignment of highly qualified experts in safety and work progress management to oversee the execution of the entire operation is essential.		
1)	Noise and vibration resulting in opposition to the construction activities and subsequent delays or project termination, due to lack of mitigation measures to deal with noise and vibration during construction.	Local residents would be informed of the project at meetings. Environmental monitoring would be carried out regularly. Public comments would be considered in the planning for work safety and progress management.
2)	Administrative penalty, schedule delays or project abandonment, due to lack of confirmation of appropriate disposal site for excavated soil and waste materials.	The site for disposal of excavated soil and waste materials was identified by the engineering officer of the subway project in Jakarta. A meeting with the government officials was held, and the disposal site was confirmed.
3)	Extended construction period and related penalty, due to inadequate work progress management.	Weekly and monthly review shall be prepared based on the original work progress management plan. Measures required to avoid any delay would be executed.
4)	Inadequate daily progress in pipe jacking and land subsidence at the jacking site, due to lack of control of the amount of excavated soil and excavation distance.	The difference in the amount of excavated soil is checked against the correlation table. Prepared correction measures would be made when deviance is observed.
5)	Unsuccessful pipe jacking operation requiring second attempt, due to lack of daily survey of the jacking pipe causing meandering.	The work sequence would be confirmed daily according to a checklist.
6)	Subsidence and destruction of the jacking pipe, due to inadequate injection of filling material with a void forming between end of the jacking pipe and the surface of the excavated soil.	The work sequence would be confirmed daily according to a checklist.

Stage	Potential Risks	Measures to Avoid the Adverse Impacts
7)	Increase in compensation cost to households affected by the pipe jacking operation, due to difficulty in estimating the damages to nearby houses and roads.	The conditions of the houses and roads before and after the pipe installation would be carefully and clearly recorded and compared. The compensation costs would be estimated based on the comparison to avoid unjustifiable expenses.
3. Operation Stage		
1)	Land subsidence in roads and shafts circumference resulting in excessive recovery fee and loss of trust in the contractor, due to lack of monitoring for subsidence.	An official process for monitoring conditions after the completion of the project would be established and the monitoring would be conducted as scheduled.
2)	Increase in compensation cost to households affected by the pipe jacking operation, due to difficulty in estimating the damage to nearby houses and roads.	Same as explained in the risk of 7) in construction stage.

CHAPTER 3 Proposed Step-wise Sewerage Development Using Existing Drainage System

3.1 Aim of the Study

3.1.1 Aim of Step-wise Sewerage Development Plan

A sewerage system is a large-scale urban infrastructure. Sewerage development plan is required to urgently produce project results while keeping the costs low. Accordingly, sewerage development project of DKI Jakarta will apply step-wise sewerage development which principally consists of interceptor sewer and centralized wastewater treatment using the existing drainage system.

Japanese sewerage development projects have applied step-wise development program, which focuses on the fundamental facilities of main sewer and wastewater treatment plant as well as projects prioritized in urban center as follows:

- Sewerage system development takes a long time and entails a huge amount of budget. Accordingly, sewerage project focuses on prioritized facilities which can maximize project results.
- High operation rate of wastewater treatment plant is a serious concern. However, in order to urgently improve water environment as well as financial operation sustainability and tariff levy in a broad area, the high rate of wastewater treatment plant operation must be maintained. Interceptor sewer system maximizes the collection rate of wastewater flow.
- Constructed main sewer accelerates lateral sewer construction and wastewater treatment in the whole sewerage service area.

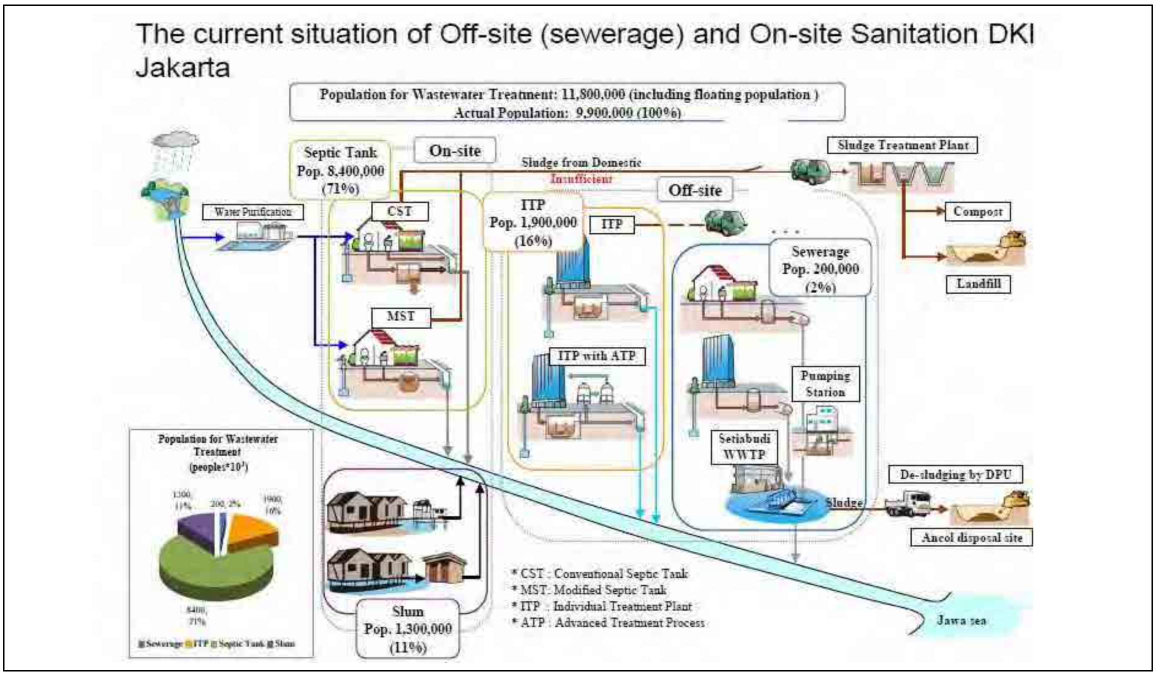
Interceptor sewer system sometimes affects wastewater collection and project result due to malfunction of existing drainage caused by garbage deposits and incorrect gradient. This study surveys the preliminary information of existing drainage system in which issues and integrating methodology for sewerage system are scrutinized. Issues on financial operation and private sector participation during construction stage and operation stage are studied. The study also proposes practicable measures with low cost and high speed by focusing on prioritized projects.

3.1.2 Viewpoints on Sewerage Development Methodology in DKI Jakarta

(1) Present Wastewater Treatment in DKI Jakarta

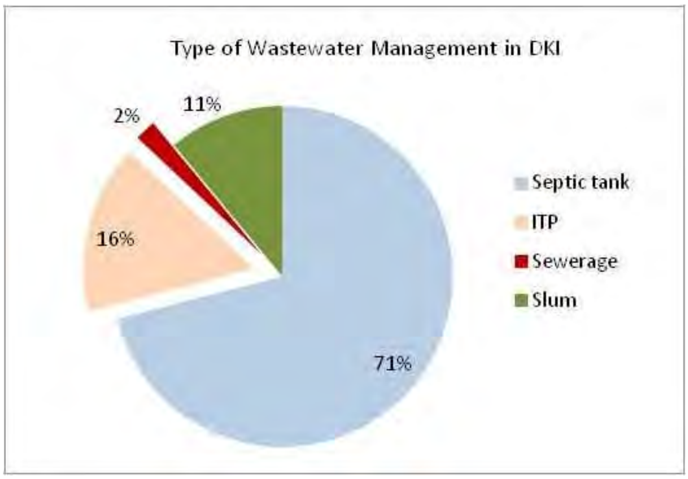
Sewerage service ratio in DKI Jakarta is estimated at 2% as shown in Figure 3.1. In addition, individual treatment plant (ITP), which treats human waste and gray water, has a 16% share. Sewerage and ITP are categorized as off-site treatment system in DKI Jakarta. Recently, manufactured modified septic tanks (MST) are being used in newly-constructed houses, since it treats both human waste and gray water.

Almost all septic tank users in the residential and slum areas discharge gray water without treatment; therefore, they are principal sources of water pollution. Human waste is almost always treated by septic tanks and off-site system; accordingly, flush toilets are most prevalent.



Source: PD PAL Jaya Concept and Strategy for Wastewater Management of Jakarta City, 2014

Figure 3.1 Wastewater Management in DKI Jakarta



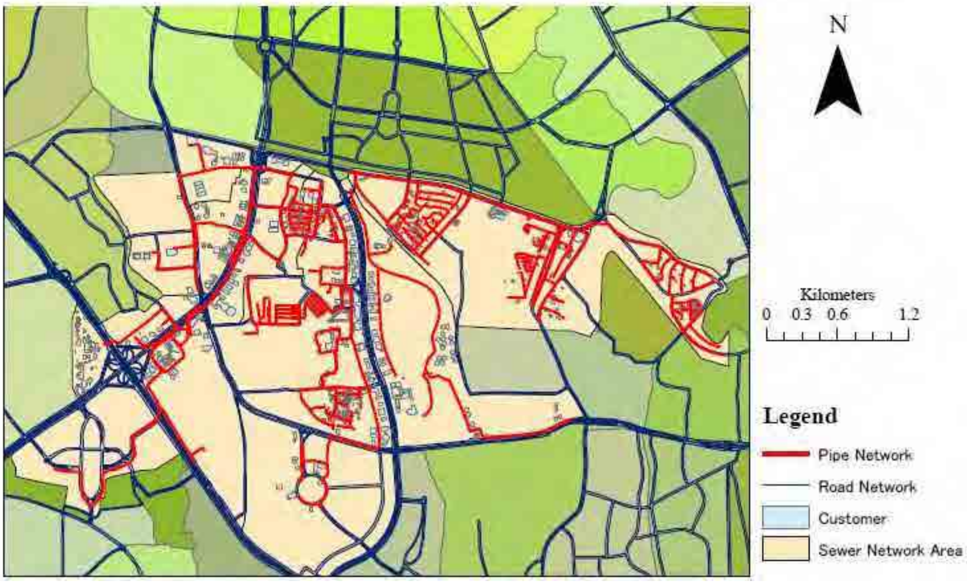
ITP: Individual Wastewater Treatment Plant

Source: Acceleration Plan for Wastewater Management in DKI Jakarta, PD PAL Jaya, 2014

Figure 3.2 Types of Wastewater Management in DKI Jakarta

Sewerage development in Zone-0, where sewerage service is provided, applies separate sewerage system shown in Figure 3.3 and Table 3.1. Existing sewer is constructed in the main road, in the artificially-developed residential area and in the existing urban area adjacent to Manggarai Station. Existing house connections are 1,556, for a total of 1,922 including small commercial, large commercial, and social. There was an increase of 64 house connections from 2012 through 2013, which is almost 20% of the target.

Present house connections of 1,556 residences, which PD PAL Jaya has developed since its inauguration in 1991, is equivalent to 1/1,674 or 0.06% of the number of household of 2,604,600 in the whole DKI Jakarta area (Statistics Indonesia 2014). Wastewater is still being discharged into drainage culverts in existing sewerage service area as shown in Figure 3.4. On the other hand, sewerage remarkably improves environmental sanitation. House connections and separate sewerage system have not been completed despite the continuous sewer construction since the inauguration of PD PAL Jaya in 1991.



Source : PD PAL Jaya Concept and Strategy for Wastewater Management of Jakarta City, 2014

Figure 3.3 Sewerage Development Plan, Zone-0

Table 3.1 House Connection Served by PD PAL Jaya

No	*Pelanggan*/User Group	*Jumlah Pelanggan*/Household			Remarks
		Realisasi RKAP2012 /2012 Actual	RKAP 2013 /2013 Planned	*Realisasi* RKAP /2013 Actual	Increase in 2012-2013
1	*Rumah Tangga*/Residence	1,542	1,862	1,556	14
2	*Niaga Kecil*/Small commercial	129	124	167	38
3	*Niaga Besar*/Large commercial	157	173	167	10
4	*Bangunan* Social/Social	30	29	32	2
5	*Industri*/Industry	0	1	0	0
Jumlah/Total		1,858	2,189	1,922	64

Source: PD PAL Jaya Annual Report 2013

Manhole

Residents enjoying improved sanitation

Wastewater in sewerage-served area

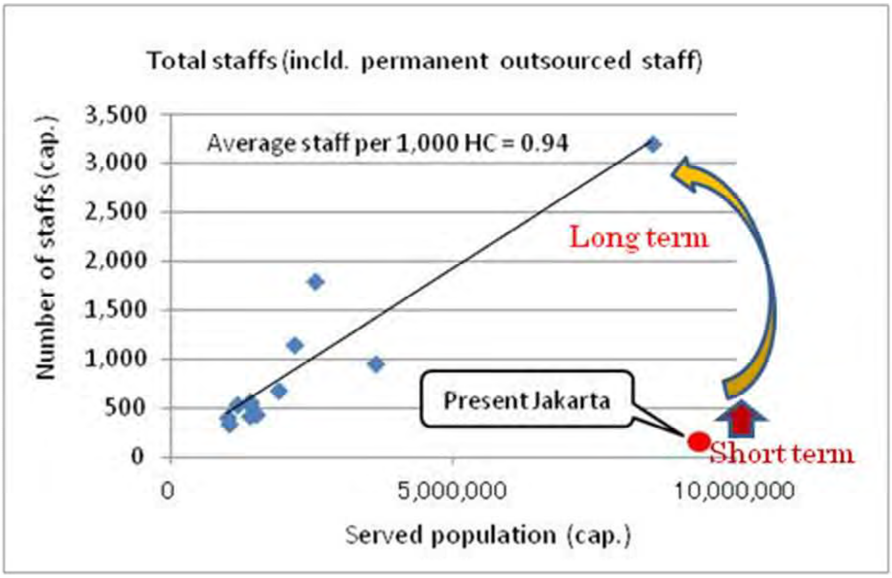
Building sewer not connected

Source: JICA Study Team

Figure 3.4 Sewerage-served Area (Kuningan, Jakarta)

The organization of PD PAL Jaya consists of the six divisions of general affairs, finance, customer service, development and program, technical, and operation & maintenance (O&M) under the general director, technical and business director, and administration and finance director. The total number of staff is 109, which is almost less than half of the number of staff in a city with a population of one million in Japan. The number of staff working for the Sewerage Bureau of Tokyo, whose population is equivalent to DKI Jakarta, is 30 times that of PD PAL Jaya. This means that sewerage development in the entire DKI Jakarta requires the enhancement of organization of PD PAL Jaya remarkably.

Accordingly, experience in DKI Jakarta presents some issues on organizational enhancement and on step-wise sewerage development which invests human resource and budget into prioritized projects.



Source: JICA Study Team

Figure 3.5 Number of Staff Employed in the Sewerage Sector in Japan and DKI Jakarta

(2) Change of Sewerage Role in Developed Countries

Sewerage systems developed in the European Union (EU), the United States of America (USA), and Japan have historically changed from wastewater and stormwater drainage to water pollution control of receiving water courses, followed by sustaining water environment through protecting the water resource and bio-diversity, recycling, and reuse of sewage products and use of facilities, and then contributing to the global environment and socio-economic improvement.

At present, sewerage system contributes to sound water environment, safe water cycle, and amenity and safety of urban lives. Sewerage system has the following roles:

(i) Improvement of environmental sanitation through wastewater and stormwater drainage,
(ii) Flush toilet installation and human waste treatment,
(iii) Water pollution control of public water course,
(iv) Recycling of treated wastewater and sewage sludge and use of sewerage facilities, and
(v) Sound water environment and water cycle.

Sewerage development plan shall consider the affordability to the public and the need for short- and medium-term plan as well as the comprehensive role for long-term plan. Accordingly, sewerage development project becomes financially feasible and maximizes project results. Regarding the long-term plan, sewerage development plan is reviewed in accordance with the rehabilitation project and the national development policy.

Source: JICA Study Team

Figure 3.6 Change of Sewerage Role

(3) Priority Project of Sewerage Sector (NCICD Project)

Flooding in DKI Jakarta is a serious disaster that happens regularly such as the flooding in 2007 that displaced 590,000 refugees. Principal causes are ground subsidence at a rate of 7.5 cm/year on average (17 cm/year in serious district) and the increase of stormwater runoff due to urban development in Bogor and Kota located upstream of south Jakarta.

Flood mitigation measures in DKI Jakarta were changed from conventional measures like thin-walled embankment and pumping to “National Capital Integrated Coastal Development Project (NCICD)”, which develops credible flood mitigation measures such as giant sea wall and new urban infrastructure. NCICD is now implemented as a national project.

DKI Jakarta is seriously affected by traffic congestion, lack of east-west transportation, and land for business district, congested sea port, deteriorated environment, etc. NCICD is expected to solve such issues comprehensively, and reclaimed land can be used for transportation network, business center, water supply resource, and aesthetic urban environment as well as for economic policy (Figure 3.7).

Sewerage is a fundamental infrastructure for water pollution control of newly developed reservoir and water supply resources.

Source: National Capital Integrated Coastal Development Master Plan (Draft) 2014

Figure 3.7 NCICD Project (Bird's-eye View)

Wastewater management strategy of NCICD aims to remove 75% of BOD discharged to Jakarta Bay by 2022. PD PAL Jaya proposes a 70% sewerage service rate, which is served by sewerage system and upgraded on-site wastewater treatment, in order to comply with NCICD strategy. The highest priority role of Jakarta sewerage is water pollution control of public water course and environmental sanitation improvement through wastewater collection.

(4) Viewpoints of Sewerage Development Methodology in DKI Jakarta

Sewerage development in DKI Jakarta requires a step-wise development program which can be executed from the viewpoints of medium- and long-term strategy as well as focusing on prioritized roles of sewerage.
Needs of sewerage in DKI Jakarta are projects with following concerns:

(i) Wastewater drainage and improvement of environment sanitation
(ii) Water environment improvement of public water

Groundwater pollution caused by septage leachate has scarcely improved since the mitigation of pathogen and ammonia contamination including nitrate, as well as, replacing septic tanks with house connection takes a long time. Accordingly, combination of step-wise separate sewerage development and water supply service is more practicable.

Table 3.2 Step-wise Sewerage Facility Development

Sewerage Facility	Priority of Construction Project
Trunk sewer and sub-trunk sewer	Most urgent
Wastewater treatment	Phased construction is available in accordance with wastewater inflow
Service sewer and house connection	Practicable project site is prioritized and step-wise project programming is applied in accordance with capacity of institutional organization and speed of construction.

Source: JICA Study Team

3.2 Survey Method

The study on step-wise sewerage development, which is composed of interceptor sewerage using existing drainage and centralized sewerage system, examines the condition and use of existing drainage. It also provides a road map for conventional separate sewerage system, which facilitates house connection in due course. Sewerage development program requires a legal background for sewerage tariff levy through improving water environment and enhancing house connection.

Tariff system is a fundamental requirement for financial sustainability, at the same time maximizing wastewater treatment flow is indispensable for private sector participation.

The survey confirms the applicability of integrating existing drainage to the interceptor sewerage system and proposes features of institutional and financial design (Figure 3.8).

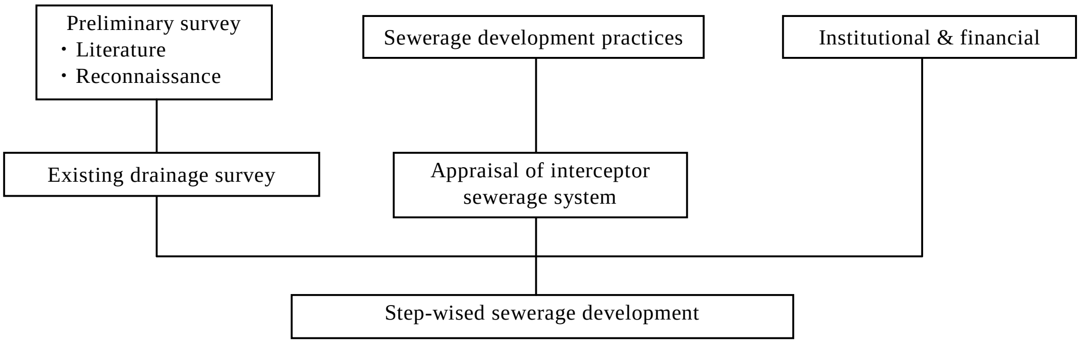
Stormwater drainage systems are managed by the Ministry of Public Works and People's Housing (Directorate Generals of Human Settlements and Water Resources), Dinas PU of DKI Jakarta, and Suku Dinas PU of Walikota Jakarta (municipalities) in accordance with individual drainage areas. The Jakarta Emergency Dredging Initiative (JEDI) promotes flood mitigation project.

Existing drainage survey consists of preliminary literature survey and reconnaissance, and detailed field survey. Model districts are selected among districts of representative land use for residential, commercial, and slum areas, where tributary drainages will drain wastewater into interceptor sewers.

Applicability of interceptor sewerage system examines the technical features of wastewater collection system, experiences in other countries and combined sewer overflow (CSO) mitigation technology in Japan, as well as advantages of pollution control and cost of separate sewer.

Institutional and financial design scrutinizes sewerage tariff system, public relations, and regulatory system of public sewer connection such as sewerage ordinance and building construction approval.

Step-wise sewerage development proposes practicable features in DKI Jakarta exploited by the above survey.



Source: JICA Study Team

Figure 3.8 Survey Method

3.3 Features of Interceptor Sewerage System

3.3.1 Sewerage Development Programming Applying Interceptor Sewer

(1) Overview of Interceptor Sewer

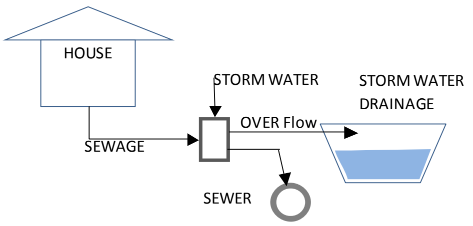
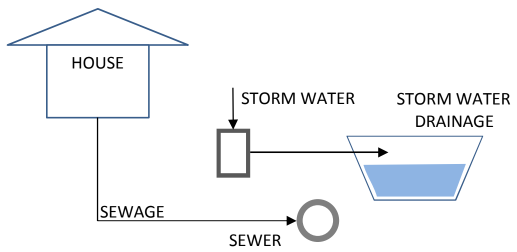
Interceptor sewer system is a practicable development technology focusing on main sewers and wastewater treatment plant for step-wise sewerage development. It has been applied not only in large cities in Japan but also in Seoul, Kaohsiung in Taiwan, Bangkok, Ho Chi Minh, New Delhi, and Manila. These cities have improved water environment and wastewater management capacity by integrating existing drainage into sewerage system.

The initial stage of interceptor sewerage system focuses on the development of main sewer and wastewater treatment plant and on the collection of wastewater from existing drainage as shown in Figures 3.9 and 3.10. Human waste is treated by septic tank.

Lateral sewer and house connections are constructed after the main sewer is developed, and wastewater is collected separately from stormwater. Accordingly, separate sewer system will be developed step-by-step.

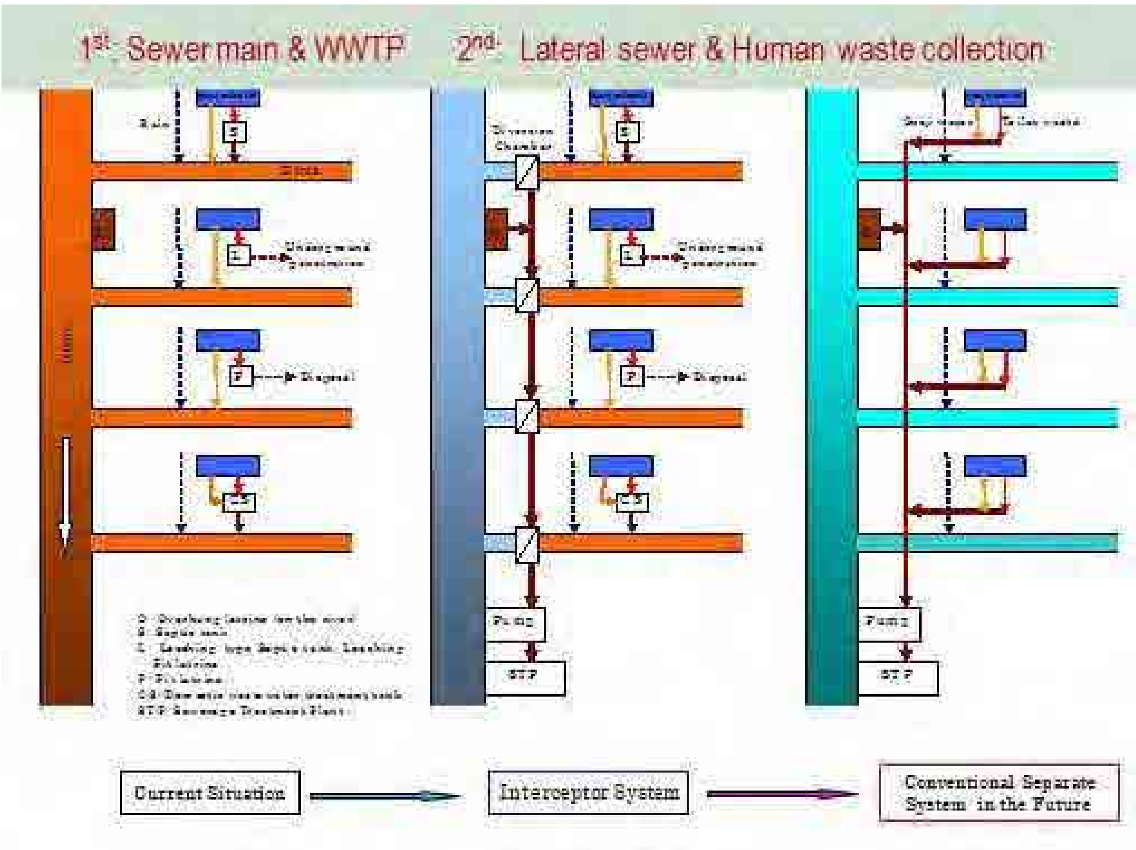
Interceptor sewer is a transitional development technology to a conventional sewerage system. This system focuses on the improvement of sanitation and pollution control in public water by collecting wastewater immediately.

In medium-term and long-term development, interceptor sewerage system will be integrated to the conventional separate sewer system.

Early stage (approx. from Year 1 to Year 10)	Later stage (after Year 10)
a. Primary sewers are constructed downstream in the whole of Zone 1. b. Secondary sewers and manholes are constructed for collection of sewage from drainage. c. House connections are constructed mainly for connection to CSO chamber.	a. Secondary sewers, tertiary sewers, and further small sewers are constructed gradually in Zone-1. b. Manholes to connect sewers and house connections are constructed gradually.
	

Source: JICA Study Team

Figure 3.9 Step-wise Sewer Development



Source: Guideline of Urban Drainage and Wastewater Treatment Technology in Developing Country, then the Ministry of Construction, Japan

Figure 3.10 Step-wise Sewer Development Programming

Interceptor sewer system, which is described in detail in later sections, possesses the following characteristics and advantages compared with separate sewerage system:

Table 3.3 Characteristics of Interceptor Sewer

Subjects	Description
Exploits of project result	Wastewater drainage and water pollution control, which are prioritized in DKI Jakarta, are achieved at high speed.
Investment cost	By focusing on the most prioritized projects, financial investment efficiency is enhanced. Private investment into sewerage project mitigates government financial requirement through collaboration with urban development project.
Efficiency on prevalence of sewerage service	Trunk sewer and sub-trunk sewer are constructed in the main road at high speed, accordingly, every building can connect to the public sewer.
Effects on financial	Large commercial and high income sewerage users, who can connect to the trunk and sub-trunk sewers, can afford to pay sewerage charge sufficiently.
Overflow of human waste	In order to mitigate pathogen discharge during combined sewer overflow (CSO), whole human waste in separate sewerage area will be captured by CSO mitigation technology and disinfected.
Inflow of garbage	Public relations campaign is required so that proper garbage management and cleaning of community roads will be implemented.
Improvement of on-site sanitation	Septic tanks remain in interceptor sewerage area. Sanitation in on-site treatment area is improved by sewerage sector through the provision of a septic tank cleaning service.

Source: JICA Study Team

(2) Experience of Manila

Sewerage system in Manila was obstructed by the following issues, which were implemented in order to comply with a 1997 contract on sewerage and sanitation service that developed the conventional sewerage system of a centralized sewer and treatment plant:

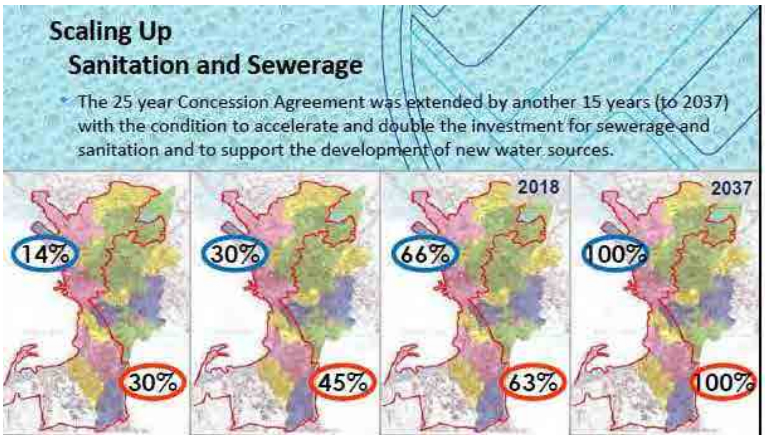
- Huge investment (higher tariff)
- Significant construction impact (traffic congestion)
- Customer resistance (water as a priority)
- Difficulty in securing land

Wastewater management in Manila has switched to the following from a separate sewerage system:

- Up-grading existing communal septic tanks
- Septage management
- Combined sewer-drainage system (interceptor sewer system)

Source: Domestic Wastewater Management in Mega Manila, Metropolitan Waterworks and Sewerage System

Figure 3.11 Change of Sewerage Development Program in Manila



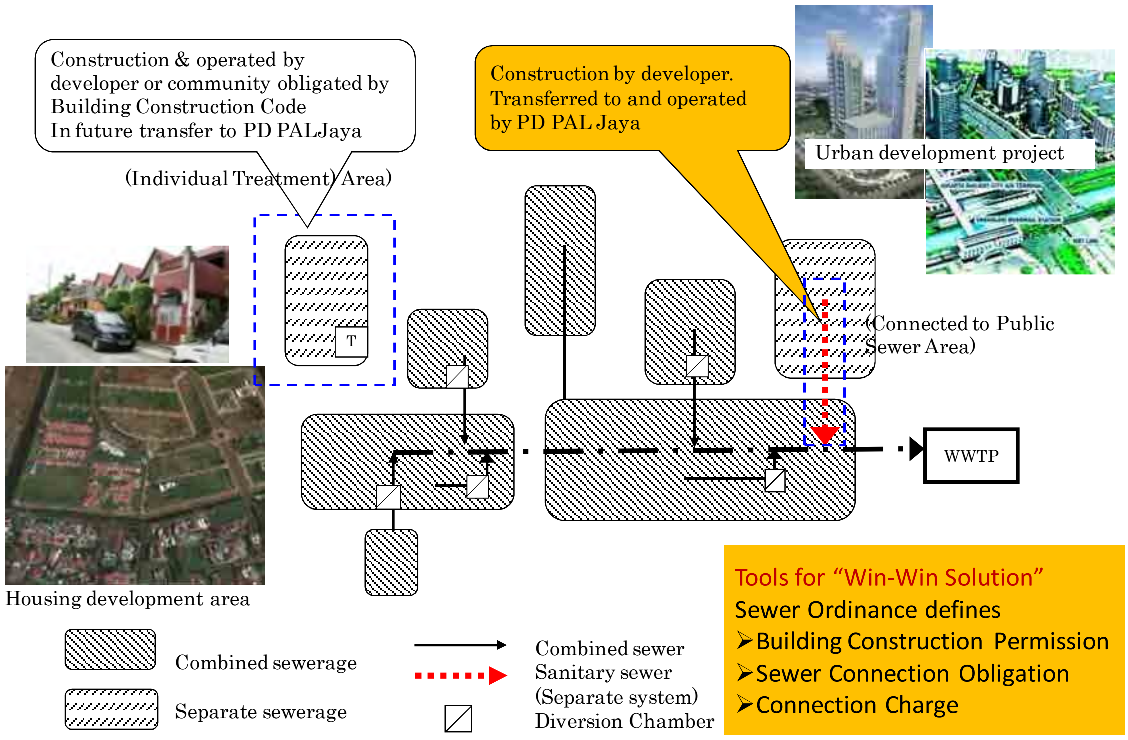
Source: Domestic Wastewater Management in Mega Manila, Metropolitan Waterworks and Sewerage System

Figure 3.12 Sewerage Development Plan of Manila

(3) Step-wise Sewerage Development Collaboration with Urban Development Project

In order to avoid duplication of investment on wastewater management in medium-term sewerage system development, project programming shall be demarcated into a separate sewerage development area with urban development project and an interceptor sewerage development area in densely built-up areas.

Public-private collaboration can be applicable, such as when the regulatory system of public sewer connection encourages private sector participation by building construction approval (Figure 3.13). Large cities in Japan have applied such sewerage development methodology, with urban development projects being constructed adjacent to existing sewerage service areas.



Source: JICA Study Team

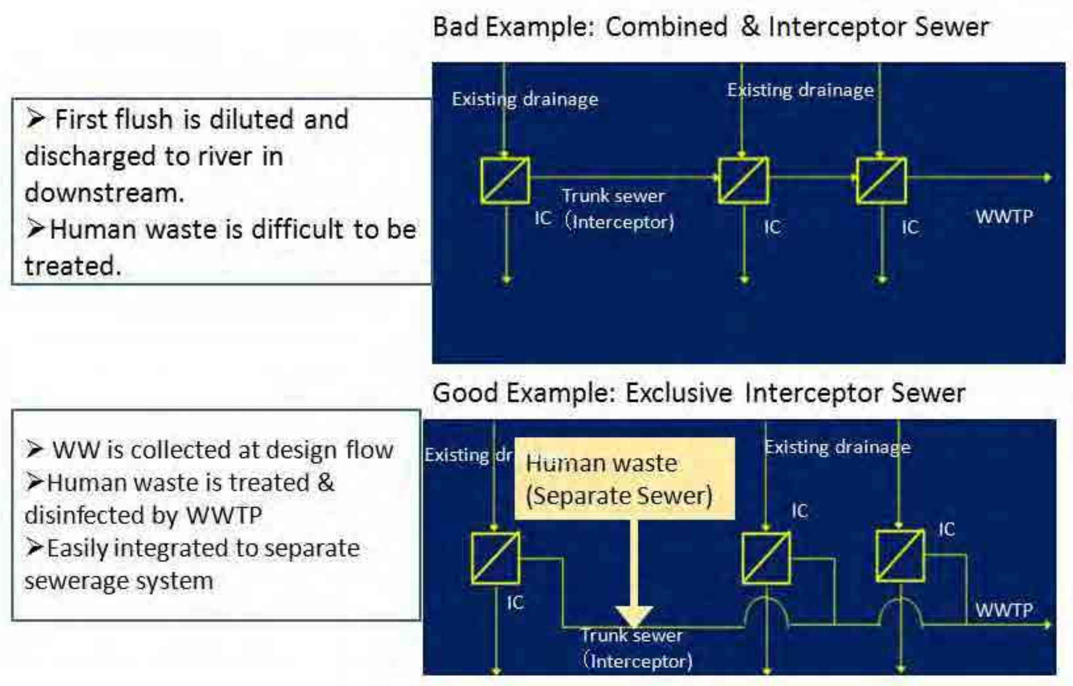
Figure 3.13 Sewerage Development Collaboration with Urban Development

(4) CSO Mitigation Technology (Measures for Human Waste and Hygiene)

Mixed sewerage service area having separate sewer and interceptor sewer discharges human waste during stormwater events. Discharged human waste brings hygienic issues such as germs. CSO mitigation aims to remove debris and hygienic risk as well as to reduce discharged BOD pollutants during stormwater events (Sewerage Planning and Design Manual, Japan Sewage Works Association).

Segregated intercepted sewage (bottom of Figure 3.14) is recommended since mixed intercepted sewage with combined sewage (top of Figure 3.14) discharges human waste into public water body. Segregated intercepted sewage is conveyed to the treatment plant first and then discharged into the public water body after treatment and disinfection. Microtunneling method will be used for the construction of interceptor sewers in DKI Jakarta to mitigate traffic congestion. Accordingly, deep sewers can collect human waste of the separate sewer line and convey whole human waste to the wastewater treatment plant.

Since MRT stations accelerate urban development project in central Jakarta, high-rise buildings will be constructed. New buildings promote sewerage development as well as expand separate sewerage system through public-private collaboration.

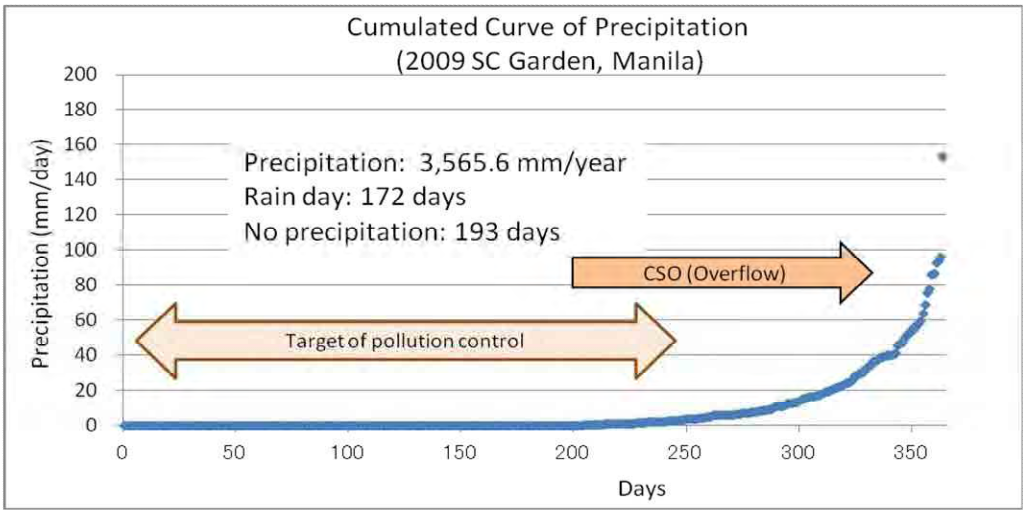


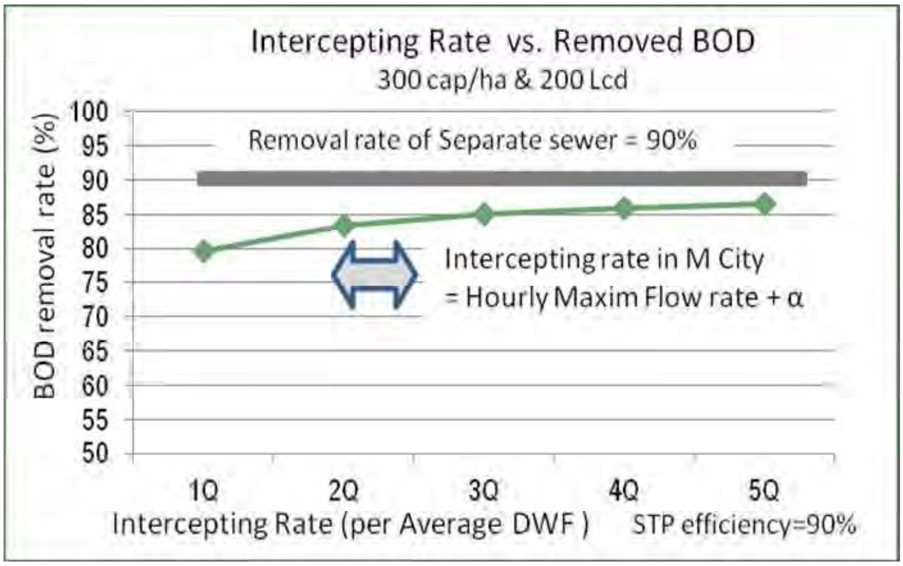
Source: JICA Study Team

Figure 3.14 Interceptor Methodology

(5) Pollutant Removal Efficiency of Interceptor Sewerage System

In relation to stormwater events, interceptor rate and BOD removal in the city of Manila is shown in Figure 3.15. Small precipitations are predominant among all the stormwater events in a year similar to stormwater in DKI Jakarta. For example, precipitation exceeding 50 mm/hr, which causes inundation, are scarce in a year. Accordingly, interceptor sewerage system contributes pollutant removal due to the treatment of wastewater during storm events even though stormwater dilutes wastewater. BOD removal rate of interceptor sewer system is estimated at 83% in 2Q collection and 85% in 3Q collection during stormwater events. This means remarkable pollutant removal efficiency is expected even though it is lower than the 90% BOD removal rate of a separate sewerage system.





Source: JICA PPP FS

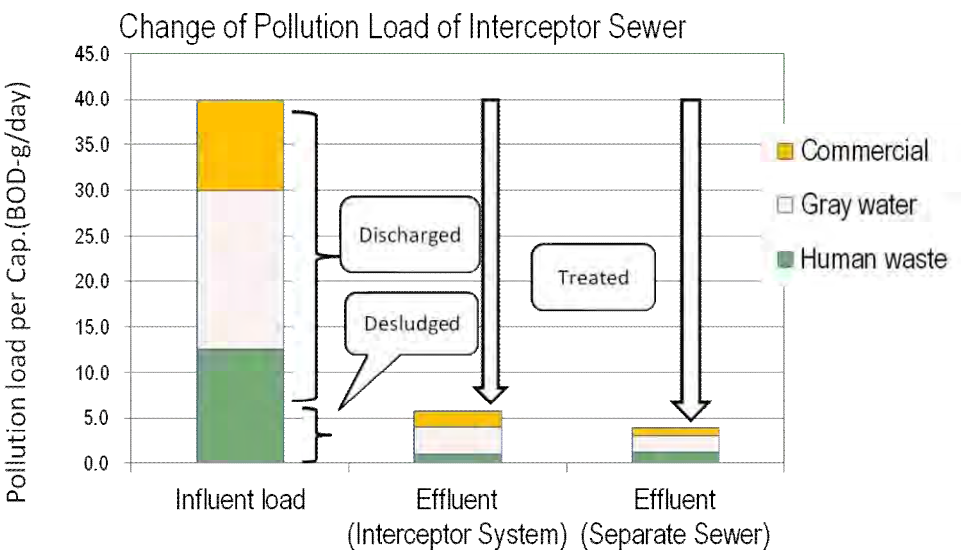
Figure 3.15 Pollutant Removal Efficiency

Change of BOD pollutant removal of separate sewerage system and interceptor sewerage system is shown in Table 3.4 and Figure 3.16. Pollutant removal efficiency is estimated to an equivalent level (assuming 90% and 83% of wastewater treatment rates, respectively).

Table 3.4 Unit Pollution Load

Category	Removal Rate[1]	Pollution Load per Capita			
		Domestic (150 ℓ/cap. day)[2]		Commercial (50 ℓ/cap. day)[2]	Total (200 ℓ/cap. day)
		Human Waste	Gray Water		
	%	g/cap	g/cap	g/cap	g/cap
Influent Load	–	12.5	17.5	10.0	40.0
Estimated Effluent Load Interceptor System	83%	1.1[3]	3.0	1.7	5.8
Separate Sewer	90%	1.3	1.8	1.0	4.1
Commercial: Same concentration as domestic Source: (1) JICA PPP Study Team, (2) MP Review, and (3) ST removal rate 50%					

Source: JICA Study Team



Source: JICA PPP FS

Figure 3.16 Pollutant Removal Efficiency of Interceptor Sewerage System

Sewerage system contributes to the improvement of quality of public water bodies since wastewater collection mitigates offensive odor and accumulation of garbage in rivers. Furthermore, road and park construction projects develop vitalized urban establishments such as cafés and restaurants accordant with sewerage development.

Before sewerage development

After sewerage development

Source: JICA Study Team

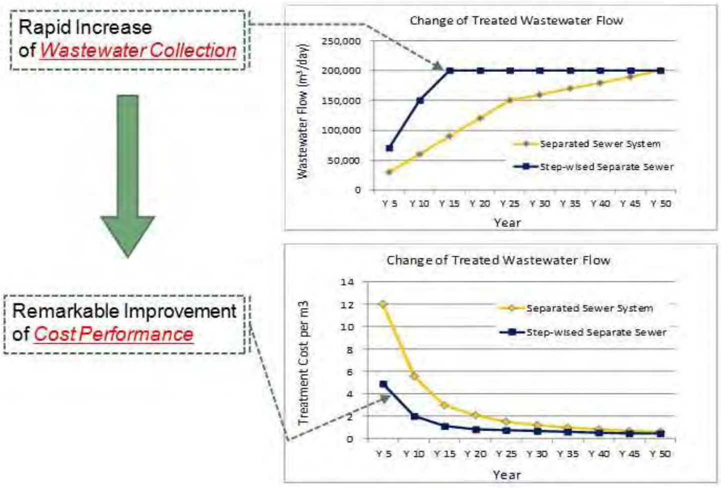
Figure 3.17 Effects of Sewerage Development (Ho Chi Minh City)

(6) Cost Saving Efficiency of Interceptor Sewerage System

1) Cost Saving on O&M

Interceptor sewerage system collects wastewater faster than separate sewerage system since it intercepts wastewater from existing drainage without the need for a house connection. Separate sewerage system requires house connection, which is a way to collect wastewater from residences. Furthermore, construction of lateral sewer and house connection affects traffic congestion and requires financial outlay from municipality governments and property owners. Experience of separate sewerage system in Japan provided approximately 10,000 m^3/year of annual wastewater increase, which takes 20 to 50 years for construction project completion.

Larger amount of wastewater collected by interceptor sewerage system contributes to the increase of facility operation rate as well as accelerated construction schedule of wastewater treatment. This means saving O&M cost per m^3 since the economy of scale is expected for wastewater treatment. Treated wastewater flow and cost per m^3 are shown in Figure 3.18.



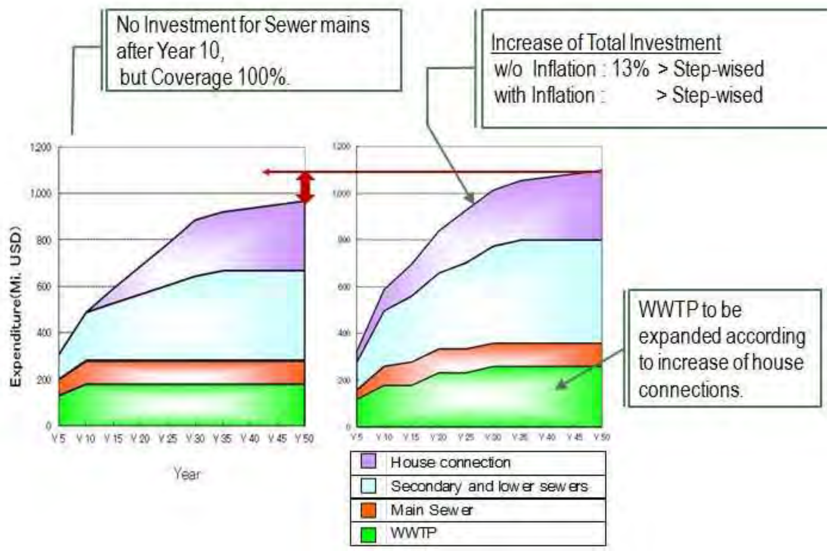
Source: JICA PPP FS

Figure 3.18 O&M Cost Saving of Interceptor Sewerage System

2) Cost Saving on Construction

Interceptor sewer system focuses on the main sewer and wastewater treatment plant at the beginning of the construction project, and collects wastewater from existing drainage. Construction project of main sewer and treatment plant is a large-scale contract package, which can save on construction cost, making it less than the cost of small-scale contract packages in long duration.

Furthermore, delayed investment schedule of lateral and house connections mitigates the budgetary burden.



Source: JICA PPP FS

Figure 3.19 Cost Saving on Construction of Interceptor Sewerage System

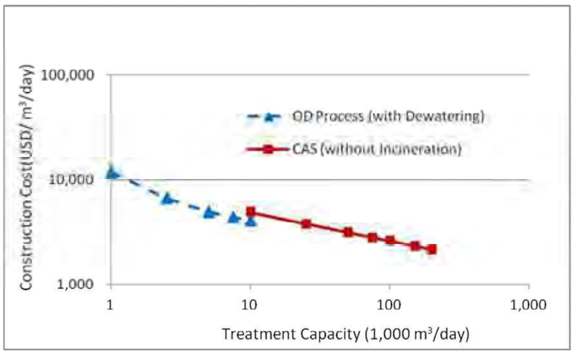
3.3.2 Features of Step-wise Sewerage Development Plan

(1) Integrating Small-scale Sewerage System into Large-scale Sewerage System

Sewerage system development requires a long time and a large amount of cost. On the other hand, new urban development projects are generally executed in short term and start operation with full capacity. Accordingly, both construction projects are difficult to adjust their construction schedule with respect to each other.

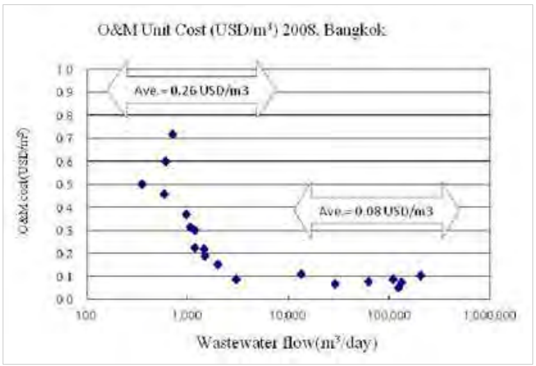
However, costs of construction and O&M of sewerage system are expected to have economy of scale as shown in Figure 3.20. Small-scale wastewater treatment plant is less advantageous in terms of professional assignment and sludge treatment as well as operation cost than large-scale wastewater treatment plant.

Integration of sewerage system from the viewpoint of medium- and long-term refurbishment program is recommendable since machinery equipment requires periodic rehabilitation.



Construction Cost

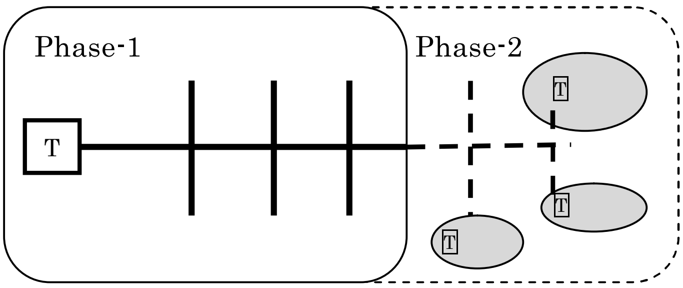
Source: Sewerage Planning Manual, Working Group of Sewerage Planning, Japan



O&M Cost

Source: JICA Study Team

Figure 3.20 Economy of Scale of Treatment Cost



Source: Sewerage Planning Manual, Working Group of Sewerage Planning, Japan

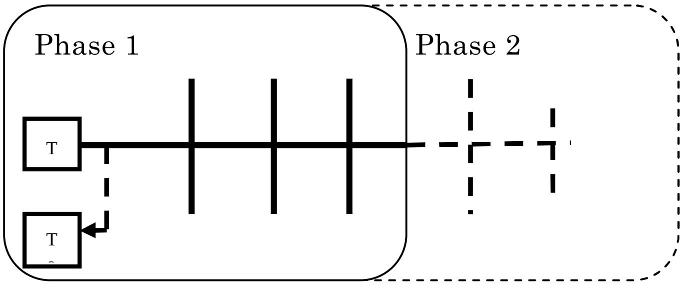
Figure 3.21 Integration of Small-scale Sewerage System

(2) Expansion of Wastewater Treatment Capacity and Division of Sewerage Service Area

Wastewater treatment plant is generally expanded in accordance with the increase of wastewater flow due to expansion of sewerage service area and population growth. Sewerage project is also planned based on a design criteria of 20 years of planning target.

However, wastewater treatment plant operates for 50 to 100 years from the start of operation. Planning of wastewater treatment plant applies a step-wise development procedure since uncertain factors are not considered at the initial project stage.

- Wastewater flow increase due to population growth and lifestyle change
- Advanced treatment process applied for eutrophication control in reservoir of NCICD and wastewater effluent reuse
- Sewage sludge reuse, etc.



Source: Sewerage Planning Manual, Working Group of Sewerage Planning, Japan

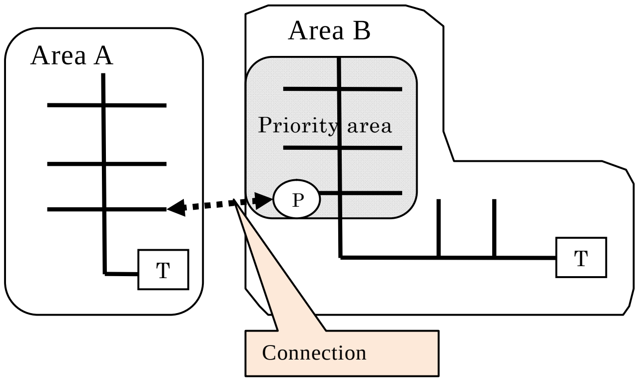
Figure 3.22 Step-wise Treatment Capacity Expansion

(3) Provisional Wastewater Treatment Using Connecting Sewer

Construction of main sewer and wastewater treatment plant takes a long time and a large amount of cost.

Provisional wastewater treatment is sometimes applied since priority area requires sewerage service and project cost sometimes exceed budgetary appropriation. Connecting sewer conveys wastewater into adjacent sewerage service area and limited budget is allocated to another prioritized facility.

Connecting sewer adjusts construction schedule of both treatment plants and accommodates treatment capacities each plant during disasters and rehabilitation projects. Plant operation rate will be raised.



Source: JICA Study Team

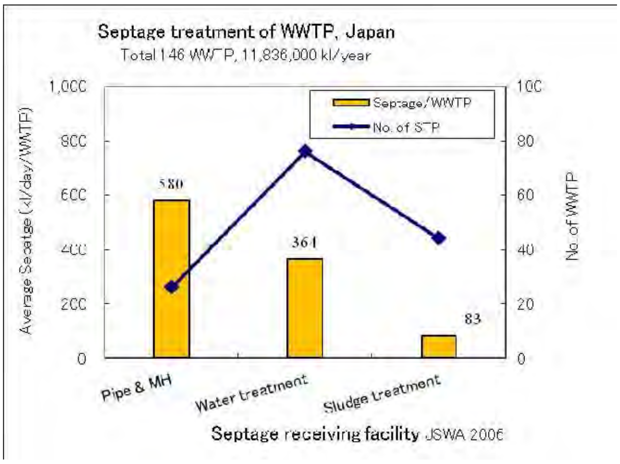
Figure 3.23 Provisional Treatment Using Connecting Sewer

(4) Septic Tank Sludge Treatment in the Wastewater Treatment Plant

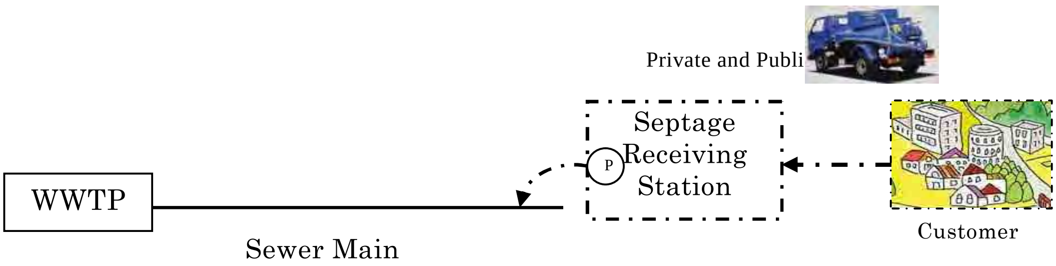
Septage is decomposed under anaerobic atmosphere since desludging interval may take as long as two to five years. Accordingly, septage is difficult to treat biochemically. Wastewater treatment plant can dilute septage and then separate it into liquid waste and solids. Furthermore, septic tanks will be abolished in accordance with expansion of sewerage service area.

Almost all wastewater treatment plants in urban areas in Japan accept septage of household wastewater treatment plant and human waste (Figure 3.24). Septage and human waste are accepted at receiving tanks installed in sewers, wastewater treatment process, or sludge treatment process. The receiving tank of a wastewater treatment plant is predominant since wastewater effluent is supplied to the cleansing water of septage receiving facilities. Receiving tanks of sewers accept a large amount of septage due to the accessibility of tanker trucks.

Septage treatment can avoid duplication of investment into sewerage and septage service, and septage treatment fee is also transferred to the sewerage sector. Accordingly, septage treatment is appropriate from the viewpoint of municipal administration.



Septage Treatment of Sewerage Sector in Japan



Septage Receiving Station of Sewerage System

Truck Scale and Manifest Recording

Receiving Screen and Tank

Source: JICA Study Team

Figure 3.24 Septage Treatment of Sewerage Sector

3.4 Survey on Existing Drainage Management

3.4.1 Current Situation of Existing Drainage

Survey of existing drainage is carried out by a two-step survey methodology.

Preliminary survey scrutinizes overall condition through reconnaissance and provides detailed survey plan, which is outsourced to a consultant firm in DKI Jakarta. Detailed survey examines the existing ledger, and checks physical condition through visual tests and measurement.

Existing facilities are affected by the following:

- Structure failure: Safety of traffic and pedestrians may be affected.
- Deposits of soil and garbage: Flooding may occur due to clogging.
- Occupation of drainage: Maintenance difficulty due to vendor and private residence use.
- Occupation of public utilities of water supply, electricity, and telecommunication: Flooding due to clogged soil and garbage.

Small roads and ditches are cleanly maintained since the community is pleased with a neat environment. Limited areas managed voluntarily by residents are less damaged.

Existing drainages along the main road are sometimes affected by deposits due to heavy traffic. However, serious failure, such as collapsed drainage covers which may cause traffic accidents and accidents for walking pedestrians, are fixed through corrective maintenance. Periodic cleaning is generally executed.

Deposits of soil

Failure and clogged

Source: JICA Study Team

Figure 3.25 Situation of Existing Drainage (1)

Occupied by vendor

Occupied by utilities

Cleaning

Neat drainage in the community

Source: JICA Study Team

Figure 3.26 Situation of Existing Drainage (2)

Garbage issues are serious. Roads are cleaned up periodically, however, garbage in the drainage is continuously supplied by wastewater and stormwater flow from upstream to downstream.

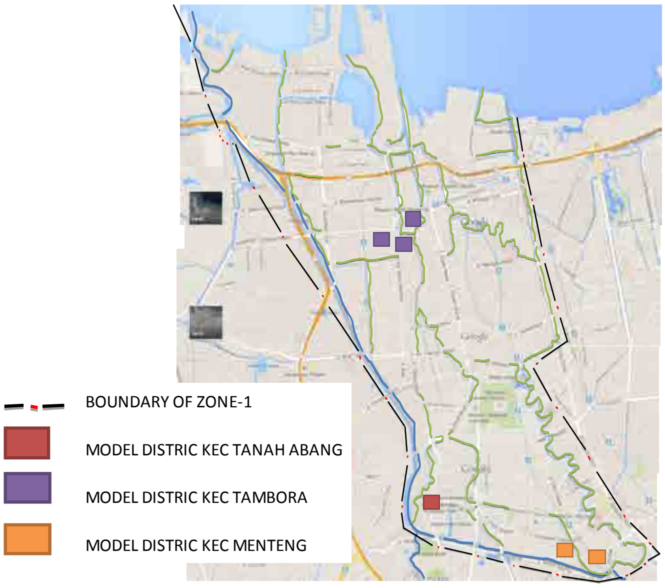
Source: JICA Study Team

Figure 3.27 Garbage Deposited in Existing Drainage

3.4.2 Detailed Survey of Existing Drainage Management

Six model districts are selected in order to detect issues on the existing drainage system and their causes in Zone 1 area. Three model districts of concentrated slum and commercial use, one district of middle class residences properly drained and two districts of small offices and high income residences are selected (Figure 3.28). Existing drainage line along the main road (Jalan Raya and Jalan Besar) are examined by reconnaissance.

Existing drainages are classified in Table 3.5. Drainage lines were visually examined for deposits, damage, and subsidence. Location, structure, dimension, and water depth were noted in a ledger and measured on site.



Source: JICA Study Team

Figure 3.28 Model Districts of Existing Drainage Survey

Table 3.5 Survey Items of Existing Drainage

Survey Objects and Failure A-C	Survey Method
Location	Drainage ledger and map
Structure	Drainage ledger and measurement
Dimension	Drainage ledger and measurement
Clogging due to deposits (A)	Visual test
Structural damage (B)	Visual test
Subsidence of drainage (C)	Visual test
Inundation, flow rate, water depth	Visual test and measurement

Source: JICA Study Team

Surveyed result is shown in Tables 3.6 and 3.7.

Almost all existing drainage lines are clogged by deposits, and damage and subsidence are also detected. There are four completely clogged drainage lines out of 71. Damage is also reported in at least one spot per road.

Report of existing drainage survey concludes the following:

Comments on the report of existing drainage survey

Water tunnel condition: a) Damages The water closure malfunction does not happen very often in the residential area. It is caused by the residents in this area who are able to maintain/take care of water closure. The problem on water closure can be found in Jalan Pengukiran 3 (1 unit) and Jalan Pasar Pagi caused by solid cement that fell into the channel (because the size of solid cement cover does not fit, the same as in Jalan Pekojan). The underground channel malfunction cannot be seen or cannot be found.
Mostly, the problems are caused by sediments (80%-90% sediments), whereas damage caused by buildings are only approximately 5% of the total length of roads along the main road.

The existing drainage survey recommends management methodology as follows:

- Cleaning of deposits and garbage is indispensable in order to retain drainage function properly.
- Corrective maintenance is executed for damages such as cave-ins on the road which can cause serious damage to vehicles. Pedestrians are aware of the abandoned failure or damage; accordingly, standard operating procedure (SOP) in Japan is not recommendable due to exceeding affordability in DKI Jakarta.

Table 3.6 Damage and Subsidence of Existing Drainage (Model Districts)

No.		Kelurahan	Jalan	Structure					Condition		Remark
				Type	W Top / dia (m)	W Bottom (m)	H (m)	L (m)	Clogged / Failed / Subsidy	A / B / C	hf = Depth of flow
1	1	TANAH ABANG	KH. MAS MANSYUR	□	1.00	1.00	1.20	510.00	Failed/Clogged	B/C	0.8
2	2	TANAH ABANG	KEBON PALA 1	□	0.65	0.65	1.10	295.00	Subsidy	B/C	0.3
3	3	TANAH ABANG	KEBON PALA 2	_/	0.60	0.40	0.75	350.00	Subsidy	B/C	0.1
4	4	TANAH ABANG	KEBON PALA 4	_/	0.70	0.60	0.60	190.00	–	C	0.1
5	5	TANAH ABANG	KEBON PALA 6	_/	0.60	0.40	0.45	320.00	–	C	0.15
6	6	TANAH ABANG	KEBON PALA 9	_/	1.00	0.60	0.70	685.00	Failed	B/C	0.2
7	7	TANAH ABANG	AWALUDIN 1	_/	1.00	0.60	0.60	315.00	Subsidy	B/C	0.15
8	8	TANAH ABANG	GG. MESS	_/	0.60	0.40	0.60	350.00	Failed	B/C	0.1
9	9	TANAH ABANG	GG. PORRA	_/	0.45	0.25	0.45	265.00	Subsidy	B/C	0.1
10	10	TANAH ABANG	GG. 01	_/	0.50	0.30	0.45	175.00	–	C	0.1
11	11	TANAH ABANG	GG. 02	_/	0.45	0.25	0.45	115.00	–	C	0.15
12	12	TANAH ABANG	GG. 03	_/	0.45	0.15	0.75	115.00	–	C	0.1
13	13	TANAH ABANG	GG. 04	_/	0.40	0.20	0.45	80.00	–	C	0.1
14	14	TANAH ABANG	GG. 05	_/	0.50	0.30	0.45	110.00	Subsidy	B/C	0.15
15	15	TANAH ABANG	GG. 06	_/	0.40	0.20	0.45	115.00	–	C	0.15
16	1	TAMBORA-1	PERNIAGAAN	□	0.60	0.60	1.20	250.00	Subsidy	B/C	0.5
17	2	TAMBORA-1	PERNIAGAAN BARAT	□	0.70	0.70	1.20	320.00	Subsidy	B/C	0.6
18	3	TAMBORA-1	PERNIAGAAN TIMUR	□	0.50	0.50	0.60	290.00	Subsidy	B/C	0.6
19	4	TAMBORA-1	PETONGKANGAN	□	0.60	0.60	1.20	280.00	Subsidy	B/C	0.9
20	5	TAMBORA-1	PERNIAGAAN TIMUR 1	□	0.50	0.50	0.70	205.00	Subsidy	B/C	0.5
21	6	TAMBORA-1	PERNIAGAAN TIMUR 3	□	0.50	0.50	0.70	220.00	Subsidy	B/C	0.5
22	7	TAMBORA-1	GG. JELAKENG 2	□	0.50	0.50	0.70	150.00	Subsidy	B/C	0.5
23	8	TAMBORA-1	PETAK BARU	□	0.80	0.80	1.00	215.00	Subsidy	B/C	0.8
24	9	TAMBORA-1	PASAR PAGI	□	0.80	0.80	1.00	185.00	Subsidy/Failed	B/C	0.8
25	10	TAMBORA-1	PASAR PAGI 2	□	0.40	0.40	0.60	100.00	Subsidy	B/C	0.4
26	1	TAMBORA-2	PEJAGALAN	□	1.00	1.00	1.65	335.00	Subsidy	B/C	1
27	2	TAMBORA-2	PENGUKIRAN 2	□	0.70	0.60	0.65	400.00	Subsidy	B/C	0.5
28	3	TAMBORA-2	PENGUKIRAN 3	□	0.90	0.90	0.90	350.00	Subsidy	B/C	0.7
29	4	TAMBORA-2	PENGUKIRAN 4	□	0.65	0.65	0.90	265.00	Subsidy	B/C	0.7
30	5	TAMBORA-2	PENGUKIRAN DALAM 2	□	0.30	0.30	0.50	100.00	Subsidy	B/C	0.3
31	6	TAMBORA-2	JEMBATAN 5	□	0.50	0.50	0.60	285.00	Subsidy	B/C	0.4
32	7	TAMBORA-2	PEJAGALAN 3	_/	0.80	0.80	1.00	100.00	Subsidy	B/C	0.2
33	8	TAMBORA-2	PENGUKIRAN	_/	0.80	0.70	0.65	310.00	Subsidy	B/C	0.2
34	9	TAMBORA-2	PEKOJAN	□	0.90	0.90	1.20	560.00	Subsidy	B/C	0.9
35	1	TAMBORA-3	P. TUBAGUS ANGKE	□	1.00	1.00	1.00	435.00	Subsidy	C	0.7
36	2	TAMBORA-3	LAKSA 1	□	0.90	0.90	0.70	265.00	Subsidy	C	0.5
37	3	TAMBORA-3	LAKSA 2	□	0.90	0.90	0.70	320.00	Subsidy	C	0.5
38	4	TAMBORA-3	LAKSA 3	□	0.80	0.80	0.60	200.00	Clogged	A	0.4
39	5	TAMBORA-3	LAKSA 4	□ _/	1.25	1.25	0.70	315.00	Clogged	A	0.2
40	6	TAMBORA-3	LAKSA 5	□	0.80	0.80	0.80	115.00	Clogged	A	0.5
41	7	TAMBORA-3	H. MOCH. MAS MANSYUR	□	1.00	1.00	1.00	360.00	Subsidy	A	0.7
42	8	TAMBORA-3	TAMBORA 6 DALAM	□	0.80	0.80	0.80	105.00	Subsidy	B/C	0.6
43	9	TAMBORA-3	TAMBORA 5	□	0.90	0.90	0.80	275.00	Subsidy	C	0.6
44	10	TAMBORA-3	TAMBORA 6	_/	0.50	0.50	1.20	315.00	–	C	0.3
45	1	MENTENG-1	MENTENG JAYA	_/	0.60	0.50	0.55	955.00	Subsidy	B/C	0.15
46	2	MENTENG-1	MENTENG TENGGULUN	_/	0.60	0.50	0.50	795.00	Subsidy	B/C	0.15
47	3	MENTENG-1	GG. ARENG UJUNG	□	0.60	0.60	0.70	260.00	Subsidy	B/C	0.6
48	4	MENTENG-1	GG. DAAR	□	0.60	0.60	0.60	200.00	Subsidy	B/C	0.4
49	5	MENTENG-1	GG. TEKOKAK	_/	0.75	0.65	0.50	125.00	Subsidy	B/C	0.15
50	6	MENTENG-1	GG. SIROJUL	_/	0.60	0.50	0.50	230.00	Failed/Subsidy	B/C	0.2
51	7	MENTENG-1	GG. BODREK	□ _/	0.60	0.50	0.50	265.00	Subsidy	B/C	0.15
52	8	MENTENG-1	GG. AMPERA	_/	0.60	0.50	0.50	215.00	Subsidy	B/C	0.15
53	9	MENTENG-1	GG. MASJID JAMI	_/	0.70	0.60	0.50	160.00	Subsidy	B/C	0.15
54	10	MENTENG-1	GG. 01	_/	0.50	0.40	0.50	40.00	Subsidy	B/C	0.2
55	11	MENTENG-1	GG. 02	□	0.50	0.50	0.50	45.00	Subsidy	B/C	0.3
56	12	MENTENG-1	GG. 03	□	0.50	0.50	0.50	40.00	Subsidy	B/C	0.4
57	13	MENTENG-1	GG. 04	_/	0.50	0.40	0.50	50.00	Subsidy	B/C	0.2
58	14	MENTENG-1	GG. 05	_/	0.50	0.40	0.50	50.00	Subsidy	B/C	0.2
59	1	MENTENG-2	SUKABUMI	□	1.00	1.00	0.90	170.00	Subsidy	B/C	0.7
60	2	MENTENG-2	SINDANGLAYA	□	1.00	1.00	0.90	200.00	Subsidy	B/C	0.6
61	3	MENTENG-2	MENTENG SUKABUMI	_/	0.60	0.50	0.50	235.00	Subsidy	B/C	0.15
62	4	MENTENG-2	GG. 01	□	0.50	0.50	0.40	160.00	Subsidy	B/C	0.2
63	5	MENTENG-2	GG. 02	□	0.50	0.50	0.40	265.00	Subsidy	B/C	0.2
64	6	MENTENG-2	GG. 03	_/	0.60	0.50	0.50	245.00	–	C	0.2
65	7	MENTENG-2	GG. 04	_/	0.60	0.50	0.50	110.00	–	C	0.2
66	8	MENTENG-2	GG. 05	_/	0.60	0.50	0.50	100.00	–	C	0.15
67	9	MENTENG-2	GG. 06	_/	0.60	0.50	0.50	215.00	–	C	0.15
68	10	MENTENG-2	GG. 07	_/	0.50	0.40	0.50	100.00	Failed	B/C	0.2
69	11	MENTENG-2	GG. 08	_/	0.60	0.50	0.50	75.00	Subsidy	B/C	0.2
70	12	MENTENG-2	GG. 09	□	0.50	0.50	0.50	100.00	Failed	B/C	0.3
71	13	MENTENG-2	GG. 10	_/	0.50	0.50	0.50	65.00	–	C	0.2

Table 3.7 Damage and Subsidence of Existing Drainage (Main Road 1/2)

No.		Name Of Road	Structure									Condition		Remark
			Left				Right				L (m)	Clogged Failed Subsidy	A B C	(Water Depth)
			Type	Width Top	Width Bottom	Height	Type	Width Top	Width Bottom	Height				
1	1	JL. SOEDIRMAN		1.50	1.50	1.00		1.50	1.50	1.00	800.00	Subsidy	B/C	0.80
2	2	JL. MERDEKA BARAT		0.70	0.70	1.20		0.70	0.70	1.20	1050.00	Subsidy	B/C	0.80
3	3	JL. MERDEKA SELATAN		0.70	0.70	1.20		0.75	0.75	0.70	1050.00	Subsidy	B/C	0.70
4	4	JL. MERDEKA TIMUR		0.70	0.70	1.20		0.70	0.70	1.20	900.00	Subsidy	B/C	0.80
5	5	JL. MERDEKA UTARA		0.70	0.70	1.20		0.70	0.70	1.20	950.00	Subsidy	B/C	0.60
6	6	JL. MAJAPAHIT		0.70	0.70	1.00	-				550.00	Subsidy	B/C	0.50
7	7	JL. HAYAM WURUK		0.70	0.70	1.20	KALI CILIWUNG TIGA				2800.00	Failed / Subsidy	B/C	0.70
8	8	JL. GAJAHMADA	KALI CILIWUNG TIGA					0.70	0.70	1.20	2850.00	Failed / Subsidy	B/C	0.60
9	9	JL. JUANDA	KALI CILIWUNG TIGA					0.90	0.90	1.20	1100.00	Failed / Subsidy	B/C	0.70
10	10	JL. KH. HASYIM ASHARI		1.00	1.00	1.50		1.00	1.00	1.50	2000.00	Failed / Subsidy	B/C	0.80
11	11	JL. CIDENG TIMUR		0.90	0.90	1.20	KALI CIDENG				2400.00	Failed / Subsidy	B/C	0.80
12	12	JL. CIDENG BARAT	KALI CIDENG					0.90	0.90	1.20	2400.00	Failed / Subsidy	B/C	0.70
13	13.1	JL. PLUIT SELATAN RAYA (TYPE-1)		0.75	0.75	1.10		0.75	0.75	1.10	950.00	Failed / Subsidy	B/C	0.60
14	13.2	JL. PLUIT SELATAN RAYA (TYPE-2)		1.00	0.80	1.20		1.50	1.50	1.10	1000.00	Failed / Subsidy	B/C	0.40
15	13.3	JL. PLUIT SELATAN RAYA (TYPE-3)		1.00	0.80	1.20		1.50	1.50	1.10	1000.00	Failed / Subsidy	B/C	0.40
16	14.1	JL. PLUIT TIMUR RAYA (TYPE-1)		1.00	1.00	1.10		2.20	2.00	1.10	500.00	Failed / Subsidy	B/C	0.40
17	14.2	JL. PLUIT TIMUR RAYA (TYPE-2)	-					2.50	2.30	1.30	500.00	Subsidy	B/C	0.40
18	14.3	JL. PLUIT TIMUR RAYA (TYPE-3)		1.30	1.10	1.10		2.50	2.30	1.50	400.00	Subsidy	B/C	0.30
19	15.1	JL. PLUIT INDAH (TYPE-1)	-					5.00	5.00	2.50	200.00	Subsidy	B/C	0.40
20	15.2	JL. PLUIT INDAH (TYPE-2)		1.00	1.00	1.20		5.00	5.00	2.50	600.00	Subsidy	B/C	0.50
21	15.3	JL. PLUIT INDAH (TYPE-3)		1.00	1.00	1.20		5.00	5.00	2.50	300.00	Subsidy	B/C	0.50
22	16	JL. PLUIT PERMAI TIMUR		1.40	1.40	1.20		4.00	4.00	2.00	1100.00	Failed / Subsidy	B/C	0.60
23	17	JL. JEMBATAN TIGA		0.70	0.70	0.80		5.00	5.00	2.00	1200.00	Subsidy	B/C	0.50
24	18	JL. BANDENGAN UTARA		0.70	0.70	0.80		0.70	0.70	0.80	2150.00	Subsidy	B/C	0.50
25	19	JL. P. TUBAGUS ANGKE		0.70	0.70	1.20	KALI MUARA KARANG				1900.00	Failed / Subsidy	B/C	0.60
26	20	JL. JEMBATAN DUA	-					1.00	1.00	1.10	1800.00	Failed / Subsidy	B/C	0.60
27	21	JL. KALI BESAR		0.70	0.70	1.20		0.70	0.70	1.00	650.00	Failed / Subsidy	B/C	0.60
28	22	JL. PINTU BESAR SELATAN		1.30	1.30	1.10		1.30	1.30	1.10	550.00	Subsidy	B/C	0.60
29	23.1	JL. KH. MAS MANSYUR (TYPE-1)		1.10	1.10	1.50		1.10	1.10	1.50	400.00	Failed / Subsidy	B/C	0.40
30	23.2	JL. KH. MAS MANSYUR (TYPE-2)		1.10	1.10	1.50		0.90	0.90	0.90	500.00	Failed / Subsidy	B/C	0.40
31	23.3	JL. KH. MAS MANSYUR (TYPE-3)		1.10	1.10	1.50		1.00	1.00	1.25	400.00	Failed / Subsidy	B/C	0.30
32	24	JL. KEBON KACANG RAYA		1.30	1.30	1.20		1.30	1.30	1.20	1000.00	Failed / Subsidy	B/C	0.40
33	25	JL. JATI BARU		1.60	1.60	1.60		0.80	0.80	1.00	900.00	Subsidy	B/C	0.40
34	26	JL. KEBON JAHE		0.60	0.60	1.00		0.60	0.60	0.80	500.00	Failed / Subsidy	B/C	0.50
35	27	JL. RIDWAN RAIZ		1.20	1.20	1.20		1.20	1.20	1.20	400.00	Failed / Subsidy	B/C	0.60
36	28	JL. PASAR SENEN		1.35	1.35	1.50		1.35	1.35	1.50	1250.00	Subsidy	B/C	0.40
37	29	JL. TAMBAK		1.00	1.00	1.10		1.00	1.00	1.10	600.00	Subsidy	B/C	0.40
38	30	JL. PROKLAMASI		1.40	1.40	2.60		1.00	1.00	1.50	1300.00	Failed / Subsidy	B/C	0.50
39	31	JL. PRAMUKA		1.40	1.40	1.25		1.40	1.20	1.25	2600.00	Failed / Subsidy	B/C	0.30
40	32.1	JL. KH. ZAINUL ARIFIN (TYPE-1)		0.60	0.60	0.60		0.60	0.60	0.60	350.00	Failed / Subsidy	B/C	0.30
41	32.2	JL. KH. ZAINUL ARIFIN (TYPE-2)		0.60	0.60	0.60		1.00	0.60	1.20	350.00	Failed / Subsidy	B/C	0.30
42	32.3	JL. KH. ZAINUL ARIFIN (TYPE-3)		1.00	0.70	1.20	KALI KETAPANG				300.00	Failed / Subsidy	B/C	0.30
43	32.4	JL. KH. ZAINUL ARIFIN (TYPE-4)		0.80	0.70	1.20		2.10	1.90	2.10	300.00	Failed / Subsidy	B/C	0.40
44	33	JL. BIAK		1.00	1.00	1.00		1.00	1.00	1.00	650.00	Subsidy	B/C	0.50
45	34	JL. KYAI CARINGIN		0.80	0.80	0.85		0.80	0.80	0.85	700.00	Subsidy	B/C	0.30
46	35	JL. BALIKPAPAN		1.00	1.00	1.00		1.00	1.00	1.00	450.00	Subsidy	B/C	0.40
47	36	JL. SURYOPRANOTO		1.00	1.00	1.10		1.00	1.00	1.10	800.00	Subsidy	B/C	0.30
48	37	JL. TANAH ABANG		1.00	1.00	1.00		1.00	1.00	0.90	1000.00	Subsidy	B/C	0.50
49	38	JL. ABDUL MUIS	KALI CIDENG					1.00	1.00	1.00	1550.00	Failed / Subsidy	B/C	0.40
50	39	JL. POS	KALI CILIWUNG TIGA					1.00	1.00	1.30	550.00	Failed / Subsidy	B/C	0.30

Table 3.7 Damage and Subsidence of Existing Drainage (Main Road 2/2)

No.		Name Of Road	Structure: Left Type	Left Width Top	Left Width Bottom	Left Height	Right Type	Right Width Top	Right Width Bottom	Right Height	L (m)	Condition: Clogged / Failed / Subsidy	A / B / C	Remark (Water Depth)
51	40	JL. DR. SOETOMO	KALI CILIWUNG TIGA				□	1.00	1.00	1.00	550.00	Failed / Subsidy	B/C	0.30
52	41	JL. GUNUNG SAHARI	KALI CILIWUNG TIGA				□	1.00	1.00	1.00	4750.00	Failed / Subsidy	B/C	0.30
53	42.1	JL. MANGGA BESAR (TYPE-1)	□	0.70	0.70	0.90	□	1.00	1.00	1.00	400.00	Subsidy	B/C	0.50
54	42.2	JL. MANGGA BESAR (TYPE-2)	□	1.00	1.00	0.80	KALI KETAPANG				250.00	Subsidy	B/C	0.50
55	42.3	JL. MANGGA BESAR (TYPE-3)	□	1.00	1.00	1.20	□	1.00	1.00	1.20	1550.00	Subsidy	B/C	0.50
56	43	JL. MH. TAMRIN	□	1.50	1.50	1.50	□	1.50	1.50	1.50	600.00	Failed / Subsidy	B/C	0.30
57	44	JL. PANGERAN JAYAKARTA	□	1.40	1.40	1.30	□	1.40	1.40	1.30	1950.00	Failed / Subsidy	B/C	0.40
58	45	JL. DR. SURATMO	□	1.40	1.40	1.00	□	1.40	1.40	1.00	350.00	Failed / Subsidy	B/C	0.50
59	46	JL. PRAPATAN	□	1.40	1.40	1.00	–				1100.00	Failed / Subsidy	B/C	0.20
60	47.1	JL. KWITANG (TYPE-1)	□	0.70	0.70	0.80	□	1.00	1.00	0.90	300.00	Subsidy	B/C	0.50
61	47.2	JL. KWITANG (TYPE-2)	⊔	0.60	0.60	1.50	□	1.00	1.00	0.90	300.00	Subsidy	B/C	0.50
62	47.3	JL. KWITANG (TYPE-3)	□	0.70	0.70	1.20	□	1.00	1.00	0.90	650.00	Subsidy	B/C	0.50
63	48	JL. KRAMAT RAYA	□	1.10	1.10	1.20	□	1.10	1.10	1.20	900.00	Failed / Subsidy	B/C	0.40
64	49	JL. SALEMBA RAYA	□	1.00	1.00	1.50	□	1.10	1.10	1.20	1450.00	Failed / Subsidy	B/C	0.40
65	50.1	JL. PANGERAN DIPONEGORO (TYPE-1)	□	1.10	1.10	1.10	□	1.10	1.10	1.10	350.00	Subsidy	B/C	0.50
66	50.2	JL. PANGERAN DIPONEGORO (TYPE-2)	–				□	1.10	1.10	1.20	450.00	Subsidy	B/C	0.50
67	50.3	JL. PANGERAN DIPONEGORO (TYPE-3)	□	1.10	1.10	1.10	□	1.00	1.00	1.20	650.00	Subsidy	B/C	0.50
68	50.4	JL. PANGERAN DIPONEGORO (TYPE-4)	⊔	0.40	0.40	0.70	⊔	0.40	0.40	0.70	800.00	Subsidy	B/C	0.50
69	51	JL. TEUKU CIK DI TIRO	□	1.10	1.10	1.20	□	1.10	1.10	1.20	1350.00	Subsidy	B/C	0.40
70	52	JL. RP. SOEROSO	□	1.10	1.10	1.50	□	1.10	1.10	1.50	800.00	Failed / Subsidy	B/C	0.30
71	53	JL. MENTENG RAYA	□	1.10	1.10	1.20	□	1.10	1.10	1.00	650.00	Failed / Subsidy	B/C	0.40
72	54	JL. KEBON SIRIH	□	1.10	1.10	1.10	□	1.10	1.10	1.10	1850.00	Failed / Subsidy	B/C	0.50
73	55	JL. CEMARA	□	1.10	1.10	2.00	□	1.10	1.10	2.00	400.00	Failed / Subsidy	B/C	0.30
74	56	JL. CUT MEUTIA	□	1.20	1.20	1.20	□	1.10	1.10	0.90	450.00	Failed / Subsidy	B/C	0.20
75	57.1	JL. TEUKU UMAR (TYPE-1)	□	0.80	0.80	1.70	□	0.80	0.80	1.70	400.00	Subsidy	B/C	0.30
76	57.2	JL. TEUKU UMAR (TYPE-2)	□	1.00	1.00	1.20	□	1.00	1.00	1.20	850.00	Subsidy	B/C	0.30
77	58	JL. SUNDA KELAPA	□	1.10	1.10	1.00	□	1.10	1.10	1.00	650.00	Subsidy	B/C	0.50
78	59.1	JL. LATUHARHARY (TYPE-1)	□	1.10	1.10	1.00	⊔	0.70	0.70	1.30	600.00	Subsidy	B/C	0.50
79	59.2	JL. LATUHARHARY (TYPE-2)	⊔	1.00	1.00	0.80	⊔	0.70	0.70	1.60	1000.00	Failed / Subsidy	B/C	0.40
80	60	JL. T. IMAM BONJOL	□	1.20	1.20	1.20	□	1.20	1.20	1.20	1300.00	Failed / Subsidy	B/C	0.30
81	61	JL. COKROAMINOTO	□	1.00	1.00	0.90	□	1.00	1.00	0.90	1950.00	Failed / Subsidy	B/C	0.50
82	62.1	JL. WAHID HASYIM (TYPE-1)	□	2.00	2.00	1.20	□	2.00	2.00	1.20	1000.00	Subsidy	B/C	0.30
83	62.2	JL. WAHID HASYIM (TYPE-2)	□	2.00	2.00	1.20	□	1.50	1.50	1.60	1300.00	Subsidy	B/C	0.30
84	63.1	JL. MANGGA DUA (TYPE-1)	□	1.50	1.50	1.20	□	1.50	1.50	1.20	600.00	Subsidy	B/C	0.70
85	63.2	JL. MANGGA DUA (TYPE-1)	⊔	2.50	2.10	1.50	⊔	2.50	2.10	1.50	1500.00	Subsidy	B/C	0.70
86	64	JL. RE. MARTADINATA	⊔	1.50	1.50	1.50	KALI CILIWUNG DUA				1500.00	Failed / Subsidy	B/C	0.50
87	65	JL. PAKIN TO MARTADINATA	KALI KRUKUT SATU				□	1.00	1.00	1.50	2150.00	Failed / Subsidy	B/C	0.40
		TOTAL									**88150.00**			

3.5 Proposed Sewerage Development Using Existing Drainage

3.5.1 Principle of Existing Drainage Management

(1) Proposed Types of Existing Drainage Management

Reconnaissance survey recommends operating procedure of existing drainage management as follows:

- Deposits and garbage affects drainage capacity seriously. Drainage management requires periodic cleaning.
- Drainage in communities is managed properly. Voluntary cleaning of drains in the community works well.
- For drainage lines occupied by vendors and gardens like private properties, rule of public property management is required since walking and facility management are affected.
- Overall rehabilitation program is not required. Corrective management, which is applied at present, is suitable in accordance with the amount of rehabilitation works and required budget.

Table 3.8 Principles of Existing Drainage Management

Role/Function \ O&M Type	Cleaning	Repair	Refurbishment
Safety for pedestrian and vehicular traffic	—	○	—
WW drainage	○	○ (partially fixed)	Not required
Stormwater drainage	○	○ (partially fixed)	Not required
Flood control	—	—	—
Traffic lane use	—	—	○ (Covered conduit)

Source: JICA Study Team

(2) Rehabilitation Plan of Drainage

Reconnaissance survey also recommends principles of rehabilitation plan as follows:

- Failure, which can cause serious traffic accident, shall be punctually fixed the same as corrective maintenance at present.
- Deteriorated drainage function due to subsidence is improved through dredging and will not cause serious flooding. Flood mitigation measure for a large area requires the building of a new pumping station and to decrease river water level.
- As for flood mitigation measure in a large area, comprehensive stormwater control is practicable. It is combined with retention technology and drainage facilities of channels and

pumping stations. Existing drainage shall be renovated in accordance with rehabilitation plan of main roads and rivers as well as Jakarta Emergency Dredging Initiative (JEDI) project.

3.5.2 Sewerage Development Plan Using Existing Drainage

Existing drainage is poorly functioning due to submerged channel. Properly drained area during the dry season gets inundated in the rainy season since the water level of receiving river rises.

Sewerage development using existing drainage shall consider the following issues:

- River water inflow into sewerage system
- Diluted wastewater
- Useless cost for pumping and wastewater treatment

Drop connection

Submerged connection

Source: JICA Study Team

Figure 3.29 Water Level of Existing Drainage

Habitual inundation causes damage in Zone 1 sewerage area; accordingly, countermeasure for raised river water level is required. Pumping and gate for backflow are used in order to prevent inflow into sewer line.

- Properly drained area such as Pluit drainage area: River water level decreases with pumping. Flap gate is also practicable in order to prevent river water inflow.
- Poor drainage area such as submerged connection: Motor drive gate and automatic flap gate are applicable. Automatic flap gate is operated in conjunction with river water level. Periodic inspection and garbage removal are required since gate loses sealing function due to clogging.

A small-scale pumping station was installed in Central Jakarta in order to prevent inundation in a limited area due to continuous land subsidence. The pumping station has small and low head pump facilities. This pumping station works to prevent river water inflow by retaining drainage water level properly.

Source: JICA Study Team

Figure 3.30 Flap Gate

Small pumping station (Central Jakarta)

Control unit of pumping station

Source: JICA Study Team

Figure 3.31 Small Pumping Station

Land subsidence in Central Jakarta is progressing; accordingly, provisional measure for diversion facility is required in order to prevent flooding in the pumping station of wastewater treatment plant. Diversion chamber must work in the dry season as well as high water level.

Interceptor sewer in low land area has a dual mode wastewater collection. Measure for flooding is not required in dry weather and small rain events; however, it is required during heavy rain events which inundate large areas. Sewerage systems in Ho Chi Minh City and Kaohsiung in Taiwan have movable gates that stop river water inflow in dry weather and open during heavy rains in order to release stormwater.

Cities in Japan have two types drainage system, namely gravity drainage and pumping drainage. However, small catchment area, which experiences only small-scale inundation, has a diversion chamber with flap gate in order to prevent river water inflow.

Sewerage systems equipped with these simplified facilities are practicable in low land area in DKI Jakarta. In medium- and long-term, pumping drainage system is more feasible in accordance with the Giant Sea Wall project and large scale pumping station proposed by NCICD project.

Diversion facility and pumping station

Submerged pump unite

Source: JICA Study Team

Figure 3.32 Diversion Facility (Ho Chi Minh City)

Stormwater outfall

Gate and control unit

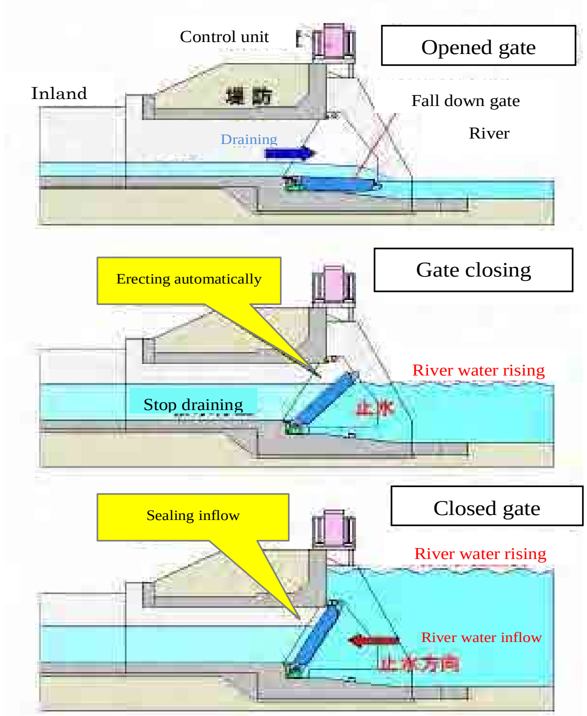
Screen facility and sewerage exhibition facility

Diversion weir

Source: JICA Study Team

Figure 3.33 Diversion Facility(Kaohsiung in Taiwan)

Installation



Gate operation

Source: Japan Construction Information Center

Figure 3.34 Automatic Flap Gate

3.6 Institution for Step-wise Sewerage Development

3.6.1 Sewerage Tariff System

(1) Need for Tariff System

Sewerage works requires working budget for operation in order to sustain financial management.

Sewerage construction is only temporary financial needs. However, O&M of sewerage system not only continues forever but also requires a huge amount for operation and machinery replacement. Small-scale wastewater treatment plants reportedly do not work well due to insufficient maintenance as well as lack of O&M budget.

Interview survey on sewerage management at BPLHD, DKI Jakarta proved the following:

- Sewerage management requires huge amount of resources contrary to road and river management.
- Wastewater treatment plant does not work properly due to lack of maintenance. Sewerage works require sustainable O&M.
- Permanent financial resource is required because O&M costs are continuous.

Regional Secretary of DKI Jakarta stated that public service commonly compensates charges in accordance with service quality. Sewerage service plans to introduce tariff system for O&M cost.

Many cities have applied appropriate tariff systems in accordance with affordability and the public’s willingness to pay. This study introduces tariff system in Asian countries.

(2) Sewerage Tariff in Osaka City, Japan

Sewerage system in Japan originally had a combined drainage system of wastewater and stormwater composed of sewers and pumping stations without wastewater treatment plant. Accordingly, sewerage sector has provided two types of service areas: a wastewater treatment area where human waste is treated by sewerage system, and a drainage area where only gray water was collected and human waste was treated by septic tank or pit latrine.
Osaka City abandoned tariff on flush toilet user and introduced progressive tariff rate in 1972.

Table 3.9 Tariff System in Osaka City (Year 1972)

Tariff Structure of Osaka City, Japan in 1972 JPY 1.00 = USD 0.004 (1972)

Category			Consumption (m^3 per month)	Old Tariff (JPY/m^3)	New Tariff (JPY/m^3)
General User (Gray water discharge)	Basic Charge	Individual house	8 m^3 or less	50	50
		Public bath	10 m^3 or less	70	70
		Flat house	8 m^3 or less	24	24
	Consumption charge	Individual house	Per 1 m^3	10	11-20 m^3/month 10 21-30 m^3/month 15 31-50 m^3/month 16 51-100 m^3/month 17 >101 m^3/month 18
		Public bath	Per 1 m^3	4.5	4.5
		Flat house	Per 1 m^3	3.9	3.9
Flush Toilet User	Household	Closet bowl	Per unit	20	To be abolished
		Urinal lavatory	Per unit	10	
	Commercial	Closet bowl	Per unit	40	
		Urinal lavatory	Per unit	20	

(3) Tariff System in Singapore

Singapore applies water supply, sewerage tariff of water conservation tax, and waterborne fee as well as water tariff at a fixed rate per volume of water consumption. Furthermore, sanitary appliance fee is charged in accordance with the number and size of fittings.

Table 3.10 Waster Supply and Sewerage Tariff in Singapore

Tariff Category	Consumption Block (m^3 per month)	Water Tariff (SGD/m^3) [before GST]	Water Conservation Tax (% of Water Tariff)
Domestic	0 to 40	1.17	30
	Above 40	1.40	45
Non-domestic	All units	1.17	30
Shipping	All units	1.92	30
Tariff Category	**Consumption Block (m^3 per month)**	**Waterborne Fee (SGD/m^3)[after GST]**	**Sanitary Appliance Fee [after GST]**
Domestic	All units	0.30	SGD 3.00 per chargeable fitting per month GST: Good & Service Tax (7%) SGD 1.00 = USD 0.79
Non-domestic	All units	0.60	
Shipping	All units	0.60	

Reference: Charge of Water Supply and Sewerage of Singapore

Water Conservation Tax
To reinforce the message that every drop of water is precious and everyone must do their part to conserve water, the *Water Conservation Tax* was introduced in 1991. It is imposed as a percentage of the total water consumption.
Sanitary Appliance Fee and Waterborne Fee
The sanitary appliance fee (SAF) and the waterborne fee (WBF) are levied to offset the cost of treating used water and for operating and maintaining the used water network.
The SAF is a fixed component based on the number of sanitary fittings in each premise whereas the WBF is charged based on the volume of water used in any premises. Source: Water Tariff, PUB Singapore

(4) Tariff System in Malaysia

Indah Water Konsortium (IWK), Malaysia applies a cross-subsidized sewerage tariff to households in accordance with income level as well as service quality with/without septage treatment. Sewerage tariff for commercial establishments depends on business size (annual value) and service quality with/without septage treatment. Excess water use of more than 100 m^3 per month is also charged.

Table 3.11 Sewerage Tariff, Malaysia (Household)

Domestic

Category	Monthly Charge (RM)
Low-cost houses and government quarters in Categories F, G, H, and I (receiving either individual septic tank or connected sewerage services)	2
Houses in Kampung, new villages, and estates (receiving either individual septic tank or connected sewerage services)	3
Premises and government quarters in Categories A, B, C, D, and E receiving individual septic tank services	6
Premises and government quarters in Categories A, B, C, D, and E receiving connected sewerage services	8

Table 3.12 Sewerage Tariff, Malaysia (Commercial)

Monthly sewerage services charges for commercial premises

Band/*Kumpulan*	Annual Value (RM)/ *Nilai Tahunan* (RM)	Basic Charge (RM) / *Caj Asas* (RM)	
		Connected/ *Bersambung*	Septic Tank/ *Tangki Septik*
1	0 - 2,000	8	7
2	2,001 - 5,000	14	8
3	5,001 - 10,000	20	14
4	10,001 - 20,000	26	19
5	20,001 - 30,000	29	21
6	30,001 - 40,000	32	23
7	40,001 - 50,000	35	25
8	50,001 - 60,000	38	27
9	60,001 - 70,000	41	29
10	70,001 - 80,000	44	31
11	80,001 - 90,000	47	33
12	90,001 - 100,000	50	35
13	100,001 - 200,000	180	120
14	200,001 - 400,000	495	330
15	400,001 - 600,000	522	348
16	600,001 - 800,000	1,980	1,320
17	800,001 - 1,000,000	2,160	1,440
18	1,000,001 - 3,000,000	4,320	2,880
19	3,000,001 - 5,000,000	8,800	5,400
20	5,000,001 - 7,000,000	9,200	6,000
21	More than/*Melebihi* 7,000,001	9,600	6,600

Monthly Excess Charge/*Caj Penggunaan Air Bulanan*	
Water usage/*Penggunaan Air*	Excess charge/*Caj Pengunaan Air*
Up to/*Sehingga* 100 m^3	No charge/*Tiada Caj*
More than 100 m^3 but less than 200 m^3/ *Melebihi* 100 m^3 *tetapi kurang daripada* 200 m^3	30 *sen* per/*setiap* m^3
More than/*Melebihi* 200 m^3	45 *sen* per/*setiap* m^3

(5) Tariff System in Shanghai, China

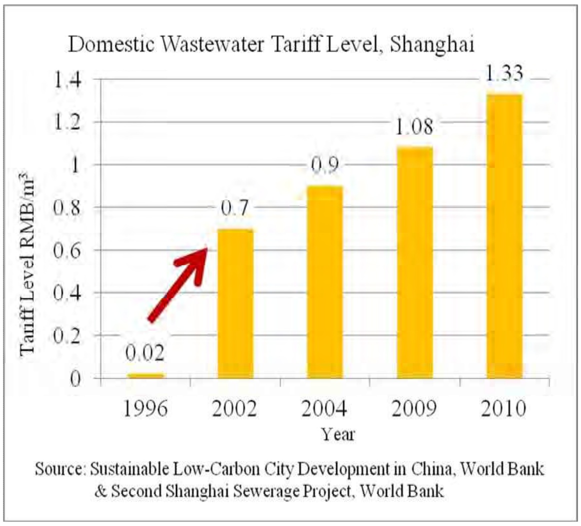
Shanghai City has raised tariff level periodically from virtually zero at the beginning of sewerage service to appropriate level. Present tariff level is 82% of water supply tariff, and is still not enough for full cost recovery. However, sewerage tariff is stressed because government must allocate its budget to the other social services.

Principle of Sewerage Tariff in Shanghai City

(1) Over the past 20 years, Shanghai has increased tariff from virtually zero to appropriate level. However, it is still not enough for full cost recovery.

(2) Higher user charge and lower government subsidies mean that local government has more funds available for other services such as health, education, social services, and public infrastructures that must be financed by the government.

Source: Financing for Urban Development of Shanghai



Source: JICA Study Team

Figure 3.35 Change of Sewerage Tariff in Shanghai

Table 3.13 Water Supply and Sewerage Tariff, Shanghai

Water Supply and Wastewater Tariff in Shanghai 2010 (RMB/m^3) RMB 1.00 = USD 0.16

Group	Water Supply	Wastewater	WW/WS
Industrial	2.00	1.80	0.90
Commercial/Institutional	2.00	1.70	0.85
Domestic	1.63	1.33	0.82
WS(Water Supply): Shanghai South Water Company WW(Wastewater): Shanghai Municipal Sewerage Company			

Source: JICA Study Team

3.6.2 Public Awareness for Water Environment Improvement

(1) River and Road Cleaning Campaign in Japan

Rivers and roads are cleanly maintained through residents and the municipality collaborative effort. Clean public space provides amenity to the community; accordingly, it brings benefits to the public.

Government supports voluntary cleaning activities of resident's association and/or women's circle by subsidizing the expenses such as equipment and tea cakes.

River cleaning

Road cleaning and pocket park management

Source: JICA Study Team

Figure 3.36 River and Road Cleaning Campaign

(2) River Cleaning Project in Indonesia (PROKASIH)

Proyek Kali Bersih (PROKASIH), River Cleaning Project, is promoting hometown river improvement in Indonesia by using catchy phrases such as nol-sampa (zero garbage) and Code-ku (our Code River). A previous study in Yogyakarta proved that "living environment is improved by sewerage project. Residents are pleased with improved river" (The Study on Operation and Maintenance Know-how Transfer, JICA).

(3) Cleaning Campaign in Bali

Residents in Bali work together with the government and NPO for cleaning beaches, rivers, and roads as well as for water pollution improvement in order to retain Bali as a beautiful tourist destination.

Community environment is improved synergistically in accordance with enhanced public awareness.

River Cleaning Program, Yogyakarta
Source: JICA Study Team

Earth Day Cleaning Campaign
Source: ROLE Foundation, Bali

Figure 3.37 River and Drainage Cleaning

3.6.3 Regulatory System Enhancing Sewer Connection

(1) Obligation of Sewerage Connection Regulated in Sewerage Ordinance

From the viewpoint of sewerage system on social contribution, the Sewerage Law and ordinance of local government notify sewerage service area and oblige owners of properties and buildings to discharge sewage into public sewers when sewerage service starts.

Sewerage Law, Japan
Article 10 "Private Sewer Installation and Relevant"
In case sewerage service notified, property owner, lease holder or occupant, who are in sewerage service area, shall install necessary sewer pipe, conduit and other drainage (hereinafter defined as "private sewer") in accordance with the right of property ownership and as soon, in order to drain sewage into public sewerage.
However, this provision is exempted in case that sewerage administrator approves in accordance with special situation or in case that circular regulates.

Standard Sewerage Ordinance, Japan
Article 3 "Private Sewer Installation"
Private sewer owner, who are responsible to facilitate private sewer at notified date of beginning sewerage service, shall install private sewer in ★★★ days since notified date.

Article 5 "Approval of Private Sewer Planning"
Sewage discharger, who install private sewer or newly install facilities to be approved for Article 24 of Sewerage Law, shall submit application form with necessary documents and shall accept the verification of mayor in accordance with the installed private sewer complying with the regulation on installation and structure.

Article 11 "Pre-treatment Installation"
Sewage discharger, who continuously discharges sewage not complying with discharge standard to sewerage, shall install pretreatment facility.
Discharge standard to sewerage (omitted)

Large cities in Japan are also required to install sewerage system equivalent to public sewers and not to be an obstacle for sewerage development program in accordance with the regulations of development activity stipulated by the Urban Planning Law.

The building construction permission is issued afterwards.

Example of Building Construction Order Regulated by Urban Planning Law, Japan
(Drainage and sewer)
Drainage and sewer shall be designed in order to properly discharge wastewater and stormwater, and shall facilitate structure and capacity that will not cause flooding in either the development area or any adjacent area. In case urban planning is provided, drainage and sewer planning shall comply with urban planning.

Documents to be submitted (Sewer):

Layout plan of sewer
Longitudinal profile and cross-section
Structural drawing
Structural calculation sheet
Layout plan of drainage area
Flow calculation sheet

(2) Direction of Urban Development Project Based on Building Construction Permission

The Government of DKI Jakarta regulates direction of building construction permission (IMB) and building utilization (KMB) the same as in Japan.

Building Construction Permission, Jakarta

The procedures for obtaining IMB, IPB, and KMB in Jakarta Capital City
Definition
1.Application for construction concession (PIMB) is an application form to obtain a construction permit;
2.Application for building utilization eligibility (PKMB) is an application form to obtain a certificate of building utilization eligibility;
3. Construction permit is a concession issued to carry out construction activities;
4. Building utilization permit (IMB) is a permit that is issued to utilize a building after being deemed appropriate based on technical aspects; and
5. Building utilization eligibility (KMB) is a certificate regarding the eligibility to utilize the proposed building after its conditions and building utilization are deemed appropriate based on technical aspects.

Construction Permit (IMB)
I. Requirement and procedures of applying for IMB-PB
1. Every construction has to have IMB; and
2. In order to obtain IMB, applicants are required to apply in paper to a governor, in this case the head office through the sub-district development program (PPK) department, by completing the provided application form and enclose it with the requirements.

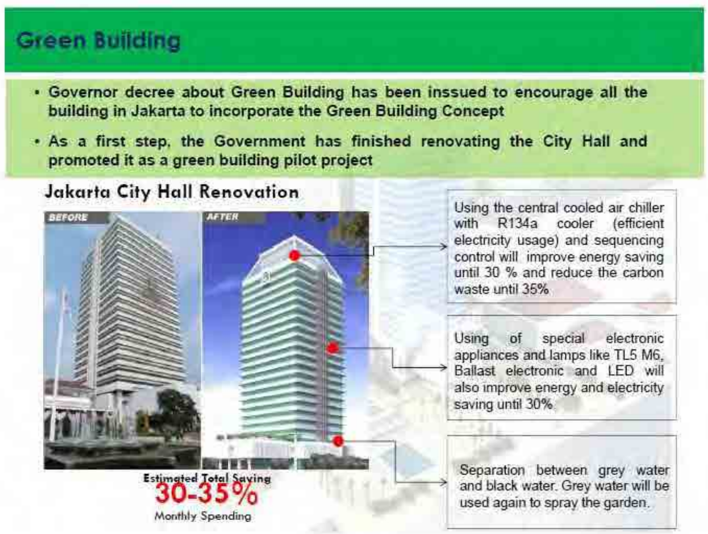
Source:DKI Jakarta home page
http://www.jakarta.go.id/eng/news/2012/01/the-procedures-of-obtaining-imb-ipb-and-kmb-in-jakarta-capital-city

An example of building construction permission is shown below.

An innovative institution was already executed, such as stormwater infiltration well for preventing ground subsidence and for ground water recharge, and wastewater effluent reuse.

Regarding public sewer connection, direction by building construction permission can be applied.

New Governor Decree enforces all buildings in Jakarta to build infiltration well and puts it as a requirement for issuing building permit.



Using the centrally-cooled air chiller with R134a cooler (efficient electricity usage) and sequencing control will improve energy saving up to 30% and reduce carbon waste up to 35%.

Separation between gray water and black water. Gray water will be used again to water the garden.

Source: Pursuing Harmonious and Sustainable Development, *The 12th Plenary Meeting of the ANMC21,Deputy Governor of Jakarta for Spatial Planning and Environment*

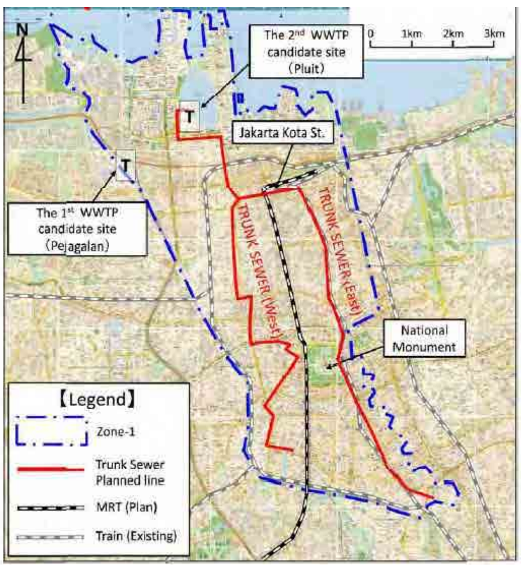
Figure 3.38 Example of Building Construction Permission, DKI Jakarta

3.7 Issues to Be Solved and Proposal

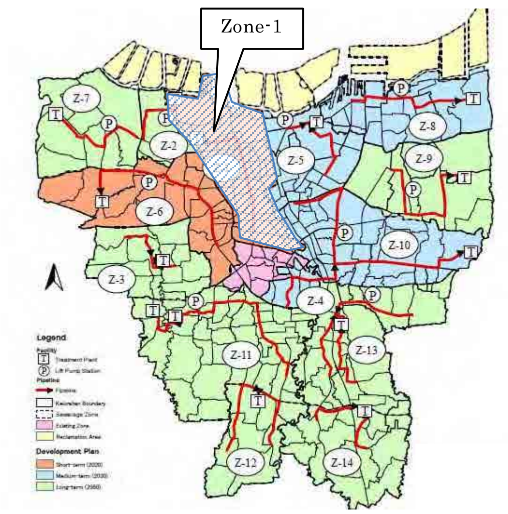
DKI Jakarta now studies wastewater management strategy in the whole administrative area in order to improve water environment and pollution control in order to sustain NCICD which requires sewerage development. However, present sewerage systems are only in Zone 1 area and small-scale sewerage system developed by housing and urban development projects. Present house connections of 1,556 residences, which PD PAL Jaya has developed since its inauguration in 1991, is equivalent to 1/1,674 or 0.06% of the number of household amounted to 2,604,600 in the whole DKI Jakarta area (Statistics Indonesia 2014). Sewerage sector of DKI Jakarta faces various issues on sewerage development program, implementation organization, applied technology, and finance.

Wastewater management in DKI Jakarta shall provide step-wise sewerage development plan of 75% BOD reduction, which is the target of NCICD in 2022. Sewerage system shall be developed not only in Zone 1 but in all 14 treatment areas.

Accordingly, it is essential for step-wise sewerage development to focus on sewer main and treatment plant in order to allocate the limited budget for the whole area as well as to mitigate traffic congestion.



Zone 1 Sewerage Service Area
Source: JICA Study Team



Review Master Plan
Source: Review Master Plan 2012

Figure 3.39 Sewerage Development Plan

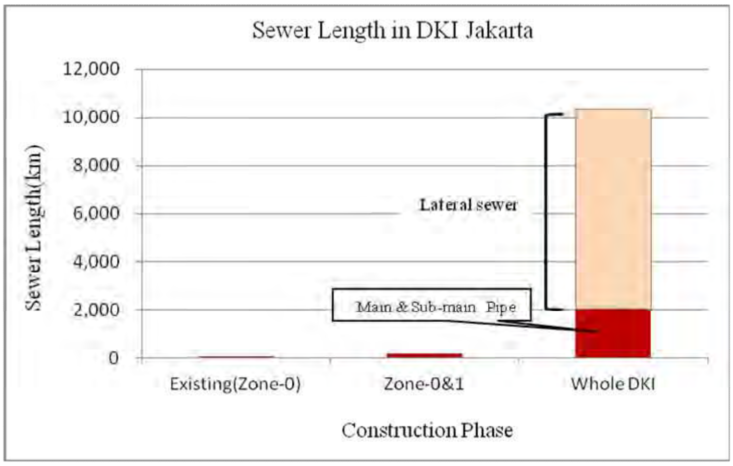
Sewer length of each phase is shown in Figure 3.40.

Existing sewer length is approximately 84 km (Annual Report 2013, PD PAL Jaya), and planned sewer length in Zone 1 is almost 89 km. Sewer length in the whole DKI Jakarta is estimated to be 10,343 km (Review Master Plan 2012).

Lateral sewers make up approximately 80% of the total sewers. Construction of lateral sewers and house connections require approval to occupy the road and approval from traffic/police as well as agreement of property owner. Furthermore, traffic congestion will be serious due to sewer construction.

Step-wise sewer development plan is indispensable for the expected huge amount of sewer construction in accordance with solving the following issues:

- Sewer construction technology of curve and long distance micro-tunneling in order to mitigate traffic congestion;
- Human resource development and organization enhancement for lateral sewer and house connection construction;
- O&M task force that will provide sewer maintenance and sewerage service to residents;
- Financial source for construction and O&M; and
- Public awareness for sewer construction, public sewer connection, and sewerage tariff.



Source: JICA Study Team

Figure 3.40 Planned Sewer Construction

Step-wise sewerage development, which focuses on main sewers in the beginning, followed by lateral sewers and house connections, is practicable. Collaboration between private and public sectors for projects such as road construction and urban development is also useful.
Constructing trunk sewers during the first phase produces the following results:

- Organization and budget are limited. Accordingly, concentrating the project to trunk sewer construction can help to provide sewerage service at an early stage and achieve water pollution control target.
- Traffic congestion caused by sewer construction is minimized since developed trunk sewers

and sub-trunk sewers provide construction site of service pipe and house connection in different parts of the whole treatment area.

- Collaboration on urban development project enhances separate sewerage system financially and technically. Sewerage connection of large commercial establishments contributes to better financial management.

Institutional development is required for public sewer connection as well as public awareness on wastewater treatment and water environment improvement in order to achieve sustainable sewerage management.

CHAPTER 4 PRELIMINARY DESIGN AND COST ESTIMATION OF WASTEWATER TREATMENT PLANT AT PLUIT SITE

4.1 Preliminary Design of Wastewater Treatment Facilities

4.1.1 Basic Design Condition

(1) Design Influent Flow Rate and Water Quality

The inlet pipe to the WWTP was designed with a diameter of 2,200mm in the previous study "The preparatory survey on DKI Jakarta sewerage development project (PPP Infrastructure Project) " (Hereinafter refer to "PPP Project"), but it was changed to 2,000mm in "Pilot Project to be implemented by DKI Jakarta" of which design is included in this Study. Accordingly, maximum hourly flow rate is changed from 400,000m^3/day to 350,000m^3/day as shown in Table 4.1.

Taking into account that the construction of sewer systems takes long time, JST considers a two-phased construction for WWTP as Case 2 on the design conditions that its construction in Phase 1 will meet the influent flow rate shown in Table 4.1 and the Phase 2 starts from 8th year after the commencement of Phase1. The design quality of influent and effluent in this study is set as shown in Table 4.2 that is same as PPP Project.

Table 4.1 Design Conditions of Influent Flow Rate

Design Condition			Unit	PPP Project	This Study
Case 1		Daily Average	m^3/day	200,000	200,000
		Daily Maximum	m^3/day	264,000	264,000
		Hourly Maximum	m^3/day	400,000	350,000
Case 2	Phase 1	Daily Average	m^3/day	100,000	100,000
		Daily Maximum	m^3/day	132,000	132,000
		Hourly Maximum	m^3/day	200,000	175,000
	Phase 2	Daily Average	m^3/day	200,000	200,000
		Daily Maximum	m^3/day	264,000	264,000
		Hourly Maximum	m^3/day	400,000	350,000

Source: PPP-F/S

Table 4.2 Standard and Design Criteria for Major Water Quality Items

Items		Effluent Standard Regulated by Indonesian Gov.	Design Criteria by PPP Project and This Study
Influent Quality (mg/L)	BOD	-	120
	SS	-	120
Effluent Quality (mg/L)	BOD	<50	<10
	SS	<50	<10
	NH_4-N	<10	< 5

Source: PPP-F/S

(2) Conditions of Proposed Site for WWTP

Location of the proposed site for WWTP was changed from a plot of Pejagalan Park scheduled in PPP Project to a site nearby Pluit flood control pond. Locational conditions of the newly proposed site are shown in Table 4.3.

Table 4.3 Locational Conditions

Items	Conditions	Remarks
Area	Approx. 4ha	Site for park owned by DKI Jakarta
Elevation	From PP+0.1m to PP+0.8m	
Discharge point	To Pluit flood control pond	HWL: PP+1.0m, AWL: PP-1.8m, LWL: PP-1.9m
Surrounding land use	Houses, Parks, Schools, etc.	
Limitation	Gas pipes to be buried in the site	Under construction

Source: JICA study team

The boundary of the construction site is confirmed as shown in Figure 4.1, based on the results of topographic survey subcontracted to Indonesian companies.

4.1.2 Outline of Treatment Facilities

(1) Selection of Treatment Process for Design and Cost Estimation

In PPP Project, the treatment plant was designed with MBR (Membrane Bio-Reactor) process to reduce required area because the proposed site in Pejagalan Park was limited in area. As seen in Figure 4.1, newly proposed site nearby Pluit pond has also too small area of 3.96 ha to construct WWTP with treatment processes other than MBR process. As previously studied in M/P review Project and PPP Project, in this study too, CAS (Conventional Activated Sludge Process), MBBR (Moving Bed Bio-Reactor Process), and MBR are comparatively evaluated based on the following evaluation parameters shown in Table 4.4 to select the most appropriate treatment process, for which preliminary design and cost estimation are conducted.

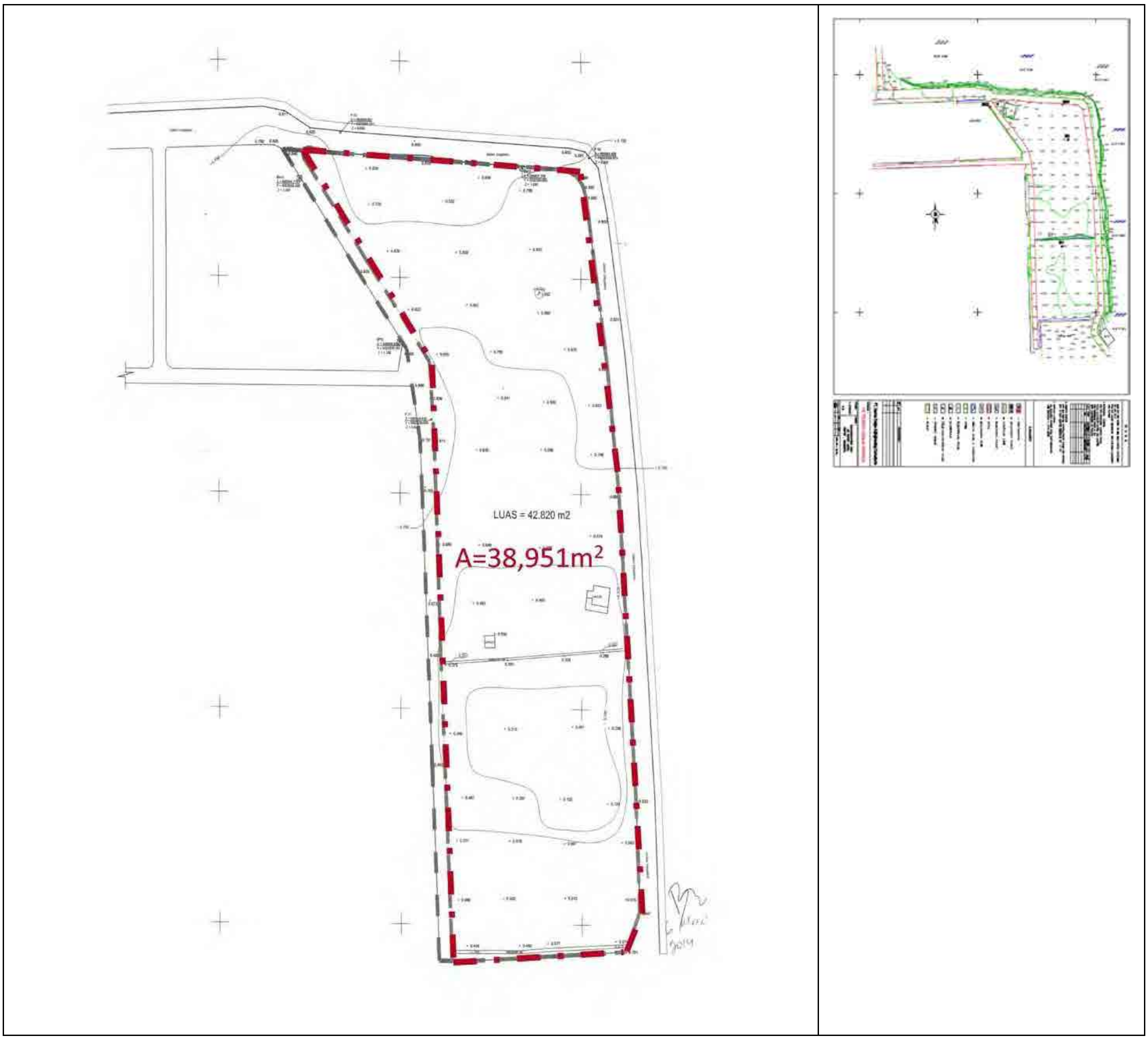


Figure 4.1 Boundary of Construction Site for WWTP at Pluit

Table 4.4 Evaluation Parameters for Treatment Process Selection

Evaluation Parameters	Evaluation Points
1. Effluent quality	Considering future effluent quality standard as well as current standard, evaluate each of 3 treatment processes if they can achieve designed effluent quality.
2. Construction area and cost	Calculating required area and cost for WWTP construction of 200,000m^3/day capacity, evaluate each 3 treatment processes if they are appropriate.
3. O&M features and cost	Evaluate operatability and maintenanceability for each of 3 treatment processes and evaluate their cost comparatively.
4. Replacement cost	Calculating required cost for replacement, evaluate each of 3 treatment processes if they are appropriate.
5. Others	Evaluate a MBR installation record, appropriateness for water reuse of each process, etc.

Source: JICA study team

1) Evaluation of Effluent Quality

DKI Jakarta has not stipulated any effluent quality standard for large-scale municipal wastewater treatment plant other than “Liquid waste disposal standard for wastewater “issued as Governor’s Decree No.122 in 2005, which regulates BOD <50mg/L, NH4-N<10mg/L, and SS<50mg/L. However, as mentioned in M/P review report, stricter standards such as BOD 20mg/L and SS 20mg/L are stipulated internationally to protect water environment considering features of receiving water bodies. In the case that the receiving water body is source of water supply, further stricter standards are applied often with regulations on T-N and T-P included.

As a lot of municipal wastewater treatment plants are installed to protect water environment in Indonesia including DKI Jakarta in near future, the standard for effluent quality is expected to be set with the regulation in the near future. Also, the standard will have several specific items and values depending on local and social characteristics of discharge water bodies. According to the recent trends of strict discharge quality regulation in big cities of the world, it is thought that the effluent quality standard of WWTPs for big cities including DKI Jakarta in Indonesia will be set strictly.

JST considers the effluent quality standard of WWTPs in DKI Jakarta will be set at 15-20mg/L of BOD and SS. To secure the effluent standard thoroughly, treatment facilities have to be designed with design criteria of BOD and SS 5-10mg/L. That is for ensuring thorough compliance with the effluent standard even when treated water quality is deteriorated due to low sludge settleability in final sedimentation tanks and so on. JST assumes design criteria of Pluit WWTP with 10mg/L of BOD and SS.

Table 4.5 describes treatment processes that meet effluent quality standard regulated by Japanese sewerage law. When the necessity of high removal of BOD, nitrogen and phosphorous arises, additional facilities such as a filtration facility and anaerobic, anoxic tanks and chemical dosing facilities should be added to traditional processes. But in this study, JST doesn’t consider removal of nitrogen and phosphorous to a high degree and only focuses on the BOD and SS removal according to PPP Project.

JST evaluated 3 processes whether each process can meet thedesign criteria of effluent quality by JST and the evaluation results are shown in Table 4.6. As shown in Table 4.6, CAS and MBBR can’t fulfill design criteria by JST according to the design effluent quality of treatment processes by Japanese Sewerage Law. To fulfill design effluent criteria by JST, rapid filtration facility for BOD, SS and disinfection facility for total coliform are needed. But, MBR fulfill all design criteria of effluent quality proposed by JST without any additional facilities.

Table 4.5 Design Effluent Quality of Treatment Processes by Japanese Sewerage Law (1/2)

Design effluent quality			Treatment Process
BOD (mg/L)	T-N (mg/L)	T-P (mg/L)	
≤ 10	≤ 10	≤ 0.5	Recycled Nitrification/Denitrification MBR Process (Limited to process using addition of coagulants) or Anaerobic-Anoxic-Oxic Process (A^2/O Process) + Rapid Filtration (Limited to process using addition of organics & coagulants)
		0.5<, ≤1	Recycled Nitrification/Denitrification MBR Process (Limited to the process using addition of coagulants) or Anaerobic-Anoxic-Oxic Process (A^2/O Process) + Rapid Filtration (Limited to process using addition of organics & coagulants) or Recycled Nitrification/Denitrification Process + Rapid Filtration (Limited to process using addition of organics & coagulants)
		1<, ≤3	Recycled Nitrification/Denitrification MBR Process (Limited to process using addition of coagulants) or Anaerobic-Anoxic-Oxic Process (A^2/O Process) + Rapid Filtration (Limited to process using addition of organics) or Recycled Nitrification/Denitrification Process + Rapid Filtration (Limited to process using addition of organics & coagulants)
		-	Recycled Nitrification/Denitrification MBR Process or Anaerobic-Anoxic-Oxic Process (A^2/O Process) + Rapid Filtration (Limited to process using addition of organics) or Recycled Nitrification/Denitrification Process + Rapid Filtration (Limited to process using addition of organics)

Source: Japanese Sewerage Law Enforcement Order (Article5, Paragraph5, (ii) of item1)

Table 4.5 Design Effluent Quality of Treatment Processes by Japanese Sewerage Law (2/2)

<table>
<tr><th colspan="3">Design effluent quality</th><th rowspan="2">Treatment Process</th></tr>
<tr><th>BOD
(mg/L)</th><th>T-N
(mg/L)</th><th>T-P
(mg/L)</th></tr>
<tr><td rowspan="6">≤ 10</td><td rowspan="3">10<, ≤20</td><td>≤ 1</td><td>Anaerobic-Anoxic-Oxic Process (A^2/O Process) + Rapid Filtration
(Limited to process using addition of coagulants)
or
Recycled Nitrification/Denitrification Process + Rapid Filtration
(Limited to process using addition of coagulants)</td></tr>
<tr><td>1<, ≤3</td><td>Anaerobic-Anoxic-Oxic Process (A^2/O Process) + Rapid Filtration
or
Recycled Nitrification/Denitrification Process + Rapid Filtration
(Limited to process using addition of coagulants)</td></tr>
<tr><td>-</td><td>Anaerobic-Anoxic-Oxic Process (A^2/O Process) + Rapid Filtration
or
Recycled Nitrification/Denitrification Process + Rapid Filtration</td></tr>
<tr><td rowspan="3">-</td><td>≤ 1</td><td>Anaerobic-Anoxic-Oxic Process (A^2/O Process) + Rapid Filtration
(Limited to process using addition of coagulants)
or
Anaerobic-Oxic Activated Sludge Process (A/O Process) + Rapid Filtration
(Limited to process using addition of coagulants)</td></tr>
<tr><td>1<, ≤3</td><td>Anaerobic-Anoxic-Oxic Process (A^2/O Process) + Rapid Filtration
or
Anaerobic-Oxic Activated Sludge Process (A/O Process) + Rapid Filtration</td></tr>
<tr><td>-</td><td>Conventional Activated Sludge Process (CAS)+ Rapid Filtration</td></tr>
<tr><td rowspan="4">10<, ≤15</td><td rowspan="2">≤ 20</td><td>≤ 3</td><td>Anaerobic-Anoxic-Oxic Process (A^2/O Process)
or
Recycled Nitrification/Denitrification Process
(Limited to process using addition of coagulants)</td></tr>
<tr><td>-</td><td>Anaerobic-Anoxic-Oxic Process (A^2/O Process)
or
Recycled Nitrification/Denitrification Process</td></tr>
<tr><td rowspan="2">-</td><td>≤ 3</td><td>Anaerobic-Anoxic-Oxic Process (A^2/O Process)
or
Anaerobic-Oxic Activated Sludge Process (A/O Process)</td></tr>
<tr><td>-</td><td>Conventional Activated Sludge Process (CAS)</td></tr>
</table>

Source: Japanese Sewerage Law Enforcement Order (Article5, Paragraph5, (ii) of item1)

Table 4.6 Effluent Quality Evaluation of Treatment Process according to Japanese Sewerage Law

<table>
<tr><th colspan="2">Treatment Process / Effluent Quality</th><th>CAS</th><th>MBBR</th><th>MBR</th><th>Remarks</th></tr>
<tr><td rowspan="3">BOD</td><td><50mg/L</td><td>Satisfied</td><td>Satisfied</td><td>Satisfied</td><td>Current water quality standard</td></tr>
<tr><td rowspan="2"><10mg/L</td><td>Unsatisfied</td><td>Unsatisfied</td><td rowspan="2">Satisfied</td><td rowspan="2">Design criteria by JST</td></tr>
<tr><td colspan="2">Rapid filtration needed to always fulfill design criteria</td></tr>
<tr><td rowspan="3">SS</td><td><50mg/L</td><td>Satisfied</td><td>Satisfied</td><td>Satisfied</td><td>Current water quality standard</td></tr>
<tr><td rowspan="2"><10mg/L</td><td>Unsatisfied</td><td>Unsatisfied</td><td rowspan="2">Satisfied</td><td rowspan="2">Design criteria by JST</td></tr>
<tr><td colspan="2">Rapid filtration needed to always fulfill design criteria</td></tr>
<tr><td rowspan="2">NH4-N</td><td><10mg/L</td><td>Satisfied</td><td>Satisfied</td><td>Satisfied</td><td>Current water quality standard</td></tr>
<tr><td><5mg/L</td><td>Satisfied</td><td>Satisfied</td><td>Satisfied</td><td>Design criteria by JST</td></tr>
<tr><td colspan="2" rowspan="2">Coliform group (<3,000MPN/100mL)</td><td>Unsatisfied</td><td>Unsatisfied</td><td rowspan="2">Satisfied</td><td rowspan="2">3,000/100mL is design criteria by JST. MBR does not require disinfection facility.</td></tr>
<tr><td colspan="2">Necessity of disinfection facility</td></tr>
<tr><td colspan="2" rowspan="2">Comprehensive Judge</td><td>Unsatisfied</td><td>Unsatisfied</td><td rowspan="2">Satisfied</td><td rowspan="2">For securing stable water quality in CAS and MBBR, additional area and cost required for installing additional equipment.</td></tr>
<tr><td colspan="2">Rapid filtration and disinfection facility needed to fulfill design criteria.</td></tr>
</table>

Source: JICA study team

2) Evaluation of Required Area and Construction Cost

Required area for the construction of WWTP with CAS, MBBR and MBR having the capacity shown in Table 4.1 are calculated as Table 4.7 and Figure 4.2.

When every facility is single story building, required areas of CAS, MBBR and MBR are 8.4ha, 6.9ha and 4.0ha, respectively. In PPP Project, every construction cost for WWTP was calculated to be 185 million USD without any other indirect cost such as financial cost for PPP; all are the same regardless of the treatment processes. However in this case, CAS and MBBR cannot be constructed within the proposed site area.

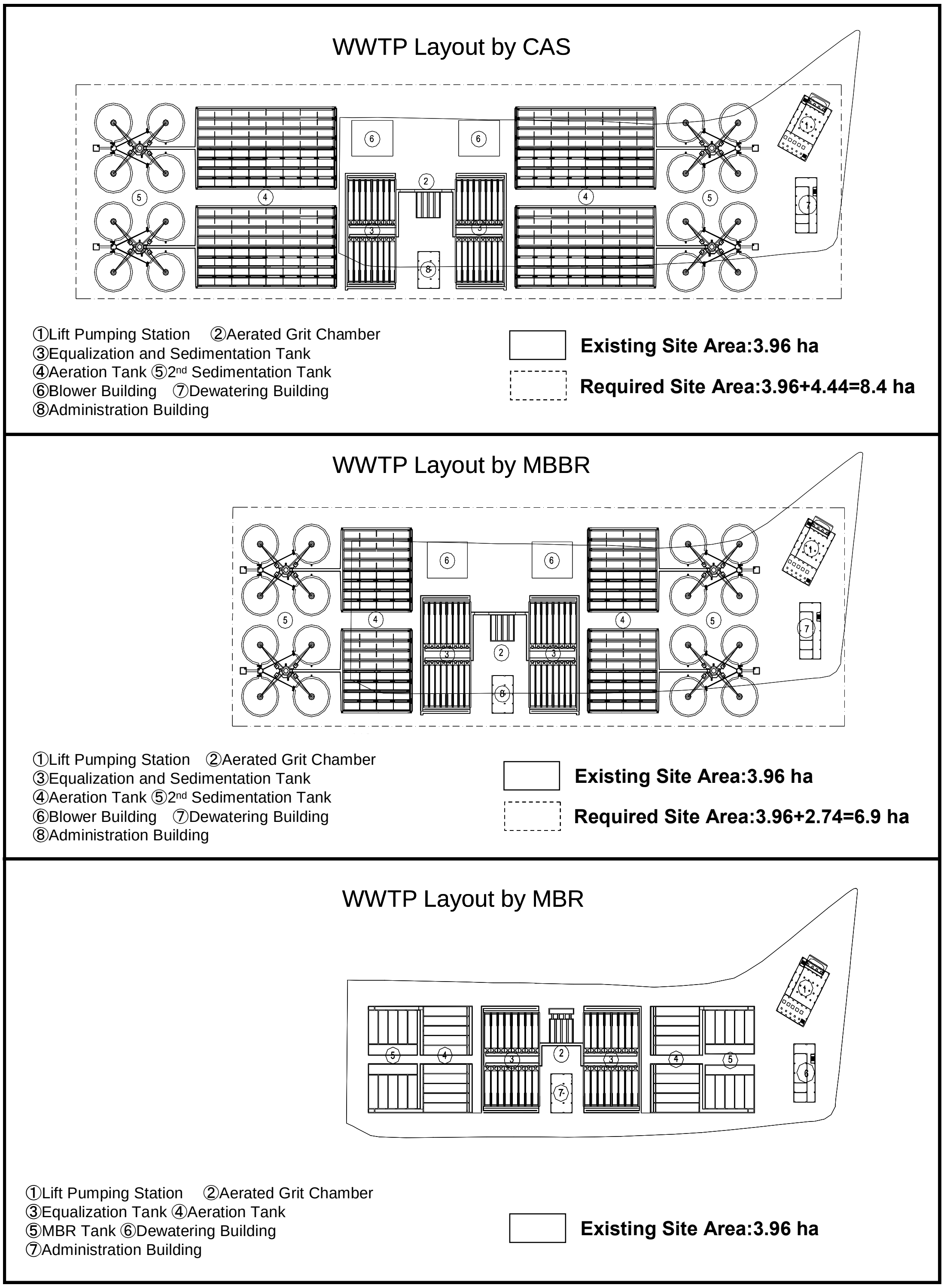
Therefore, JST has considered an alternative plan to reduce construction area targeting water facilities excluding a lift pumping station, a dewatering building and an administration building by applying deep aeration for aeration tanks, and adopting two story buildings for primary and final sedimentation tanks etc..

With this proposed plan, required area for CAS and MBBR are 5.5ha and 4.5ha, respectively. And the required construction costs are calculated to be 1.5 times and 1.3 times of costs when they are single story buildings, respectively. According to these estimations, we selected MBR as the most suitable process because CAS and MBBR cannot be constructed within the site even if they are built as two story buildings and they require considerably high construction cost.

Table 4.7 Evaluation of Required Area and Cost for Construction by Treatment Process

Evaluation Item \ Treatment Process		CAS	MBBR	MBR	Remarks
All Single-Story	Required area (ha)	8.4	6.9	4.0	Sourced from estimate of PPP Project Capacity of 200,000m^3/day
		Rapid filtration for BOD･SS removal not considered			
	Construction cost (Ratio to MBR)	1.0	1.0	1.0	Sourced from estimate of PPP Project: app.185 million USD.
		Rapid filtration cost excluded			
Partially Two-Story	Required area (ha)	App. 5.5	App. 4.5	Not necessary	Construction cost ratio to MBR is estimated by JST.
		Rapid filtration for BOD･SS removal not considered			
	Construction cost (Ratio to MBR)	App. 1.5	App. 1.3		
		Rapid filtration cost excluded			
Comprehensive Judge		Unsatisfied	Unsatisfied	Satisfied	

Source: JICA study team and PPP project



Source: JICA study team

Figure 4.2 WWTP Layout and Required Area by Treatment Process

3) Evaluation of O&M Features and Cost

With MBR process, operation and maintenance is easy because treated water hardly upset due to deteriorated sludge settleability, and sludge-liquid separation and sludge management is not needed.

With CAS and MBBR, it takes long time to investigate causes of deteriorated sludge settleability which usually caused by several conditions and therefore the effluent quality cannot be stable until they are solved. On the contrary, MBR can produce satisfactory water quality stably at all times by solid-liquid separation of membrane. Differential pressure of membrane checked automatically indicates proper membrane cleaning time and replacement time. Even when effluent is deteriorated due to membrane failures, stable effluent quality can be secured immediately by replacing the membrane.

Maintenance of equipment in MBR facilities is easy because the number of required equipment is less than other processes.

Electricity cost for MBR facilities is little higher than other processes because it need to operate blowers for membrane clogging prevention. However, PPP Project reported that total O&M cost of MBR was estimated as 0.16 USD/m^3, which is less than 0.18 USD/m^3 of other processes, because with MBR process final sludge disposal cost is lower due to little sludge generation and equipment repair cost is lower due to less number of equipment.

Table 4.8 O&M Features and Cost by Treatment Process (1/2)

Treatment Process / Evaluation Item	CAS	MBBR	MBR	Remarks
1. Operationability (Features of operation)				
Effluent quality upset	Caused by deteriorated sludge settleability			MBR: effluent quality is deteriorated in case of membrane failures.
	Yes	Yes	No	
Recovery time from effluent quality upset	By improving sludge settleability		By replacing membranes	
	Relatively long	Relatively long	Short	
Solid-liquid separation and return sludge management	Difficult	Difficult	Not needed	
Skill of operator	Long experience and advanced knowledge			
	Required	Required	Not needed	
Sludge generation	Much	Much	Little	MBR: App. 30% less than CAS
Comprehensive Judge	Good	Good	Excellent	
2. Maintenanceability (Features of maintenance)				
Equipment requiring maintenance	Complicated and many		Simple and few	Estimated by JST with the data of existing facilities.
	About 1,000 pieces of equipment		About 600 pieces of equipment	
Comprehensive Judge	Good	Good	Excellent	

Source: JICA study team

Table 4.8 O&M Features and Cost by Treatment Process (2/2)

3. O&M cost (In the case of capacity of 200,000m^3/day)					
Labor cost		Much	Much	Little	Necessary personnel numbers and labor cost associated therewith
Chemical cost	Coagulant	Much	Much	Little	
	Membrane cleaning	Not needed	Not needed	Required	
	Disinfection	Required	Required	Not needed	
	Total 1)	Approx. 240-250 Rp./m3 ; almost the same			
Electricity cost (kW/m3)		0.3-0.5 2)		0.6	Deep location (about 30meters) of a lift pump station increases total electricity consumption. If the lift pump station is located in shallower as normal, electricity consumption may be decreased by about 10%.
Sludge disposal cost	Generation Volume (m^3/day) 1)	Approx. 130		Approx. 100	
	Cost (USD/y)	4,745,000		3,650,000	Estimated using unit cost of 100USD/m^3
Repair cost (Mil.USD) 1)		34.6		29.7	20year Total from O&M start
Unit O&M cost (USD/m^3) 1)		0.18	0.18	0.16	20year average from O&M start
Comprehensive Judge		Good	Good	Excellent	
Total Judge		Good	Good	Excellent	Operatability, Maintenanceability, and O&M cost

Note 1) PPP Project
Note 2) Japanese cases of CAS WWTP with equal to or more capacity
Source: JICA study team

4) Evaluation of Replacement Cost

PPP Project reported that replacement cost of MBR plant (Capacity of 200,000m^3/day) during the first 20 years from O&M start is 122 Mil. USD, which is less than 125 Mil. USD for other processes.

5) Evaluation of Other Items

Municipal or industrial wastewater treatment plants with capacity of 100,000m^3/day and more and with MBR processes constructed in the world from 2007 to 2012 are listed in Table 4.9. As seen in this table, more than 10 MBR plants have been constructed in USA, Asia, and EU. As for MBR plants with capacity less than 100,000m^3/day, innumerable plants have been built in the world. MBR processes have been adopted in large scale WWTPs thanks to a price fall of membranes as a result of advance of membrane production technology and to reduction in electricity consumption with advance of energy saving techniques. It is expected that MBR will expand in large cities in South East Asia where newly construction of WWTPs are urgent need and construction sites are limited.

Furthermore, MBR that can produce reusable water without additional facilities is regarded as the suitable process because necessity of water reuse will increase due to exhausting water resources.

Table 4.9 MBR Installation Record in the World from 2007

	Country	Project Name or Region	Installation Year	Capacity (m^3/day)
1	UAE	Jumeirah Golf Estates	2010	189,000
2	USA	State of Washington	2011	170,000
3	China	Qinghe	2011	150,000
4	China	Wenyuhe	2007	135,000
5	USA	State of Nevada	2011	133,000
6	USA	State of Georgia	2011	111,000
7	China	Shiyan Shendinghe	2009	110,000
8	France	Aquaviva, Cannes	2012	106,000
9	Korea	Busan City	2012	100,000
10	China	Guangzhou	2010	100,000
11	China	Wenyuhe, Beijing	2007	100,000

Source: JICA Study Team

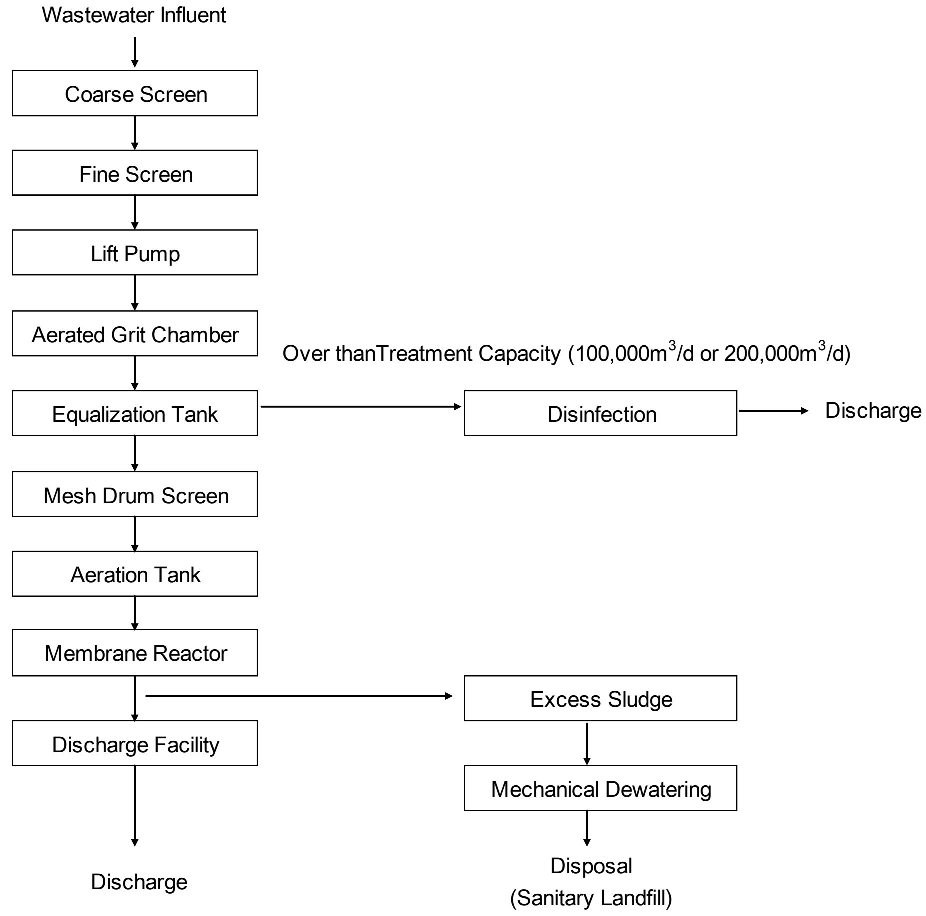
6) Selection of Treatment Process

As explained above, JST selects MBR as the most appropriate process in this study because MBR can achieve superior performance with less construction and management cost than other processes and estimates construction, replacement and O&M cost.

When it comes to bidding this Project with PPP method, it is recommendable to accept submission of construction, replacement, and O&M cost with all acceptable treatment processes not limited to MBR, compare the costs submitted in the proposals and costs estimated in this study, and then select the most appropriate proposal or process.

(2) Outline of Facilities

The treatment process flow with the adopted MBR process is shown in Figure 4.3.



Source: JICA study team

Figure 4.3 Designed Treatment Process of the WWTP

Two cases for construction of treatment facilities: Case 1: construction all facilities at once, Case 2: mechanical equipment are procured and installed into two phases as summarized in Table 4.10. For Case 2, as far as structures and buildings are concerned, the phased-construction seems to be difficult due to limited locational conditions and result in high construction cost. Therefore, both structures and buildings are assumed to be constructed to final capacity of 200,000m^3/day at once at Phase 1.

Table 4.10 Phased Construction Schedule of the WWTP by Case (Unit: m^3/day)

Case	Subject Facilities	Phase 1	Phase 2
1	Whole WWTP	200,000	-
2	Buildings / Structures	200,000	-
	Mechanical Equipment	100,000	100,000
	Electrical Equipment	200,000	-

Source: JICA study team

Primary specifications of major structures and equipment are summarized in Table 4.11.

Table 4.11 Structures and Equipment Specifications (1/2)

Facility		Specification	Unit	Qty. Phase 1	Qty. Phase 2	Qty. Total	Remarks
1. Pumping Station							
	Inlet	Inflow Pipe: 2,000mm Dia. Inflow Gate : 1.4mW x 3.1mH	lot	4	-	4	
	Coarse screen	Flat bar, Spacing 100mm 2.5mW x 4.6mH, 65 deg installation Manual raking	units	2	2	4	
	Fine screen	Single rake automatic Screen Spacing 15mm 2.5mW x 4.6mH, 70 deg installation	units	2	2	4	
	Pump	Vertical shaft Volute type mixed flow pump 650mm x 61.0m^3/min x 33.3mH Motor Output : 480kW	units	3	2	5	incl. 1 standby
2. Grit Chamber							
	Chamber	Aerated Type 1.4mW x 15.5mL x 1.4mD	chan	4	-	4	
	Grit collector	Screw type, Capacity 0.2m^3/hr 300mm Dia., 13.0mL	units	2	2	4	
	Grit lifting pump	Submersible sludge pump 80mm Dia. x 0.5m^3/min x 10mH Motor Output : 5.5kW	units	3	3	6	incl. 2 standbys
	Blower	Turbo Blower 150mm x 11m^3/min x 42kpa Motor Output : 22kW	units	2	1	3	incl. 1 standby
3. Equalization Tank							
	Tank	Retention time 4hours 19mW x26.0 mL x8.5mD	tanks	8	-	8	
	Constant rate pump	Nonclogging pump 250mm Dia. x 7.0 m^3/min x 14mH Motor Output 37kW	units	12	12	24	incl. 4 standbys
	Mixer for antisettling	Submersible propeller type Propeller dia. 500mm,Motor Output 5.5kW	units	32	32	64	
	Ultra fine screen	Motorized step screen Spacing 5mm, Motor Output 0.4kW	units	10	10	20	
4. Dicinfection							
	Method	Chlorine dicinfection with sodium hypochlorite					
	Channel	1.2mW x 80mL x 1.5mD	chan	4	-	4	
	Dosing pump	Diaphragm pump, 2.5L/min	units	3	3	6	incl. 2 standbys
	Chlorine storage tank	Fiberglass plastic construction Cylindrical tank 10m^3	units	2	2	4	
5. Aeration Tank							
	Tank	Spiral-flow type 6mW x 32mL x 5mD	tanks	20	-	20	
	Blower	Turbo Blower 350mm Dia. X 90m^3/min x 68kpa Motor Output 150kW	units	6	6	12	incl. 4 standbys

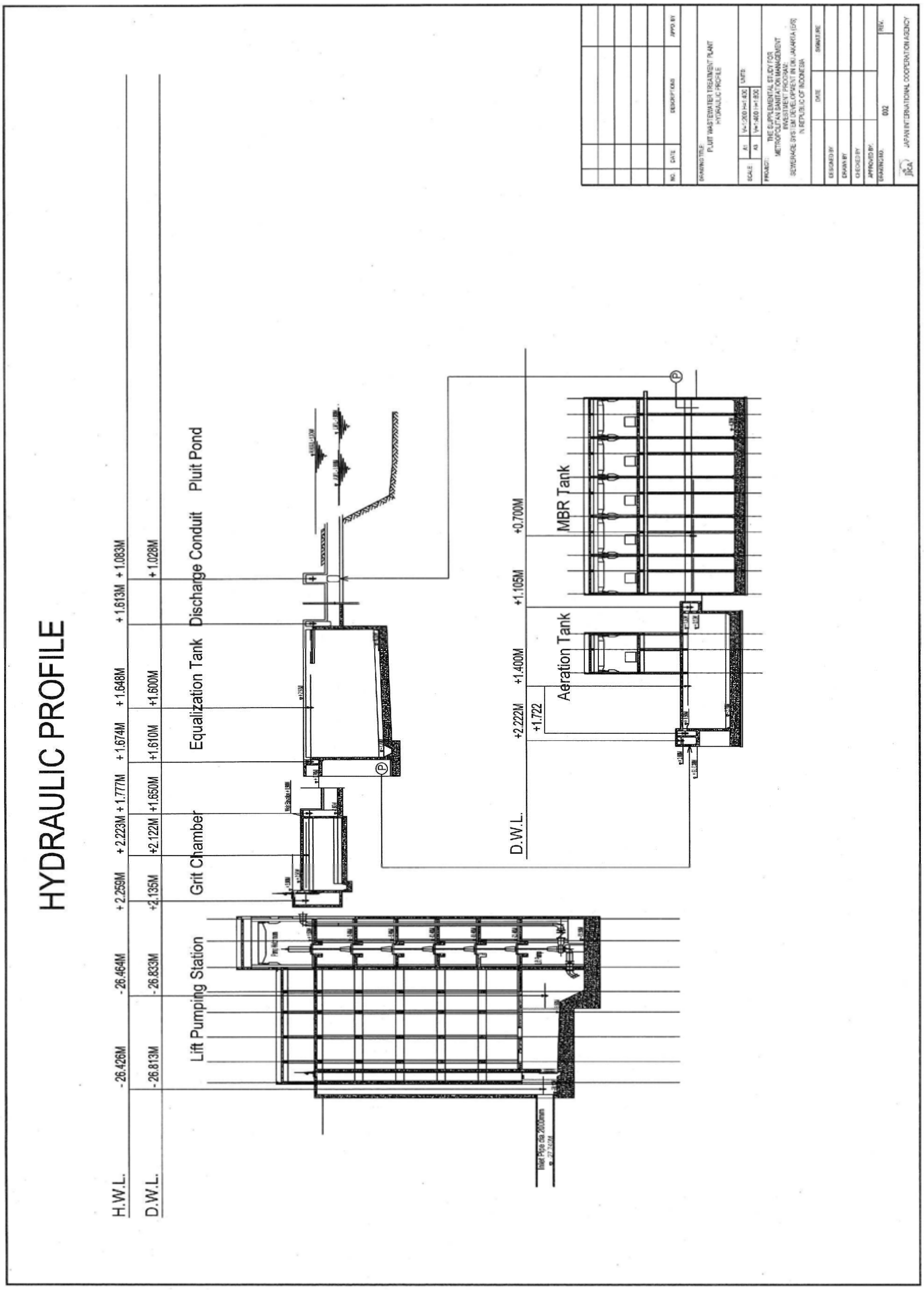
Source: JICA study team

Table 4.11 Structures and Equipment Specifications (2/2)

Facility		Specification	Unit	Qty. Phase 1	Qty. Phase 2	Qty. Total	Remarks
6.Membrane reactor							
	Membrane reactor	6.8mW x 22.2mL x 5mD	tanks	20	-	20	
	Mesh screen	Mesh Drum Screen, Spacing 1mm Capacity 2,084m^3/h or more	units	4	4	8	
	Membrane skid	Hollow fiber membrane Membrane area 1,200m^2/skid	skid	200	200	400	
	Filtration pump	Centrifugal pump, 10.6m^3/min x 10m Motor Output 22kW	units	12	12	24	incl. 2 standbys
	NaOCl pump for maintenance cleaning	Diaphragm pump, 4.2L/min Motor Output 0.2kW	units	8	8	16	incl. 4 standbys
	NaOCl pump for recovering cleaning	Diaphragm pump, 25.2L/min Motor Output 1.5kW	units	8	8	16	incl. 4 standbys
	Dilution water pump	Diaphragm pump, 1.2m^3/min Motor Output 3.7kW	units	8	8	16	incl. 4 standbys
	Blower for membrane scrubbing	Turbo type Blower, 160m^3/min x 64kpa Motor Output 188kW	units	12	12	24	incl. 4 standbys
	Circulation pump	Submergible Axial Pump, 14m^3/min Motor Output 64kW	units	14	14	28	incl. 8 standbys
	Excess sludge pump	Non-clog type Sludge Pump, 1.4m^3/min Discharge pressure 14m, Motor Output1.6kW	units	4	4	8	incl. 4 standbys
7.Dewatering facility							
	Dehydrator	Pressing Rotary Outer Cylinder-type Screw Press Capacity 320kg/h/unit	units	3	2	5	incl. 1 standby
	Excess sludge feed pump	Progressive cavity pump 125mm x 4.3 - 35m^3/h 30mH, Motor Output 11kW	units	3	2	5	incl. 1 standby
	Chemical dosage pump	Progressive cavity pump 65mm x 40-100L/min 30mH, Motor Output 2.2kW	units	3	2	5	incl. 1 standby
8. Deordorization Facility							
	Doeodorization Equipment	Biological deodorization with AC 20 m^3/min, 30m^3/min, 50m^3/min	units	3	-	3	
9. Electric facility							
	Transformer	20kV/380V 50Hz 3,000kVA	lot	1	-	1	
	Generator	Diesel generation 380V 50Hz, 3,300kVA	lot	1	-	1	

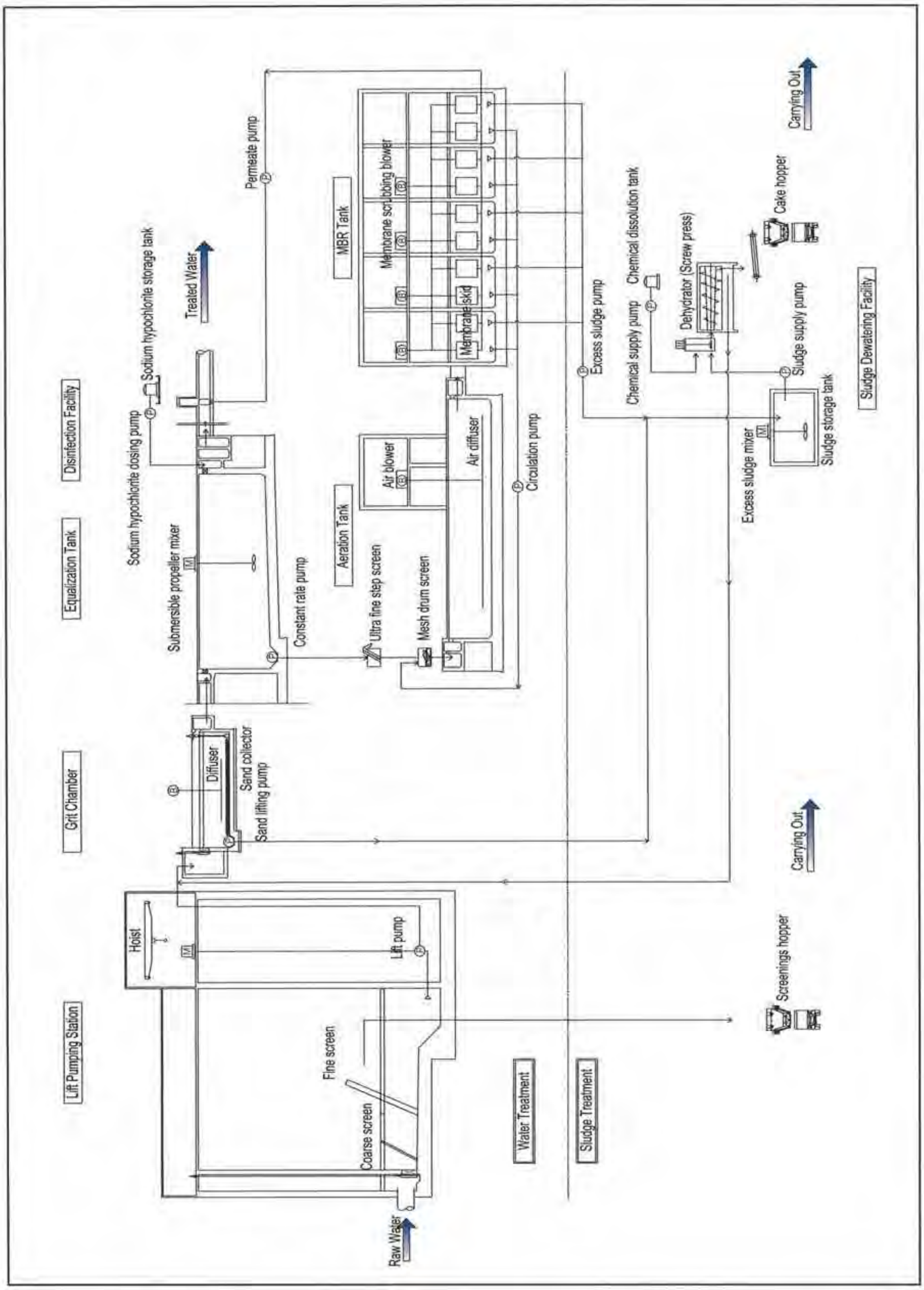
Source: JICA study team

Hydraulic profile and process flow of the WWTP is shown in Figure4.4 and Figure 4.5.



Source: JICA study team

Figure 4.4 Hydraulic Profile



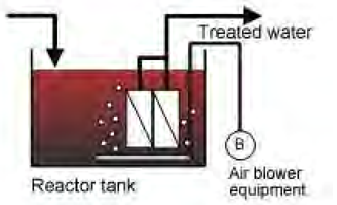
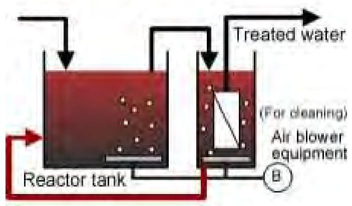
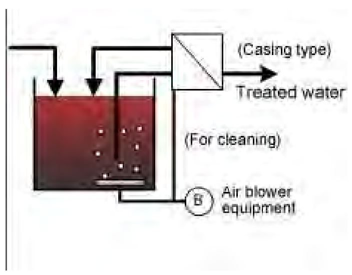
Source: JICA study team

Figure 4.5 Treatment Process Diagram

4.1.3 Preliminary Design of Treatment Facilities

This section outlines preliminary designs of major facilities in the WWTP. Details of the facility design are attached in Appendix 4.1 - 4.5. Characteristics of types of installing membrane modules of MBR process are summarized in Table 4.12. In this design, an immersed type (separate tank type) MBR process is adopted considering its various advantages described in the table.

Table 4.12 Types of Installations of Membrane Modules in MBR Process

Immersed type (Integrated Type)		-Most commonly adopted -Process configuration is simple -Aeration equipment in the reactor tank can also be used for cleaning of the membrane module. -By linking with other systems, or by installing multiple membrane units, this approach eliminates the need to stop the reactor tank during inspection, repair and replacement of membrane module.
Immersed type (Separate Tank Type)		-It is possible to select the aeration equipment necessary for biotreatment and backwashing depending on the specifications (fine bubbles or coarse bubbles). - It can operate with an MLSS for the reactor that is higher than that for the membrane separating tank. -By linking with other systems, or by installing multiple membrane units, this approach eliminates the need to stop the reactor tank during inspection, repair and replacement of membrane module. -It consumes a large amount of energy because it requires a pump for sludge circulation. -It requires high construction costs compared with the integrated type. -It enables easy immersion cleaning (the membrane separating tank can be used as the chemical solution cleaning tank).
External Type		-It can maximize the permeation flux, which leads to a decrease in the number of membrane modules. -It can handle the time fluctuation most flexibly. -It achieves easy control of sludge circulation, etc. -By linking with other systems, or by installing multiple membrane units, this approach eliminates the need to stop the reactor tank during inspection, repair and replacement of membrane module. -It consumes a large amount of energy because it requires a pump for sludge circulation. -It enables easy chemical solution cleaning.

Note: The characteristics (advantages and disadvantages) stated in the above table may change, depending on the improvement or development of membrane module or the introduction of novel techniques for operation management.
Source: Guidelines for Introducing Membrane Technology in Sewage Works: The 2nd Edition, Sewage

Technical Meeting on Membrane Technology, March of 2011

The WWTP is designed to consist of 4 trains; only the grit chamber facility consists of 1 train. Equalization tank facility consists of 2 tanks/train and 4 channels/tank. Aeration tank facility and MBR tank facility consist of 1 tank / train and 5 channels / tank. (Refer to Table 4.13)

Table 4.13 Configuration of the Facilities

Facility	Train	Tank	Channel	Remarks
Grit Chamber	1	1	4	
Equalization Tank	4	8	32	2 tanks / train, 4 channels / tank
Aeration Tank		4	20	1 tank / train, 5 channels / tank
MBR		4	20	1 tank / train, 5 channels / tank

Source: JICA Study Team

(1) Lift Pumping Station

Lift pumping facility in the WWTP mainly consists of inlet chamber, coarse and fine screens, and lift pumps. Because the inlet pipe is designed to be buried in the ground of about 28m depth, the construction of the lift pumping facility inevitably costs considerably high. Also, difficulties in the stage of O&M are anticipated in such deep places. Therefore, a grit chamber facility is designed following the lift pumping facility, instead of prior to the facility as usual, to reduce area of underground construction, to reduce the construction cost, and to improve the easiness of operation and maintenance.

In constructing the WWTP, a phased-construction of buildings and structures are judged to be difficult and cost highly due to the following reasons:

- Area of the construction site is small
- Structure is to be constructed in deep position

Therefore, both buildings and structures are assumed to be constructed to final capacity of 200,000m^3/day at once at first. On the other hand, the phased-construction will be applied to mechanical equipment.

1) Inlet Chamber

Because sites for constructing relay pumping stations in the middle of sewer mains cannot be prepared due to densely populated intercepting area locating in the center of the city, the invert of the inlet pipe (Diameter 2,000mm) reaches to considerably deep level of pp-27.4m. In this preliminary design, the invert of inlet chamber is set at pp- 28.1m with influent gates (1.4mW×3.1mH×4sets).

2) Screens

In order to remove large materials or debris contained in influent, coarse screens and fine screens are designed to be installed. Coarse screens are designed to have openings of 100mm wide (cf. Design Standard of WWTP in Japan: 50-150mm) and be installed with angle of 65°. Fine screens are designed to have openings of 15mm (cf. Design Standard of WWTP in Japan: 15-25mm) and be installed with angle of 75°.

As for rakes of screenings, coarse screens are designed with manual operation because frequency of raking is predicted low. On the contrary, fine screens are designed with continuous mechanical raking because much screenings is predicted.

3) Lift Pumps

Vertical shaft volute type mixed flow pump is selected from viewpoints that it hardly generates clogging, is resistant to corrosion, and is easy maintenance. The number of pumps is designed to be 6 units (including 2 standbys) because small influent fluctuation owing to the large capacity of the plant does not require frequent operation change.

Design specifications of the lift pumping facility are shown in Table 4.14. Considering that this Project is PPP contracted project, the influent volume will become the important factor for adjusting O&M cost. Therefore, flow meters are designed to be installed in sections of straight pipes between the lift pumping facility and the grit chamber facility.

Table 4.14 Design Specification of Lift Pumping Station

Facility	Design Specification		
Lift Pump	Type	Vertical shaft volute type mixed flow pump	
	Diameter and flow rate	650mm, 61m^3/min	
	Pumping head	Actual	31.3m
		Total	33.3m
	Number of units	5 units（Including 1 standbys）	
Flow Meter	Type	Ultrasonic flowmeter	
	Installed point	In sections of straight pipes between the lift pumping station and the grit chamber	

Source: JICA Study Team

(2) Grit Chamber

Grit chambers are installed to remove inorganic materials or large floating materials. Anticipating that influent into this WWTP will contain much inorganic materials and floating materials due to the interceptor sewer system while membrane separation bioreactors are applied, aerated grit chambers are adopted appreciating its high removal efficiency in order to protect membranes in the MBR tanks. Grit settled in the chambers is collected by screw conveyors and removed by sand pumps. Maximum amount of sands and gravels is set as 0.5m^3 per 1,000m^3 of influent for designing the grit collectors' specification.

Table 4.15 Design Specification of Grit Chamber

Facility	Design Specification		
Grit Chamber (Aeration Type)	Size	4mW×15.5m L×3mD	
	Configuration	1Tank, 4channels	
	Required air flow	18.8m^3/min	
	Blower	Type	Turbo type blower
		Number of units	3units (Including 1 standby)
		Air flow rate	11m^3/min/unit
	Grit collector	Type	Screw conveyor
		Number of units	4units (1unit/tank)
		Capacity	0.2m^3/hr/unit
	Grit lifting pump	Submersible sand pump	

Source: JICA Study Team

(3) Equalization Tanks

Equalization tanks are constructed to suppress fluctuation of quality and quantity of influent in order to secure stable treatment in the following aeration tanks and MBR tanks. Equalization tanks enable to transfer wastewater to aeration tanks and MBR tanks at even flow rate. By eliminating excess inflow into MBR tanks over than the membrane flux, back flow from the MBR tanks to the aeration tanks or overflow in the MBR tanks can be prevented, and smooth O&M and stable treated water quality can be materialized.

In this design, constant rate pumps are designed to transfer wastewater from equalization tanks to aeration tanks. Using pumps increases O&M cost but realize stable wastewater supply and stable treatment performance in the following processes. Effluent from the equalization tanks exceeding the capacity of aeration tanks and MBR tanks is to be disinfected by hypo chlorine and discharged. Anti-settling mixers to prevent accumulation of substances are designed in the bottom of equalization tanks. Table 4.16 shows design specification of the equalization tank facility.

Table 4.16 Design Specification of Equalization Tank

Facility	Design Specification		
Equalization Tank	Size	19mW×26m L×8.5mD	
	Configuration	4trains,8tanks(2tanks/train),32channels(4channels/tank)	
	Constant rate pump	Type	Non-clog type pump
		Specification	Dia.250mm, Flow rate7.0m^3/min, Pump head14m
		Number of units	24units (Including 4 standbys)
	Anti-settling mixer	Type	Submergible propeller type
		Specification	Propeller Diameter 500mm
		Number of units	64 units (2units/channel)

Source: JICA Study Team

(4) Aeration / MBR Tanks

Separate tank type is selected appreciating its advantage in O&M convenience and that it can eliminate the need to stop the reactor tank during repair and replacement.

Aeration tanks are designed with spiral flow type and to promote nitrification so that ammonia nitrogen in effluent meet the Indonesian effluent standard of <10mg/L.

Hollow fiber membranes are adopted for the MBR tanks because they have high flux and therefore installation area can be saved.

Design specifications of the aeration tanks and MBR tanks are shown in Table 4.17. Excess sludge generation rate is 2,000m^3/day with solids concentration of 0.9%, or the solids generation rate is 18.04t/day.

Table 4.17 Design Specification of Aeration Tank and MBR Tank

Item \ Facility	Aeration tank	MBR tank
Size	6mW×32m L×5mD	6.8mW×22.2m L×5mD
Configuration	4trains,4tanks(1tanks/train),20channels(5channels/tank)	
Volume	19,200m^3	15,100m^3
HRT	1.8hr	2.3hr
	4.1hr	
MLSS	9,000mg/L	12,000mg/L
Circulation sludge rate	300%	
Excess sludge		Solids: 18.04 ton/day Sludge: 2,000m^3/day
Required Oxygen	633N/m^3/min	2,880N/m^3/min
Blower	Turbo blower 90Nm^3/min,12units (Inc.4standbys)	Turbo blower 160Nm^3/min,20units(Inc.4standbys)

Source: JICA Study Team

(5) Dewatering Facility

Because of limited area in this construction site, sludge thickeners are avoided and excess sludge from the MBR tanks are designed to be dewatered directly by dehydrators. Considering this matter, screw type dehydrators are selected from viewpoints of high dewatering efficiency, easy maintenance, and low O&M cost such as electricity. Dewatered sludge generation rate is 100m^3/day with water content of 83%, or the solids generation rate is 17.13t/day. All of the generated sludge is designed to be carried out to final landfill.

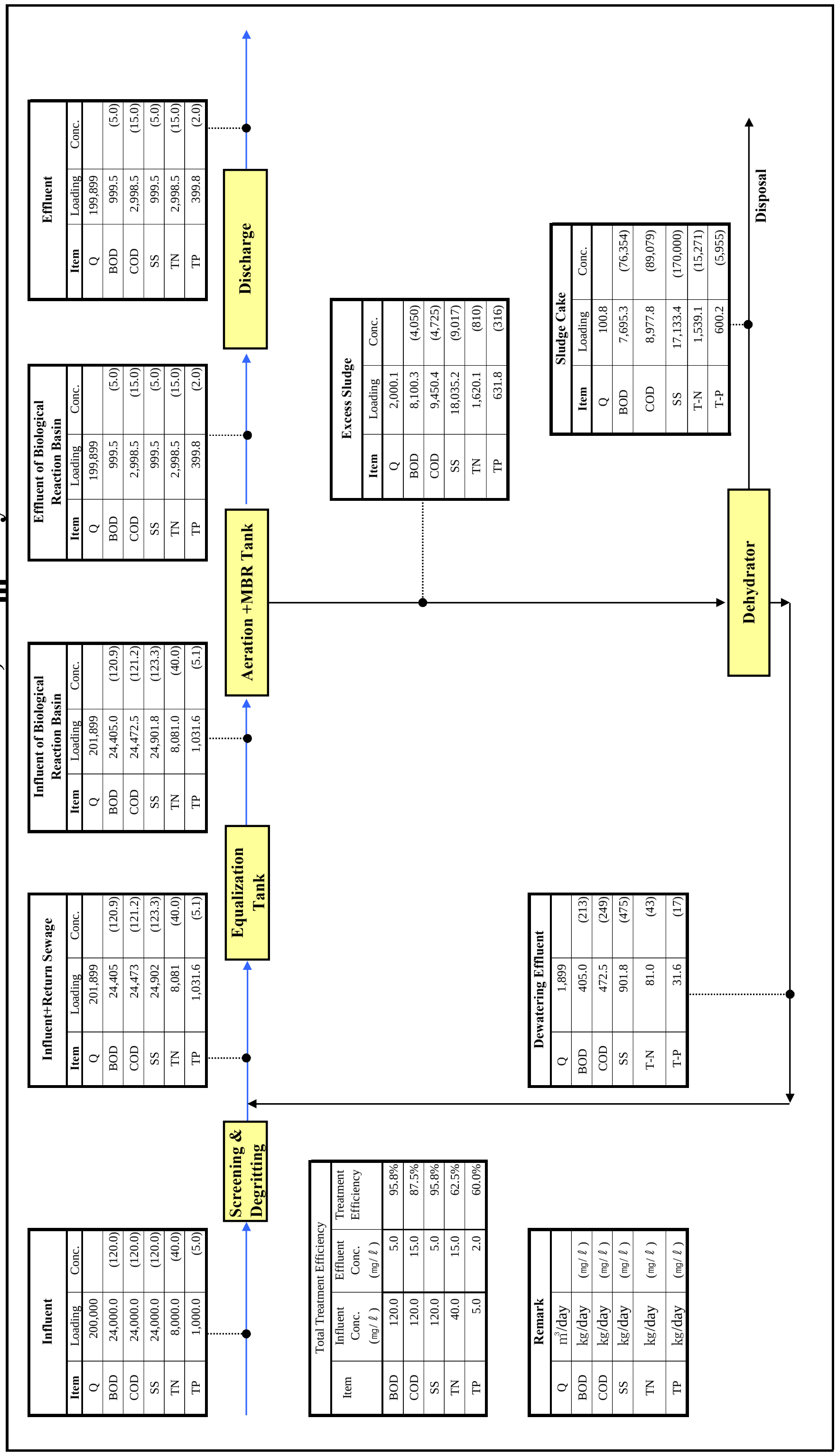


Figure 4.6 Mass Balance (Capacity 200,000 m^3/day)

Source: JICA Study Team

4.2 Preliminary Cost Estimation

Preliminary cost is prepared by reviewing initial construction cost, replacement cost, and O&M

cost separately. Replacement cost and O&M cost are estimated on the assumption that this Project is implemented by PPP contract of 20 years after construction of the WWTP.

The project cost estimated in this study is based on values of 2014 and the following expenses are excluded:

- Interest on private fund to be invested
- Various expenses related to SPC (Taxes such as fixed asset tax, other expenses, divided to stockholder, insurances, etc.)
- Cost increase of additional installation in Phase 2 on Case 2 due to unit price escalation
- Cost increase in replacement and O&M due to price escalation
- VAT etc.

To coordinate with the Pilot Project estimation of inlet sewer to the WWTP with pipe jacking method, the same exchange rates as shown below are used for this estimation.

- 1 USD=11,500 Rp.
- 1 USD=102 JP¥
- 1 JP¥=112.75 Rp.

4.2.1 Construction Cost

(1) Estimation Conditions for Construction Cost

1) Materials for civil and architect works, construction machine and labor are able to be procured in Indonesia. Therefore, local procurement is principally applied.
2) Because not so many mechanical and electrical facilities are able to be procured in Indonesia, they are principally procured in international market. Some equipment procurable in Indonesia is locally procured.
3) It is understood Indonesian contractors have sufficient experience and capacity for general civil and architectural works, implementation organization system include application of local contractors.
4) Disposal cost of industrial waste buried in the WWTP construction site is separately estimated and is not included in the construction cost.
5) Engineering cost is set as 3% of the construction cost considering that the construction is implemented by PPP.

(2) Estimation Methods for Construction Cost

Because this Project will be implemented by PPP method, accurate and appropriate estimation of construction cost is important factor to decide success or failure of this Project. However, there is neither standard for cost estimation for construction of wastewater treatment plant nor construction experience of large-scale WWTP in Indonesia. Therefore, unit prices for appropriate estimate of this study are set based on standard unit price for public works in Indonesia referring to local unit rate collected by hearing from local construction companies. Unit rate estimation method and Approximate estimation method are applied as seen in Table 4.18.

Table 4.18 Estimation Methods for Construction Cost

Construction	Estimation Method	Remarks
Civil Works	Unit rate estimation	For construction of structures, approximate estimation considering local performance records
Architecture Works	Approximate estimation	Estimate referring to local performance record
Auxiliary Works	Approximate estimation (10 % of cost of civil and architecture works)	Internal road, landscaping and drainage channels, etc.
Mechanical and Electrical Facility Works	Combined unit rate estimation Assess based on quotations on mechanical and electrical facilities	Based on quotations from local suppliers as well as Japan

Source: JICA Study Team

(3) Preliminary Estimation of Construction Cost

As shown in Table 4.19, preliminary estimate of construction cost on the conditions above is calculated at 2,593,960 Mil. Rp. (225,561,759 USD excluding VAT). The breakdown of the cost is attached in Appendix 4.7.

Timings of construction for mechanical and electrical facilities of capacity of 100,000m^3/day is different between Case 1 and Case 2, but price escalation in not applied to the estimate of the construction cost, total construction cost of Case 1 and Case 2 becomes equal.

Table 4.19 Preliminary Estimate of Construction Cost (Excluding VAT)

Item	F/C	L/C	Total (FC+LC)	
	(Mil.Rp.)	(Mil.Rp.)	(Mil.Rp.)	Equiv. to USD
I. Construction Cost				
A. Civil/Building works				
a. Soil Work	0	14,357	14,357	1,248,418
b. Foundation works	0	184,283	184,283	16,024,601
c. Concrete Work	0	314,147	314,147	27,317,130
d. Temporary Work	0	386,033	386,033	33,568,106
e. Building work	0	78,796	78,796	6,851,850
f. Others works(Miscellaneous works)	0	39,294	39,294	3,416,898
Sub Total (a+b+c+d+e+f)	0	1,016,911	1,016,911	88,427,003
B. Mechanical/Electrical works				
g. Mechanical works	949,644	44,311	993,955	86,430,859
h. Electrical works	130,244	39,330	169,574	14,745,600
Sub Total (g+h)	1,079,888	83,641	1,163,529	101,176,459
Total (A+B)	1,079,888	1,100,552	2,180,440	189,603,462
C. Site Overhead				
5% of Total(A+B)	53,994	55,028	109,022	9,480,173
Total (A+B+C)	1,133,882	1,155,579	2,289,462	199,083,635
D. General Overhead				
10% of Total(A+B+C)	113,388	115,558	228,946	19,908,363
E. Total Construction cost				
(A+B+C+D)	**1,247,271**	**1,271,137**	**2,518,408**	**218,991,999**
Ⅱ. Engineering Cost				
3% of Construction Cost	37,418	38,134	75,552	6,569,760
Grand Total (Ⅰ + Ⅱ)	**1,284,689**	**1,309,271**	**2,593,960**	**225,561,759**

Source: JICA Study Team

(4) Disposal Cost of Industrial Waste Buried in the WWTP Construction Site

Industrial waste such as construction waste buried in the construction site is seen as shown in Figure 4.7. Because little information on volume and characteristics of the buried waste is available, disposal cost is separately estimated and excluded from the estimate of the construction cost.

The disposal cost is estimated for three cases by differing coverage ratio of the waste over the site area; 50%, 75% and 100%, and calculated at from 53,027 to 106,053 Mil.Rp..

Source: JICA Study Team

Figure 4.7 Industrial Waste Buried in the WWTP Construction Site

Table 4.20 Disposal Cost of Buried Industrial Waste by Case

Item		Unit	Case 1	Case 2	Case 3	Remarks
Total Area of Candidate Site		m^2	39,637			
Area with Industerial waste (of total area)		%	**50**	**75**	**100**	
		m^2	19,820	29,730	39,640	
Depth of Industerial Waste layer		m	1.0			
Unit Weight of Industerial Waste		ton/m^3	2.0			Reinforced Concrete:2.4
Total Volume of Waste		m^3	19,820	29,730	39,640	
Total Weight of Waste		ton	39,640	59,460	79,280	
Disposal Unit Cost	Excavation	$Rp./m^3$	10,162			
	Loading	Rp./m3	6,216			
	Disposal	Rp./ton	1,150,000			Including transportation
Disposal Cost	1. Direct Cost					
	Excavation	Mil.Rp.	201	302	403	
	Loading	Mil.Rp.	123	185	246	
	Disposal	Mil.Rp.	45,586	68,379	91,172	
	Sub Total	Mil.Rp.	45,911	68,866	91,821	
	2. Site Overhead	Mil.Rp.	2,296	3,443	4,591	5% of Direct Cost
	3. General Overhead	Mil.Rp.	4,821	7,231	9,641	10% of (1+2)
	Total	Mil.Rp.	**53,027**	**79,540**	**106,053**	
		Equiv. to USD	**4,611,022**	**6,916,533**	**9,222,043**	Excluding VAT

Source: JICA Study Team

4.2.2 Replacement Cost

The WWTP is managed by PPP contract including O&M works (Assumed 20 years). Appropriate repair and replacement of facilities are inevitable to bring out their functions at full during the contract period. In Japan, standard depreciation periods of equipment are stipulated as shown in Table 4.21.

Replacement timings for the equipment in this Project are decided as shown in Table 4.21 to calculate the replacement cost by referring to the standard and considering the following points:
- Provide adequate facility maintenance during the PPP contract period to secure stable operation by DKI Jakarta at least one year after being transferred.
- Apply adequate replacement timing considering repair cost from the LCC points of view.
- Implement well-planned replacement to realize stable operation of facilities by preventing plant suspension due to unpredicted breakdowns of equipment.

Estimate of the replacement cost based on replacement timings decided from viewpoints of above is summarized in Table 4.22 and Table 4.23. Total replacement costs in Case 1 and Case 2 are 1,781,845 Mil.Rp. (Equivalent to 154.9 Mil.USD) and 1,246,351 Mil.Rp. (Equivalent to 108.4 Mil.USD). The breakdown of the estimate is attached in Appendix 4.8.

Table 4.21 Standard Depreciation Period in Japan and Replacement Timing Applied

Item		Standard*	Applied	Item		Standard*	Applied
1. Lift Pumping Facility				5. Aeration Tank & Membrane Bioreactor Facility			
	Inflow gate	25	25		Mesh screen	15	18
	Coarse screen	15	18		Air diffuser for aeration tank	10	10
	Fine screen	15	18		Blower for aeration tank	20	20
	Lift pump	15	20		Membrane unit	15	25
	Flow meter	10	12		Membrane Module	—	7
	Hoist	20	25		Membrane filtration pump	15	15
	Pump up well connection gate	25	25		NaOCl pump for maintenance cleaning	20	20
2. Grit Chamber Facility					NaOCl pump for recovering cleaning	15	15
	Grit collector	15	18		Dilution water pump	15	18
	Grit lifting pump	15	18		Blower for membrane scrubbing	20	20
	Air blower	20	20		Circulation pump	15	18
	Outflow gate	25	25		Excess sludge pump	15	15
3. Equalization Tank Facility				6. Dewatering & Deodorization Facility			
	Inflow weir gate	25	25		Excess sludge mixer	10	15
	Constant rate pump	15	20		Excess sludge feed pump	15	15
	Mixer for antisettling	10	15		Dehydrator	15	17
	Ultra fine screen	15	18		Deodorization equipment	10	12
4. Disinfection Facility				7. Electrical Facility & Control System			
	Sodium hypochlorite storage tank	10	10		GIS, Transformer	20	25
	Sodium hypochlorite dosing pump	10	10		Generator	15	25
					Monitoring and control system	7-15	7-15

∗Standard was estimated from the notice No.77 of Ministry of Land, Infrastructure and Tourism of Japan（2003.6.19.）

Table 4.22 Replacement Cost in Case 1 (20 years after operation commencement)

Facility \ Year / Cost	1		2		3		4		5	
	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)
1. Lift Pumping Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Grit Chamber Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. Equalization Tank Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Disinfection Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	968.8	169.7
5. Aeration Tank & Membrane Bioreactor Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6. Dewatering & Deodorization Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7. Electrical Facility & Control System	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8. Site Overhead(5% of sum of 1 to 7)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.4	8.5
9. General Overhead(10% of sum of 1 to 8)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	101.7	17.8
Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,118.9	196.0

Facility \ Year / Cost	6		7		8		9		10	
	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)
1. Lift Pumping Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	552.0	138.0
2. Grit Chamber Facility	0.0	0.0	0.0	0.0	0.0	0.0	132.5	19.3	0.0	0.0
3. Equalization Tank Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Disinfection Facility	16.6	4.1	0.0	0.0	0.0	0.0	0.0	0.0	1,035.0	178.0
5. Aeration Tank & Membrane Bioreactor Facility	2,591.6	353.3	0.0	0.0	248,400.0	2,760.0	248,400.0	2,760.0	8,171.4	5,548.5
6. Dewatering & Deodorization Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	138.0	27.6
7. Electrical Facility & Control System	0.0	0.0	0.0	0.0	6,900.0	2,760.0	0.0	0.0	0.0	0.0
8. Site Overhead(5% of sum of 1 to 7)	130.4	17.9	0.0	0.0	12,765.0	276.0	12,426.6	139.0	494.8	294.6
9. General Overhead(10% of sum of 1 to 8)	273.9	37.5	0.0	0.0	26,806.5	579.6	26,095.9	291.8	1,039.1	618.7
Total	3,012.5	412.8	0.0	0.0	294,871.5	6,375.6	287,055.0	3,210.1	11,430.4	6,805.4

Facility \ Year / Cost	11		12		13		14		15	
	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)
1. Lift Pumping Facility	0.0	0.0	0.0	0.0	690.0	276.0	0.0	0.0	0.0	0.0
2. Grit Chamber Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. Equalization Tank Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	559.6	11.0
4. Disinfection Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	968.8	169.7
5. Aeration Tank & Membrane Bioreactor Facility	2,591.6	353.3	0.0	0.0	0.0	0.0	604.4	143.5	26,496.0	143.5
6. Dewatering & Deodorization Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21,693.6	5,542.1
7. Electrical Facility & Control System	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13,800.0	5,520.0
8. Site Overhead(5% of sum of 1 to 7)	129.6	17.7	0.0	0.0	34.5	13.8	30.2	7.2	3,175.9	569.3
9. General Overhead(10% of sum of 1 to 8)	272.1	37.1	0.0	0.0	72.5	29.0	63.5	15.1	6,669.4	1,195.6
Total	2,993.3	408.0	0.0	0.0	797.0	318.8	698.1	165.8	73,363.2	13,151.3

Facility \ Year / Cost	16		17		18		19		20	
	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)
1. Lift Pumping Facility	0.0	0.0	0.0	0.0	0.0	0.0	4,324.0	667.0	40,480.0	1,886.0
2. Grit Chamber Facility	0.0	0.0	0.0	0.0	0.0	0.0	3,568.7	168.4	4,926.6	209.1
3. Equalization Tank Facility	7,948.8	883.2	7,948.8	883.2	7,355.4	138.0	14,945.4	669.3	7,590.0	531.3
4. Disinfection Facility	16.6	2.1	0.0	0.0	0.0	0.0	0.0	0.0	1,035.0	178.0
5. Aeration Tank & Membrane Bioreactor Facility	250,387.2	2,969.8	249,004.4	2,903.5	34,776.0	463.7	129,352.0	1,154.6	43,904.2	6,228.4
6. Dewatering & Deodorization Facility	1,283.4	89.7	0.0	0.0	0.0	0.0	42,053.3	127.7	42,156.8	155.3
7. Electrical Facility & Control System	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17,084.4	690.0
8. Site Overhead(5% of sum of 1 to 7)	12,981.8	197.2	12,847.7	189.3	2,106.6	30.1	9,712.2	139.3	7,858.8	493.9
9. General Overhead(10% of sum of 1 to 8)	27,261.8	414.2	26,980.1	397.6	4,423.8	63.2	20,395.5	292.6	16,503.6	1,037.2
Total	299,879.5	4,556.2	296,781.0	4,373.7	48,661.8	694.9	224,351.0	3,218.9	181,539.4	11,409.1

Facility \ Year / Cost	1-20			
	FC(Mil.Rp.)	LC(Mil.Rp.)	Total(FC+LC)	
			Mil. Rp.	USD
1. Lift Pumping Facility	46,046.0	2,967.0	49,013.0	4,262,000
2. Grit Chamber Facility	8,627.8	396.8	9,024.5	784,740
3. Equalization Tank Facility	46,348.0	3,116.0	49,464.0	4,301,220
4. Disinfection Facility	4,040.6	701.7	4,742.4	412,380
5. Aeration Tank & Membrane Bioreactor Facility	1,244,679.0	25,782.1	1,270,461.1	110,474,880
6. Dewatering & Deodorization Facility	107,325.0	5,942.3	113,267.3	9,849,329
7. Electrical Facility & Control System	37,784.4	8,970.0	46,754.4	4,065,600
8. Site Overhead(5% of sum of 1 to 7)	74,742.5	2,393.8	77,136.3	6,707,507
9. General Overhead(10% of sum of 1 to 8)	156,959.3	5,027.0	161,986.3	14,085,766
Total	1,726,552.7	55,296.6	1,781,849.4	154,943,422

Source: JICA Study Team

Table 4.23 Replacement Cost in Case 2 (20 years after operation commencement)

Year / Cost / Facility	1		2		3		4		5	
	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)
1. Lift Pumping Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Grit Chamber Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. Equalization Tank Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Disinfection Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	484.4	84.9
5. Aeration Tank & Membrane Bioreactor Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6. Dewatering & Deodorization Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7. Electrical Facility & Control System	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8. Site Overhead(5% of sum of 1 to 7)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.2	4.2
9. General Overhead(10% of sum of 1 to 8)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.9	8.9
Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	559.5	98.0

Year / Cost / Facility	6		7		8		9		10	
	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)
1. Lift Pumping Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	331.2	82.8
2. Grit Chamber Facility	0.0	0.0	0.0	0.0	0.0	0.0	79.5	11.6	0.0	0.0
3. Equalization Tank Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Disinfection Facility	16.6	2.1	0.0	0.0	0.0	0.0	0.0	0.0	500.9	86.9
5. Aeration Tank & Membrane Bioreactor Facility	201.5	71.8	0.0	0.0	248,841.6	2,809.7	0.0	0.0	3,985.0	2,774.3
6. Dewatering & Deodorization Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	138.0	27.6
7. Electrical Facility & Control System	0.0	0.0	0.0	0.0	6,900.0	2,760.0	0.0	0.0	0.0	0.0
8. Site Overhead(5% of sum of 1 to 7)	10.9	3.7	0.0	0.0	12,787.1	278.5	4.0	0.6	247.8	148.6
9. General Overhead(10% of sum of 1 to 8)	22.9	7.8	0.0	0.0	26,852.9	584.8	8.3	1.2	520.3	312.0
Total	251.8	85.3	0.0	0.0	295,381.5	6,433.0	91.8	13.4	5,723.2	3,432.2

Year / Cost / Facility	11		12		13		14		15	
	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)
1. Lift Pumping Facility	0.0	0.0	0.0	0.0	414.0	165.6	0.0	0.0	0.0	0.0
2. Grit Chamber Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. Equalization Tank Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	447.7	8.8
4. Disinfection Facility	0.0	0.0	484.4	84.9	0.0	0.0	0.0	0.0	484.4	84.9
5. Aeration Tank & Membrane Bioreactor Facility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	261,648.0	2,831.8
6. Dewatering & Deodorization Facility	0.0	0.0	0.0	0.0	21,196.8	5,531.0	0.0	0.0	0.0	0.0
7. Electrical Facility & Control System	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13,800.0	5,520.0
8. Site Overhead(5% of sum of 1 to 7)	0.0	0.0	24.2	4.2	1,080.5	284.8	0.0	0.0	13,819.0	422.3
9. General Overhead(10% of sum of 1 to 8)	0.0	0.0	50.9	8.9	2,269.1	598.1	0.0	0.0	29,019.9	886.8
Total	0.0	0.0	559.5	98.0	24,960.5	6,579.6	0.0	0.0	319,219.0	9,754.5

Year / Cost / Facility	16		17		18		19		20	
	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)	FC(Mil.Rp.)	LC(Mil.Rp.)
1. Lift Pumping Facility	0.0	0.0	0.0	0.0	0.0	0.0	3,427.0	414.0	23,184.0	1,200.6
2. Grit Chamber Facility	0.0	0.0	0.0	0.0	0.0	0.0	3,542.2	164.5	993.6	60.0
3. Equalization Tank Facility	7,948.8	883.2	0.0	0.0	0.0	0.0	7,355.4	138.0	15,538.8	1,414.5
4. Disinfection Facility	16.6	2.1	484.4	84.9	0.0	0.0	0.0	0.0	550.6	93.2
5. Aeration Tank & Membrane Bioreactor Facility	250,439.6	3,058.1	0.0	0.0	21,171.5	2,934.3	48,576.0	358.8	37,655.1	3,229.2
6. Dewatering & Deodorization Facility	641.7	44.9	0.0	0.0	0.0	0.0	0.0	0.0	42,653.6	166.3
7. Electrical Facility & Control System	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17,084.4	690.0	30,884.4
8. Site Overhead(5% of sum of 1 to 7)	12,952.3	199.4	24.2	4.2	1,058.6	146.7	3,145.0	53.8	6,883.0	342.7
9. General Overhead(10% of sum of 1 to 8)	27,199.9	418.8	50.9	8.9	2,223.0	308.1	6,604.6	112.9	14,454.3	719.6
Total	299,198.9	4,606.4	559.5	98.0	24,453.1	3,389.2	72,650.2	1,242.0	158,997.4	7,916.1

Year / Cost / Facility	1-20			
	FC(Mil.Rp.)	LC(Mil.Rp.)	Total(FC+LC)	
			Mil. Rp.	USD
1. Lift Pumping Facility	27,356.2	1,863.0	29,219.2	2,540,800
2. Grit Chamber Facility	4,615.3	236.1	4,851.4	421,860
3. Equalization Tank Facility	31,290.7	2,444.5	33,735.2	2,933,496
4. Disinfection Facility	3,022.2	523.7	3,545.9	308,340
5. Aeration Tank & Membrane Bioreactor Facility	872,518.3	18,067.9	890,586.2	77,442,280
6. Dewatering & Deodorization Facility	64,630.1	5,769.8	70,399.8	6,121,725
7. Electrical Facility & Control System	37,784.4	8,970.0	46,754.4	4,065,600
8. Site Overhead(5% of sum of 1 to 7)	52,060.9	1,893.8	53,954.6	4,691,705
9. General Overhead(10% of sum of 1 to 8)	109,327.8	3,976.9	113,304.7	9,852,581
Total	1,202,605.8	43,745.6	1,246,351.4	108,378,386

Source: JICA Study Team

4.2.3 O&M Cost

O&M cost for the WWTP is estimated on the assumption that the WWTP will be operated and maintained for 20 years under the contract of PPP. Two cases are set with conditions as below, and costs for each Case are estimated separately.

1) Case1 : At first, construct WWTP of 200,000m^3/day at once and start its operation and maintenance.
2) Case2 : At the first phase, construct WWTP of 100,000m^3/day (200,000m^3/day for civil construction) and start its operation and maintenance.
   From 8th year: Expand the WWTP capacity to 200,000m^3/day in coordination with sewer development and serve O&M services.

Estimate conditions of O&M including unit prices are shown in Table 4.24.
Considering labor cost hike with economic growth in Indonesia, JST assumes disposal work of dewatered sludge and environmental maintenance work of the Plant to be outsourced aiming to reduce labor management and risk of the related works.

Although water and sewerage businesses has been conducted with PPP methods in many countries, not a few projects had results in failure mainly because O&M cost was estimated too low at the time of total project cost estimation. Facilities become deteriorated as time goes by, and that will increase O&M cost including repair and replacement cost. If the appropriate O&M cost of facilities are not estimated considering such aged deterioration, O&M companies would be faced with financial difficulties and often come to neglect proper O&M. At the same time in many cases, such O&M companies come to demand an increase in payment that sometimes caused failure of projects.

In this Study, JST estimates appropriate O&M cost to assure efficient operation and maintenance. O&M cost consists of direct costs, site overhead and general overhead including profits shown below.

1) Direct Cost
   a) Labor cost
   b) Utility cost (electricity, chemicals, etc.)
   c) Disposal cost of dewatered sludge
   d) Repair cost (Including small scale repair)
   e) Legally required water quality analysis cost and equipment inspection cost
   f) Environmental maintenance cost (cleaning and planting)
   g) Other expenses
   h) Consulting fee during the first 3 years of O&M
   i) Insurances expenses

2) Site Overhead (5% of sum of direct cost)
3) General Overhead (25% of sum of direct cost and site overhead)

JST considers that site overhead should be 5% of direct cost and general overhead be 25% of the sum direct cost and site overhead. Efficient operation and maintenance must be assured by general overhead including appropriate profit of O&M company. When it comes to the real contract, in return for appropriate profit provided, a penalty term which is imposed on the O&M company in case proper O&M is not provided (such as compliance breach of discharge water quality) should be incorporated.

Table 4.24 Estimate Conditions of O&M including Unit Prices

Item			Number	Unit	Remarks
1. Exchange rate adopted					
	JPY/USD		102	-	Investigated by JST, the same rate used in cost estimation of WWTP construction
	Rp./USD		11,500	-	
2. Volume of wastewater					
2.1	Case 1	Annual	200,000	m^3/d	Amount of 200,000m3/day is considered to be treated from initial stage.
2.2	Case 2	1-7th yr.	100,000	m^3/d	Form 1st to 7th year, only amount of 100,000m3/day is considered to be treated.
		8th yr. -	200,000		At 8th year from initial stage, all sewers and WWTP is considered to be constructed.
＊Overflow than WWTP treatment capacity(100,000m3/d or 200,000m3/d)at each Case is not included.					
3. Direct cost					
3.1	Labor cost	Director	540,960,000	Rp./y	Estimated by JST
		Vice Director	490,820,000		
		Manager	245,410,000		
		Operator	121,727,500		
3.2	Electricity	Peak time	1,784	Rp./kWh	Unlisted company of I-3/TM in the Tariff, JICA Survy team
		Other time	1,115	Rp./kWh	
3.3	Chemicals	Polymer	69,000	Rp./kg	6USD/kg、investigated by JST
		NaOCl(12%)	5,640	Rp./kg	In case of using 35kg packing, investigated by JST
		NaOH	6,600	Rp./kg	In case of using 300kg packing, investigated by JST
		Citric acid	50,000	Rp./kg	In case of using 25kg packing, investigated by JST
		$FeCl_3$	17,250	Rp./kg	In case of using 50kg packing, investigated by JST
3.4	Fuel	Gasoline	13,000	Rp./L	Investigated by JST at Sep. of 2014
		Diesel	13,000		
3.5	Sludge disposal		100	USD/t	Investigated by JST (In case of contract disposal using local private company)
3.6	Repair		―	Set	Estimated by JST using experience and know-how in Japan
3.7	Legal inspection cost Cleaning and yard		―	Set	Outsourcing Estimated by JST using experience and know-how in Japan
3.8	Miscellaneous cost		―	%	Estimated by JST using experience and know-how in Japan
3.9	O&M Consulting Fee		400,000.0	USD/y	Estimated by JST During 3 years from the beginning of O&M
4. Site overhead					
4.1	Site overhead		5	%	Rates to the total direct cost (sum of 3.1 to 3.9)
5. General overhead					
5.1	General overhead		25	%	Rates to the sum of direct cost and site overhead (3+4)
6. The gross Operation & Maintenance cost					
6.1	The gross O & M cost		―	―	The sum of direct cost, site overhead and general overhead(3+4+5)
7. Others					
-	Overall unit costs are values as of Sep. of 2014. （Electricity cost is value as of Nov. 2014)				
-	Customs duties on imported materials for repair are not included. And, also VAT is not inclued.				
-	Fluctuation of each unit cost due to price fluctuation is not considered.				

Source: JICA study team

In this estimate, the O&M cost is estimated on the assumption of daily treatment capacity of 200,000m^3/day and treatment cost (grit settling, disinfection and discharge) for excess influent volume over the capacity is not considered. This cost should be paid according to actual treatment volume based on unit prices set at the time of contract separately.

20-year O&M cost is summarized in Table 4.25 and Table 4.26. The whole estimate result is attached in Appendix 4.9. In Case 1, average O&M cost of 170,041 million Rp./year (14,785,678 USD/year) is required annually, that is converted to 2,330 Rp./m^3 (About 0.203USD/m^3) per unit treatment volume. In Case 2, average O&M cost of 141,187 million Rp./year (12,320,098 USD/year) is required annually, that is converted to 2,353Rp./m^3 (About 0.205USD/m^3) per unit treatment volume.

Table 4.25 O&M Cost in Case 1 (20years)

Item / year	1st		2nd		3rd		4th		5th		6th	
Wastewater Qty (m^3/y)	73,000,000											
Currency	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD
Total O&M cost	162,607	14,139,338	162,607	14,139,338	164,664	14,318,209	164,328	14,288,963	205,512	17,870,136	176,131	15,315,302

Item / year	7st		8th		9th		10th		11th		12th	
Wastewater Qty (m^3/y)	73,000,000											
Currency	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD
Total O&M cost	163,893	14,251,131	158,653	13,795,463	158,037	13,741,913	187,458	16,300,249	196,694	17,103,477	160,446	13,951,646

Item / year	13th		14th		15th		16th		17th		18th	
Wastewater Qty (m^3/y)	73,000,000											
Currency	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD
Total O&M cost	161,488	14,042,847	166,628	14,489,264	182,197	15,843,291	172,738	15,020,558	161,116	14,009,649	163,117	14,184,387

Item / year	19th		20th		Total		Average annual O & M Cost		Unit O & M Cost	
Wastewater Qty (m^3/y)	73,000,000				1,460,000,000					
Currency	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Rp./m^3	USD/m^3
Total O&M cost	165,284	14,372,608	167,219	14,535,787	3,400,818	295,713,556	170,041	14,785,678	**2,330**	**0.203**

Note: Exclude VAT

Source: JICA study team

Table 4.26 O&M Cost in Case 2 (20years)

Item / year	1st		2nd		3rd		4th		5th		6th	
Wastewater Qty (m3/y)	36,500,000											
Currency	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD
Total O&M cost	89,142	7,751,072	89,142	7,751,072	91,199	7,929,943	89,233	7,758,947	97,880	8,510,926	96,507	8,391,493

Item / year	7st		8th		9th		10th		11th		12th	
Wastewater Qty (m^3/y)	36,500,000		73,000,000									
Currency	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD
Total O&M cost	7,670,321	158,653	13,795,467	158,037	13,741,917	179,111	15,574,470	1,137,117	169,290	14,720,496	171,054	14,874,131

Item / year	13th		14th		15th		16th		17th		18th	
Wastewater Qty (m^3/y)	73,000,000											
Currency	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD
Total O&M cost	164,645	14,317,394	177,483	15,433,174	169,968	14,779,880	168,255	14,630,722	165,208	14,365,526	162,985	14,172,927

Item / year	19th		20th		Total		Average annual O & M Cost		Unit O & M Cost	
Wastewater Qty (m^3/y)	73,000,000				1,204,500,000					
Currency	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Mil. Rp.	Equiv. to USD	Rp./m^3	USD/m^3
Total O&M cost	175,890	15,294,840	171,836	14,937,242	2,833,730	246,401,960	141,687	12,320,098	**2,353**	**0.205**

Note: Exclude VAT

Source: JICA study team

(1) Labor Cost

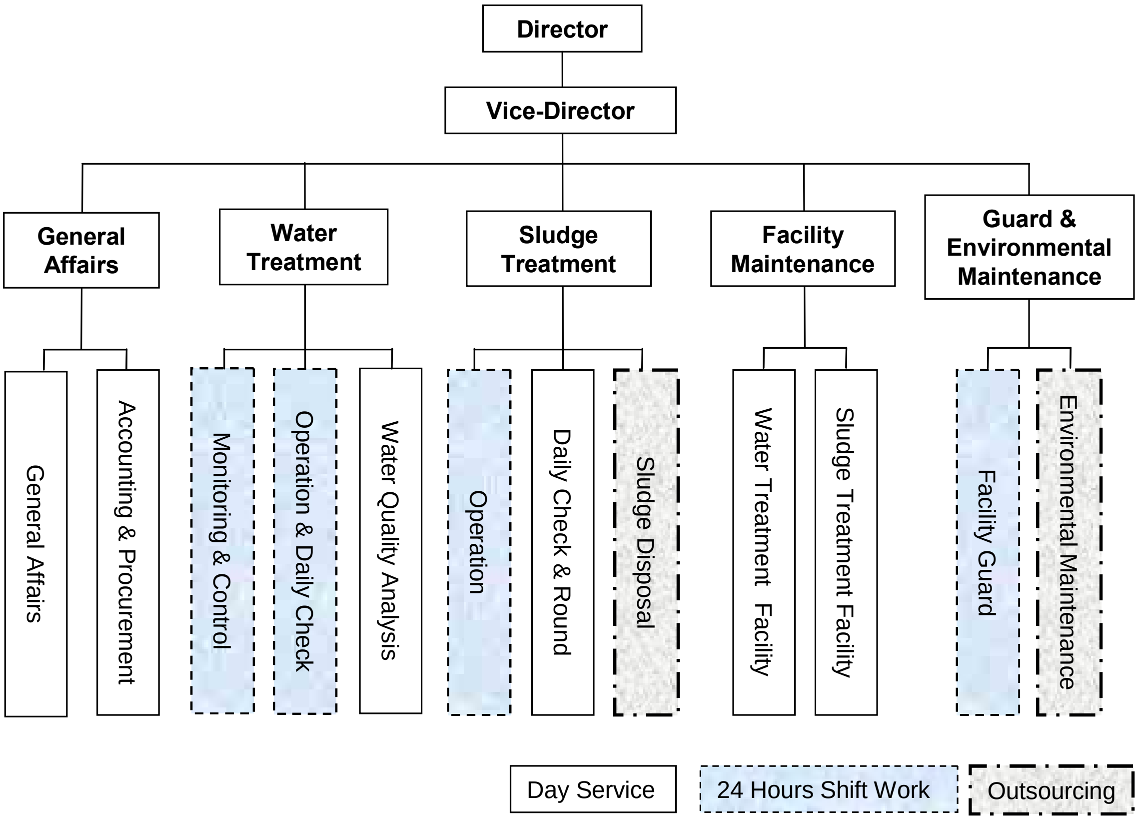
Being constructed, the WWTP is assumed to be operated and maintained under the organizational system shown in Figure 4.8. Under a director and a vice-director, departments in charge of general affairs, Water treatment, Sludge treatment, Facility maintenance, and Guard & environmental maintenance are organized, which subcategorized into specific groups as shown in Figure 4.8.

Fourth shift system is assumed for Monitoring and Control and Operation and Daily Check of water treatment, Operation of sludge treatment and Guard. JST assume sludge disposal and environmental maintenance to outsource in order to reduce fixed labor cost and related labor management cost.

The scope of O&M works with this organizational structure is limited to operation, facility inspection and small-scale repair, therefore middle- to large-scale of repairs are assumed to be outsourced. And during the first three years of O&M, consulting by foreign O&M company is assumed but the number of the consultants is not counted in the necessary staff and the cost of the consulting is estimated separately.
Work description, necessary qualification and number of staff for each work group in this organization are shown in Table 4.27. JST calculates the necessary number of staff as 39 staff in the case of 100,000m^3/day and as 56 staff in the case of 200,000m^3/day. This calculation excludes operators in charge of sludge reuse and water reclamation when these works arises.

Investigating the labor cost of PD Pal Jaya, JST set the labor cost at appropriate level so that necessary personnel resources to provide proper O&M are secured.

Estimate results of labor cost with the conditions above are shown in Table 4.28 and Table 4.29.



Source: JICA study team

Figure 4.8 O&M Organizational Structure of Newly Constructed WWTP (Tentative)

Table 4.27 Number of Staff and Work Description of Newly Constructed WWTP

Department / Group		Number of Staff		Remarks (Work description)
		Case 1	Case 2	
Director		1	1	General manager of WWTP Graduated from sewage technology and experienced in WWTP
Vice-director		1	1	Vice-general manager of WWTP Graduated from mechanical engineering and experienced in WWTP
General Affairs	Manager	1	1	Manager of general accounting works and labor management works
	General	1	1	Responsible for general affairs related to O&M organization
	Accounting & Procurement	1	1	Accounting works and procurement works of goods
	Sub total	3	3	-
Water Treatment	Manager	1	1	Graduated from sewage technology and experienced in WWTP
	Monitoring & Control	5	10	Responsible for monitoring and control of the facilities Case1:1staff ×4shift, 1staff for day shift, total 5staff
	Operation & Daily check	4	4	Responsible for operation and daily check of the facilities 1staff ×4shift, total 4staff
	Water analysis	2	4	Daily water and sludge analysis Legally required analysis is outsourced
	Sub total	12	19	
Sludge Treatment	Manager	1	1	Graduated from sewage technology and experienced in WWTP
	Operation	5	8	Responsible for operation of sludge treatment facilities Case1:1staff ×4shift, 1staff for day shift, total 5staff / Case2:2staff×4shift, total 8 staff
	Daily check	2	4	Daily check of dewatering facilities
	Sludge carrying out	-	-	Outsourced
	Sub total	8	13	
Maintenance	Manager	1	1	Graduated from mechanical engineering or electrical engineering and experienced in WWTP
	Water treatment	4	7	Responsible for daily and regular inspection and small-scale repair of facilities Prepare repair and replacement schedule
	Sludge treatment	4	7	
	Sub total	9	15	
Guard & Environmental maintenance	Manager	1	1	Experienced in plant guarding
	Guard	4	4	1staff ×4shift, total 4staff
	Environmental maintenance	-	-	Outsourced
	Sub total	5	5	
Total		39	57	

* Case1: O&M in the case of capacity of 100,000m^3/day

** Case2: O&M in the case of capacity of 200,000m^3/day

Table 4.28 Labor Cost in Case1

No.	Works Items	Jobs Category	Num. Pers.	Direct Labor cost Mil.Rp./year	Direct Labor cost Equiv. to USD/year	Indirect Labor cost Mil.Rp./year	Indirect Labor cost Equiv. to USD/year	Total Mil.Rp./year	Total Equiv. to USD/year
1	Director	Wastewater treatment	1	450.8	39,200	90.2	7,840	541.0	47,040
2	Vice Director	Machines	1	408.9	35,560	81.9	7,120	490.8	42,680
3	General affairs	Manager	1	204.5	17,780	40.9	3,560	245.4	21,340
		General	1	101.4	8,820	20.4	1,770	121.8	10,590
		Accounting & Procurement	1	101.4	8,820	20.4	1,770	121.8	10,590
		Sub total	3	407.3	35,420	81.7	7,100	489.0	42,520
4	Water treatment	Manager	1	204.5	17,780	40.9	3,560	245.4	21,340
		Water anaysis	2	202.9	17,640	40.6	3,530	243.5	21,170
		Monitoring & Control	5	507.2	44,100	101.4	8,820	608.6	52,920
		Daily check & Round	4	405.7	35,280	81.2	7,060	486.9	42,340
		Sub total	12	1,320.2	114,800	264.2	22,970	1,584.4	137,770
5	Sludge treatment	Manager	1	204.5	17,780	40.9	3,560	245.4	21,340
		Operation	5	507.2	44,100	101.4	8,820	608.6	52,920
		Daily check & Round	2	202.9	17,640	40.6	3,530	243.5	21,170
		Sub total	8	914.5	79,520	183.0	15,910	1,097.4	95,430
6	Maintenance	Manager	1	204.5	17,780	40.9	3,560	245.4	21,340
		Water treatment	4	405.7	35,280	81.2	7,060	486.9	42,340
		Sludge treatment	4	405.7	35,280	81.2	7,060	486.9	42,340
		Sub total	9	1,015.9	88,340	203.3	17,680	1,219.2	106,020
7	Guards	Manager	1	143.3	12,460	28.8	2,500	172.0	14,960
		Guard	4	283.4	24,640	56.7	4,930	340.1	29,570
		Sub total	5	426.7	37,100	85.4	7,430	512.1	44,530
Total			39	4,944.3	429,940	989.6	86,050	5,933.9	515,990

Source: JICA study team

Table 4.29 Labor Cost in Case2

No.	Works Items	Jobs Category	Num. Pers.	Direct Labor cost Mil.Rp./year	Direct Labor cost Equiv. to USD/year	Indirect Labor cost Mil.Rp./year	Indirect Labor cost Equiv. to USD/year	Total Mil.Rp./year	Total Equiv. to USD/year
1	Director	Wastewater treatment	1	450.8	39,200	90.2	7,840	541.0	47,040
2	Vice Director	Machines	1	408.9	35,560	81.9	7,120	490.8	42,680
3	General affairs	Manager	1	204.5	17,780	40.9	3,560	245.4	21,340
		General	1	101.4	8,820	20.4	1,770	121.8	10,590
		Accounting & Procurement	1	101.4	8,820	20.4	1,770	121.8	10,590
		Sub total	3	407.3	35,420	81.7	7,100	489.0	42,520
4	Water treatment	Manager	1	204.5	17,780	40.9	3,560	245.4	21,340
		Water anaysis	4	405.7	35,280	81.2	7,060	486.9	42,340
		Monitoring & Control	10	1,014.3	88,200	202.9	17,640	1,217.2	105,840
		Daily check & Round	4	405.7	35,280	81.2	7,060	486.9	42,340
		Sub total	19	2,030.2	176,540	406.2	35,320	2,436.4	211,860
5	Sludge treatment	Manager	1	204.5	17,780	40.9	3,560	245.4	21,340
		Operation	8	811.4	70,560	162.4	14,120	973.8	84,680
		Daily check & Round	4	405.7	35,280	81.2	7,060	486.9	42,340
		Sub total	13	1,421.6	123,620	284.5	24,740	1,706.1	148,360
6	Maintenance	Manager	1	204.5	17,780	40.9	3,560	245.4	21,340
		Water treatment	7	710.0	61,740	142.0	12,350	852.0	74,090
		Sludge treatment	7	710.0	61,740	142.0	12,350	852.0	74,090
		Sub total	15	1,624.5	141,260	325.0	28,260	1,949.5	169,520
7	Guards	Manager	1	143.3	12,460	28.8	2,500	172.0	14,960
		Guard	4	283.4	24,640	56.7	4,930	340.1	29,570
		Sub total	5	426.7	37,100	85.4	7,430	512.1	44,530
Total			57	6,770.1	588,700	1,354.8	117,810	8,124.9	706,510

Source: JICA study team

(2) Electricity Cost

Electricity Tariff in Indonesia is shown in Table 4.30. Recently, electricity tariff for industrial use is increased widely and the rise is foreseen to continue. In this estimate, tariff for November 2014 announced by Ministry of Energy and Mineral Resources in Indonesia (Table 4.30) is applied.

Table 4.30 Electricity Tariff for Industrial Use in Indonesia (From November 2014)

<table>
<tr><th rowspan="2">No</th><th rowspan="2">Tariff Class</th><th rowspan="2">Power Limit</th><th colspan="3">Regular</th><th rowspan="2">Pre-pay (Rp/kWh)</th></tr>
<tr><th>Charge Cost (Rp/kVA/mo.)</th><th colspan="2">Usage Cost (Rp/kWh) and kVARh cost (Rp/kVArh)</th></tr>
<tr><td>1</td><td>I-1/KR</td><td>450 VA</td><td>26,000</td><td colspan="2">Block I : 0 - 30 kWh : 160
Block I1 : > 30 kWh : 395</td><td>485</td></tr>
<tr><td>2</td><td>I-1/TR</td><td>900 VA</td><td>31,500</td><td colspan="2">Block I : 0 - 72 kWh : 315
Block II : > 72 kWh : 405</td><td>600</td></tr>
<tr><td>3</td><td>I-1/TR</td><td>1.300 VA</td><td>*</td><td colspan="2">930</td><td>930</td></tr>
<tr><td>4</td><td>I-1/TR</td><td>2.200 VA</td><td>*</td><td colspan="2">960</td><td>960</td></tr>
<tr><td>5</td><td>I-1/TR</td><td>3,500 VA - 14 kVA</td><td>*</td><td colspan="2">1,112</td><td>1,112</td></tr>
<tr><td>6</td><td>I-2/TR</td><td>14 kVA - 200 kVA</td><td>**</td><td colspan="2">Peak Time = K × 972
Off-peak Time = 972
kVArh = 1,057****</td><td>-</td></tr>
<tr><td rowspan="2">7</td><td rowspan="2">I-3/TM</td><td rowspan="2">> 200 kVA</td><td rowspan="2">**</td><td>Unlisted Company</td><td>Peak time = K × 1,115
Off-peak time = 1,115
kVArh = 1,200****</td><td rowspan="2">-</td></tr>
<tr><td>Listed Company</td><td>Peak time = K × 1,115
Off-peak time= 1,115
kVArh = 1,200****</td></tr>
<tr><td>8</td><td>I-4/TT</td><td>> 30,000 kVA</td><td>***</td><td colspan="2">Block WBP and LWBP = 1,191
kVArh = 1,191****</td><td>-</td></tr>
</table>

Remarks:
* : Minimum Bill (RM) is applied : RM1 = 40 (hours usage) x Connected Power (kVA) x Usage Cost
** : Minimum Bill (RM) is applied : RM2 = 40 (hours usage) x Connected Power (kVA) x Usage Cost of Block I
*** : Minimum Bill (RM) is applied : RM3 = 40 (hours usage) x Connected Power (kVA) x Usage Cost of LWBP
**** : Applied in case average power factor is lower than 0.85.
K : Comparation factor between Peak time and Off-peak time based on the loading of onsite electrical system (1,4 ≤ K ≤ 2), the factor is determined by Board of Directors of PT PLN

Source: Changes in the regulation of No.09 of 2014 on the tariff of electricity provided by PLN, Stipulated by MEMR (No.19, 2014)

As shown in Table 4.31, required electricity to operate the WWTP is calculated by considering operation time of each facility and equipment. For treatment of 100,000m^3/day (Phase 1), 59,695kWh/day is consumed, which is equivalent to electricity consumption per unit influent volume of 0.597kWh/m^3. In the case of 200,000m^3/day (Phase 2), 117,913kWh/day is consumed, which is equivalent to electricity consumption per unit influent volume of 0.590kWh/m^3.

Estimate of electricity cost based on the calculated electricity consumption is shown in Table 4.32. According to the electricity tariff for industrial use in Indonesia, tariff is set for peak time and non-peak time separately by PT PLN (National electricity company) and an additional coefficient (K) is applied for the consumption during peak time.

In this estimate, the coefficient is set as 1.6. The peak time is defined from 18:00 to 22:00.
Although peak time of sewage generation corresponds to the peak time for the electricity tariff, hourly treatment capacity is assumed to be even (200,000m^3/24hours=About 8,333.3m^3/hour) throughout a day, either in peak time or off-peak time because influent fluctuation in volume is minimized owing to long sewer networks and utilizing pumping wells and equalization tanks in the plant.

Table 4.31 Electricity Consumption in Newly Constructed WWTP

No.	Equipment	Motor Output	Efficiency	Operating units		Operation hours		Electricity Consumption		Remarks
				Phase I	Phase II	Frequency	Operation Time	Phase I	Phase II	
		kW	-	sets	sets	times/day	min/1 time	kWh/day	kWh/day	
1. Lift Pumping Facility										
1.1	Inflow Gate	3.7	0.7	4	4	0	0	0	0	Only being used for emergency, it was taken as 0 in the normal.
1.2	Fine screen	2.2	0.7	2	4	72	5	18	36	1 time/20 minutes 5 minutes/1 time
1.3	Lift pump	480	0.7	2	4	-	822	9,206	18,412	50,000m^3/13.7hrs・1set
1.4	Hoist	5.0 (Hoisting)	0.7	1	1	0	0	0	0	Only being used for repair, it was taken as 0 in the normal.
		0.85 (Travelling)	0.7	1	1	0	0	0	0	
2. Grit Chamber Facility										
2.1	Outflow gate	3.7	0.7	4	4	0	0	0	0	Only being used for emergency, it was taken as 0 in the normal.
2.2	Grit collector	5.5	0.7	2	4	2	30	7	15	2 times/day 30 minutes/1 time
2.3	Grit lifting pump	5.5	0.7	2	4	2	10	2	5	Grit generation quantity : 0.05m^3/1,000m^3 of wastewater
2.4	Air blower	22	0.6	1	2	1	1,440	316	633	Continuous running for 24 hours
3. Equalization Tank Facility										
3.1	Constant rate pump	37	0.7	10	20	1	1,440	6,216	12,432	Continuous running for 24 hours
3.2	Mixer for antisettling	5.5	0.7	32	64	1	1,440	2,956	5,913	Continuous running for 24 hours
3.3	Ultra fine screen	0.4	0.7	10	20	1	1,440	67	134	Continuous running for 24 hours
4. Disinfection Facility										
4.1	Sodium hypochlorite dosing pump	0.4	0.7	2	4	0	0	0.0	0.0	Only being used in the rainy day, it was taken as 0.
5. Aeration Tank & Membrane Bioreactor Facility										
5.1	Mesh screen	9	0.7	4	8	1	1,440	604	1,209	Continuous running for 24 hours
5.2	Blower for aeration tank	150	0.6	4	8	1	1,440	8,640	17,280	Continuous running for 24 hours
5.3	Membrane filtration pump	22	0.7	10	20	1	1,440	3,696	7,392	Continuous running for 24 hours
5.4	NaOCl pump for maintenance cleaning	0.2	0.7	4	8	1	79	0.7	1.5	
5.5	NaOCl pump for recovering cleaning	1.5	0.7	4	8	1	7	0.5	1.0	
5.6	Dilution water pump	3.7	0.7	4	8	1	1,440	248	497	
5.7	Blower for membrane scrubbing	150	0.6	10	20	1	1,440	21,600	43,200	
5.8	Circulation pump	11	0.7	10	20	1	1,440	1,848	3,696	
5.9	Excess sludge pump	11	0.7	2	4	-	1,000	256	513	Q=2,000m3/d
6. Dewatering & Deodorization Facility										
6.1	Excess sludge mixer	11	0.7	1	1	1	1,200	154	154	20 hours running per day
6.2	Excess sludge feed pum	11	0.7	2	4	1	1,200	308	616	20 hours running per day
6.3	Dehydrator	2.2	0.7	2	4	1	1,200	61	123	20 hours running per day
6.4	Deodorization equipmen	453	0.7	0.5	1	1	600	1,585	3,171	
7. Electrical Facility & Control System										
7.1	Monitoring and control system	10	0.7	1	1	1	1,440	168	168	
Sub Total (1-7)								57,957	115,601	
8. Others (Phase I: 3% of 1-7, Phase II: 2% of 1-7)								1,738	2,312	
Total Electricity Consumption (kWh)								59,695	117,913	
Electricity Consumption per unit wastewater (kWh/m3)								0.597	0.590	

Source: JICA study team

Electricity consumption in the case of 100,000m^3/day (Phase1) cost 26,725 million Rp./year and 200,000m^3/day (Phase2) requires 52,787 million Rp./year.

Table 4.32 Electricity Consumption and Cost Necessary in Newly Constructed WWTP

No.	Daily Influent volume			Unit	100,000m^3		200,000m^3		Remaks
					Peak Load Time (4 hours)	Off-Peak Load Time (20 hours)	Peak Load Time (4 hours)	Off-Peak Load Time (20 hours)	
1	Influent Volume by time zone			m^3/d	16,667	83,333	33,333	166,667	Peak Load Time :18:00-22:00
2	Electricity Consumption	Unit electricity Consumption		kWh/m^3	0.597		0.590		
		By time zone		kWh/d	9,949	49,746	19,652	98,261	
		Total		kWh/d	59,695		117,913		
3	Electricity Unit price at each time zone			Rp./kWh	1,784	1,115	1,784	1,115	Applying tariff for unlisted company of I-3/TM category, K=1.6(presumtion)
4	Electricity Cost	Daily Cost	Time zone	Rp./d	17,749,383	55,466,824	35,059,606	109,561,270	
			Total		73,216,207		144,620,876		
		Annual Cost	Time zone	Mil.Rp./yr	6,479	20,246	12,797	39,990	
			Total		26,725		52,787		

(3) Chemical Cost

Chemicals used in the newly constructed WWTP include the followings.

- Polymer coagulant (Sludge dewatering)
- Sodium hypo chlorite (Membrane cleaning for maintenance and recovery, deodorization)
- Sodium hydroxide (Membrane recovery cleaning)
- Citric acid (Membrane recovery cleaning)
- Activated carbon (Deodorization)

Excess influent flowing into the plant in rainy days over the plant capacity is planned to be discharged after grit settling and disinfection. Cost of chlorine chemical for disinfection of excess influent is not included in this estimate because the correct usage cannot be calculated. When it comes to actual contract, it is recommended that cost for chlorine chemical to treat excess influent should be reimbursed based on the actual monthly usage.

Chemicals needed for membrane cleaning is calculated on the conditions of cleaning intervals for maintenance cleaning of 2 times/day and for recovery cleaning of 2 times/year. Concentration of sodium hypo chlorite is assumed 200 mg/L for maintenance cleaning and 3,000 mg/L for recovery cleaning. Necessary chemical concentration and dosage for membrane cleaning is shown in Table 4.33 as well as those of sodium hydroxide and citric acid.

In addition to chemical usage for membrane cleaning shown in Table 4.33, all chemical usage and cost required for the Plant operation including sludge dewatering and deodorization was summarized in Table 4.34.

Table 4.33 Concentration and Consumption of Chemical for Membrane Cleaning

Cleaning	Frequency	Chemical (Conc.)	Concentration	Chemical consumption per unit membrane area
For Maintenance	2times/day	NaOCl (12%)	200 mg/L	0.0365 L/m^2・year
For Recovery	2times/yr.	NaOCl (12%)	3,000 mg/L	1.312 L/m^2・year
		NaOH (20%)	Up to pH12	0.0934 L/m^2・year
		Citric Acid (99%)	2%	0.25 L/m^2・year

Source: JICA study team

Table 4.34 Chemical Consumption and Cost

Chemical	Purpose	Unit cost (Rp./kg)	Annual consumption (kg/yr.)		Annual cost (Mil. Rp./yr.)	
			Phase 1	Phase 2	Phase 1	Phase 2
Polymer Coagulant	Sludge Dewatering	69,000	65,828	131,657	4,543	9,085
NaOCl (12%)	Maintenance Cleaning	5,640	64,569	129,137	365	729
	Recovery Cleaning		49,614	99,227	280	560
	Sub-total		114,182	228,364	645	1,289
NaOH (20%)	Recovery Cleaning	6,600	37,180	74,359	246	491
	Deodorization		33,696	33,696	223	223
	Sub-total		70,876	108,055	469	714
Citric acid (99%)	Recovery Cleaning	50,000	20,519	41,037	1,026	2,052
Activated carbon	Deodorization	92,000	2,800	2,800	258	258
Total					6,941	13,398

* Phase1:Treatment of 100,000m^3/d, Phase 2:Treatment of 200,000m^3/d
** Maintenance cleaning is designed to be operated by 2 times a day.
***Recovery cleaning is designed to be operated by 2 times a year.

Source: JICA study team

(4) Sludge Disposal Cost

Sludge disposal cost is estimated on the assumption that the disposal is outsourced to private waste disposal company considering the current situation that DKI Jakarta has difficulties to secure final disposal site of dewatered sludge. According to JST investigation, transportation and disposal by private companies cost approximately 100 USD/t and the unit price are applied for the estimation.

Annual sludge generation is expected to be about 18,400m^3 in the case of 100,000m^3/day capacity and 36,800m^3 in the case of 200,000m^3/day capacity. To dispose such amount of sludge, 21,160million Rp./year and 42,320 million Rp./year are required respectively. Anticipating future problem of insufficient disposal site nearby and increase in transport cost to far away, it is recommended to take any countermeasure.

(5) Repair Cost

Repair cost is estimated adding up repair costs of main equipment during the first 20years after O&M commencement. In estimating the cost, the following points are considered to prevent operation suspension due to major equipment breakdowns and increase in O&M cost due to excess repair.

a. Preventive maintenance for major equipment to prevent serious breakdowns hindering plant normal operation and to restrain increase in repair cost due to critical failure.

b. Corrective repair for replaceable equipment that does not have serious damage on plant operation by operating a standby even in an accident.

c. Appropriate timing of repair considering LCC of each piece of equipment

d. Easy maintenance such as parts replacement and oil replacement by site staff not to be included in repair cost.

e. Replacement in stead of repair in case replacement is more economical than repair, etc.

Also, repair during the PPP contract period (20 years after O&M commencement) is scheduled and its cost is estimated so that all equipment can continue working for another one to two years after the plant is transferred to Jakarta Government from the PPP contractor.

As well as replacement cost, customs duties are not included on imported equipment, all expenses is based on the values of 2014, and no price escalation is considered.

Estimate of repair cost in Case1 and Case2 under the conditions above are shown in Table 4.35 and Table 4.36 respectively.

In 20 years, Case1 requires 191,475 million Rp. (Equivalent to 16,650,000USD) and Case2 requires 151,225 million Rp. (Equivalent to 13,150,000USD) in total.

Table 4.35 Repair Cost in Case 1

Facility \ Year		1	2	3	4	5	6	7	8	9	10	Sub total
1.Lift Pumpuing Facility	Mil.Rp	0	0	159	0	377	4,588	1,614	377	0	745	7,860
	Equiv.USD	0	0	13,783	0	32,783	398,957	140,348	32,783	0	64,783	683,435
2.Grit Chamber Facility	Mil.Rp	0	0	146	0	2,755	0	146	0	0	2,755	5,800
	Equiv.USD	0	0	12,652	0	239,541	0	12,652	0	0	239,541	504,385
3.Equalization Tank Facility	Mil.Rp	0	0	143	0	4,148	1,763	0	143	0	4,148	10,344
	Equiv.USD	0	0	12,435	0	360,652	153,304	0	12,435	0	360,652	899,478
4.Disinfection Facility	Mil.Rp	0	0	32	0	0	32	0	32	0	32	128
	Equiv.USD	0	0	2,783	0	0	2,783	0	2,783	0	2,783	11,130
5.Aeration Tank & Membrane Biorreactor Facility	Mil.Rp	0	0	546	0	24,518	5,662	2,785	0	0	4,349	37,859
	Equiv.USD	0	0	47,435	0	2,131,957	492,348	242,174	0	0	378,174	3,292,087
6. Dewatering & Deodorization Facility	Mil.Rp	0	0	83	0	4,112	513	0	0	83	6,652	11,443
	Equiv.USD	0	0	7,200	0	357,577	44,580	0	0	7,200	578,477	995,033
7. Electrical Facility & Contrrol System	Mil.Rp	0	0	0	5,451	920	1,311	0	0	0	3,818	11,500
	Equiv.USD	0	0	0	474,000	80,000	114,000	0	0	0	332,000	1,000,000
8. Small Scale Repairs including Structures and Buildings	Mil.Rp	0	0	460	460	460	1,035	1,035	1,035	1,035	1,035	6,555
	Equiv.USD	0	0	40,000	40,000	40,000	90,000	90,000	90,000	90,000	90,000	570,000
Total	Mil.Rp	0	0	1,567	5,911	37,289	14,904	5,580	1,587	1,118	23,534	91,489
	Equiv.USD	0	0	136,287	514,000	3,242,508	1,295,971	485,174	138,000	97,200	2,046,409	7,955,549

Facility \ Year		11	12	13	14	15	16	17	18	19	20	Total
1.Lift Pumpuing Facility	Mil.Rp	8,280	653	0	2,152	377	8,280	0	791	0	0	28,392
	Equiv.USD	720,000	56,783	0	187,130	32,783	720,000	0	68,739	0	0	2,468,870
2.Grit Chamber Facility	Mil.Rp	0	146	0	0	2,910	0	0	145	0	0	9,001
	Equiv.USD	0	12,656	0	0	253,021	0	0	12,633	0	0	782,696
3.Equalization Tank Facility	Mil.Rp	1,763	0	0	1,516	2,489	143	0	0	0	970	17,224
	Equiv.USD	153,304	0	0	131,783	216,435	12,435	0	0	0	84,304	1,497,739
4.Disinfection Facility	Mil.Rp	32	0	0	32	0	0	32	0	0	32	256
	Equiv.USD	2,783	0	0	2,783	0	0	2,783	0	0	2,783	22,261
5.Aeration Tank & Membrane Biorreactor Facility	Mil.Rp	10,837	0	546	2,240	7,769	1,021	0	0	545	1,366	62,181
	Equiv.USD	942,304	0	47,435	194,739	675,565	88,783	0	0	47,391	118,739	5,407,043
6. Dewatering & Deodorization Facility	Mil.Rp	0	430	166	0	4,256	0	166	2,098	0	894	19,451
	Equiv.USD	0	37,380	14,400	0	370,059	0	14,400	182,400	0	77,718	1,691,391
7. Electrical Facility & Contrrol System	Mil.Rp	7,935	0	1,311	0	0	920	1,311	0	4,140	2,898	30,015
	Equiv.USD	690,000	0	114,000	0	0	80,000	114,000	0	360,000	252,000	2,610,000
8. Small Scale Repairs including Structures and Buildings	Mil.Rp	1,725	1,725	1,725	1,725	1,725	1,955	1,955	1,955	1,955	1,955	24,955
	Equiv.USD	150,000	150,000	150,000	150,000	150,000	170,000	170,000	170,000	170,000	170,000	2,170,000
Total	Mil.Rp	30,572	2,953	3,747	7,664	19,525	12,319	3,464	4,988	6,640	8,114	191,475
	Equiv.USD	2,658,391	256,819	325,835	666,435	1,697,863	1,071,217	301,183	433,773	577,391	705,544	16,650,000

Source: JICA Study Team

Table 4.36 Repair cost in Case 2

Facility \ Year		1	2	3	4	5	6	7	8	9	10	Sub total
1.Lift Pumpuning Facility	Mil.Rp	0	0	159	0	377	2,898	823	377	0	561	5,195
	Equiv.USD	0	0	13,783	0	32,783	252,000	71,565	32,783	0	48,783	451,696
2.Grit Chamber Facility	Mil.Rp	0	0	146	0	1,543	0	146	0	0	1,543	3,376
	Equiv.USD	0	0	12,652	0	134,143	0	12,652	0	0	134,143	293,590
3.Equalization Tank Facility	Mil.Rp	0	0	143	0	2,668	899	0	143	0	2,668	6,521
	Equiv.USD	0	0	12,435	0	232,000	78,130	0	12,435	0	232,000	567,000
4.Disinfection Facility	Mil.Rp	0	0	32	0	0	32	0	32	0	32	128
	Equiv.USD	0	0	2,783	0	0	2,783	0	2,783	0	2,783	11,130
5.Aeration Tank & Membrane Biorreactor Facility	Mil.Rp	0	0	546	0	2,125	3,671	1,889	0	0	2,670	10,900
	Equiv.USD	0	0	47,435	0	184,739	319,174	164,261	0	0	232,174	947,783
6. Dewatering & Deodorization Facility	Mil.Rp	0	0	83	0	3,166	366	0	0	83	4,848	8,546
	Equiv.USD	0	0	7,200	0	275,278	31,860	0	0	7,200	421,550	743,088
7. Electrical Facility & Contrrol System	Mil.Rp	0	0	0	4,209	920	1,311	0	0	0	3,818	10,258
	Equiv.USD	0	0	0	366,000	80,000	114,000	0	0	0	332,000	892,000
8. Small Scale Repairs including Structures and Buildings	Mil.Rp	0	0	460	460	460	1,035	1,035	1,035	1,035	1,035	6,555
	Equiv.USD	0	0	40,000	40,000	40,000	90,000	90,000	90,000	90,000	90,000	570,000
Total	Mil.Rp	0	0	1,567	4,669	11,258	10,211	3,893	1,587	1,118	17,174	51,477
	Equiv.USD	0	0	136,287	406,000	978,943	887,947	338,478	138,000	97,200	1,493,432	4,476,287

Facility \ Year		11	12	13	14	15	16	17	18	19	20	Total
1.Lift Pumpuning Facility	Mil.Rp	0	3,275	0	4,268	377	1,035	184	791	2,622	823	18,570
	Equiv.USD	0	284,783	0	371,130	32,783	89,978	16,000	68,804	228,000	71,565	1,614,739
2.Grit Chamber Facility	Mil.Rp	0	146	0	1,239	1,543	0	0	145	156	1,083	7,687
	Equiv.USD	0	12,656	0	107,708	134,143	0	0	12,629	13,565	94,143	668,435
3.Equalization Tank Facility	Mil.Rp	0	899	901	1,892	2,525	144	0	0	1,923	0	14,803
	Equiv.USD	0	78,130	78,348	164,522	219,565	12,478	0	0	167,174	0	1,287,217
4.Disinfection Facility	Mil.Rp	32	0	0	32	0	0	32	0	0	32	256
	Equiv.USD	2,783	0	0	2,783	0	0	2,783	0	0	2,783	22,261
5.Aeration Tank & Membrane Biorreactor Facility	Mil.Rp	0	4,507	2,050	4,788	1,288	4,850	837	1,997	3,724	2,742	37,681
	Equiv.USD	0	391,913	178,261	416,304	112,000	421,739	72,739	173,609	323,783	238,435	3,276,565
6. Dewatering & Deodorization Facility	Mil.Rp	0	485	166	1,991	2,750	0	2,263	0	202	2,157	18,560
	Equiv.USD	0	42,182	14,400	173,152	239,150	0	196,800	0	17,522	187,578	1,613,871
7. Electrical Facility & Contrrol System	Mil.Rp	7,935	0	1,311	0	0	920	1,311	0	4,140	2,898	28,773
	Equiv.USD	690,000	0	114,000	0	0	80,000	114,000	0	360,000	252,000	2,502,000
8. Small Scale Repairs including Structures and Buildings	Mil.Rp	1,725	1,725	1,725	1,725	1,725	1,955	1,955	1,955	1,955	1,896	24,896
	Equiv.USD	150,000	150,000	150,000	150,000	150,000	170,000	170,000	170,000	170,000	164,911	2,164,911
Total	Mil.Rp	9,692	11,036	6,153	15,934	10,208	8,903	6,582	4,888	14,721	11,631	151,225
	Equiv.USD	842,783	959,664	535,009	1,385,599	887,641	774,196	572,322	425,042	1,280,043	1,011,415	13,150,000

Source: JICA Study Team

(6) Consulting Fee of O&M Technology Transfer

During 3 years from the beginning of the plant operation, the plant is assumed to be operated with assistance of Japanese technical consultants intending to transfer O&M techniques to locally employed staff. The consulting fee is estimated under the following conditions.

a. Japanese technical consultants for 3 years to instruct and assist local staff

b. Provide locally employed staff with WWTP O&M trainings in Japan

c. Assist staff to prepare O&M manual, etc.

The annual consulting fee of 400,000USD for three years is estimated.

(7) Other Expenses

a. Legally required water analysis and equipment inspection

Apart from domestic water analysis of plant effluent by the site staff for their water quality management, plant influent and effluent is legally obligated to be analyzed, recorded, and reported. Therefore, the legal analysis is to be outsourced to provincially certified bodies. The outsourcing cost is estimated as 276 million Rp./year (Equivalent to 24,000USD).

b. Site cleaning and planting

Site cleaning and planting are assumed to be outsourced instead of done by site staff. Labor of site cleaning is assumed to be 4 persons / day and planting works is assumed to be done 4times / year.

c. General expenses

The following expenses are included in general expenses.

- Vehicle expenses (Car lease cost and fuel cost included)
- Communication expenses including telephone
- Office cost
- Office supplies expenses
- Others

General expenses total 1,116 million Rp./year (Equivalent to 97,000USD/year) in the case of daily treatment of 100,000m^3/day, and 1,219 million Rp./year (Equivalent to 106,000 USD/year) in the case of daily treatment of 200,000m^3/day.

Table 4.37 Breakdowns of General Expenses

Item			Influent(m^3/d) 100,000	200,000	Remarks
Office Rents			0		Using site office
Viecle expenses (USD/year)	Car lease	Sedan	22,000	22,000	One car for each type Fuel cost calculated based on travelling distance below : Sedan : 30,000km/year SUV : 20,000km/year Truck : 20,000km/year
		SUV	22,000	22,000	
		Small Truck	33,000	33,000	
		Sub total	77,000	77,000	
	Fuel		14,000	14,000	
	Sub Total		36,000	36,000	
Communication Expenses（USD/year)			4,000	5,000	
Business equipment retal fee(USD/year)			20,000	20,000	
Office supplies(USD/year)			25,000	30,000	
Others(USD/year)			12,000	15,000	
Total	USD/yr.		97,000	106,000	
	Equiv. to Mil.Rp./yr.		1,116	1,219	

Source: JICA Study Team

(8) Site Overhead

Site overhead is assumed to be 5% of sum of direct cost mentioned above.

Site overhead includes the expenses for site following items.

- Labor management cost
- Safety related cost
- Taxes and dues
- Insurance expenses (O&M performance bond, Facility insurance, etc.)
- Reserve for retirement allowance of employee
- Legal welfare expenses
- Miscellaneous expenses, etc.

(9) General Overhead

General overhead is assumed to be 25% of sum of direct cost and site overhead mentioned above.
General overhead includes the following items for maintaining the SPC.

- Directors' fee
- Salary of administrative workers in head office other than site staff
- Retirement allowance of administrative workers in head office other than site staff
- Legal welfare cost of administrative workers in head office other than site staff
- Research study expenses
- Public relations cost
- Entertainment expenses, contributions, etc.
- Taxes and dues
- Insurance expenses
- Performance bond
- Miscellaneous expenses
- Added benefits (Income tax, dividends to stakeholders, Directors' bonus, Internal reserve)

Chapter 5 Environmental and Social Considerations

5.1 Target Area – DKI Jakarta

5.1.1 Natural Environment

(1) Climate Conditions

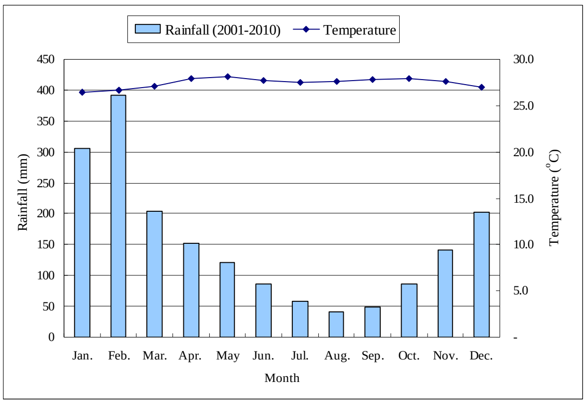
Climate conditions in DKI Jakarta are shown in Table 5.1.

Table 5.1 Climate conditions in DKI Jakarta

No.	Item	Data
1	Category	Tropical monsoon
2	Season	Dry season：July to Oct., Wet season：Nov. to Jun.
3	Monthly Temperature	Ave.：27.4℃ Max.：34.3℃(Jun.) Min：24.2℃(Jan.)
4	Precipitation	Yearly rainy days：168 day Average yearly precipitation：1,830mm(2001～2012)
5	Relative humidity	Yearly average humidity：81％ Dry season：75～78％ Wet season：81～85％

Source：World Meteorological Organization / 2011

Monthly average rainfall and temperature are shown in Figure 5.1.



Source: DKI Jakarta Waste BOT Project Report 2012 / Wikitravel

Figure 5.1 Monthly average rainfall and temperature

(2) Geography

The terrain is mostly flat and low lying in the north, hilly in the south, with the rivers running from south to north. Figure 5.2 shows the geology of the area.

The soil is mainly alluvial deposits to the depth of 50 m, with organic clayey sand in the north and tuff clay in the south

Source: PPP F/S Report 2013

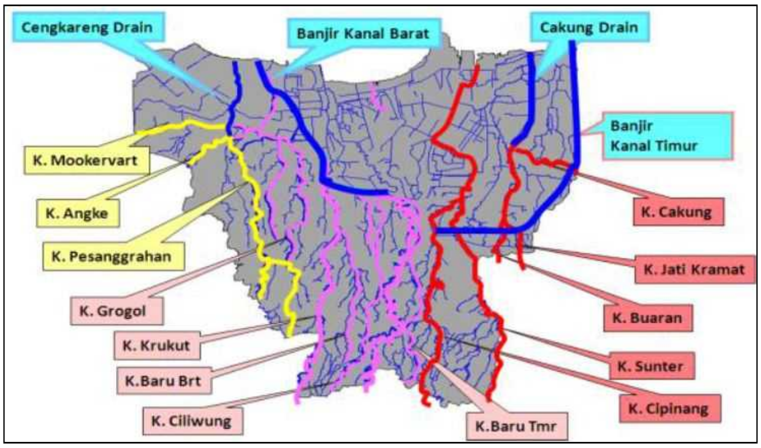
Figure 5.2 Geology in Jakarta

(3) Water Quantity and Quality

DKI Jakarta has 13 major rivers and the most important is the Ciliwung River (catchment: 467 km^2, length: 119 km) which runs through the center of Jakarta (Figure 5.3). The rivers overflow at low elevations at high tides and in the wet season.

Floods are more likely to occur with the increase in population and forest exploitation around Bogor city and Depok city, which are the backlands and water sources of Jakarta.

Floods cause socio-economic problems. In 2007, 70% of Jakarta was flooded with flood water reaching 4 m. Eighty-five people were killed, and homes of 0.35 million people were damaged. The extent of economic loss was more than 400 million USD.



Source: PERATURAN DAERAH PROVINSI DAERAH KHUSUS IBUKOTA JAKARTA 2014

*) Banjir Kanal; Flood canal

Figure 5.3 Major rivers in DKI Jakarta

Most of the organic waste materials are discharged without treatment because the sewerage system is not developed in DKI Jakarta. 5% of BOD inflow load in the South China Sea is assumed to be from Jakarta.

BOD value increases from upstream to downstream of the Ciliwung River. BOD value of the Ciliwung River in DKI Jakarta often exceeds the environmental standard of 20 mg/L. The water quality at the upstream of the Pluit reservoir is shown in Table 5.2. BOD values are very high compared to the standard. T-P values are also over the standard which indicates eutrophication.

Table 5.2 Water quality upstream of Pluit reservoir

Item	Feb, 2011 (Wet season)	Jun-Jul, 2011 (Dry season)	Environmental Standard (class D; DKI Jakarta)
BOD (mg/L)	195	49	20
Fecal Coliform	-	710	40,000
T-N (mg/L)	24.7	-	-
T-P (mg/L)	1.5	1.5	0.5

Source：Reviewed MP 2012

Design parameters for sewerage development for DKI Jakarta are shown in Table 5.3.

Table 5.3 Design parameters for sewerage development for DKI Jakarta

Design Parameter	Data	Remarks
Population	1,236,800	By 2030; 4,900 ha
Sewered Population	989,500	By 2030
% Population Served	80%	By 2030
Unit Load	200 L/person/day	Domestic & commercial
WWTP Capacity	198,000 m^3/day	Nil

Inflow Water Quality	BOD = 120 mg/L SS = 120 mg/L	Nil
Treated Water Quality	BOD = 10 mg/L SS = 10 mg/L NH_4-N = 5 mg/L	Standard (Governor decree No.122, 2005): BOD < 50 mg/L SS < 50 mg/L NH_4-N < 10 mg/L

Source：PPP-FS Report 2013

(4) Air Quality

Air quality data in DKI Jakarta in 2012 shown in Table 5.4. NO2, SO2 and Pb concentrations are below the air quality standards but TSP in some industrial areas exceeds the standard.

Table 5.4　Air quality in DKI Jakarta in 2012

	NO_2	SO_2	TSP	Pb
Residential area	8.9-31.4	32.0-40.9	114-133	0.12-0.27
Industrial area	19.1-36.5	34.4-41.2	163-239	0.19-0.27
Air Quality Standard (24h)	150	365	230	2

Unit：$\mu g/m^3$
Source：JAKARTA DALAM ANGKA 2013(Jakarta in Figures 2013)、239：Over the Standard

(5) Protected Areas

The target area does not have any nature reserves such as national parks. However, Pluit reservoir is one of protected areas designated by DKI Jakarta.

(6) Fauna and Flora

The target area is developed urban area with no wildlife or natural forests.

5.1.2　Social Environment

(1) Administration and Population

DKI Jakarta is divided into 5 municipalities (Kota Administrasi) and 1 regency (Kabupaten Administrasi). The population in DKI Jakarta was approximately 10 million in 2012 and the natural growth rate is 1.0%.

Table 5.5　Population by city / prefecture of DKI Jakarta (2012)

No	City / Prefecture	Area (km^2)	Population	Natural growth rate	Population density (person/km^2)
1	North Jakarta	146.66	1,715,564	1.0%	11,698
2	West Jakarta	129.54	2,395,130	1.4%	18,490
3	South Jakarta	141.27	2,148,261	1.0%	15,207

4	East Jakarta	188.03	2,801,784	0.9%	14,901
5	Central Jakarta	48.13	908,829	0.2%	18,883
6	Pulau Seribu	8.70	22,220	1.6%	2,554
Total		662.33	9,991,788	1.0%	15,086

Source：JAKARTA DALAM ANGKA 2013(Jakarta in Figures 2013)

(2) Demography / Poverty Rate

a. Ethnic Mix

The ethnic groups in DKI Jakarta are shown below. Ethnic / cultural / historical heritage or other important assets are not found in the target area.

Table 5.6 Ethnic groups in DKI Jakarta

NO.	Ethnic group	Rate
1	Jawa	35%
2	Betawi	28%
3	Sunda	15%
4	Chinese	4%
5	Batak	4%
6	Minangkabau	3%
	Other	11%

Source：Trade Expo indonesia HP 2014

b. Poor people

The poverty rate and poverty line in 2012 are shown in Table 5.7. The poverty rate for the whole DKI Jakarta in 2012 was 3.7% but ranges from 3.1% to 5.1% for the main cities.

Table 5.7 Poverty rate by cities (2012)

No.	City/Regency	Population	Population Below Poverty Line	Poverty Rate	Poverty Line (Rp/pers./month)
1	North Jakarta	1,715,564	87,500	5.1%	373,879
2	West Jakarta	2,395,130	82,300	3.4%	377,168
3	South Jakarta	2,148,261	74,100	3.4%	466,004
4	East Jakarta	2,801,784	86,500	3.1%	381,424
5	Central Jakarta	908,829	33,700	3.7%	400,378
6	Pulau Seribu	22,220	2,600	11.7%	420,189
Total / Average		9,991,788	366,700	3.7%	392,571

Source：JAKARTA DALAM ANGKA 2013(Jakarta in Figures 2013)

(3) Socio-economic Conditions

a. General

The distribution of workers by economic activity in DKI Jakarta in 2012 is shown in Table 5.8. Most of the workers are in trade, hotel and restaurant businesses (33%), service industry (29.8%) and manufacturing (14.6%).

Table 5.8 Distribution of workers by economic activity in DKI Jakarta (2012)

No.	Economic activity	(%)
1	Trade, Hotel and Restaurant	33.0
2	Services	29.8
3	Manufacturing	14.6
4	Transportation, Storage and Communication	9.1
5	Finance, Banking and Business Services	9.0
6	Construction	3.6
7	Agriculture	0.5
8	Mining	0.3
9	Electricity, Gas and Water Supply	0.1

Source：JAKARTA DALAM ANGKA 2013(Jakarta in Figures 2013)

Indonesian constant GDP by sector is shown in Table 5.9 and Figure 5.4. In 2012, the manufacturing industry had the highest contribution to GDP at 23.9%, followed by agriculture and trade, hotel and restaurant.

Table 5.9 Indonesian constant GDP by industry (2012)

No.	Industry	GDP (Tri. IDR)
1	Manufacturing Industry	1972.9
2	Agriculture	1190.4
3	Trade, Hotel and Restaurant	1145.6
4	Mining	970.6
5	Services	888.7
6	Construction	861.0
7	Financial, Real Estate & Business Services	598.5
8	Transportation & Communications	549.1
9	Electricity, Gas and Water	65.1

Source：JAKARTA DALAM ANGKA 2013(Jakarta in Figures 2013)

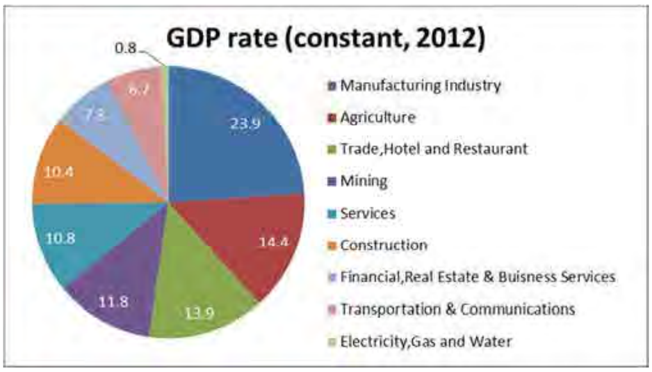


Figure 5.4 Indonesian constant GDP by industry sector (2012)

The number of education and medical facilities in DKI Jakarta is shown in Table 5.10.

Table 5.10 Education and medical facilities in DKI Jakarta (2012/2013)

No	Important infrastructure	Number
Educational		
1	Kindergarten	1,924
2	Primary School	3,026
3	Junior High School	1,041
4	Senior High School	471
5	Senior Vocational High School	584
6	University (State + Private)	3+52
Medical		

No	Important infrastructure	Number
1	Hospital	158
2	Medical Clinics	779
3	Public Health Centers in Districts and Villages	1,075

Source：JAKARTA DALAM ANGKA 2013(Jakarta in Figures 2013)

b. Industry

The breakdown of gross output by industry sector in DKI Jakarta is shown in Table 5.11. The majority of the businesses are in food products (31.7%), followed by chemical and chemical products / apparels / pharmaceutical, medicinal chemistry and traditional medicine.

Table 5.11　Output by industry sector in DKI Jakarta (2012)

No.	Industry	Gross Output (%)
1	Food Products	31.7%
2	Chemical and Chemical Products	21.3%
3	Wearing Apparels	14.1%
4	Pharmacy, Medicinal Chemistry and Traditional Medicine	13.5%
5	Printing and Reproduction of Recorded Media	13.0%
6	Textiles	2.8%
7	Beverages	1.4%
8	Paper and Paper Products	1.0%
9	Tanning and Dressing of Leather	0.9%
10	Wood and Products of Wood and Bamboo etc.	0.4%

Source：JAKARTA DALAM ANGKA 2013(Jakarta in Figures 2013)

c. Agriculture

The agricultural outputs in DKI Jakarta are shown in Table 5.12. Mango (154,133 ton / 28.6%) is the largest crop, followed by star fruit and swamp cabbage.

Table 5.12　Agriculture crop yields in DKI Jakarta (2012)

No.	Agricultural Crop	Yield (ton)	%
1	Mango	154,133	28.6%
2	Star Fruit	87,970	16.3%
3	Swamp Cabbage	49,469	9.2%
4	Rambutan	41,926	7.8%
5	Chinese Cabbage	36,125	6.7%
6	Tuft	35,284	6.6%
7	Common Guava	23,853	4.4%
8	Banana	21,944	4.1%
9	Jack fruit	19,902	3.7%
10	Papaya	11,331	2.1%
11	Wetland Paddy	11,044	2.1%
12	Durian	9,367	1.7%
13	Spinach	8,874	1.6%
14	Sapodilla	6,947	1.3%
15	Duku	6,340	1.2%

16	Bread fruit	4,581	0.9%
17	Orange	3,169	0.6%
18	Avocado	3,037	0.6%
19	Salacia	2,492	0.5%
20	Sour sop	465	0.1%

Source：JAKARTA DALAM ANGKA 2013(Jakarta in Figures 2013)

(3) Land Use

DKI Jakarta covers a land area of 662 km^2, about 0.04% of Indonesia's total land area. The land use breakdown in 2007 is shown in Table 5.13.

Table 5.13　Land use in DKI Jakarta (2007)

No.	Land use	%
1	Residential	53%
2	Commercial	16%
3	Green space	10%
4	Industrial	7%
5	Other	13%

Source：DKI Jakarta Dinas TaTa Ruang 2007

(4) Water Supply and Sewerage

In 2010, 5.61 million (62.3%) of the total population in DKI Jakarta had access to water supply service. With only 2% access to sewerage in urban areas, water environmental problems are worsening because of rapid urbanization along with economic growth. Sewerage system development is urgently needed in order to deal with environmental and health problems caused by public water pollution.

(5) Waste

In 2010, DKI Jakarta produces 6,139 tons of wastes per day, or 640 g person per day. The proportion of organic waste is 55%. Most of the wastes go to Bantangebang (Bekasi city) dump site and are landfilled.

5.1.3 Landscape of the Project Sites

Pic.-1 WWTP planned site (currently a green open space)

Pic.-2 WWTP - Pilot Project, Site of planned shaft hole (geological survey)

Pic.-3 Pluit Reservoir (the color of the water is black, it smells like H_2S, the shore is covered with garbage)

Pic.-4 Eastern sewer trunk route (picture taken on a holiday – traffic jam occurs constantly on week days)

Pic.-5 Eastern sewer trunk route (picture taken on a holiday – traffic jam occurs constantly on week days)

Pic.-6 Sewer route – example of narrow road (pipe jacking method minimizes impacts to surrounding environment)

Pictures were taken by JICA Study Team, Feb-May, 2014

5.2 Environmental and Social Considerations

5.2.1 Legal Framework

The Basic Provision for Living Environment Management Law (No. 4-1982) was the original basis of the environmental legal framework. The regulation was revised and the Environmental Management Law (No. 23-1997) was established in 1997. The law was further improved and the Environmental Protection and Management Law (No. 32-2009) was established in 2009. The law defines the details of the environmental license system.

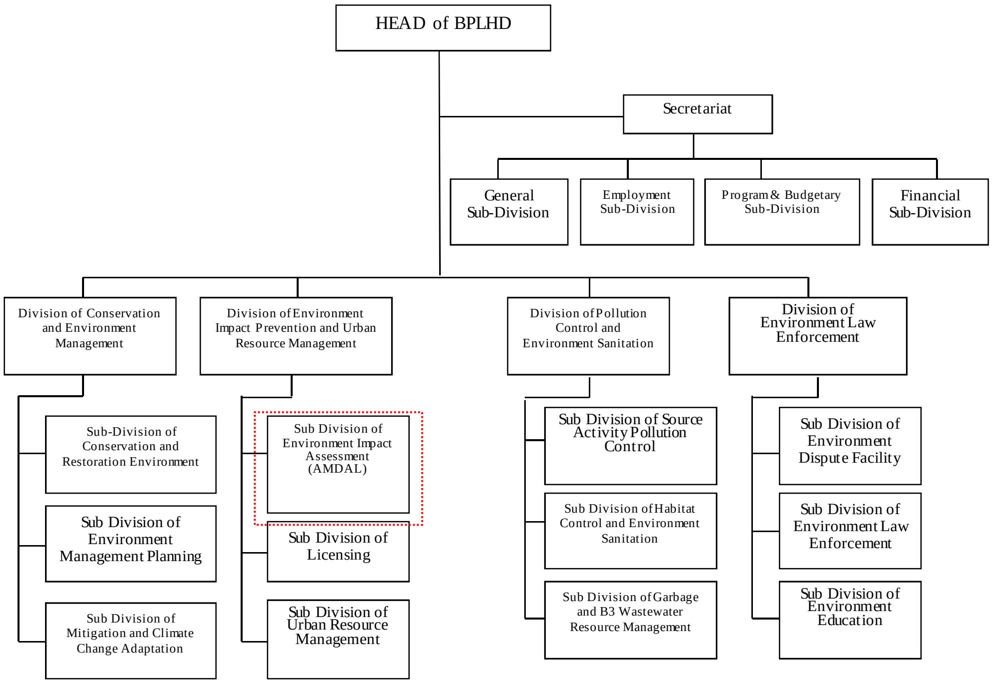
Table 5.14 Legal framework for environmental impact assessment

Class	Name of Laws / Regulations	Outline
Nationwide	Environmental Protection and Management Law No. 32-2009	Present environmental basic law defining the details of AMDAL
	Government Regulation No. 27-2012	Defining general administrative procedures of AMDAL, UKL and UPL
	Government Regulation No. 11-2006	Defining the development programmes and activities which AMDAL is required
	Decree of State Minister for the Environment No. 17-2002	Defining the development programmes and activities which AMDAL is required
	Decree of State Minister for the Environment No. 86-2002	Defining general administrative procedures of UKL and UPL
	Decree of State Minister for Environment No. 2-2000	Guidelines for preparation of ANDAL
	Decree of BAPEDAL No. 8-2000	Rules for public participants and information disclosure
	Decree of BAPEDAL No. 9-2000	Guidelines for contents of ANDAL, and environmental management and monitoring plans
	Decree of State Minister for Environment No. 40-2000	Rules on establishment of ANDAL evaluation committee
	Decree of State Minister for Environment No. 41-2000	Rules on ANDAL evaluation committee
	Decree of State Minister for the Environment No. 42-2000	Rules on members of ANDAL evaluation committee
	Decree of State Minister for Environment No. 5-2006	Rules on authority of ANDAL evaluation committee
	Decree of State Minister for Environment No. 6-2006	Rules on license of ANDAL evaluation committee
	Decree of State Minister for Environment No. 8-2006	Defining the details of ANDAL
DKI Jakarta	Decision of Jakarta City Governor No 2333-2002	Defining the development programs and activities which environmental management program is required in DKI Jakarta
	Decision of Jakarta City Governor No. 189-2002	Rules for public participants and information disclosure
	Decision of Jakarta City Governor No. 99l-2002	Guidelines for contents of ANDAL, and environmental management and monitoring plans
	Decision of Jakarta City Governor No. 2863-2001	Rules on establishment of ANDAL evaluation committee
	Decision of Jakarta City Governor No. 76-2001	Rules on ANDAL evaluation committee
	Decision of Jakarta City Governor No. 57-2001	Rules on members of ANDAL evaluation committee

Source : PPP-FS Report 2013

5.2.2 Indonesian Environmental Organization

The sub-division of AMDAL (environmental impact assessment) under the Division of Environmental Impact Prevention and Urban Resources Management is in charge of the evaluation of AMDAL. The organizational structure of BPLHD is shown in Figure 5.5.



Source：BPLHD 2014

Figure 5.5 Organizational structure of BPLHD

5.2.3 Projects Subject to AMDAL

BPLHD of DKI Jakarta will be responsible for the evaluation and approval of AMDAL of this Project. AMDAL and environmental permit will be processed in accordance with Governmental Regulation No. 27-2012 and AMDAL related documents shall be prepared by licensed/certified Indonesian consultants.

As shown in Table 5.15, AMDAL is required for the sewer and WWTP Projects. Besides, UKL and UPL are required for the Pilot Project.

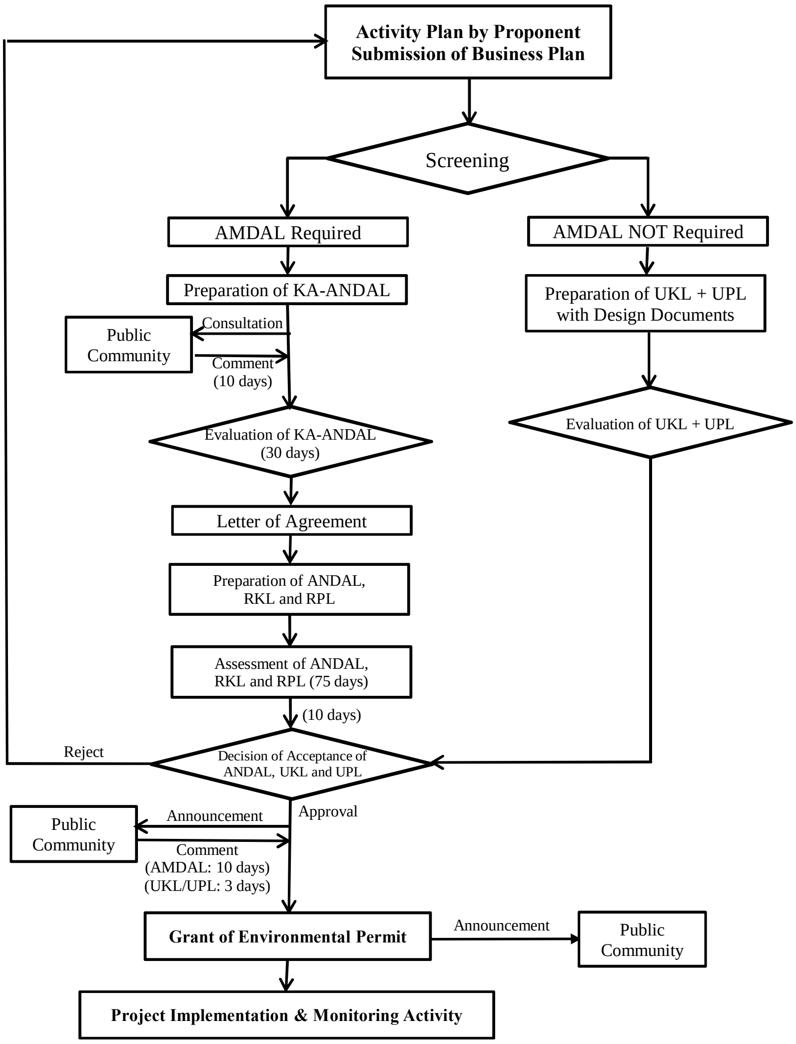
Table 5.15 Project/activities subject to AMDAL

No.	Type of Activity	Area/Length	Concerns/Triggers
10	Sludge treatment, including supporting facilities.	1 ha	Unpleasant odor. Visual impacts. Traffic disruptions during construction. Overcrowding. Impacts on land use. Impacts on behavior of residents and their daily lives.
	Wastewater treatment, including supporting facilities.	1 ha	
	Wastewater collection	> 10 ha	
11	Urban drainage improvement requiring land acquisition	> 3 km	Traffic, noise, vibration. Impacts on water management. Disruption to municipal utility network. Population density.
	Urban drainage improvement requiring land acquisition and widening	> 5 km	
	Urban drainage improvement requiring widening	> 7 km	

Source：Decision of Jakarta City Governor No. 2863-2001and PPP-FS Report 2013

5.2.4 Procedure for AMDAL

The general procedure for AMDAL is shown in Figure 5.6. Prior to the preparation of ANDAL (KA-ANDAL), the executing agency will prepare documents on the outline of the project. The evaluation agency will review the documents submitted by the executing agency and determine if AMDAL is required. For those projects subject to AMDAL, the executing agency shall prepare the Terms of Reference for ANDAL, stating the survey areas and methodology, and submit these to the evaluation committee. Upon approval of KA-ANDAL by the evaluation committee, the executing agency will prepare Environmental Impact Assessment Report (ANDAL). Based on the report and recommendation by the evaluation committee, the Governor would make the final decision on whether the environmental permit would be issued.



Source : PPP-FS Report 2013

Figure 5.6 Flow chart for AMDAL

5.2.5 Comparison with JICA's Environmental and Social Guidelines (April 2010)

There is no significant difference between the Indonesian environmental regulations and JICA's Guidelines for Eenvironmental and Social Considerations (April 2010), with respect to procedures, survey items, information disclosures and public involvement through the process of AMDAL.

5.3 Alternatives

5.3.1 WWTP Site

(1) Without the Project

The percentage of sewered population is only 2% in DKI Jakarta. Water pollution problems are worsening because of rapid urbanization along with economic growth. Sewerage system development is urgently needed in order to deal with environmental and health problems caused by water pollution. Thus, it is necessary to conduct the Project.

(2) Pejagalan Site

The Pejagalan site was chosen at the stage of the PPP F/S study but the approval of use from the Park Development Division was not issued. It is therefore not possible to construct the WWTP at this location.

(3) Pluit Site

As of August 2014, the Pluit site is a park similar to Pejagalan. The change of land use is approved for this location. Initially there was some concern with the soft soil structure but the problem is resolved with the discovery of a base rock layer in the soil survey.

The Pluit site was selected for the construction of the WWTP.

5.3.2 Trunk Sewer Route

(1) Shortest route

Sewer routes are usually designed by selecting the shortest distance and minimum depth. In this case, taking the shortest route, the sewer lines would cross the planned construction of the MRT (subways) running north to south of the target area. The construction would be costly and complicated.

(2) Double lines

To avoid crossing the MRT, trunk sewers would run on both sides of the MRT. The double lines would collect sewage separately, until they converge at the point where the sewer would be deep enough not to interfere with the MRT. This construction is cheaper and less complicated compared to the shorter but much deeper route.

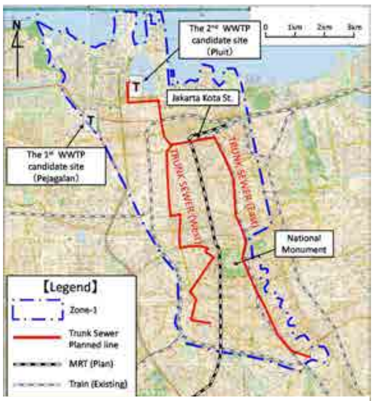


Figure 5.7 Double Routes

(3) High and low-stage trunk sewers

The end of the sewer line would be 28 m deep so the cost of pumping would be high. The idea of collecting sewage from the surrounding area of the WWTP by installing a high-stage sewer was studied. Given the sewered population, flow, cost, etc., it was found that high and low-stage trunk sewers do not lower the cost enough to merit further consideration.

In conclusion, the double line alternative is selected.

5.3.3 Pilot Project Route

(1) Route Alternative-1

The trunk sewer would enter the WWTP site from the north. Since the main sewered area is located to the south, the length of the sewer required would be longer. Inspite of this disadvantage, the pipe-jacking method can be adopted because there is enough space to construct a vertical shaft where the sewer turns.

Figure 5.8 Pilot Project Routes

(2) Route Alternative-2

The trunk sewer would enter the WWTP site from the south. The length of the sewer required would be shorter. However, the pipe-jacking method cannot be adopted because the point where the sewer turns has traffic congestion constantly and the shield method has to be used for the construction.

The final cost for Route Alternative-2 is higher and the construction period longer. Therefore, Route Alternative-1 is adopted.

5.4 Scoping

The content and extent of the environmental information to be submitted to the competent authority under the EIA procedure is identified in this process. Scoping for the WWTP / the sewer projects and the reasons for the evaluation are shown in the table below.

Table 5.16 Scoping in the preparation of EIA

Item	Evaluation	Reason
2 Water pollution	B	Turbidity will be produced during pipe jacking.
3 Waste	B	Construction waste (soil, pavement and other) and sludge waste would be produced.
4 Soil pollution	C	Leakage of leachate from sludge in dump sites
5 Noise and vibrations	B	From construction and transfer activities.
7 Offensive odors	B	From sewage.
15 Land use	B	Dust produced during construction.
17 Existing Social Infrastructure	C	Underground buried utilities shall be carefully examined.
24 Infectious diseases such as HIV/AIDS	B	Long stay of migrant workers is expected.
25 Accidents	B	During construction and operation of WWTP.

EvaluationA：Significant and irreversible negative impact is expected. B：Some negative impact is expected. C：The extent of impact is indistinct. D：No impact is expected.

5.5 Expected Outcomes and Assessment of Environmental Impacts

The scoping shown in Table 5.16 was updated based on the EIA study items identified. The expected impacts, evaluation results and the mitigation measures are presented in (Table 5.17). The table includes the proposed EMP measure for each item.

Table 5.17 Expected outcomes of environmental evaluation

Item	Scoping	Evaluation	Reason / Mitigation measure
2 Water pollution	B	B	Turbidity will be reduced by water treatment facilities.
3 Waste	B	B	Construction waste (soil, pavement and other) and sludge waste should be treated adequately at dump sites in the suburbs.
4 Soil pollution	C	B	This can be mitigated by monitoring adequate treatment of sludge during transportation and at dump sites.
5 Noise and vibrations	B	B	This can be mitigated by the use of low noise construction vehicle and installation of temporary wall.
7 Offensive odors	B	B	This can be mitigated by adopting deodorization processes and enclosing the treatment facilities. These measures will be taken into consideration at the detailed design stage.
15 Land use	B	B	Dust production can be minimized by spraying water on the roads and construction sites.

17 Existing Social Infrastructure	C	B	Surveys to find out underground buried utilities should be conducted.
24 Infectious diseases such as HIV/AIDS	B	B	Appropriate public health education programs should be implemented by the contractor.
25 Accidents	B	B	Appropriate worker safety education programs should be implemented by the contractor. Safety measures would be incorporated in the detailed design and O/M manuals by PD Pal Jaya.

5.6 Monitoring plan

The monitoring plan shown in Table 5.6.1 is necessary for implementing the above mitigation measures. The contents should be updated when modifications are made at subsequent stages of the project.

5.6.1 Construction Phase

Items	Methods and Monitoring Item	Frequency	Organization
Water Pollution	➢ Visual inspection of water turbidity.	Daily	PMU / Contractor
Waste Materials / Soil Pollution	➢ Inspection of contractor's certificate. ➢ Management with manifest. ➢ Contractor's monthly management report.	Monthly	Contractor
Noise and vibrations	➢ Sound level survey. ➢ Complaints from residents.	Monthly On Demand	PMU / Contractor
Land use	➢ Confirmation of watering and covering sources of dust.	Daily	PMU / Contractor
Infectious diseases such as HIV/AIDS	➢ Appointment of safety supervisor and safety officer. ➢ Implementation of safety and hygiene education program.	On Demand	Contractor
Accident	➢ Appointment of safety supervisor and safety officer. ➢ Holding safety meetings. ➢ Confirmation of availability of safety equipment.	Daily	Contractor

5.6.2 Operation Phase

Items	Methods and Monitoring Item	Frequency	Organization
Water Pollution	➢ Water quality analysis (pH, BOD, DO, NH_3-N, total coli and E. coli). ➢ Visual inspection for igns of eutrophication.	Monthly	PD Pal Jaya / BPLHD
Waste Materials / Soil Pollution	➢ Control by manifest.	Monthly	PD Pal Jaya
Noise and vibrations	➢ Sound level survey. ➢ Complaints from residents.	On Demand 3 month after the transfer	PD Pal Jaya / BPLHD
Offensive Odor	➢ Complaints from residents.	On Demand	PD Pal Jaya / BPLHD
Accident	➢ Compliance with relevant regulations. ➢ Holding periodic meetings. ➢ Initial training by the contractor. ➢ OJT.	Monthly Monthly Before the transfer On Demand	PD Pal Jaya Contractor

5.7 Land Acquisition / Resettlement

5.7.1 Change of the Land Use on the West Shore of Pluit Reservoir

The space was once a park called “Taman Burung Pluit” (Pluit Bird Park). However, significant illegal occupation started in 2011, and became wide spread in subsequent years. In January 2013, severe flooding brought serious damage around the Pluit reservoir area. DKI Jakarta provided 1,000 units of housing in the Marunda Apartment to the flood victims and cleared the occupied areas.

Source : ”Waduk Pluit ”, Jakarta Propartindo, 2014

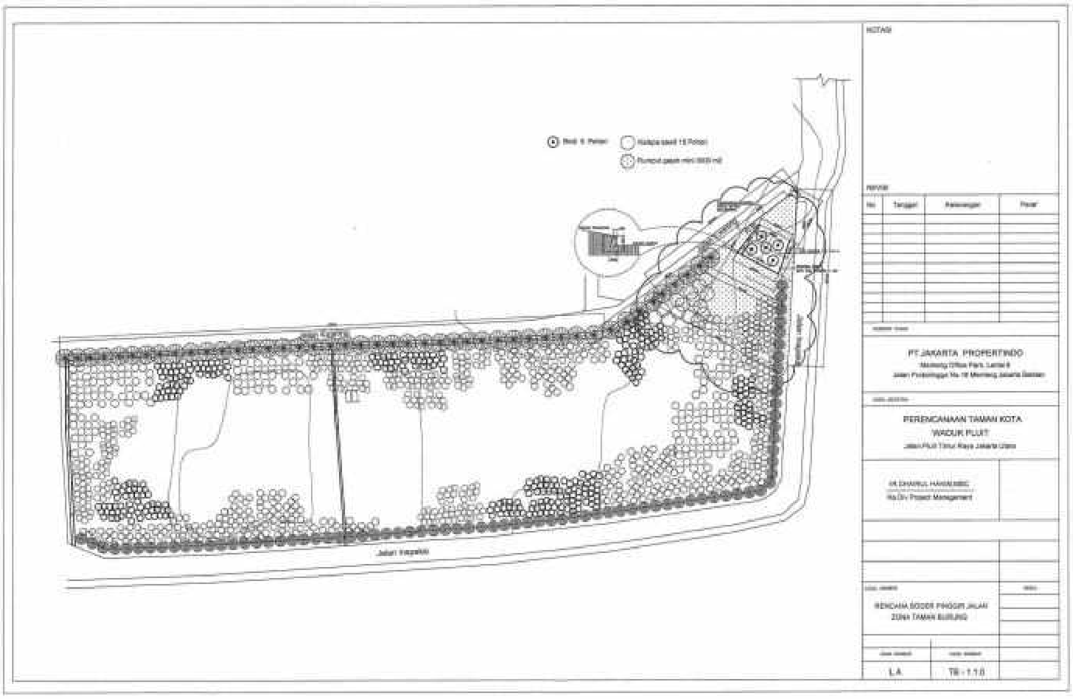
Pic.-1 Pluit area (Jan. 2013) Pic.-2 Vice Governor speaking to refugees

After the flood, the Normalization Project of Pluit Reservoir (Proyek Nomalisasi Waduk Pluit) was conducted under the supervision of the Governor of Jakarta. The reservoir without flood control was dredged and the surrounding areas developed into parks. The planned site for WWTP is a green open space as of August 2014.

Source : ”Waduk Pluit ”, Jakarta Propartindo, 2014

Pic.-3・4 Governor visiting the reservoir being dredged (Nov. 2013)

Taman Burung Pluit was redeveloped from November 2013 to January 2014. PT Jakarta Propertindo (a.k.a. Jakpro, the land owner, 100% invested by BAPPEDA) turned it into a green open space according to the Site Plan Taman Burung Pluit (see the figure below).



Source：PT Jakarta Propertindo 2014

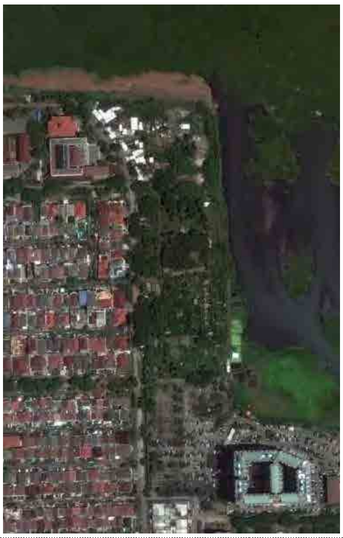
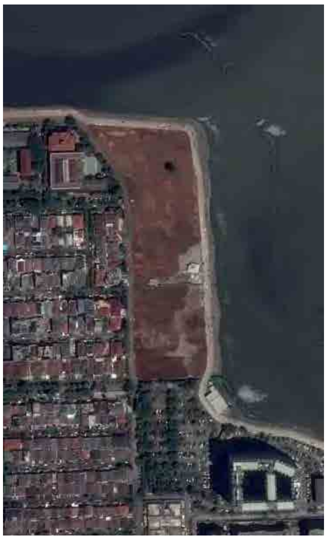
Figure 5.9　Taman Burung Pluit Re-development plan

Source：JICA Survey Team

Pic.-5・6　Taman Burung Pluit re-developed into a park again (Feb. 2014)

The change of Taman Burung Pluit from a park, to illegally occupied settelement and then re-developed into a park again is shown below.

Table 5.18　Taman Burung Pluit (2009-2014)

		
Mar. 2009	May 2011	Jan. 2013
Original bird park	Illegal occupation started	Occupation spread
		
Oct. 2013	Feb. 2014	July 2014
Before resettlement	After clearance	Planting started

Source：Google Earth 2014

Taman Burung Pluit can be used for a WWTP construction site after making the transition of the owner from Jakpro to BAPPEDA without a process of land use change because green open spaces can be used for environmental improvement facilities including WWTPs.

5.7.2　Displaced People

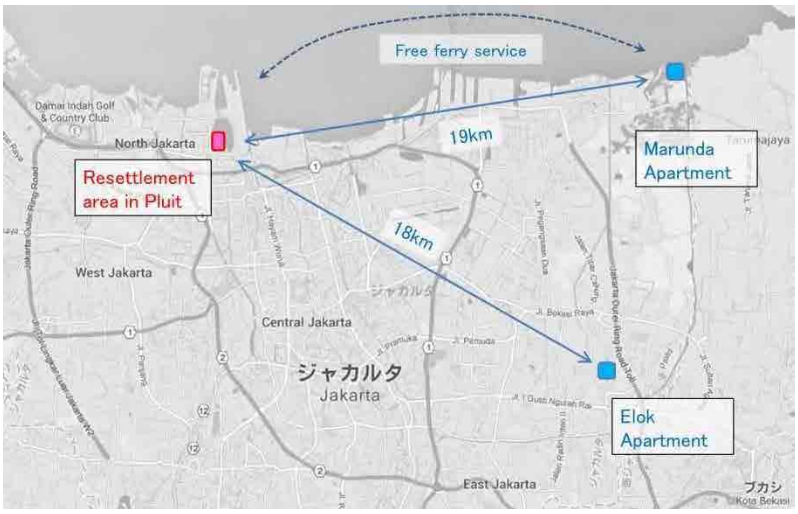
The new land acquisition law of Indonesia enacted in January, 2012, stipulates the process for dealing with displaced people, including planning / preparation and compensation to squatters.

Since the land is owned by Jakpro (since 1992) the law is deemed not applicable. Jakpro did not prepare a LARAP (Land Acquisition and Resettlement Action Plan).

Nevertheless, Jakpro and DKI Jakarta provided compensation and support to the displaced families as follows:

- Moving cost (4 million Rp)
- Apartment (free rent for 6 months)
- Furniture (bed / TV set / refrigerator / cooking stove)
- Ferry service to Pluit (Marunda)
- Transport service to the nearest bus terminal (Elok)

The displaced people moved into apartments in Marunda and Elok areas.



Source：Google Map 2014

Figure 5.10　Location of Marunda and Elok apartments

The Marunda Apartment is 19 km from the resettlement area in Pluit where educational and industrial complexes are located. Some displaced people got jobs in the industrial complex. Some people still have jobs in the Pluit area. Ferry transportation is provided by DKI Jakarta.

The rent is free for the first 6 months and Rp. 138,000 to Rp. 150,000 per month there after, much cheaper than the average rent in Jakarta[*)] (Rp. 462,077/month). The displaced people have the right to continue the rental arrangement.

The favorable comment from people interviewed is “we would like to keep on living here because of the good conditions and not having to worry about floods”. The complaints include “too far away from work but ferry services solved the problem” or “children still go to school near Pluit but that is only until the end of the semester”. Mostly they all sounded satisfied with their new lives.

*) Source: JAKARTA DALAM ANGKA 2013, living cost including utility fee (2012)

Source : Google Earth 2014

Figure 5.11 Marunda apartment and surrounding area

Pic.-7・8 Marunda apartment (venders facilities are almost the same as before)

The Elok apartment is 18 km from the resettlement area in Pluit where convenient commercial areas along the main street are located. Some people still have jobs in the Pluit area. There is a bus terminal, a railway station and a highway nearby.

The rent is free for the first 6 months and Rp.238,000 to Rp. 255.000 per month there after, much cheaper than the average rent in Jakarta. They have a right to continue the rental arrangement.

As Marunda, the residents would like to keep on living there because of the good conditions. They also have complaints about "too far away from work but transport services solved the problem" and "would like to get a new job near here but still have not been able to do so". Mostly they all sounded satisfied with their new lives.

Source：Google Earth(2014)

Figure 5.12　Elok apartment and surrounding area

Pic.-9・10　Elok apartment (convenient area with many commercial facilities)

5.8 Others

5.8.1 Monitoring Form (draft)

(1) During Construction

(1)-1 Water Quality (Turbid water)

Monitoring Item	Result	Monitoring Method	Location
Turbid water		Visual inspection	Discharged water

(1)-2 Waste / Soil Pollution

Monitoring Item	Result	Monitoring Method	Location
Waste materials	Amount (this month) Treatment Transport to:	Confirmation of records / Visual inspection	Produced place to where to transport

(1)-3 Noise / Vibration

Item	Measured Value	Country's Standards	Remarks (Measurement Point, Frequency, Method, etc.)
Noise Level		60 dB	Boundary of the Site

Item	Monitoring Results during Report Period
Acceptance of complaints from residents	

(1)-4 Land use

Monitoring Item	Result	Monitoring Method	Location
Dust prevention	Watering Usage of Cover	Visual inspection	Project and adjacent areas

(1)-5 Infectious diseases such as HIV/AIDS

Monitoring Item	Result	Monitoring Method
Hygiene education program	Name of trainee Date	Recording

(2) During Operation

(2)-1 Water Quality (Effluent/ Ambient Water Quality)

Item	Measured Value	Country's Standards *	Remarks (Measurement Point, Frequency, Method, etc.)
pH		6.0 – 8.5	Monthly monitoring for Effluent
SS		-	
BOD		20	
DO		3	
NH_3-N		-	
Fiscal Coliform		4,000	
Total Coliform		20,000	

* Decision of Jakarta City Governor No. 582, 1995

Monitoring Item	Result	Monitoring Method	Location
Eutrophication		Visual inspection	Discharged area

(2)-2 Waste / Soil Pollution

Monitoring Item	Result	Monitoring Method	Location
Waste materials	<u>Amount (this month)</u> <u>Treatment</u> <u>Transport to:</u>	Confirmation of records / Visual inspection	Produced place to where to transport

(2)-3 Noise / Vibration

Item	Measured Value	Country's Standards	Remarks (Measurement Point, Frequency, Method, etc.)
Noise Level		60 dB	Boundary of the Site

Monitoring Item	Monitoring Results during Report Period
Comments and complaints from local residents	

(2)-4 Odor

Monitoring Item	Monitoring Results during Report Period
Comments and complaints from local residents and stakeholders regarding odor	

(2)-5 Accident

Monitoring Item	Monitoring Results during Report Period
Initial operation training by the contractor	

5.8.2 Environmental Check List

Environmental checklist (JICA's format) for this Survey is attached in Table 5.19, 5.20 and 5.21.

Table 5.19 Environmental Checklist (1)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) N (b) N/A (c) N/A (d) N/A	(a) AMDAL documents will be prepared by the Indonesian side and the environmental permit is expected to be granted at the stage of E/S loan. (b) , (c) , (d) *Ditto*
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) N (b) N/A	(a) Holding public consultation meeting is compulsory in AMDAL in accordance with Indonesian regulations. Therefore, the Indonesian side will hold stakeholders' meeting at the stage of E/S loan. (b) The comments put forward at the meetings will be reflected in the detailed design.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) They are mentioned in this report.
2 Pollution Control	(1) Water Quality	(a) Do pollutants, such as SS, BOD, COD, pH contained in treated effluent from a sewage treatment plant comply with the country's effluent standards? (b) Does untreated water contain heavy metals?	(a) Y (b) N/A	(a) Design values are set based on Indonesian standards. (b) Heavy metal contamination is not expected.
	(2) Wastes	(a) Are wastes, such as sludge generated by the facility operations properly treated and disposed of in accordance with the country's standards?	(a) Y	(a) Sludge will be treated at the dewatering facility to be constructed at the WWTP and disposed at the designated disposal sites.
	(3) Soil Contamination	(a) If wastes, such as sludge are suspected to contain heavy metals, are adequate measures taken to prevent contamination of soil and groundwater by leachates from the wastes?	(a) N/A	(a) Heavy metal contaimination is not expected.
	(4) Noise and Vibration	(a) Do noise and vibrations generated from the facilities, such as sludge treatment facilities and pumping stations comply with the country's standards?	(a) Y	(a) Potential noise sources above ground will be installed in RC structures. If further reduction is required, necessity of sound hood silencer and soundproof walls for sound insulation will be considered.
	(5) Odor	(a) Are adequate control measures taken for odor sources, such as sludge treatment facilities?	(a) Y	(a) Odor reduction facilities will be designed because the site is next to a residential area.

Table 5.20 Environmental Checklist (2)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) Pluit reservoir (discharge area) is designated as a protected area by DKI Jakarta. The Project would improve the environmental conditions in the area.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Is there a possibility that the project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms?	(a) N (b) N (c) N/A (d) N	(a) & (b) No protected area or valuable habitats exist in or near the site. (c) N/A (d) The objective of the Project is to improve water environment.
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Is the compensations going to be paid prior to the resettlement? (e) Is the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a) N (b) N (c) N (d) N (e) N (f) N (g) N (h) N (i) N (j) N	(a), (b), (c), (d), (e), (f), (g), (h), (i) & (j) Involuntary resettlement is not expected in this Project.
	(2) Living and Livelihood	(a) Is there a possibility that changes in land uses and water uses due to the project will adversely affect the living conditions of inhabitants? (b) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary?	(a) N (b) Y	(a) The Project will contribute to improved hygiene and public health. (b) Adverse impacts to residential livings are not expected in this Project.

Table 5.21 Environmental Checklist (3)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4 Social Environment	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) No cultural heritage exists in or near the Project site.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) No project component will affect the landscape.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to lands and resources respected?	(a) N (b) N	(a) & (b) No ethnic minorities or indigenous peoples live in or near the Project site.
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(a) Y (b) Y (c) Y (d) Y	(a), (b), (c) & (d) Safety aspects will be fully considered in the detailed design. Additionally, education programs will be carried out by the contractor to improve the workers' awareness of safety and health conditions.
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts? (d) If the construction activities might cause traffic congestion, are adequate measures considered to reduce such impacts?	(a) Y (b) N (c) N (d) Y	(a) They are mentioned in this report. (b) & (c) The Project will not cause significant adverse impact on natural and social environments. (d) Progressive application of pipe jacking method and detailed examination of the construction schedule would mitigate the impact on traffic. Information on the construction activities would be disclosed to public through mass media on a timely basis. Additionally, public consultation with the residents would be held.
	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) Y (c) Y (d) Y	(a), (b), (c) & (d) Monitoring system will be established in AMDAL study based on this F/S survey.
6 Note	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) N	The impacts to transboundary or global issues are not expected.

CHAPTER 6 SEMINARS AND WORKSHOP ON PIPE JACKING TECHNOLOGY IN JAKARTA AND JAPAN

6.1 General

Two seminars and one workshop on pipe jacking technology were held in Jakarta and in Japan.

The first seminar focused on technical information regarding the selection of pipeline construction method, sewer design, construction management and quality control standards. The second seminar provided supplemental information on the previous discussions and arrived at suggestions for the Pilot Project.

The workshop in Japan covered the following topics:
i) Case study on the applicability of the pipe jacking method for the Pilot Project.
ii) Step-wise sewer development strategy utilizing existing drainage.
iii) Institutional framework for managing sewer and storm-water drainage systems and WWTP.
iv) Tariff system and sewerage management.
v) Legislations for sewerage connections and sewer use bylaws in the urban development plan.

6.2 Seminars in Jakarta

6.2.1 First Seminar

The first seminar was held at Cipta Karya on the 3rd of June 2014. The seminar program is shown in Table 6.1.

Table 6.1 Program for the First Seminar in Jakarta

No.	Time	Program	Speaker
1	9:00 ～ 9:15	Opening Remarks	Director of DGHS, and Representatives from JICA and MLIT
2	9:15 ～ 10:05 10:05 ～ 10:20	1) Step-wised Sewer Development learned from Overseas Experience in View Points of Project Programming and Financial Operation Questions and Answers	JICA Study Team member
	10:20 ～ 10:30	Coffee break	
3	10:30 ～ 11:00 11:00 ～ 11:15	2) Optimal Approach for Promoting Sewerage Projects～Kitakyushu's Experience & Know-how～ Questions and Answers	Kitakyushu City representative
4	11:15 ～ 12:05 12:05 ～ 12:30	3) Pipe Jacking (Micro-tunneling), Shaft Construction Methods, and Sewer Alignment and Profile of the Pilot Project Questions and Answers	JICA Study Team member
5	12:30 ～ 12:40	Closing Remarks	Deputy Director

Source: JICA Study Team

The 50 participants were from PU, DKI Jakarata, PD Pal Jaya and other related organizations.

The areas of discussion on each topic are summarized below:

1) "Step-wised Sewer Development learned from Overseas Experience in View Points of Project Programming and Financial Operation" (Project Implementation Planning and Financial Management in Overseas Sewer Development)

Q: Explain examples of storm-water management strategies in other countries and the associated costs.

A: The team explained that

a) the interceptor sewer system will mitigate inundation problems. For example since the interceptor sewer system in Ho Chi Minh city has twice capacity of design average daily flow, the inundation problem is mitigated somewhat;

b) it was difficult to inform the cost for storm-water management now because there are so many different kinds of storm-water management measures and the cost is covered by public expenses; and

c) the step-wise sewer development and implement schedule were proposed in the PPP F/S.

It was also stated that a) the storm-water management is needed for slum areas and b) the interceptor sewer system could solve storm-water drainage in slum areas (DKI Jakarta) and c) the separate sewer system should be applied to other areas (PD PAL JAYA).

2) Optimal Approach for Promoting Sewerage Projects

Q: Is the plan of pipe installation at 28m below from the ground surface appropriate? Such deep installation of sewers are practiced in other countries or are there any measures to install the sewer at smaller depth?

A: Representative of Kitakyushu replied that wastewater is conveyed by gravity flow in principle, the wastewater is pumped up intermittently at some intermediate pumping stations and finally reached to WWTP. But as the pipe installation technology is developed, the sewers can be installed at deeper position, then the wastewater is conveyed by gravity flow to WWTP then finally pumped up within the WWTP. This practice increases. In Kitakyushu city, the sewers were installed at shallow depth with construction of intermediate pumping stations in the initial development stage. But in improvement plans and projects, because of difficulties in obtaining appropriate land space for pumping stations, the sewers have been installed at deeper position by one of the latest micro-tunneling technologies, and a pumping station at WWTP pumps up the wastewater finally for treatment. In Jakarta, the trunk sewers are planned to be installed along main roads where the traffic is heavy, appropriate land spaces for intermediate pumping stations are difficult to obtain along the route, therefore, the trunk sewers are planned to install at deeper positon without any intermediate pumping station until the WWTP.

In addition it was commented that sharing of Kitakyushu City's knowledge and experiences on sewerage development and O&M are useful and relevant to DKI Jakarta.

3) Pipe Jacking (Micro-tunneling), Shaft Construction Methods, and Sewer Alignment and Profile of the Pilot Project

The following comments were provided:

- ✓ Need a confirmation on ownership of land right when sewers are planned under private properties. According to DKI Jakarta regulations, the land owner has the land right to GL -10 m, beyond which the right belongs to DKI Jakarta.
- ✓ Cost of curved micro-tunneling may expensive when straight alignment is not possible.
- ✓ Potential damages to houses near the site of vertical shaft construction.
- ✓ Public outreach to inform nearby residents of the project.
- ✓ Confirm that the Indonesian government will pay the expenses for conducting the work required to address environmental concerns related to the Pilot Project.

6.2.2 Second Seminar

The second seminar in Jakarta was held as a joint seminar with the "Sanitation and Urban Drainage Working Group for the 2nd High Level Meeting on Infrastructure Development" from 13:30 to 16:30 at the 7th floor meeting room of Cipta Karya on 26th of November, 2014. The agenda of the seminar was as follows:

1) Opening Remarks (a PU representative and a MLIT representative).
2) "Acceleration on Jakarta Sewerage System Improvement", presented by the director of DGHS, PU.
3) "Trunk Sewers, the Wastewater Treatment Plant and the Pilot Project for Zone-1", presented by the team leader of JICA Study Team.
4) "Step-wised Sewer Development learned from Overseas Experience in View Points of Project Programming and Financial Operation", presented by the team member of JICA Study Team.
5) "Establishment of Implementation Systems and Development of Human Resources for Sustainable Sewerage Projects", by the chief executive of Water and Sewer Bureau, City of Kitakyushu.
6) Discussions
7) Closing Remarks (the PU representative and the MLIT representative).

About 70 persons participated in the seminar from PU, BAPPENAS, DKI Jakarata, PD Pal Jaya, University, JICA Indonesia, JICA Study Team and other related organizations.

The main points of discussion are summarized below:

1) Influent wastewater quality

Q: Considering the wastewater will be collected by separate sewer system ultimately, the design influent BOD_5 concentration should be set higher than 120 mg/L. Is it necessary to justify the design influent BOD_5 concentration of 120 mg/L?

A: The team explained:

a) the measured influent BOD_5 concentration at the Setia Budi WWTP was 120 mg/L in average and ranging from 70 to 150 mg/L;

b) the influent BOD_5 concentrations at WWTP in the neighboring countries are ranging from 100 to 150 mg/L;

c) the design influent BOD_5 concentration affects the capacity of aeration tanks and of related equipment and causes an increase in investment and running costs; and finally

d) it would be possible for the project ordering party to change the design BOD_5 concentration and the wastewater treatment method from the proposed MBR to other method, if the design figures were secured and the facilities were able to be constructed at the site.

2) Step-wise sewer development

Q: It was commented that the separate sewer system should apply to the commercial areas.

A: The team explained that:

a) buildings along main streets where the sewer mains and trunk sewers would be installed could be connected to the those sewers directly; and

b) the interceptor sewer system was proposed to apply to areas where individual house connections were difficult technically or would need much time to be installed.

3) Status of sewerage development in Zone-1 and Zone-6 in Jakarta

Q: Is it possible to confirm the following points ?

a) the sewerage development projects for Zone-1 and Zone-6 are priority projects and would be implemented with government budgets. It is understand that the Indonesian governments are studying that the sewerage project in Zone-1 would be implemented by a foreign loan and a PPP scheme. This policy in the implementation has not been changed or not?

b) the presentation indicated that the implementation of sewerage development project for Zone-6 was also accelerated. Kindly provide the information on the projects implementation schedule.

A: The Director explained that

a) the sewerage development projects for Zone-1 and Zone-6 are priority projects and would be implemented with foreign loans;

b) the construction plan of WWTP for Zone-1 by PPP scheme are still being study; and

c) DKI Jakarta expects that the WWTP construction by PPP scheme due to accelerate the sewerage development.

A: The present of PD PAL JAYA provided additional information that DKI Jakarta had an idea that the implementation of sewerage projects of Zone-6 would be started during the implementation sewerage project of Zone-1.

From the floor, it was expressed that the construction of WWTP for Zone-1 by PPP scheme are studied by PPP scheme as the engineering services of E-S Loan for the sewerage development project of Zone-1.

4) Two-phased construction plan of wastewater treatment facilities
Q: Why the civil and architectural work is not proposed in the two-phased construction plan?

A: Team explained that the civil and architectural work are implemented at the first phase but the mechanical and electrical work with control equipment would be implemented into two phases; at each phase the equipment having half of the design capacity would be installed. The second phase was assumed to be started 7 to 8 years after the commissioning year of the first phase project.

Team also explained that the reasons why the civil and architectural works were constructed at the first phase project were: a) the civil and architectural works should be constructed within a very limited area, b) the construction works would be easier and cheaper to complete at the first phase project.

5) Groundwater Inflow and Infiltration Estimation
Q: The pipe design calculation sheet seemed not to count the groundwater inflow and infiltration (I/I).

A: Team explained that the groundwater I/I was already considered in the calculation of unit wastewater generation rate in which the per capita water consumption rate was assumed to be equal to the per capita wastewater generation rate. But actually all of consumed water should not be discharged as wastewater, therefore the balance could be counted as the groundwater I/I.

Additional explanation on this issue is provided as follows: The unit wastewater generation rate is set at 200 liter per capita per day (lpcd) based on the unit water supply volume of 200 lpcd. This assumed that all water supplied becomes wastewater and the wastewater is discharged to public sewer network. But in actual situations, some portion of the water supplied is used for gardening etc., in such case the water used is not discharged to the public sewer network. The rate is assumed to be about 20%, then 40 lpcd (=200lpcd x 0.20) is counted as the groundwater I/I, and expressed as about 25% (=40/160) of wastewater generation. The groundwater I/I, about 10 to 20% to design maximum daily flow, is generally considered in the separate sewer plans in Japan. Considering the groundwater level is high in Jakarta Zone-1, the rate 25% of groundwater I/I to wastewater generation would be sound.

6.3 Workshop in Japan

6.3.1 Report on the Workshop

(1) Participants

Eight Indonesian officials participated at the workshop in Japan. They are key personnel from the organizations involved in the Pilot Project and the sewerage system development in Jakarta.

Table 6.2 Indonesian Participants to Workshop in Japan

No.	Organization	Position	Name
1	Directorate General of Human Settlements, Ministry of Public Works and People's Housing	Director of Environmental Sanitation Development (PLP)	Muhammad Maliki Moersid (Mr.)
2	- ditto -	Sub-Director of Environmental Sanitation Development (PLP)	Emah Sudjimah (Ms.)
3	- ditto -	Head of Sub-directorate Foreign Cooperation, Sub-director Bina Program	Dwityo Akoro Soeranto (Mr.)
4	- ditto -	Head of Implementation Unit of PLP Jabodetabek	Anthonius Pongsilurang (Mr.)
5	PD PAL Jaya	President Director	Yudi Indardo (Mr.)
6	PD PAL Jaya	Director of Technical and Business Division	Junifer Panjaitan (Mr.)
7	BAPPEDA, DKI Jakarta	Staff of City Infrastructure Facilities and Environmental Division	Fadley Haley Tanjung (Mr.)
8	Dinas PU, DKI Jakarta	Staff of Planning on Natural Resources Management Division	Sarah Dewi Yani (Ms.)

Source: JICA Study Team

(2) Program and Schedule

The workshop was organized with the assistance from and coordination among the following organizations: Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Kitakyushu city, and Japan Micro-tunneling Association, Akashi city, and contractors and manufacturers of pipe jacking technology in Japan. The program and schedule of the workshop is shown in Table 6.3.

Table 6.3 Program and Schedule of Workshop in Japan

Date		Program	Venue
Aug. 24	Sun.	Travel: Jakarta ⇒ Kitakyushu	—
25	Mon.	Arrive at Kitakyushu PM: Micro-tunneling Technology, construction site visit.	Kitakyushu
26	Tue.	AM: Session on Sewerage System Development Experience. Courtesy Call on the Mayor of the City of Kitakyushu. PM: Site visits to the Hiagaru WWTP and Water Plaza for water environment.	Kitakyushu
27	Wed.	AM: Kitakyushu ⇒ Akashi City PM: Session on Micro-tunneling Technology, construction site visit.	Osaka
28	Thu.	AM: Session on Micro-tunneling Technology, factory visit. PM: Site visits in Osaka.	Osaka
29	Fri.	Travel from Osaka to Jakarta	(Flight)

Source: JICA Study Team

6.3.2 Program in Kitakyushu City

(1) Session on Sewerage System Development Experience. Special Conference Room B, 15th Floor, City Hall of Kitakyushu August 26, 2014.

The session started with keynote speeches and presentations on technical issues. The 15 participants were from the following organizations:

1) Indonesian side: Ministry of Public Works and People's Housing (PU), DKI Jakarta, and PD PAL JAYA.
2) Japanese side: Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Water and Sewer Bureau of City of Kitakyushu, JICA and JICA Study Team.

Table 6.4 shows the agenda for this session.

Table 6.4 Kitakyushu Session on Sewerage System Development Experience

Time Schedule	Program
8:45 ～ 8:50	Introduction of participants.
8:50 ～ 9:05	Welcome speech by MLIT, City of Kitakyushu and JICA.
9:05 ～ 9:25	1) Keynote speech by MLIT - Outline of Sewerage Works in Japan.
9:25 ～ 9:35	2) Keynote speech by PU - Policy and Strategy of Sewerage Development in Indonesia.
9:35 ～ 9:50	3) Presentation by DKI Jakarta - Sewerage Development in DKI Jakarta.
9:50 ～ 10:10	4) Presentation by Water and Sewer Bureau of City of Kitakyushu - City of Kitakyushu's Experience on Wastewater Management.
10:10 ～ 10:40	Questions and Answers
10:45 ～ 11:00	Courtesy call on the Mayor of Kitakyushu.

11:05 ～ 11:45	Discussions.

Source: JICA Study Team

The presentations are summarized in the following:

1) Outline of Sewerage Works in Japan

- Based on practices and experience of Tokyo and Osaka.
- Roles and responsibilities of central and local governments.
- Capital investment and time required for sewerage development.
- Human resources and capacity development.

2) Policy and Strategy of Sewerage Development in Indonesia

The national intermediate-term (2015-2019) development program is under preparation. The national long-term (2005-2025) development plan sets the goal on access to safe drinking water and improved sanitation facilities by 2019. Over the last 5 years, a working group on water and sanitation was established with representation from 33 states and more than 400 cites, and the urban sanitation strategy was formulated for 444 cities. The five key issues for the Indonesian governments are:

i) improve access to sanitation services,

ii) increase collaboration and partnership between the public and private sectors,

iii) improve laws and regulations for wastewater management by local governments,

iv) capacity building in local governments, and

v) capacity building in financial and budget management required for sanitation facilities development.

The promotion of sanitation facilities development must also be supported by relevant laws and regulations and improvement in monitoring and evaluation of sewerage projects.

Figure 6.1 Indonesian Participants to the Workshop Session in Kitakyushu City

3) Sewerage Development in DKI Jakarta

The problems related to off-site systems are:
i) lack of appropriate construction sites for WWTPs,
ii) lack of budget,
iii) lack of cooperation and contribution among concerned organizations.

Problems related to on-site systems are:
i) not having an appropriate user fee system,
ii) lack of standards in operation and management,
iii) lack of capability in monitoring,
iv) design and operation of the septic tanks not meeting the standards.

The following issues are identified with regards to Zone-1 sewerage development:
i) financial viability,
ii) WWTP construction under PPP scheme,
iii) user fee collection for the interceptor sewer system,
iv) cooperation among concerned organizations,
v) public understanding of the sewerage development, and
vi) meeting the challenge of 75% pollution reduction goal set by the National Capital Integrated Coastal Development (NCICD).

4) City of Kitakyushu's Experience on Wastewater Management

Kitakyushu shared the city's experience with urban developments, budget preparation, sustainable management, public outreach on better understanding of the sewerage development efforts.

(2) Site Visits

The sites visited in Kitakyushu City and the respective subject of interest are as follows:

1) Mizukankyokan, Environmental Museum of Water located in the urban area along Murasaki River. Public relations.
2) Kitamati No.1, diversion chamber, structures and functions of diversion chambers. Example of interceptor sewer system.
3) Hiagaru WWTP. Wastewater and sludge treatment facilities and the use of natural energy (solar, wind, and small-scale hydropower).
4) Water Plaza. Demonstration plant for advanced wastewater treatment technologies using membranes.
5) Construction site of the storm-water drainage system using the pipe jacking method.

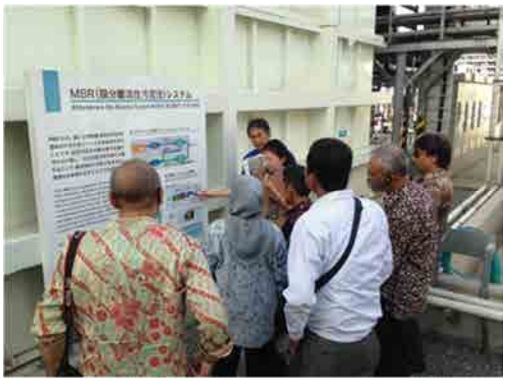
	
Inside of Kitamati No.1, diversion chamber	"Water Plaza" in the Hiagaru WWTP
	
Demonstration plant of MBR method at "Water Plaza"	Enjoyed beautiful water front along Murasaki River

Figure 6.2 Site Visits in Kitakyushu City

6.3.3 Visits to Site of Sewer Installation Using Pipe Jacking and Pipe Jacking Equipment Factory

After the Kitakyushu workshop session, all members except the Director of DGHS, Mr. Maliki, travelled to Akashi City and Osaka to visit the sewer installation work site and a manufacturer of pipe jacking machine. The following are pictures on these visits.

(1) Long distance and curved pipe jacking (micro-tunneling) installation of 2000 mm diameter and 406 m long storm-water drainage pipe.

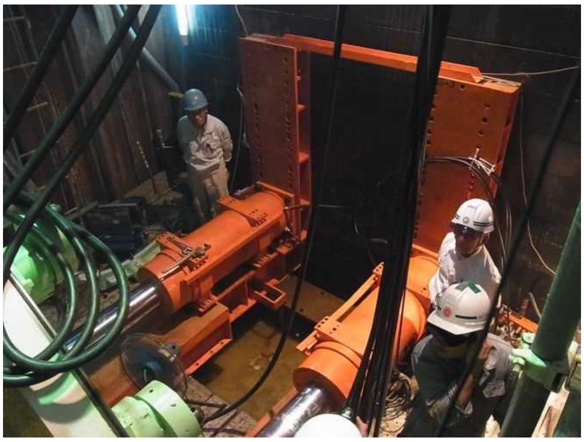
	
Briefing on pipe installation.	Assembling shied-machine (hybrid type)
	
Pipe jacking machines installed at the departure shaft, the installation to start very soon.	Hydraulic cylinder set to the wall of vertical shaft.

Figure 6.3 Visit to Site of Pipe Installation by Micro-tunneling Method in Akashi City

(2) Factory visit - assembling of micro-tunneling machines and maintenance services for the machines.

	
The jacking machine was put into operation to explain the mechanical structure.	Assembling new pipe jacking machine.
	
Visit to the stock-yard for pipe jacking equipment.	Participants appeared satisfied with the visit to the factory, staying more than two hours.

Figure 6.4 Visit to Micro-tunneling Equipment Factory

CHAPTER 7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

The supplemental study updated the Zone-1 sewerage plan which was outlined in the "PPP F/S" as a step-wise sewerage development with an interceptor sewer system and the construction of the WWTP at the proposed Pejagalan site.

1) The trunk sewer route was revised because the site for the construction of the WWTP was changed from the Pejagalan site to the Pluit storm-water reservoir area for better flood control. Reconnaissance surveys were conducted along the sewer routes to check for suitable conditions for construction by micro-tunneling. The design flows for the sewers were reviewed and revised. The profile drawings of all trunk sewers were updated based on the levelling survey results, and the invert levels were checked and determined.

2) As a pilot project, the Indonesian governments would construct 1 km of trunk sewer from the receiving point of the WWTP. Pipe installation involves the construction of three vertical shafts and micro-tunneling. Pre-qualification and tender documents were prepared and submitted to the Indonesian Ministry of Public Works and People's Housing.

3) The Pluit site for the construction of the WWTP was carefully evaluated from technical, environmental and social perspectives.

- Technical constraints: The construction of the WWTP will take into consideration the geotechnical survey finding that the surface layer is made up of 16 to 17 m of soft soil. In case of open cut excavation, the appropriate side slope will be based on survey findings as well as the dewatering strategy, with special attention to the nearby roads and houses. Dewatering is also important when planning for the construction of retaining walls. Pile instead of spread foundation would be used for all structures except the inflow pumping station building which would be constructed to meet the invert level of the inlet pipe. The piles would be driven beyond 17 m to reach the load bearing stratum.
  The available area for the construction of the WWTP at the Pluit site is only about 3.9 ha. Only the treatment facilities in the MBR process could be accommodated within the area. Multi-storied facilities would be required for the CAS and MBBR methods which would increase significantly the construction and O&M costs.
- Environmental and social factors: Noise and vibration during the construction and operation stages and offensive odor during the operation stage may be a nuisance to nearby residents. A monitoring program for noise, vibration and offensive odor would be implemented so that appropriate mitigation measures can be taken on a timely basis. Measures to prevent the spread of offensive odor outside of the treatment plant are incorporated in the preliminary design and the cost estimation. The Pluit site is officially a park, owned by PT Jakarta Propertindo but was illegally occupied from 2011 to 2013. After flooding occurred, DKI Jakarta developed the area near the Pluit

storm-water reservoir as the park and the land owner resettled the occupiers away from the site in an appropriate manner and promoted to use the site as a park.

The Pluit site is deemed appropriate for the construction of the WWTP.

4) The preparation for the implementation of an interceptor sewer system using exiting drainage channels includes the following tasks.

- Surveys to gather preliminary information on the existing drainage system and to confirm the methodology for integrating with the overall sewerage system.
- Consideration of manual and automatic flap gates, small pumping stations, and diversion facilities to be used in the existing drainage system.
- Review of the use of interceptor sewer systems in other Asian countries and high pollutant removal and cost saving efficiencies of interceptor sewerage system.
- Review of sewerage tariff systems in other Asian countries, to obtain the financial resources for operation and maintenance of the sewerage system.

5) Layout plans of three wastewater treatment methods (CAS, MBBR, and MBR) are prepared for the Pluit site of about 3.9 ha. The MBR process is selected as the most appropriate wastewater treatment method within the site. The preliminary design and cost estimation including capital, replacement and O&M costs for the MBR process are prepared and presented.

7.2 Recommendations

1) About one km of 2,000 mm diameter trunk sewers from the vertical shaft at the site of WWTP would be installed at about 28 m depth, because there is no available land upstream for pumping stations. The trunk sewers includes the construction of the 680 m section of the sewer that has a curved alignment between two vertical shafts. The micro-tunneling technology for long and curved alignment is recommended as the most promising pipe installation method of trunk sewers in Zone-1 sewerage plan and other zone plans in DKI Jakarta.

2) Sewerage development would be implemented in a step-wise manner. Trunk sewers would be developed at the beginning stage, followed by lateral sewers and house connections. The merits of this approach are as follows:

- The top-priority of increasing sewerage coverage and reducing pollution load can be achieved effectively and efficiently;
- Traffic congestion caused by sewer construction work would be minimized; and
- Coordination with privately funded redevelopment plans will promote connection of large commercial establishments to the public sewerage system. This would enhance the separate sewer development.

3) The preliminary design and project cost estimation for the construction at the Pluit site should be used for studying the feasibility of the WWTP construction project.

4) Following the strengthening of and improvement made to the Indonesian project executive agencies and legal system, the following should be implemented:

- Establishment of appropriate management frameworks for the operation and maintenance of sewers and WWTP;
- Build-up of adequate human resources and organizational capacity for the development of lateral sewers and house connections;
- Raising public awareness of the environmental improvement as a result of public sewer connections, the necessity of public sewer connections, and the concept of cost burden of the sewerage system; and
- Sewerage tariff system.